AUTHENTICATION MECHANISMS IN PUBLIC PAYMENT SYSTEMS: CHALLENGES AND SOLUTIONS

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ABSTRACT

Public Payment Systems (PPS) are characterized with numerous security challenges for all major players involved. These major players include: the Card Holder, the Issuer, the Merchant and the Acquirer. Public payment platforms combine different complex systems in its environment, this make them prime target for fraudsters. Review of the critical components of public payment system would help in understanding the payment system cycle, processes and transactional flow with more emphasis on their security models and authentication mechanisms. This further leads to a critical understanding of the gaps that bring about challenges in the system, and the provision of necessary solutions.

Keywords*: Public Payment System, Electronic payment, Authentication, Biometrics Cashless transactions and Fingerprint Authentication.*

1. INTRODUCTION

Public Payment System (PPS) has become a vital part of human activities on a regular basis (Solat, 2017). It serves as a means of settling payment for services rendered, goods purchased and any other form of transaction where monetary value is exchanged. The era of cash payment is far behind us due to challenges such as money theft, transporting large sum of money needed for a transaction and stress of queuing up to get cash from the over crowded banking halls (Sullivan, 2008). The Federal Government of Nigeria through the apex financial Institution, Central Bank of Nigeria (CBN) recently implemented a nationwide cashless society policy.

The challenges sighted above has given birth to the concept of cashless society. This is an easier and convenient payment system otherwise known as electronic cash (e-cash), which can be transacted anywhere regardless of the geographical location of the parties involved. There are different platforms for carrying out e-cash transactions, from online payment, Internet banking, Terminal payment via Automated Teller Machine (ATM), Point of System (POS) systems and most recently Near Field Communication (NFC) payment systems (Usman & Ishola, 2017).

The security of PPS has always been scrutinized due to the numerous loopholes. Such loopholes allow fraudsters to take advantage and defraud customers. Some of

this security challenges cut across all the various available PPS platforms (Sullivan, 2008).

2. PUBLIC PAYMENT SYSTEMS

The conduct of cashless transactions requires an electronic payment platform for execution. With the diverse transaction dynamics that exist in this present age, where we have card holder (Individual) to card holder (Individual) transaction, card holder to Issuer transaction and card holder to merchant transaction to mention a few (Terán, Horst, Valencia & Rodriguez, 2016). A robust platform is required to carry out these transactions electronically.

Some of these public payment platforms include; online payment via Internet, POS payment as seen mostly in retail shops, ATM payments and most recently NFC payment platform. This section takes a look at these payment platforms to examine the security provided and challenges encountered.

2.1 Online Payment System

Online payment platform gives card holder the opportunity to carry out cashless transaction from the comfort of their homes, offices or anywhere they have Internet connection and mostly carried out nowadays with Internet connected mobile phones. This has improved tremendously and helped with e-commerce (Mohamadi & Ranjbaran, 2013).

This payment platform represents a Card Holder not Present (CNP) transaction as merchant cannot verify the person making the transaction nor sight the payment card being used. As long as the payment information passes the security checks put in place, the transaction is executed regardless of if the card holder is aware of the transaction or not (Teran et al., 2016).

Fraudsters take advantage of CNP platforms like the online system to perpetuate financial fraud using stolen credit cards, stealing cardholder data using social engineering and other sophisticated methods. This allows purchase to be made from genuine merchant using someone else's payment details, genuine cardholder making payment to a rogue merchants and Man In The Middle (MITM) attacks (Mayes & Markantonakis, 2008).

Jarupunphol & Mitchell (2003) in their review of Three Dimension (3D) secure introduced by Mastercard to help e-commerce (Online Platform) secure the network that transit data. Secure Socket Layer (SSL) and Transport Layer Socket (TLS) are inbuilt web browsers that ensure that cardholder information is not modified during transit. The major disadvantage of SSL/TLS is that it only transmits the data securely but doesn't not provide security for data stored at card holder or merchants browser, and cannot also identify stolen card since it's a CNP transaction.

Zhang, Huang & Peng (2010) in their paper stated that Secure Electronic Transaction (SET) was introduced by Visa and MasterCard as an improvement to

some of the weaknesses associated with SSL/TLS. SET provides confidentiality and integrity but is not widely used due to its complexity and high cost implication to merchant. It also securely stores card holder data in the SET initialized computer, thereby restricting the card holder to only perform transactions using the set up computer.

Murdoch & Anderson (2010) proposed the usage of authentication code via text messages to registered mobile numbers or Chip Authentication Programme (CAP). This represents a stopgap to the security weakness in 3D secured, otherwise known as Verified by Visa or MasterCard secure code used in online payment platform. 3D Secure requires card holder to register and use a password, it's no news that people always use easy to remember password which are usually weak security wise. The use of weak passwords is vulnerable to attacks that can be exploited. Another vulnerability that exist is the Activate during Shopping (ADS) for first time users of the 3-D secure model, the card holders' security usability and trust experience is exploited by criminals, using phishing website to impersonate the ADS form and obtaining customer's bank details.

El Ismaili, Houmani & Madroumi (2015) proposed the use of additional password by card holder during checkout. The password is requested upon completion of a transaction to verify that the card holder is the genuine owner of the card. The authentication process done directly between issuer and card holder using issuer security certificate without involvement of third parties, thus offering an additional layer of protection for both card holder and merchant.

Jayasinghe, Akram, Markantonakis, Rantos & Mayes proposed the enhancement of Europay Mastercard & Visa (EMV) online Personal Identification Number (PIN) verification (OPV) process, that placed indelible trust assumptions on the intermediary entities between a payment terminal and scheme operator. Where the protection of the PIN is premised on a card-based solution with symmetric and asymmetric cryptography. Payment terminal based solution with asymmetric cryptography and binding each OPV with the respective Authorization Request Cryptogram (ARQC). This proposal focuses mainly on the payment network online (Jayasinghe et al., 2015).

2.2 Terminal Payment System

There are two well-known terminal payment platforms used for credit/ debit cards transactions, which are POS and ATM terminals (Teran et al., 2016). Their mode of operation requires a direct contact with a credit/debit card to carry out a transaction; hence they are referred to as contact terminal.

The ATM is a computerized real-time online telecommunication device deployed by most commercials banks across the globe. It enables card holders to withdraw cash, transfer funds, pay for bills such as water bills, electricity bills and a whole lot of other services (Usman & Ishola, 2017). A typical architecture of an ATM as shown in Figure 1 encompasses of a processor, a system clock, a remote database of accounts, and a set of peripheral devices such as the card reader, monitor, keypad, bills storage, and bills disburser (Wang et al., 2012).

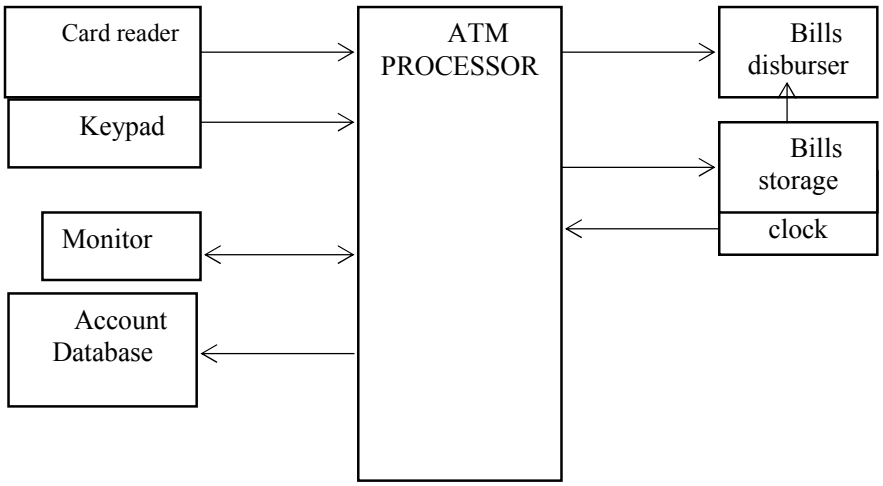


Figure 1: Architecture of ATM System

For operation a credit/debit card must be inserted and the corresponding PIN punctured in correctly. Some of the fraud cases often carried out on this payment system include, card/cash fraud (card skimming, cloning, transaction reversal fraud), fake equipment (fake ATM, card readers and skimming machines) and exposure of PIN (key stroke and shoulder surfing) to mention a few (Shaikh & Shah, 2012).

The survey carried out by Onyesolu & Ezeani (2012) revealed that, bank customers are open to the idea of biometric fingerprint authentication on ATM machines as an addition form of security. They believe it will help reduce fraud, as the biometric fingerprint of a customer is directed linked and non-transferable and also produces non-repudiation if properly implemented.

Krishnamurthy & Redddy implemented biometric authentication on ATM using GSM modem and fingerprint authentication. They relied on the S3C2440 Chip embedded system, where an SMS is sent to customer as authentication code if fingerprint is authenticated by the ATM and then, customer inputs code to complete transaction. Delay in Network communication or downtime from GSM network provider, loss of phones makes this practically impossible to operate (krishnamurthy & Redddy, 2012).

The POS unlike the ATM can only be used to make payment, which goes directly to the account linked with the POS terminal. The mode of operation is similar to that of the ATM, as the credit/debit card has to be inserted into the POS machine and corresponding PIN punctured correctly. However, some POS machines are designed for usage of magnetic stripe cards, where the card is just swiped through and no PIN is required. Security of such is obviously flawed and fraud prone (Ogundele et al., 2012).

The usage of Payment cards at contact terminals (POS & ATM) requires card holders to use their PIN for authentication. This exposes card holders to most well known attacks like Pin Guessing, Key Strokes, social engineering attacks (Bonneau et

al., 2012), shoulder surfing, Dumpster driving (Li & Zhang, 2006) and relay attack (Hancke, 2005).

2.3 Contactless Payment System

CPS is a platform that enables cashless transaction that does not require physical contact between the devices used to execute the payment (Ghosh et al., 2017). The payment card does not need to come in contact with the receiving terminal. However, the devices must be complaint with the International Organization Standard (ISO) 14443 standard, which uses Radio Frequency Identifier (RFID) or NFC for making secure payments. The contactless payment system also relies on the terminal payment system architecture with only a few additional upgrades to the devices utilized (Mayes & Markantonakis, 2008).

Contactless devices contain chips and antenna. This allows for communication between payment devices, as long as the devices are within the proximity range for communication signal. The three major card merchants have begun implementation of contactless payment through the introduction of Visa contactless by Visa, MasterCard Paypass by MasterCard and Express pay by America Express Company (Lacmanovic et al., 2010).

As mentioned earlier, contactless payment system uses the same infrastructure as the contact terminal payment. The major difference is in the mode of operation, as a contactless device needs to be in range of approximately 10cm of a contactless terminal for a secure payment transaction (Mayes & Markantonakis, 2008). Once the communication line is opened, the transaction is completed without the card holder using his/her PIN. Due to the weak form of transaction authentication, a low spending limit of between $20-$100 is usually set on contactless payment cards by most issuers (Sullivan, 2008).

The Introduction of NFC has also provided mobile phones the opportunity of have interfaces, allowing it to act as a smart card reader or to emulate smart cards (Chen et al., 2011). With the increasing popularity of smart handsets, the mobile phone is likely to become the preferred device of choice in accessing sophisticated applications and services in the nearest future.

Currently in Nigeria, usage of NFC devices has been hindered due to poor Internet service network as provided by the telecom industry. Lots of people still rely on the credit/debit cards for transactional purposes.

3. PROTECTION OF PUBLIC PAYMENT SYSTEM

The importance and usage of PPS in a society cannot be over emphasized. It has become an important tool in conducting monetary transactions on a daily basis. With the numerous threats and vulnerabilities associated with PPS as highlighted in previous sections, protection of these PPS is of utmost importance.

Some of the protection mechanisms utilized on PPS include; physical, logical and administrative security. The most common and widely known form of protection in PPS is the use of authentication mechanisms before conclusion of payment transactions.

Authentication is an important aspect in payment transactions. Authentication can be defined as a process of verifying that a claimed identity is authentic, the claimant of an identity is required to provide additional information based on already shared data with the entity verifying the claim (Stewart et al., 2012). They are three major factors generally used for authentication. They are; something a person knows

(knowledge), something a person has (ownership) and something a person is (characteristic). Authentication can be used to achieve verification and identification of an entity.

In relation with terminal payment transactions, authentication plays a major role as a security measure. Authentication with something a person has (ownership), in the form of having possession of a credit/debit card is insecure in a card payment transaction. This form of authentication cannot proof that the person in possession of a payment card is the owner, or that the person is authorized to use the card (Majumder et al., 2017). This relates directly to a major flaw in the current operation of contactless card payment, as transactions are completed without verification of the true identity of the person with the card. Hence, the limit of between $20-$100 placed on contactless card payment (Sullivan, 2008).

The most utilized form of authentication in card payment transaction is the authentication by something a person knows. The knowledge of the 4 digits PIN code attached to a payment card serves as a source of authentication (Rankl & Effing, 2004). It is expected that only the card owner should have knowledge of the correct PIN. However, most well known attacks like Pin Guessing, Key Strokes, social engineering attacks (Bonneau et al., 2012), shoulder surfing, Dumpster driving (Li & Zhang, 2006) have made this form of authentication weak. Also this form of authentication doesn't provide non-repudiation.

Protection of online payment system utilizes security measures such as the used of Token, One-time passwords (OTP) and PIN codes (Jarupunphol & Mitchell, 2003). These mechanisms also share the same vulnerabilities as terminal payment systems. While contactless payment systems like NFC enables mobile devices have gone a step further to introduce the usage of biometrics mode of authentication.

4. DEVELOPING TRENDS IN AUTHENTICATION MECHANISMS

Authentication by something a person is (characteristic) is generally regarded as the most secure form of authentication. Biometric refers to the identification of an individual based of a distinguishing characteristic of the individual (Ratha et al., 2007).

Ideally these distinguishing biometric characteristics could be behavioral or physiological but must have the following qualities. These are robustness, availability, accessibility and distinctiveness (Setiya et al., 2016). Robustness ensures that with time the characteristic doesn't change. Availability is required to ensure that most individuals have this characteristic and it is easily accessible, while most individuals have this particular characteristic, each individual should be uniquely identifiable with that characteristic (Wayman et al., 2005).

The financial industry has started adopting biometric authentication due to the attractive gains envisaged. Its been adopted along side traditional method of authentication in the sector. Fingerprint authentication has been incorporated on ATM transactions (Siddiqui, 2014). The existence of various biometric technologies has been established with usage in different environments. There is a need to evaluate some of the well-known biometric technologies based on some common criteria, to

establish their efficiency, ease of use, acceptance level of users and cost of implementation. Each biometric technology has its advantages and disadvantages, while its suitability for usage depends on the choice of application and the intended security purpose.

Table 1 reflects a comparism analysis of some biometric technologies based on their characteristics in reference to the criteria's used. It is no more a secret that the most widely used form of biometric technology across the world in different environment from Banking, Commercial, access Control down to industrial area is the fingerprint. Its speed, ease of usage and collectability with low cost of implementation and distinctiveness over time makes generally acceptable (Prabhakar et al., 2003).

Table 1: Comparism of Biometric Technologies for Authentication Mechanism

BIOMETRIC CRITERIA	**FINGERPRINT**	**SIGNATURE**	**VOICE**	**RETINA**	**HAND GEOMETRY**	**IRIS**	**FACIAL**
DISTINCTIVENESS	High	Medium	Low	High	Medium	High	Low
PERFOMANCE	High	Low	Low	High	Medium	High	Medium
COLLECTIBILITY	High	High	Medium	High	High	Medium	High
ACCEPTANCE	High	Low	Low	High	Medium	Medium	Low
VULNERABILITY	Low	Medium	High	Low	Low	Low	Medium
IMPEDIMENT	Worn out ridges, Finger impairment	Unstable signature	Loss of voice, Changes due to age	Damage eye	Hand impairment	Visual impairment	Damages to the face
SPEED	High	Medium	Medium	Medium	Medium	Medium	Low
COST OF IMPLEMENTAION	Low	Low	Medium	High	Low	High	High

Mastercard (Siddiqui, 2014) conducted a customer survey in September 2013 with over Three Thousand, Two Hundred and Thirteen (3,213) customers participating. The aim of the survey was to find out customers attitude towards implementation of biometric technology in payment transactions. Biometric technologies proposed include; Eye biometric (Iris, Vein and Retina), Facial recognition, Voice recognition, Palm biometric (Hand geometry and Vein analysis) and Fingerprint biometric, Fingerprint biometric got the highest positive response with 14%, followed by eye biometric with 11%.

Prabhakar at el. (2003) did a comparism of biometric technologies, which included; Fingerprint, Facial, Hand geometry, Iris and voice recognition. It was their opinion that no single biometric technology can meet the requirement of all applications, as they all have their strength and weaknesses. However, they reached a conclusion that both Fingerprint and Iris are more accurate then others, while Fingerprint is more acceptable and utilized across board.

Applicability of a biometric technology could be subjective based on the severity of the application or environment. High security facilities employ the use of expensive equipments and as such, they wont mind a high cost biometric technology like the Retina or Iris. Likewise a telephone company would most likely adopt voice recognition technology based on their need (Siddiqui & Muntjir, 2013). Payment industry like the banking sector rely more on fingerprint technology based on its perceived acceptance by customers, ease of use, collectability, permanent nature, low cost of implementation and low vulnerability (Shaikh & Shah, 2012).

The usage of biometric technology as a means of authentication in the payment system has increased over the past decade, both the research and academic community have contributed significantly in this area. This has reflected enormously in real life scenarios, where the banking industry now utilizes biometric technology as a form of authentication in electronic payment systems.

Ojha introduced a ATM prototype that can be efficiently used with fingerprint authentication, the ATM terminal recognition system relied on chip S3C2440 used for the core microprocessor in ARM9, with Gabor filter algorithm for image enhancement, the fingerprints captured initially were converted to templates, which makes it difficult to reproduce the original fingerprint (Ojha, 2015).

Krishnamurthy & Redddy (2012) implemented an ATM security using fingerprint authentication and Global System for Mobile Communication (GSM). The S3C2440 was used as the core embedded chip for the hardware and linux kernel for software. The system works in such a way that, if a wrong fingerprint match for an account is entered thrice, a notification message is sent to the registered GSM number upon opening of the account. Likewise a notification message is sent upon successful input.

The academic community can be perceived as adopting fingerprint for payment system based on the uniqueness of the fingerprint, ease of collection and use, low cost and general acceptance, some industry implementation of biometric authentication also use fingerprint and some other biometric technology (Ghosh et al., 2017).

5. CONCLUSION

The use of a single form of authentication in PPS like PIN code has been shown to be weak. Combination of at least two different forms of authentication mechanisms in public payment system is the most reliable approach for the future. This also referred to as a strong 2-factor authentication mechanism. This security schemes are applied in series,

whereby is one is broken it does not affect the other and both must be passed to authenticate a transaction.

The combination of PIN codes and fingerprint authentication mechanisms is gradually gaining grounds. It's been deployed in ATM system and POS transactions. Trying to pass-by both authentication schemes would require a lot of time and resources for the attacker, this act as a form of deterrent. The fingerprint is not the most secured biometric form of authentication, but its relatively low cost of deployment and acceptability by users makes it an attractive option.

REFERENCE

Solat, S. (2017). Security of Electronic Payment Systems: A Comprehensive Survey. *arXiv preprint arXiv:1701.04556*.

Sullivan, Richard J (2008). "Can smart cards reduce payments fraud and identity theft?." *Economic Review-Federal Reserve Bank of Kansas City* 93.3 (2008): 35.

Mohamadi, M., & Ranjbaran, T. (2013, April). Effective factors on the success or failure of the online payment systems, focusing on human factors. In *e-Commerce in Developing Countries: With Focus on e-Security (ECDC), 2013 7th Intenational Conference on* (pp. 1-12). IEEE.

Mayes, K., & Markantonakis, K. (2008). *Smart Cards Tokens Security and Applications*. Springer-Verlag.

Jarupunphol, P., & Mitchell, C. J. (2003, June). Measuring 3-D Secure and 3D SET against e-commerce end-user requirements. In *Proceedings of the 8th Collaborative Electronic Commerce Technology and Research Conference* (pp. 51-64).

Usman, M. M., & Ishola, O. B (2017). Implementing a Secured E-Payment Authorisation System Using Two-Factor Authentication (T-FA).

Terán, L., Horst, C., Valencia, B. F., & Rodriguez, P. (2016, March). Public electronic payments: A case study of the electronic cash system in Ecuador. In *eDemocracy & eGovernment (ICEDEG), 2016 Third International Conference on* (pp. 65-70). IEEE.

Zhang, X., Huang, Q., & Peng, P. (2010, May). Implementation of a suggested E-commerce model based on SET protocol. In *Software Engineering Research, Management and Applications (SERA), 2010 Eighth ACIS International Conference on* (pp. 67-73). IEEE.

Murdoch, S. J., & Anderson, R. (2010, January). Verified by visa and mastercard securecode: or, how not to design authentication. In *International Conference on Financial Cryptography and Data Security* (pp. 336-342). Springer Berlin Heidelberg.

Shaikh, A. A., & Shah, S. M. M. (2012). Auto Teller Machine (ATM) Fraud–Case Study of a Commercial Bank in Pakistan. *International Journal of Business and Management*, *7*(22), 100-108.

Jayasinghe, D., Akram, R. N., Markantonakis, K., Rantos, K., & Mayes, K. (2015, August). Enhancing EMV Online PIN Verification. In *Trustcom/BigDataSE/ISPA, 2015 IEEE* (Vol. 1, pp. 808-817). IEEE.

Wang, Y., Zhang, Y., Sheu, P. C. Y., Li, X., & Guo, H. (2012). The formal design model of an automatic teller machine (ATM). In *Breakthroughs in Software Science and Computational Intelligence* (pp. 263-287). IGI Global.

Onyesolu, M. O., & Ezeani, I. M. (2012). ATM security using fingerprint biometric identifer: An investigative study. *International Journal of Advanced Computer science and applications*, *3*(4), 68-72.

El Ismaili, H., Houmani, H., & Madroumi, H. (2015). A Secure Electronic Payment Protocol Design and Implementation. *International Journal of Computer Science and Network Security (IJCSNS)*, *15*(5), 76.

Ogundele, O., Zavarsky, P., Ruhl, R., & Lindskog, D. (2012, June). The implementation of a full emv smartcard for a point-of-sale transaction. In *Internet Security (WorldCIS), 2012 World Congress on* (pp. 28-35). IEEE.

Krishnamurthy, P., & Redddy, M. M. (2012). Implementation of ATM Security by Using Fingerprint recognition and GSM. *International Journal of Electronics Communication and Computer Engineering*, *3*(1).

Hancke, G. P. (2005). A practical relay attack on ISO 14443 proximity cards.*Technical report, University of Cambridge Computer Laboratory*, *59*, 382-385.

Li, Y., & Zhang, X. (2006). Securing credit card transactions with one-time payment scheme. *Electronic Commerce Research and Applications*, *4*(4), 413-426.

Bonneau, J., Preibusch, S., & Anderson, R. (2012). A birthday present every eleven wallets? The security of customer-chosen banking PINs. In *Financial Cryptography and Data Security* (pp. 25-40). Springer Berlin Heidelberg.

Ghosh, S., Majumder, A., Goswami, J., Kumar, A., Mohanty, S. P., & Bhattacharyya, B. K. (2017). Swing-Pay: One Card Meets All User Payment and Identity Needs: A Digital Card Module using NFC and Biometric Authentication for Peer-to-Peer Payment. *IEEE Consumer Electronics Magazine*, *6*(1), 82-93.

Chen, W. D., Mayes, K. E., Lien, Y. H., & Chiu, J. H. (2011, June). NFC mobile payment with citizen digital certificate.In *Next Generation Information*

Technology (ICNIT), 2011 The 2nd International Conference on (pp. 120-126).IEEE.

Lacmanović, I., Radulović, B., & Lacmanović, D. (2010, May). Contactless payment systems based on RFID technology. In *MIPRO, 2010 Proceedings of the 33rd International Convention* (pp. 1114-1119). IEEE.

Stewart, J. M., Chapple, M., & Gibson, D. (2012). *CISSP: Certified Information Systems Security Professional Study Guide*. John Wiley & Sons.

Majumder, A., Goswami, J., Ghosh, S., Shrivastawa, R., Mohanty, S. P., & Bhattacharyya, B. K. Pay-Cloak (2017): A Biometric Back Cover for Smartphone with Tokenization Principle for Cashless Payment.

Ratha, N. K., Chikkerur, S., Connell, J. H., & Bolle, R. M. (2007). Generating cancelable fingerprint templates. *IEEE Transactions on pattern analysis and machine intelligence*, *29*(4).

Rankl, W., & Effing, W. (2004). *Smart card handbook*. John Wiley & Sons.

Setiya, S., & Kant, C. (2016). A Novel Steganographic Approach for Securing Biometric Templates. *International Journal of Advanced Research in Computer Science*, *7*(3).

Wayman, J., Jain, A., Maltoni, D., & Maio, D. (2005). An introduction to biometric authentication systems. *Biometric Systems*, 1-20.

Prabhakar, S., Pankanti, S., & Jain, A. K. (2003). Biometric recognition: Security and privacy concerns. *IEEE security & privacy*, *99*(2), 33-42.

Siddiqui, A. T., & Muntjir, M. (2013). A study of possible biometric solution to curb frauds in ATM transaction. *IJASCSE, November*.

Siddiqui, A. T. (2014, March). Biometrics to control ATM scams: A study. In *Circuit, Power and Computing Technologies (ICCPCT), 2014 International Conference on* (pp. 1598-1602). IEEE.

Ojha, A. K. (2015). ATM Security Using Fingerprint Recognition. *International Journal of Advanced Research in Computer Science and Software Engineering*, *5*(6).

ADOPTION OF SPI IN NIGERIA SOFTWARE HOUSES: A LITERATURE REVIEW

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ABSTRACT

Software as an end product must have qualitative attributes that can be measured, controlled and managed. In Nigeria as a nation of emerging software practitioners, there is a need to examine how software firms are faring in the adoption of Software Process Improvement which is the process geared towards the realization of quality. Hence, this paper presents the review of the extent of the adoption of Software Process Improvement (SPI) in Nigerian software houses. Few studies have been done in measuring the capability and maturity levels of the software processes adopted in Nigeria software houses using various techniques. The findings of this study show that Nigeria software houses are categorized under Level 1 of the capability maturity model integration as reported in the literature using CMM, CMMI and SPICE model majorly.

***Keywords**: maturity model, CMMI, software process, SPI*

1.0 INTRODUCTION

Software as an end product must have qualitative attributes that can be measured, controlled and managed (Saiedian, 2013). For the quality of a product to be enhanced, the process that leads to the realization of the software product must be improved upon. Hence the need for Software Process Improvement (SPI) suffices so as to formally enhance software processes. SPI incorporates a set of activities that will lead to a better software process and consequently better quality software delivered within a desired budgeted time and resources. There are diverse arrays of frameworks in existence to implement SPI in software firms. Some of the frameworks according to (Pressman, 2010) include but not limited to Capability Maturity Model (CMM), Capability Maturity Model Integrated (CMMI), TickIt, Bootstrap, ISO, SPICE and Trillium.

The economic crisis, competitiveness and customer pressure has led software companies to reassess the way they develop their software (Sowunmi, Misra, Sanz, Crawford, & Soto, 2016). Their focus has shifted from technology to process in a bid to improve their performance and productivity. As a result, more effort is done in adopting SPI initiatives in order to improve the efficiency and the effectiveness of their software processes.

In Nigeria as a nation of emerging software practitioners, there is a need to examine how the software firms are faring in the adoption of SPI. In Nigeria, report has it that 10% of software products in use are built locally while the remaining 90% are imported from countries such as India (Harmonization, 2012). A veritable rationale for this might be as a result of failure of local developers to produce quality products. Conforming to the customer's requirements and how the product delivers the intending specifications/requirements coupled with the number of defects in it determines the quality of the software product. Consequently, a need for the assessment of the software development practices in indigenous companies in Nigeria with a view to formally identify the cause of its low patronage and recommend possible solutions to move the local industry forward is the motivation for this study.

Few studies have been done to measure the capability and maturity levels of Nigeria software houses using some of the maturity models. The results of all these findings have shown that Nigeria software houses are in Level 1 of the maturity models used for their assessment.

It is crucial to state that few studies have been carried out to review quality practices in Nigeria software houses but nothing in particular is done to review practices in software houses based on the premises of Software Process Improvement (SPI). This is the motivation for this work.

This paper presents a review of the studies that have examined the maturity level of Nigerian software houses. The methodology applied in this review is the empirical analysis of all the related works in the maturity and capability determinations of Nigeria software organization.

The remaining part of this paper is organized as follows. Section 2 presents the theoretical background of SPI and the various maturity models that have been applied to software process assessment. Section 3 discusses the studies that have been done to evaluate Nigerian software houses using various maturity models. Section 4 draws a conclusion and present the future work of this study.

2.0 SOFTWARE PROCESS IMPROVEMENT AND MATURITY MODELS

This section present a theoretical review of SPI and maturity models.

2.1 Software Quality

Garvin (1984) submits that "quality is a complex and multifaceted concept" that can be viewed from five different perspectives:

i) The *transcendental view* argues that quality is something that can be proximately identify and cannot be unambiguously described.
ii) The *user view* sees quality as an end user's specific goals. If a product conform to those goals, it reveals quality.
iii) The *manufacturer's view* defines quality in terms of the imaginative requirement of the product. If the product obeys the requirement, it portrays quality.
iv) The *product view* suggests that quality can be knotted to inherent features (e.g., functions and features) of a product.

v) The *value-based view* measures quality based on willingness of a customer to pay for a product, no matter what the price holds.

In reality, quality incorporates all of these views and more.

Glass contends that quality is germane and if the user is not pleased, nothing else really matters. DeMarco (Post & Kendall, 2004) strengthens this view when he stated that: "A product's quality is a function of how much it changes the world for the better." This view of quality stresses that if a software product provides extensive values to its end users, they may be willing to endure infrequent reliability or performance hitches.

According to Crosby (2001) quality has to be defined as:

i) Conformance to specification, and not goodness.
ii) Quality stems from prevention, and not detection.
iii) The quality performance standard is zero flaws, and not satisfactory quality ranks.
iv) Quality is examined by the price of nonconformance, not by keys.

During the engineering process, measurements must intermittently be taken to check the conformity to managerial requirements such as measurement model; project tracking and oversight; validation criteria; quality assurance system; and plans and commitment to improvement. Requirements must be evidently detailed such that they cannot be misconstrued. They must be complete; unambiguous; verifiable; precise; concise; consistent (Saiedian, 2013).

2.2 Software Process Improvement

SPI indicates many things (Pressman, 2010):

i) Firstly, it implies that essentials of an operative software process can be defined in an operative manner;
ii) secondly, that the current organizational approach to software development can be judged against the defined elements; and
iii) thirdly, that an expressive strategy for improvement can be well-defined.

Although an organization can choose a relatively informal approach to SPI, the vast majority choose one of a number of formally defined SPI frameworks. An SPI framework defines: (1) a set of features that must be existing if an effective software process is to be accomplished, (2) a method for assessing whether those feature are existing, (3) an instrument for summarizing the results of any assessment, and (4) a strategy for assisting a software organization in effecting those process features that have been found to be weak or non-existing.

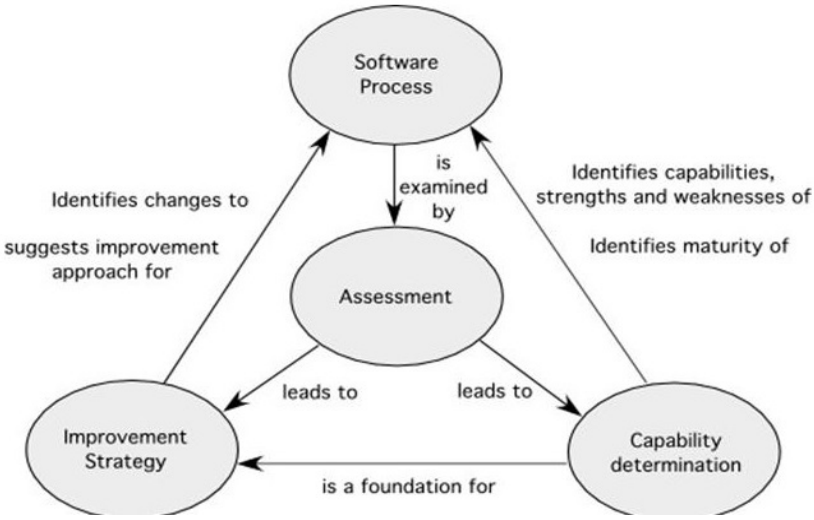


Figure 1. Elements of an SPI framework (Pressman, 2010)

Figure 1 depicts the elements that make up and SPI framework. An SPI framework assesses the "maturity" of an organization's software process and provides a qualitative indication of a maturity level. In fact, the term "maturity model" is often applied. In essence, the SPI framework embraces a maturity model that in turn incorporates a set of process quality indicators that provide an overall measure of the process quality that will lead to product quality. The application of SPI requires the organization or body conducting the assessment to:

i) ensure technology transition,
ii) determine the degree to which an organization is ready to welcome process changes that are proposed, and
iii) measure the level at which changes have been adopted.

2.3 Process Maturity Models

A maturity model is applied within the context of an SPI framework. The overall goal of a maturity model is to assess the quality of the software process practiced by software firm, the degree to which practitioners comprehend and adhere to the process, and the broad state of software engineering practice. Maturity models uses an ordinal scale measurement approach to assess software processes in software houses.

The first maturity model called the capability maturity model (CMM) was designed and upgraded by the Software Engineering Institute throughout the 1990s as a complete SPI framework. Today, it has progressed into the Capability Maturity Model Integration (CMMI) (Jones & Soule, 2002), which is a comprehensive process meta-model that is predicated on a set of system and software engineering capabilities that should be present as organizations reach different levels of process capability and maturity.

The CMMI symbolizes a process meta-model in two dissimilar ways: (i) continuous framework and (ii) staged framework. The staged CMMI framework

outlines the same process areas, goals, and practices as the continuous framework. The primary difference is that the staged model outlines five maturity levels, rather than five capability levels. To achieve a maturity level, the detailed goals and practices accompanied with a set of process areas must be practiced by an organization. Maturity levels and process areas are thus interlinked as delineated in Table 1.

Table 1: CMMI Levels

Level	Focus
Level 5 - Optimizing	Continuous process improvement
Level 4 - Quantitatively Managed	Quantitative Management
Level 3 - Defined	Process Standardization
Level 2 - Managed	Basic project management
Level 1 – Performed	

2.4 Capability Immaturity Model

Based on experience in some software industries, level lower than Level 1 have been proposed in the literature. Capability immaturity model (CIMM) consist of these level that are not in the CMMI; the levels are designated as levels 0 to -3 (Schorsch, 1996). Table 2 presents the description of the immaturity levels.

Table 2: The Four Level of Software Process Immaturity

Level	Characteristic	Description
0	Negligent	All problems are thought to be technical problems.
-1	Obstructive	Counterproductive processes are enforced
-2	Contemptuous	Disregard for good software engineering institutionalized
-3	Undermining	Total disregard of own charter.

3.0 REVIEW OF RELATED LITERATURE

In the work of Kitson & Humphrey (1989), it was reported that the role of assessment in improving an organization's software capabilities cannot be overlooked since it contributes, in no small measure, to the company's brand of quality delivery. The research was motivated by a basic principle of industrial engineering. With the use of survey, they were able to convincingly describe Software process assessments from both a conceptual and pragmatic point of view. Although study outlined the benefits

of software process assessments, no formal measurement was carried out to validate the claims.

Eke and Okengwu (2010) studied the two dimensions of SPICE and how software companies in Nigeria can leverage them in enhancing their software capability maturity rating in global software marketplace. The results from the survey implies that no industry in Nigeria has reached quantitatively managed and optimizing levels and that just one software house appear to be in the Defined Level of the maturity model. Majority of the software companies (66% of the industries tudied) are in the chaotic or initial levels. The study also showed that only about 20% are looming up in the managed and defined levels. The maturity model used in this study does not include the immaturity level. Perhaps if the immaturity levels were factored in the research, majority of the industries may not be grouped in to a level but they might be distinctively categorized individually. Hence the need to consider immaturity levels is unequivocally vital.

Rani, Rani, & Anusha (2012) by comparison observed the prevalent limitations in the existing SPI frameworks like CMM and Six Sigma and subsequently developed a software process improvement model (SPIM) that improves the process in a traditional way. Although SPIM proffered veritable solutions to the shortcomings inherent in CMM and Six Sigma, the model does not also consider toxic levels below level 1.

The work of Olalekan,Adenike and Babatunde (2009) set out to determine the magnitude to which software inspection as a step in software quality assurance is adopted and encompassed in the software development process of software companies in Nigeria. After observing the trend in the software companies, the result reveals that software inspection is highly ignored as a step in the software development process because the practitioners lack awareness of the process or they assume it is a waste of time since they have good practitioners who can produce codes within budgeted time.

In a similar development, (Aregbesola et al., 2011) examine the Capability and Maturity levels of the Nigerian software house using the CMMI Model. The outcome of the study showed that the Nigerian software house is very deficient in so many areas. The assessment also exposed that the software process of the Nigerian software industry is at the maturity level 1. Just as it is vividly seen in the work of Eke and Okengwu (2010), all the Nigerian software industries are classified to be in Level 1 of the CMMI model. There is a need to reevaluate these software houses using CIMM in order to distinctively classify these software industries.

Aregbesola and Onwudebelu (2011) probe the practices of quality assurance and quality management in Nigeria software industry through survey and case study. The study showed an abysmal performance of the Nigerian industries.

Sowunmi et al. (2016) examined software quality assurance practices of practitioners in Nigeria. It was noted that quality assurance practices are obviously unattended to and this can be the pointer to the low patronage currently enjoyed by local practitioners.

Aregbesola (2017b) investigated the level of performance and affiliation between ISM and SPE practices in the software industry of Nigeria. The outcome of the study showed a resilient closeness between the ISM and SPE KPAs and a poor performance of the key practices linked with the associated KPAs in the organizations. (M. K. Aregbesola, 2017a) carried out a research to investigate the degree of process definition and focus in software companies in Nigeria. Relatively less strong performance of the key practices affiliated with the OPF and OPD key process areas are identified in Nigeria software house.

Table 3 presents a summary of the reviewed studies.

Table 3. Related Literature

S/N	Author &Year	Aim/Objectives	Methodology(ies)	Result/Strength	Weakness/ Limitation(s)
1	David H. Kitson & Watts S. Humphrey (1989)	This report discusses the role of assessment in improving an organization's software capabilities;	Survey	Software process assessments are described from both a conceptual and pragmatic point of view	No Measurement is carried out.
2.	Eke & Okengwu (2010)	This paper examines the two dimensions of SPICE and how software organizations in Nigeria can leverage them in improving their software capability maturity rating in international software marketplace	Survey and case study	The outcome shows that no organization in Nigeria has reached Quantitatively managed and optimizing levels and that only one seem to be in the Defined level. Bulk of the software organizations are in the chaotic or initial levels which show 8 out of 12 that is given. This figure represents 66% of Given that are at the bottom level. It also indicate that only 20% are coming up in the managed and defined levels from the entire population.	Failed to factor in Immaturity levels.
3.	Rani et al. (2012)	The aim is to develop Software Process Improvement Model	Survey and case study	SPIM model cover the some limitation of	Failed to consider Immaturity

		(SPIM) that improves the process in a traditional way		existing model (CMM, SIX SIGMA)	levels.
4.	Akinola, Osofisan , & Akinkunmi (2006)	To determine the extent to which software inspection as a step in software quality assurance is embraced and included in the software development process of the software development houses in Nigeria	Survey and case study.	The results show that software inspection is highly neglected as a step in their software development process either because they are not aware of the process or they feel it is a waste of time since they have good programmers who can turn out codes in just few days.	This does not form overall improvement strategy.
5.	Aregbesola & Akinkunmi (2010)	The study was aimed at determining the Capability and Maturity levels of the Nigerian software industry using the CMMI Model.	Survey and case study	The appraisal also revealed that the software process of the Nigerian software industry is at the maturity level 1, which is the very base level.	Failed to factor in Immaturity levels.
6.	Aregbesola, Akinkunmi, & Akinola (2011)	The study was conducted to determine the Capability and Maturity levels of the Nigerian software industry using the CMMI Model	Survey and case study	The result revealed that the Nigerian software industry is very deficient in so many areas	Failed to factor in Immaturity levels.
7.	Aregbesola (2017)	The Software Quality Management (SQM) and Quantitative Process Management (QPM) are the key process areas of interest in the current study.	survey research and action research	The results show a high degree of non-performance of key practices in the associated with both Quantitative Process Management (QPM) and Software Quality Management (SQM) key process areas (KPAs).	This is just a step in the model out of many steps. Only two out of about 18 KPAs are considered.
8.	Aregbesola & Ugochukwu (2011)	To examine the practices of Quality Assurance and Quality Management in Nigeria	Survey and case study	The study revealed a low performance of these KPAs	Just a step out of many steps i.e. it does not factor in all

		software house.			KPAs.
9	Sowunmi, Misra, Fernandez-Sanz, Crawford & Soto (2016)	The aim of this work is to further investigate the software quality assurance practices of practitioners in Nigeria.	Survey and case study	it was observed that quality assurance practices are quite neglected and this can be the cause of low patronage	It does not factor in all KPAs. Also failed to consider Toxic levels for Software Organization.
10	Aregbesola (2017)	The study is conducted to determine the extent of process definition and focus in software companies in Nigeria	Survey and case study	The study revealed a relatively weak performance of the key practices associated with the OPF and OPD key process areas	Just a step out of many steps. Not all KPAs are considered.
11	Aregbesola (2017)	The study examined the level of performance and relationship between ISM and SPE practices in the software industry of a typical developing country, with Nigeria as the case study	Survey and case study	The results of the research revealed a strong relationship between the ISM and SPE KPAs and a poor performance of the key practices associated with the respect KPAs in the industry.	Just a step out of many steps. Not all KPAs are considered.

This review shows that in the assessment of the software processes adopted in Nigerian software organizations do not consider the more granular levels of maturity called the immaturity level proposed in CIMM hence the classification of all the software industries studied into Level 1 of the CMMI. It is significant to reassess these organizations using the CIMM in order to distinctively classify them.

4.0 CONCLUSION

This study presented both a theoretical review of SPI and the review of studies in the assessment of the software processes practiced by Nigerian software houses. The theoretical review identified the capability immaturity model which include levels that are not in the popular CMMI. These levels are: 0 (Negligent); -1 (Obstructive); -2 (Contemptuous); and -3 (Undermine). It is argued that the use of these immaturity levels to assess Nigerian software houses will further distinctively categorize software companies rather than clustering them into one and the same Level 1 of the CMMI. Classifying different software houses into Level 1 seems to defeats the purpose of maturity models which is to distinctively classify software organizations based on their practice of software development. Thus, there is the need to reevaluate the Nigeria software houses based on this recent model with immaturity level.

REFERENCES

Akinola, O. S., Osofisan, A. O., & Akinkunmi, B. O. (2009). Industry perception of the software inspection process: Nigeria software industry as a case study. *The Africa Journal of Computer and ICT*, *2*(2), 3–11.

Aregbesola, K., Akinkunmi, B. O., & Akinola, O. S. (2011). Process maturity assessment of the Nigerian software industry. *International Journal of Advances in Engineering & Technology*, *1*(4), 10–25.

Aregbesola, M. K. (2017a). Experiential appraisal of organizational process focus and process definition in Nigerian software companies. *Journal of Scientific and Engineering Research*, *4*(4), 306–311.

Aregbesola, M. K. (2017b). Integrated software management and product engineering: The Nigerian case study. *International Journal of Scientific and Engineering Research*, *8*(4), 1643–1650.

Aregbesola, M. K., & Onwudebelu, U. (2011). Typical software quality assurance and quality management issues in the Nigerian software industry. In *The National Association for Science, Humanities and Education Research (NASHER) 8th Annual National Conference* (pp. 107–113). Retrieved from https://www.researchgate.net/publication/282331019%0ATYPICAL

Eke, B., & Okengwu, U. (2010). Analysis of software process improvement and capability determination in sustenance of Nigerian software engineering organizations. *International Journal of Physical Science*, *5*(3), 106–111.

Garvin, D. A. (1984). What Does 'Product Quality' Really Mean? *Sloan Management Review*. https://doi.org/10.1183/09031936.00106609

Harmonization, T. ministerial committee on I. T. ministerial committee on I. policy harmonizationT policy. (2012). *National Ict Policy*.

Jones, L. G., & Soule, A. L. (2002). Software Process Improvement and Product Line Practice : CMMI and the Framework for Software Product Line Practice, (July).

Kitson, D. H., & Humphrey, W. S. (1989). *The Role of Assessment in Software Process Improvement*. Pittsburgh.

Philip B. Crosby. (2001). *QualityIsFreeIfYouUnderstandIt.pdf*. Winter Park. Retrieved from http://archive.wppl.org/wphistory/PhilipCrosby/QualityIsFreeIfYouUnderstandIt.pdf

Post, D. E., & Kendall, R. P. (2004). Software project management and quality engineering practices for complex, coupled multiphysics, massively parallel computational simulations: Lessons learned. *The International Journal of High Performance Computing Applications*, *18*(4), 399–416.

https://doi.org/10.1177/109434200404853

Pressman, R. S. (2010). *Software Engineering : A practiners's approach* (7th ed.). New York: McGraw-Hill.

Rani, E. G., Rani, S., & Anusha, D. (2012). Comparison of Software Process Improvement. *International Journal of Engineering Research & Technology*, *1*(7), 5–8.

Saiedian, H. (2013). Software process improvement : An introduction. In *Electrical Engineering & Computer Science Spring 2013* (pp. 1–41).

Schorsch, T. (1996). *The Capability Im-Maturity Model (CIMM)*. WrightPatterson. Retrieved from http://stsc.hill.af.mil/crosstalk/1996/nov/xt96d11h.asp

Sowunmi, O. Y., Misra, S., Sanz, L. F., Crawford, B., & Soto, R. (2016). An empirical evaluation of software quality assurance practices and challenges in a developing country : a comparison of Nigeria and Turkey. *SpringerPlus*, 1–13. https://doi.org/10.1186/s40064-016-3575-5

LEVERAGING ON THE RELEVANCE OF SOCIAL MEDIA FOR THE DEVELOPMENT OF NIGERIA POLITICAL ECONOMY

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ABSTRACT

The use of social media as a redoubtable force for social engineering and political electioneering has continued to grow. The technology is participatory, interactive and cost-effective. This has made it the medium of the moment as far as political communication and participation are concerned. Nigeria had her first true test of social media use for political participation during the 2015 general elections. Many positive results were recorded. Both local and foreign observers rated the election as the best in the fourteen-year history of unbroken democracy in the country. Beyond elections, the thriving of democratic practice depends mostly on the active participation of the people through different forms of political activities such as in the electoral process. World-wide, one of the areas in which this active participation of the people has been enhanced, is in the use of Information and Communication Technologies (ICTs) platforms. The evolvement of ICTS, in Nigeria has met with various types of mixed success, with focus on the 2015 general elections. Finally, the best social media utilised during the 2015 election and the impact on politics were discussed.

Keywords: *Nigeria, Political Economy, Social Media Network, Message, Information, ICT.*

1. INTRODUCTION

Information and Communication Technology (ICT) presents our collective nervous system a platform for helping to solve some of our greatest economic, social and environmental challenges (Nielsen & Schrøder, 2014). Nnanyelugo and Nwafor (2013) stated that the use of social media in politics has continued to grow in recent times. "Since Barack Obama broke the world record in the history of social media use for political purpose during the 2008 US presidential elections, many nations and politicians across the globe have continued to embrace the platform to mobilise their citizens and candidates towards active participation in the political process"(Nnanyelugo & Nwafor, 2013). In the last decade, Nigeria has witnessed an exponential growth in internet and social media use. From a modest 200,000 users in

2000, by 2015 around 30 percent of the population online, increasingly on smart phones (Bartlett, Krasodomski-Jones, Daniel, Fisher, and Jesperson, 2015).

In the 2011 general elections, Nigeria had the first real test of social media use for political participation. The adoption of social media especially Facebook by the politicians, the political parties and the electorates as a platform for political participation was a remarkable feat that characterised the 2011 general elections (Udejinta, 2011). This was demonstrated when President Goodluck Johnathan declared his intention to run for the office of the president on Facebook (Nnanyelugo & Nwafor, 2013). Adibe and Chibuwe (2011) pointed out that there is approximately 3 million Nigerians on Facebook and 60,000 on Twitter. However, the utilization of social media in elections did not end in 2011, it has now received widespread media attention for its role in informing, engaging and empowering citizens in Nigeria during the 2015 general elections – evident by the aggressive social networking outreach conducted by the Independent National Electoral Commission (INEC), political parties, candidates, media houses, civil society groups and even the police (Adibe & Chibuwe, 2011).

Bartlett, et al. (2015) reported that there were 1.38 million unique Twitter users posting content about the election on Twitter, and 216,000 Facebook users interacting with content on popular public Facebook pages. The authors further observed that within the Twitter data, seven of the 10 most popular accounts (in terms of mentions or retweeted content) were media outlets. This paper is based on an analysis of information on social media network platforms like the Facebook application, WhatsApp, Instagram and Twitter; and their impact on political development in Nigeria and globally. It shares the general views of the listed social media applications, their significance and influence on global development, particularly in Nigeria. It also discusses and analyses how the social media network has played major roles in influencing the economic development, health care, politics and government service delivery.

The rest of this paper is structured as follows, after the introduction. Section (II) literature review. Section (III) Examines social media networks. (IV). Factors to be considered when using a media. (V). Discusses the Impact of social media on politics and election, while the last section is the conclusion.

2. REVIEW OF RELATED LITERATURE

Social Media is a platform of Internet and mobile based technologies for interactive social networking built on the ideological and technological foundations of Web 2.0, which allows the creation and exchange of user-generated content for mass communication (Kaplan & Haenlein, 2010; Sajithra & Patil, 2013). The evolving technology behind social media has been defined severally by various researchers. Kaplan and Haenlein (2010) defined it as a group of Internet-based applications that build on ideological and technological foundations of web 2.0 and that allows the creation and exchange of user-generated content. The authors

recognised that a striking feature of social media is the fact that it goes beyond users being able to retrieve information, but also to create and consume information themselves.

Similarly, Sweetser (2008) conceptualised social media as a read-write Web, wherever the online audience moves beyond passive viewing of Web content to actually contributing to the content. Additionally, the social media allows user-generated participation at a new speed and scale, easing bottom-up engagement and breaking away significantly from the top-down news dissemination organisation of older media. In recent years, Web 2.0 have been described as the ideological and technological foundation of social media, so much that Kaplan and Haenlein (2010) expressed that is a platform whereby content and applications are no longer created and published by individuals, instead are continuously modified by all users in a participatory and collaborative fashion. Furthering this notion, the authors stated that the mere publishing of content is less interactive and belongs to the earlier Web 1.0 era; collaborative projects, such as blogs, belong to Web 2.0 (Kaplan & Haenlein, 2010). The social media as noted by Abubakar (2012), has the capability of boosting participation, this owes to its openness, conversation nature, connection, textual and audio-visual characteristics. As a result, politicians and business owners are using these channels of mass communication and marketing (conceptualized in Fig 1) to influence attitudes about themselves, set agendas, and shape outcomes of campaigns to mention only a few.

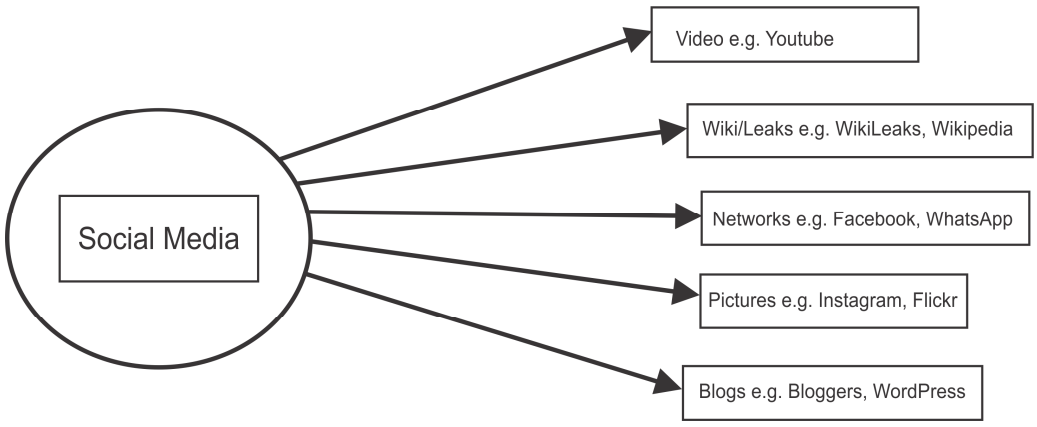


Figure 1: Classification of Social Media
Source: Author (2018)

Political Economy

Political economy is not to be confused with economic policy, it is concerned with the interactions between politics and economics. Since the rise of the Internet in the early 1990s, the world's networked population has grown from the low millions to the low billions. Over the same period, social media have become a fact of life for civil society worldwide, involving many actors – regular citizens, activists,

nongovernmental organizations, telecommunications firms, software providers, and governments. The use of social media tools - text messaging, e-mail, photo sharing, and social networking, does not have a single preordained outcome. Therefore, attempts to outline their effects on political action are too often reduced to duelling anecdotes (Cohn, 2015). The social media also drove a social change as it empowers the people to express their thoughts and opinions and share them with others. Adding to this newfound power, people realize that they were not speaking in a vacuum, a highly responsive audience, who took part in the conversation and put across their points of view. This started a social shift towards power coming back to the masses (Lees-Marshment & Jennifer, 2008; Watts, 2015). However, despite mixed record, social media have become coordinating tools for nearly all of the world's political movements, just as most of the world's authoritarian governments (and, alarmingly, an increasing number of democratic ones) are trying to limit access to it.

3. SOCIAL MEDIA NETWORKS

Facebook

Facebook is a social network service launched in February 2004. As of January 2011, it has more than 600 million active users (Wikipedia, 2017). Facebook's social impact has also changed how people communicate. Rather than having to reply to others through email, it allows users to broadcast or share content to others, and thereby to engage others or be engaged with others' posts. Facebook has been successful and more socially impactful than many other social media sites. David Kirkpatrick, technology journalist and author of The Facebook Effect, believes that Facebook is structured in a way that is not easily replaceable. He challenges users to consider how difficult it would be to move all the relationships and photos to an alternative. Facebook has let people participate in an atmosphere with the "over the backyard fence quality" of a small town, despite the move to larger cities. As per Pew Research Centre survey, 44 percent of the overall population gets news through Facebook (Zuckerberg, 2008).

WhatsApp

WhatsApp Messenger is a cross-platform instant messaging service for smartphones. It uses the Internet to make voice calls, one to one video calls; send text messages, images, GIF, videos, documents, user location, audio files, phone contacts and voice notes to other users using standard cellular mobile numbers. All data are end-to-end encrypted. It also incorporates a feature called Status, which allows users to upload photos and videos to a 24-hours-lifetime feed that, by default, are visible to all contacts, similar to Snapchat, Facebook and Instagram Stories. The client was created by WhatsApp Inc., based in Mountain View, California, which was acquired by Facebook in February 2014 for approximately US$19.3 billion. By February 2016, WhatsApp had a user base of over one billion, making it the most popular messaging application at the time (Metz, 2016).

Twitter

Twitter is an online news and social networking service where users post and interact with messages, "tweets", restricted to 140 characters. Registered users can post tweets, but those who are unregistered can only read them. Users access Twitter through its website interface, Short Message Service (SMS) or a mobile device app. Twitter Inc. is based in San Francisco, California, United States, and has more than 25 offices around the world. Twitter was created in March 2006 by Jack Dorsey, Noah Glass, Biz Stone, and Evan Williams and launched in July of that year. The service rapidly gained worldwide popularity. In 2012, more than 100 million users posted 340 million tweets a day, and the service handled an average of 1.6 billion search queries per day (Theocharis, Lowe, van Deth, & García-Albacete, 2015). Users can relate with one another in two ways: retweets and mentions. Retweets act as a form of endorsement, allowing people to rebroadcast content generated by other users, in this manner raising the content ‘s visibility (Murthy, 2011). Mentions function differently, allowing someone to address a specific user directly through the public feed, or, to a lesser extent, refer to an individual in the third person (Honeycutt, 2008).

Twitter hashtags allow users to annotate tweets with metadata specifying the topic or intended audience of a communication. For instance, the **#NigeriaDecides** was the most popular hashtag about the 2015 elections in Nigeria, and topped the trending list, most especially on election days. **#BringBackOurGirls** movement which played a key role in creating worldwide awareness about the plight of the abducted Chibok Secondary School female students, got its life, vivacity and enthusiasm from the hashtag. In 2013, it was one of the ten most-visited websites and has been described as "the SMS of the Internet". As of 2016, Twitter had more than 319 million monthly active users. On the day of the 2016 U.S. presidential election, Twitter proved to be the largest source of breaking news, with 40 million election-related tweets sent by 10 p.m. (Eastern Time) that day (Theocharis et al., 2015).

4. FACTORS TO BE CONSIDERED BEFORE USING A MEDIA

Social media is not only active but a fast-moving domain. One has to be updated, what maybe up-to-date today could disappear from the virtual landscape the next minute or the next day. It is, however, very crucial to have guidelines applied to any form of social media, whether they are part of the aforesaid list or not. Given that both the social and media component makes up the social media, this section presents factors for consideration before using a media and what being social entails.

(i.) Choice and Identification

The first step in using a media is identifying the medium that best suits your purpose alongside depending on the targeted group you want to communicate or reach out to. Dozens of social media applications are in existence, and new ones are emerging every day, hence to best utilize the media the identifying and selecting is important.

(ii.) Activity Alignment

Since nothing is more confusing than a contradicting message, ensuring activity aligns with the purpose. One major goal of communication is the resolution of ambiguity and reduction of uncertainty. Sometimes the user may decide to rely on different applications within the same category so as to reach a wider range. Here, all your social media activity has to align with each other. A prime example is "Dangote and its group of companies". Dangote uses combination of networking medium, social sites, transportation system to ensure every individual request or need is meant by his service.

(iii.) Media Plan Integration

Most social media sites are already integrated with the smart phones along with mobile websites and specially designed mobile apps to cater for all the networking needs of the people, which include sharing, gaming, collaborating, sending messages, networking, uploading/downloading media files (music and movies) and a lot more. Social media affords a multiple communication channels. Users get to interact with each other; ask questions, market the products in forms of advertising, share opinions, government uses the media to circulate information and policies and anything else they might be interested in doing (Olorunnisola & Martin, 2013).

(iv.) Accessibility, Longevity and Volatility

The internet offers an unlimited reach to available content. Anyone can access it from anywhere and anyone can reach, potentially everyone. Hence, it's important that the social media content remains accessible for a long time, maybe forever, because of the nature of the medium. Conclusively, these contents should be edited/updated anytime. A prime example is, if a user likes a particular product/service and indicates by saying so in the social media, it is not a permanent positive vote for the product or service as the case maybe, the user can always go back and change his opinion anytime.

ICTs and the Social Media

The evolution of ICTs has moved across different spectrums, it offers opportunities to encourage human development–ranging from providing basic access to education or health information to business transactions and inducing citizen involvement in the democratic process (Yonazi, 2012). ICTs adds to economic development and democratisation, including freedom of speech, the free flow of information, promotion of human rights and poverty reduction (Communications, 2009). It equally facilitates efficient administration, citizen services, transparency, accountability and formal political participation for the government (e-governance), and also provide the means for social movements, activist groupings or minority groups to engage with these processes on a global level.

Table 1 shows 29 political parties registered with INEC and 14 parties out of the 29 contested the presidential election, with 6 having official websites. This shows the level and structures of organisation as the dominant parties also dominate the online platforms. Some numbers of these parties used the ICTs platforms to raise fund through crowd-funding, APC for instance. APC also launched an online donation platform that gave opportunity to its supporters to contribute to its campaign fund through a selected account made popular on social media. Premium SMS, were also used as sources of monetary contributions from supporters. Parties also launched digitised and ICT compliant situation rooms tracking events especially during and after the Elections. They monitored results of election from polling units, collaborating with their agents, observers and citizen journalists on the ground. However, this was made possible and easy with citizens using smartphones who sent results and images from their polling units and environs. These ICTs platforms abridged the link-up gap between parties/candidates and the people. Conversely, most of these accounts were not run personally by the politicians involved, most of whom are not well versed in operating the devices and navigating their ways on the platforms. They affianced users of the social media who have amassed huge following on the platforms as advisors to run their accounts, with a view to getting issues to trend by bringing it to the consciousness of the public and influencing opinions and perceptions in their favour.

Table 1: Political Parties, ICTs Platform's for the 2015 Presidential Election as well as Candidates; Author (2018)

Party Name	candidate	facebook	twitter	candidates website	official party website
Accord	-	-	@accordparty		
Action Alliance	Tunde Anifowose Kelani				www.actionallianceng.org
Advanced Congress of Democrafts	-				-
Allied Congress Party of Nigeria	Ganiyu O. Galadima				-
Alliance for Democracy	Rafiu Salau		@rafukachang		-
African Democratic Congress	Mani Ibrahim Ahmad				-
African Peoples Alliance	Ayeni Musa Adebayo				-
All Progressives Congress	Muhammadu Buhari			mbuhari.ng	www.apc.com.ng
All Progressives Grand Alliance	-	facebook.com/allprogressivesgrangalliance			-
Citizens Popular Party	Sam Eke				-
Democratic Peoples Party	-				-
Fresh Democratic Party	-				www.freshdemocraticparty.com.ng
Hope Democratic Party	Ambrose N.A. Owuru				-
Independent Democrats	-				-
Kowa Party	Comfort O. Sonaiya	facebook.com/pages/KOWA-party/	@oluremisonaiya	remisonaiya.com	www.kowaparty.net
Labour Party	-				-
Mega Progressive Peoples Party	-				-
National Conscience Party	Martin Onovo		@onovoNCP2015		-
New Nigeria Peoples Party	-				www.newnigerapeoplesparty.org
People for Democratic Change	-				-
Peoples Democratic Movement	-				www.pdm.ng
Peoples Democratic Party	Goodluck E. Jonathan	facebook.com/pages/Official-peoples-democratic-party-PDP-Nigeria	@pdpNigeria	forwardnigeria.ng	www.peoplesdemocraticparty.com
Progressive People Alliance	-				-
Peoples Party of Nigeria	Allagoa K. Chinedu				-
Social Democratic Party	-				www.sdp.org.ng
United Democratic Party	Godson M.O. Okoye				www.udp.ng
Unity Party of Nigeria	-				-
United Progressive Party	Chekwas Okorie	facebook.com/UnitedProgressiveParty	@chekwas_okorie	chekwasokorieforpre	www.unitedprogressiveparty.org

5. IMPACT OF SOCIAL MEDIA ON POLITICS AND ELECTION

There is no way you can deny it anymore that the way people communicate with each other and hold conversations is on a completely different level than what it was, say, a decade ago. Technologies such as the internet and web initiatives have made it possible for people and business to have a wider reach due to its global nature, and therefore both – individuals and business for their respective benefits, can use the social media effectively. The politicians and those in government are not left out (Nnanyelugo &

Nwafor, 2013). The last concluded generally elections in Nigeria, experienced an era where aspirants, NGOs and political parties took to opening profile pages on various social media platforms like Facebook, Twitter, Google+, Blogs, LinkedIn and YouTube to mention a few, to spread words of campaign promises, words about themselves and their achievements on these sites to gather more fans and votes. Social media allowed these politicians to leverage their network to the benefits of their campaigns and elections eventually.

Election campaigns basically rely on communication. Over the last decade, changes in the communication environment due to innovations in digital technologies (Micó & Casero-Ripollés, 2014; Nielsen & Schrøder, 2014; Pillay & Maharaj, 2014), which themselves accompanied a process of modernization and professionalization of electoral competition (Lees-Marshment & Jennifer, 2001, 2008) have forced political elites to adopt and integrate into their campaigns increasingly sophisticated digital communication practices. Social networking sites like Facebook, microblogs like Twitter and video-sharing sites like YouTube have not only given politicians a powerful avenue for interacting with a more demanding citizenry, but also have allowed them to offer more personalised images to the public and have given less resourceful parties the opportunity to match well-funded campaigns in sophistication, using creative and relatively inexpensive strategies. Social media has also provided a platform for citizens to communicate directly with political candidates. Despite lacking in innovation, however, candidates do use digital media for other purposes. Facebook and Twitter have allowed candidates to increase their exposure at very little cost (as well as significant risk a development that enabled lesser known candidates to rise from obscurity (Theocharis et al., 2015)

6. CONCLUSION

The paper examined the use of ICTs platforms in the conduct of the 2015 elections in Nigeria. Like several other countries, innovations in ICTs have telling effects on different aspects of life in Nigeria, one of which is governance. Democratic governance being the conduct of credible, free and fair elections; can be enhanced with the use of ICTs platforms. The utility of these platforms was explicitly acknowledged by President Buhari at his inauguration, thanking ―those who tirelessly carried the campaign on the social media (Buhari, 2015). Social media now facilitates many –to-many forms of communication. No doubt, the social media have implication on public discourse in Nigeria considering the level of citizen participation on issues bordering their lives i.e. political, social and economic. More recent studies have focused exclusively on social media, rather than the integration of Web 2.0 features on older platforms such as web sites. In a first look at the use of social media during the 2015 election, (Udoka, 2015) found that candidates' presence on social media is strongly related to incumbency status,

party visibility, position on the ballot, as well as Internet penetration in Nigeria. Usage of these platforms seems specifically designed for the campaign, rather than general political communication: once elections are over, there is very little use of Twitter by parliamentarians and politicians for campaigning outside electoral periods. It was discovered that despite all the flaws of social media in Nigeria, it had the power of immediacy; they 're also very participatory. In an election where you have citizens who are participating, they were also providing the news and information surrounding the elections. Thus, serving as means of empowering people through their votes, and through their ability to disseminate information. There is no denial that the traditional media played its role in terms of analysis and punditry, they also engaged the social media via blog posts on their websites, Twitter and Facebook.

REFERENCES

Abubakar, A. A. (2012). Political Participation and Discourse in Social Media during the 2011 Presidential Electioneering. *The Nigerian journal of communication, 10*(1), 96-116.

Adibe, & Chibuwe, O. (2011). *Social Media, Electioneering and Sustenance of Democracy in Africa: A SWOT Analysis.* . Paper presented at the African Media and Democracy Conference (AMDC), Accra, Ghana.

Buhari, M. (2015). *Inaugural Speech by the President of the Federal Republic of Nigeria at the Handover Ceremony.* Abuja, Nigeria.

Cohn, T. (2015). *Global Political Economy*: Routledge.

Communications, A. f. P. (2009). ICTs for Democracy: Information and Communication Technologies for the Enhancement of Democracy – with a Focus on Empowerment. *Stockholm: Swedish International Development Cooperation Agency.* .

Honeycutt, C. H., S. C. . (2008). *Beyond Microblogging: Conversation and Collaboration via Twitter.* Paper presented at the Proceedings of the 42nd Hawaii International Conference on System Sciences. .

Kaplan, A. M., & Haenlein, M. (2010). Users of the World, Unite! The Challenges and Opportunities of Social Media. *Business horizons, 53*(1), 59-68.

Lees-Marshment, & Jennifer. (2001). *Political Marketing and British Political Parties: The Party's Just Begun*: Manchester University Press.

Lees-Marshment, & Jennifer. (2008). *Political Marketing and British Political Parties: Second Edititon*: Manchester University Press.

Metz, C. (2016). Forget Apple vs. The FBI: WhatsApp just switched on encryption for a billion people. *WIRED. Retrieved on November, 4*, 2016.

Micó, J.-L., & Casero-Ripollés, A. (2014). Political Activism Online: Organization and Media Relations in the Case of 15M in Spain. *Information, communication & society, 17*(7), 858-871.

Murthy, D. (2011). Twitter: Microphone for the masses? *Media, Culture & Society,, 33*(5), 779-789. doi: 10.1177/0163443711404744

Nielsen, R. K., & Schrøder, K. C. (2014). The Relative Importance of Social Media for Accessing, Finding, and Engaging with News: An Eight-Country Cross-Media Comparison. *Digital journalism, 2*(4), 472-489.

Nnanyelugo, O., & Nwafor, K. A. (2013). Social Media and Political Participation in Nigeria during the 2011 General Elections: The Lapses and the Lessons. *Global Journal of Arts Humanities and Social Sciences, 1*(3), 29-46.

Olorunnisola, A. A., & Martin, B. L. (2013). Influences of media on social movements: Problematizing hyperbolic inferences about impacts. *Telematics and Informatics, 30*(3), 275-288. doi: http://dx.doi.org/10.1016/j.tele.2012.02.005

Pillay, K., & Maharaj, M. S. (2014). Social media and mobile communications adoption patterns of South African civil society organisations. *South African Journal of Information Management, 16*(1), 1-8.

Sajithra, K., & Patil, R. (2013). Social Media–history and Components. *Journal of Business and Management, 7*(1), 69-74.

Sweetser, K. D., & Lariscy, R. W. (2008). Candidates Make Good Friends: An Analysis of Candidates' Uses of Facebook. . *International Journal of Strategic Communication, 2*(3), 175-198.

Theocharis, Y., Lowe, W., van Deth, J. W., & García-Albacete, G. (2015). Using Twitter to Mobilize Protest Action: Online Mobilization Patterns and Action Repertoires in the Occupy Wall Street, Indignados, and Aganaktismenoi Movements. *Information, communication & society, 18*(2), 202-220.

Udejinta, M. A. (2011). *Social Media Electioneering: Comparative Analysis of President Goodluck Ebele Jonathan and Muhammedu Buhari's Facebook Contents*. Paper presented at the ACCE, Covenant University, Ota.

Udoka, U. E. (2015). Social Media and Political Effects: A Case Study of the 2015 Nigeria's Presidential Election *International Journal of Social Science and Humanities Research, Vol. 3,* (2), 134-141.

Watts, R. L. (2015). Comparing Federal Political Systems. *Understanding Federalism and Federation*, 11.

Wikipedia. (2017). Facebook. Retrieved April, 2017, 2017

Yonazi, E. K., T. Halewood, N. and Blackman, C. (Eds.) (2012). The Transformational Use of Information and Communication Technologies in Africa. *The eTransform Africa report prepared jointly by the World Bank and the African Development Bank in cooperation with the African Union.*

Zuckerberg, M. (2008). Facebook. *Retrieved July, 15*, 2010.

ENSEMBLE-BASED STREAMING APPROACH FOR SPAM DETECTION ON TWITTER NETWORK

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ABSTRACT

Online social network, such as Twitter microblog, has become an essential part of many people daily routine. Despite the benefits offered by this platform, the social spammer has found it as a medium for disseminating spam contents. Existing approaches for spam detection on Twitter focused on batch learning and they classified messages as spam or legitimate. In this paper, an ensemble based streaming framework for spam detection and risk assessment is proposed. The proposed framework is based on data stream classification and clustering, where the risk associated with a message is determined using a combination of Multinomial Naive Bayes (Multinomial NB) and modified K-nearest neighbour (KNN) algorithms. Risk assessment function is formulated to compute the risk score from the outputs of Multinomial NB and KNN algorithms. Finally, in the clustering stage, Streaming K-means algorithm is proposed to detect spam message campaigns. Preliminary results demonstrate the scalability of the proposed ensemble framework.

Keywords: *online social network; spam detection; data streaming; classification; clustering.*

1 INTRODUCTION

Microblogging social networks, such as Twitter and Sina Weibo, have been in existence for over a decade. For instance, Twitter was introduced in 2006 and has attracted over 320 million active monthly users posting more than 500 million tweets per day (DMR, 2015; Statista, 2016). Microblogging social networks are well-established social communication media, which allow users to share short messages usually referred to as microposts. Beyond the use of micropost for communication, microblogging users can share images and multimedia contents on the network. A user on microblogging network can relate with another user through the social structural connection of a follower-to-followee relationship. However, increase in the number of data generated on microblogging social network on a daily basis has attracted the attention of social spammers (Cresci et al., 2017).

Social spammers have utilized malware such as Koobface to attack Twitter space (Ostrow, 2009). To reduce the spread of spam messages on Twitter, several approaches

have been studied in the literature. For instance, Hu et al. (2013) proposed content-based and social structure analysis to detect spammers on Twitter. Egele et al. (2015) presented a compromised account detection model based on anomaly detection technique. Benevenuto et al. (2010) proposed spammers detection on Twitter using support vector machine (SVM) classifier. Lee and Kim (2014) identified an early malicious account on Twitter with the use of hierarchical clustering algorithm and SVM classifier. Aggarwal et al. (2012) developed a real-time phishing detection system with specific focus on malicious URL analysis. However, existing studies for spam detection on Twitter focused on detecting spammers accounts with little research on spam message detection. These studies address spam detection on Twitter using batch learning approach and classified messages as spam or legitimate. However, messages shared on Twitter microblog exhibits stream characteristic where mini-batch of messages arrives within a short period.

Inspired by the need to assess the severity level of microblogging messages in real-time to cope with the large volume of data generated on a daily basis, it is important to address social spam detection using real-time learning approach and provide the risk associated with spam messages. Based on these objectives, this paper proposed an ensemble based streaming framework utilizing both classification and clustering methods to provide efficient, real-time, and scalable spam detection and risk assessment framework. Combining classifiers to combat email spam has been previously studied (Hershkop & Stolfo, 2005), however, to the best of our knowledge no research has focused on assessing the performance of different streaming algorithms to determine the risk associated with microblogging messages. The classification stage of the proposed framework is based on Multinomial NB and modified KNN algorithms for both text and link analyses. To detect campaign of spam messages, this study proposed Streaming K-means algorithm, which clusters messages based on similarity.

The remaining part of this paper is organized as follows: Section 2 focuses on related work in spam detection. Section 3 highlights the various components of the proposed scheme. Section 4 presents the results and discussion to show how well the proposed framework can scale on a large volume of data when compared with batch learning models. Finally, Section 5 concludes the paper.

2. REVIEW OF RELATED LITERATURE

In this era of web 2.0, most Internet users spent their time sharing information and connecting with friends on the social networks. However, the majority of the messages shared on social media on a daily basis are accompanied with malicious links. According to the Nexgate report in 2013, social spam has grown by about 355% (Nguyen, 2013). Spam detection has been addressed from different domains, such as email, web page, SMS, and social network.

As an example of email spam detection, Metsis et al. (2006) compared the performance of five versions of Naive Bayes (NB) algorithms on six new raw datasets. They sampled mailboxes of six employees in Enron who received large messages as at

the time of collection. Their experimental analysis with Bernoulli NB, Multinomial NB, Multivariate Gauss NB, and Flexible Bayes algorithms on the merged Enron datasets suggests that the Flexible Bayes and Multinomial NB achieved good performance. Hershkop and Stolfo (2005) assessed the impact of combining different classifiers to distinguish spam emails from legitimate contents. Their findings revealed that combining multiple classifiers achieved better results when compared with the performance of the individual classifier.

In the domain of web page spam detection, Sadan and Schwartz (2011) proposed betweenness centrality graph metric to improve the performance of web page spam filtering system. Due to the lack of labelled data to detect phishing attack on web pages, Li et al. (2013) proposed a transductive support vector machine (TSVM) algorithm using image and document object model (DOM) features. They applied quantum-inspired evolutionary algorithm to avoid the local convergence of TSVM. Ma et al. (2009) applied lexical and host-based features to identify malicious URLs on web pages. Their experiments using live URL feeds revealed some limitations of batch learning approaches in dealing with malicious URLs detection on web pages. Choi et al. (2011) combined lexical, link popularity, web page content, DNS, and network features to distinguish malicious URL from legitimate links. Aburrous et al. (2010) developed an intelligent phishing detection system based on fuzzy logic. The researchers categorized e-banking phishing websites by defining a number of layers.

There are several approaches in the literature, which have been studied to reduce the spread of SMS spam in mobile communication. For instance, in the recent study conducted by El-Alfy and AlHasan (2016), a dendritic cell algorithm (DCA) was applied to classify messages as spam or legitimate. The DCA algorithm combined the outputs of two machine learning classifiers to provide a unified approach to mobile spam filtering. Similarly, Zainal and Jali (2015) proposed a perceptron-based model to assess the risk associated with mobile messages using danger theory of artificial immune systems. The two approaches are based on batch learning techniques, which fail to address the streaming characteristics of microblogging messages.

Spam detection on microblogging social network focused on three main approaches: blacklist, graph-based, and machine learning. For example, Grier et al. (2010) applied the blacklist based approach to detect malicious tweets on Twitter. The researchers investigated users' click-stream data generated from phishing URLs in order to study the effectiveness of using malicious URL to launch large-scale phishing attacks. They further analyzed the capability of blacklist based approach in spam detection. However, their findings suggested that blacklist based technique is very slow in protecting users from new threats. Liu et al. (2015) proposed a community-based detection method to identify spammer on Twitter. Chu et al. (2012) proposed Random Forest machine learning algorithm to identify spam campaign. Martinez-Romo and Araujo (2013) combined language and content to detect malicious tweets in trending topics. Echeverría and Zhou

(2017) investigated bot detection on Twitter using a number of behavioural features. Lee and Kim (2014) proposed hierarchical clustering approach to initially group spammers with malicious profile names. They trained Markov chain model with valid account names from Twitter. Therefore, any account name that violates this pattern is flagged as malicious.

While existing studies on spam detection in microblogging social networks focused on batch learning approach and classified messages as spam or legitimate, this study proposed a different based on data stream classification and clustering to detect spam messages in real-time in order to address the streaming nature of microblogging messages. The proposed framework further applied Streaming K-means algorithm to identify spam campaigns.

3 PROPOSED SCHEME

The aim of the proposed framework is to combine different data stream models for spam detection and risk assessment. The model combination has many advantages, which include the ability to exploit different learned experts over a given task in order to improve performance. By exploring the input from different learned models, it is possible to reduce the risk of any individual classifier being compromised by the spammer. Numerous studies have adopted this approach in different domains with the aim of reducing error in classification or improving model accuracy (Bhat et al., 2014; Hershkop & Stolfo, 2005), however, the proposed scheme targets scalability, real-time detection, and risk assessment without compromising model accuracy.

3.1 Ensemble-based streaming framework

In order to reduce spamming activities on microblogging network, this study proposed ensemble based streaming framework shown in Figure 1. The framework consists of five different modules: Data collection and preprocessing, feature extraction, classification, risk assessment, and campaign detection. Table 1 briefly highlights the details of each module.

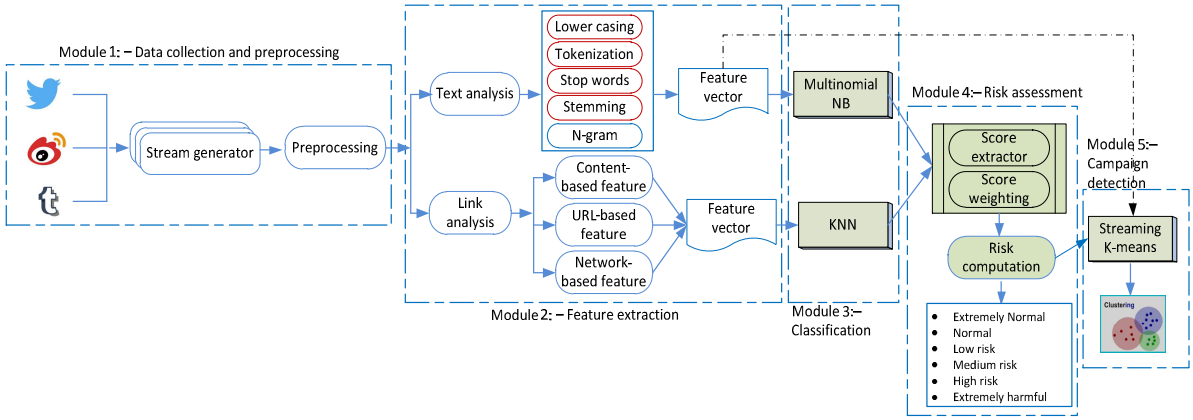


Figure 1. Proposed ensemble based streaming framework for spam detection and risk assessment

Table 1. Highlights of the proposed modules

Proposed modules	Description
Module 1:- Data collection and preprocessing	The purpose of this module is to collect a stream of data from microblogging network. For example, in a real-world situation, microblogging network like Twitter has a Streaming API, which can be used to collect live tweets from its network. The live tweets collected in JavaScript Object Notation (JSON) format can be preprocessed to extract useful entities.
Module 2:- Feature extraction	This module extracts useful features from microblogging messages, such as text-based, content-based, URL-based, and network-based features. These features are then converted to feature vectors that would serve as inputs to the streaming classification algorithms.
Module 3:- Classification	The purpose of this module is to apply the two data stream classification algorithms on the feature vectors in a simultaneous manner. The outputs from the two algorithms are submitted to the risk assessment module.
Module 4:- Risk assessment	This module extracts the score related to the decision made by each classifier to compute the risk associated with the message in real-time.
Module 5:- Campaign detection	The purpose of this module is to apply tuned Streaming K-means algorithm to identify the campaign of spam messages. Information provided by this module can help users assess the possible vulnerability of the spam message.

3.2 Proposed stream mining algorithms

The proposed framework consists of three streaming algorithms, which will be tuned to achieve the desired objectives. The proposed framework follows incremental learning approach where an instance is presented at a particular time t. The aim of the streaming algorithm is to compute a real-time classifier, which can assign a class label (e.g c_t) to the new instance at any given time. The algorithm does this using historical information (i.e summary of the training data) to decide the class of the instance at a particular time *t*. During time *t+1*, a new instance is presented to the learned classifier which in turns produces a class label c_{t+1}. This process continues unboundedly improving the performance of the classifier over time. Figure 2 shows an example of an incremental learning in data stream mining. This approach is suitable in an environment where data flow continuously. Incremental learning presents many advantages over the batch learning approach, which include model adaptation, low memory utilization, single pass learning, and real-time detection.

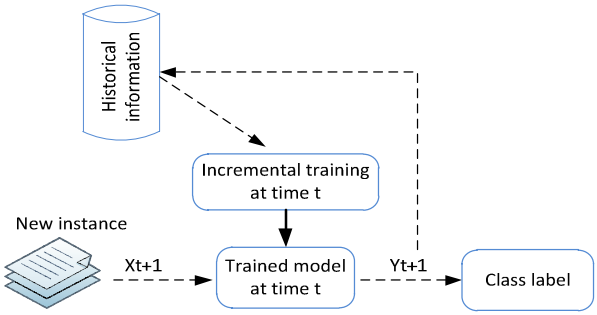


Figure 2. Incremental learning approach

3.2.1 Data Stream Classification Algorithms

Formally, suppose a sequence of instances (e.g tweets) is presented, one instance at a time, which may not necessarily be an equal time interval. Let $X_t \in \Re^d$ be a vector in *d*-dimensional feature space observed at time *t*. Now, suppose c_t is the class label associated with X_t such that $c_t \in C$. Let (X_1,....,X_t) represents historical instances at time *t*. The goal is to classify X_{t+1} instance using Multinomial NB and KNN algorithms. Note that each of these algorithms acted on different feature vector as discussed in the proposed framework. Multinomial NB is a class of Naive Bayes algorithms based on Bayes' theorem. According to Bayes theorem, the probability of classifying instance X_{t+1} to class $c \in C$, is given in Equation 1.

$$p(c \mid X_{t+1}) = \frac{p(c).p(X_{t+1} \mid c)}{p(X_{t+1})} \qquad (1)$$

The probability $p(X_{t+1})$ is not important in our case since it does not depend on any class. Naive Bayes classifies instance X_{t+1} by maximizes the joint distribution $p(c).p(X_{t+1}$

| *c)* at the numerator. Recall that in spam detection, X_{t+1} may belong to either spam or legitimate. Thus, the probability of classifying X_{t+1} as spam is given as:

$$p(spam \mid X_{t+1}) = \frac{p(spam).p(X_{t+1} \mid spam)}{p(spam).p(X_{t+1} \mid spam) + p(leg).p(X_{t+1} \mid leg)} > T, \text{ where T is a threshold.} \quad (2)$$

In the case of Multinomial NB, the value of the feature vector is the term frequency (TF) associated with each N-gram feature. Let assume that X_{t+1} contains $f_1,.....,f_m$ features at time $t+1$. Each f_i has a value TF_i assigned to it. Therefore, Multinomial NB estimates the probability $p(X_{t+1} \mid spam)$ as follows:

$$p(X_{t+1} \mid spam) = \frac{p(spam).\prod_{i=1}^{m} p(f_i \mid spam)}{\sum_{c \in \{spam,leg\}} p(c).\prod_{i=1}^{m} p(f_i \mid c)} > T, \text{where T is a threshold.} \quad (3)$$

From Equation 3, each of $p(f \mid c)$ is estimated by computing the Laplacian prior such that:

$$p(f \mid c) = \frac{1 + N_{f,c}}{m + N_c}, \quad (4)$$

where $N_{f,c}$ represents the number of occurrences of feature f appearing in X_{t+1} instance that belongs to class c, and $N_c = \sum_{i=1}^{m} N_{f,c}$. It is important to note that, apart from using TF, Multinomial NB supports Boolean features, representing the presence or absence of a feature in the message under consideration.

This study adopts KNN for link analysis in the proposed framework. KNN computes the class of a new instance as the most frequent class of its K nearest neighbours. KNN is an instance-based algorithm with linear computational complexity, which has been widely used for different classification tasks. This linear computational complexity of KNN makes it a good candidate for data stream mining. KNN uses Euclidean distance to compute the closest K-nearest neighbour to the new instance to be classified. Table 2 summarizes the procedure of KNN algorithm for data stream classification.

Table 2. Modified KNN algorithm

Data stream classification: Modified KNN algorithm
Input: Historical information $(X_1,c_1),.....,(X_t,c_t)$, $\forall c_1,...,c_t \in C$; K; $X_{t+1} = (f_1,....,f_m)$ **Output:** $c_{t+1} \in C$, $p(c_i, i=1,2)$ 1: **Foreach** labeled instance (X_j,c_j) 2: Compute $d(X_j, X_{t+1})$ using Euclidean distance

3: Arrange $d(X_j, X_{t+1})$ from lowest to highest, where $j = 1,..,t$.
4. **End foreach**
5: Choose the K nearest neighbor to X_{t+1}
6: Associate $c_{t+1} \in C$ to X_{t+1} based on majority vote
7: Compute $p(c_i, i=1,2)$, the probability of spam and legitimate class
8: Return c_{t+1}, $p(c_i, i=1,2)$

It is important to note that each of the proposed stream classification algorithms is tuned to output class label and the probability of each class label.

3.2.2 Combination Strategy and Risk Analysis

There are several techniques for combining classification algorithms. The process of combining different classifiers is called model fusion and some of the techniques for defining fusion rule have been discussed in (Kuncheva, 2004). This paper adopted majority vote technique to combine the two classification algorithms. Since each of the algorithms focuses on different feature vector, the maximum value of the class prediction for each category is used. For the sake of clarity, Equation 5 defines the combination rule.

$$p(c_j) = \max_{c_j \in C}(pNB(c_j), pKNN(c_j)), \text{ where } j=1,2. \quad (5)$$

For instance, the probability of the two algorithms predicting spam is given as:

$$p(c = spam) = \max(pNB(spam), pKNN(spam)) \quad (6)$$

Where *pNB(spam)* is the probability of Multinomial NB predicting an instance as spam, while *pKNN(spam)* is the probability of KNN algorithm predicting an instance as spam. This approach reduces bias in the ensemble model. Note that each probability returns a real value with two decimal places.

The output of this function is passed to the normalized risk assessment function defined in Equation 7. The risk assessment function determines the severity level associated with the spam prediction. This function outputs a value in the range of 0 to 100, with 0 indicating "Extremely normal" while 100 represents "Extremely harmful". Despite the fact that committee of data stream classifiers predicts a message as spam, we assert that at least there must be a level of confidence passed on the normality of the message. Therefore, we claim that the proposed framework reduces the high false positive inherent in some spam filters, which neglect such assumption. Table 3 presents the details of the risk likelihood associated with the predicted message.

$$Risk(spam) = \frac{p(spam)}{p(spam) + p(leg)} * 100 \quad (7)$$

This table was defined heuristically with expert judgments after several computations. For instance, let us assume that *p(spam)* is 0.80 and *p(leg)* is 0.20 as returned by Equation 5. Then the risk associated with this message is computed as follows:

$$Risk(spam) = \frac{0.80}{0.80 + 0.20} * 100 = 80\% \qquad (8)$$

Therefore, according to Table 3, this message is categorized as "High risk". This information will assist the social network user to make an informed decision regarding how to interact with such message.

Table 3. Risk likelihood

Risk score(%)	Message category
0 - 29	Extremely normal
30 - 49	Normal
50 - 59	Low risk
60 - 79	Medium risk
80 - 89	High risk
90 - 100	Extremely harmful

3.2.3 Campaign Detection

This study adopted Streaming K-means algorithm to detect spam campaign using the vectors extracted from the text analysis. Streaming K-means algorithm originally proposed by (Shindler et al., 2011) is a data stream clustering algorithm used to determine the cluster of an instance in real-time. The algorithm modifies the well-known K-means clustering algorithm by adapting the mini-batch K-means update rule. For each batch of data that arrives for clustering, the algorithm assigns all points to their nearest cluster, calculate new cluster centroids, and then update each cluster by applying:

$$c_{t+1} = \frac{c_t n_t \alpha + x_t m_t}{n_t \alpha + m_t} \qquad (9)$$

$$n_{t+1} = n_t + m_t \qquad (10)$$

In these equations, c_t is the previous cluster centroid, n_t is the number of points assigned to this cluster, x_t is the cluster centroid obtained during the current batch, and m_t

is total points in the cluster during the current batch. The parameter α is a decay or forgetfulness factor, which may take the value 0 or 1. 0 indicates that only the most recent data is used while the value of 1 uses all the data from beginning. Detecting cluster of spam message will help determine the possible category of the campaign, such as financial fraud, game scam, and pornography among others. The proposed ensemble based streaming algorithm is summarized in Table 4:

Table 4. Proposed ensemble algorithm

Proposed ensemble algorithm
Input: microblogging message (msg), Historical information (h)
Output: class, risk, cluster
Begin
1: text-vector < - extract-text-feature(msg)
2: link-vector < - extract-link-feature(msg)
3: [$class_{NB}$, $Prob_{NB}$] < - MultinomialNB(h, text-vector)
4: [$class_{KNN}$, $Prob_{KNN}$] < - KNN(h, K, link-vector)
5: **For** i < - 1,2 //1 for legitimate, 2 for spam
6: [c_i,P_i] < - score-weighting(score-extractor($class_{NB}$,$class_{KNN}$,$Prob_{NB}$,$Prob_{KNN}$, i))
7: risk-score < - $P_2/(P_2 + P_1) * 100$
8: risk < - risk-mapping(risk-score)
9: cluster < - StreamingK-means(text-vector)
10: $P_1 > P_2$? class < - c_1 : class < - c_2
11: return (class, risk, cluster)
End

4 PRELIMINARY RESULTS AND DISCUSSION

To evaluate the performance of the proposed approach, two experiments were conducted using 15,000 legitimate and 10,280 spam messages from Twitter making a total of 25,280 labelled samples. Text and link-based features were extracted from the metadata presented from Twitter. The first experiment evaluates the proposed model in terms of accuracy, Kappa, and processing time. The second experiment was conducted in a batch-learning environment using WEKA machine learning tool. The aim is to check the loss and gain of the proposed approach. The configuration environment of the data stream is different from the traditional environment (Bifet et al., 2010), hence, evaluating data stream algorithm is quite different from the traditional

approach. One of the challenges of data stream mining is how to build an evaluation of the model performance over time. Some standard methods, such as holdout and prequential evaluation have been used in the literature. Holdout approach is similar to the batch learning cross-validation, except that a single holdout set is used in the data stream. The prequential evaluation also called Interleaved Test-Then-Train allows each example to be used for testing the model before it is presented for training. This study adopted this method for the classification module. The proposed ensemble model achieved an accuracy of 92.12% and Kappa value of 72.32% as shown in
Figure 3. The processing time of the classification module is 3.33 seconds (see Figure 4).

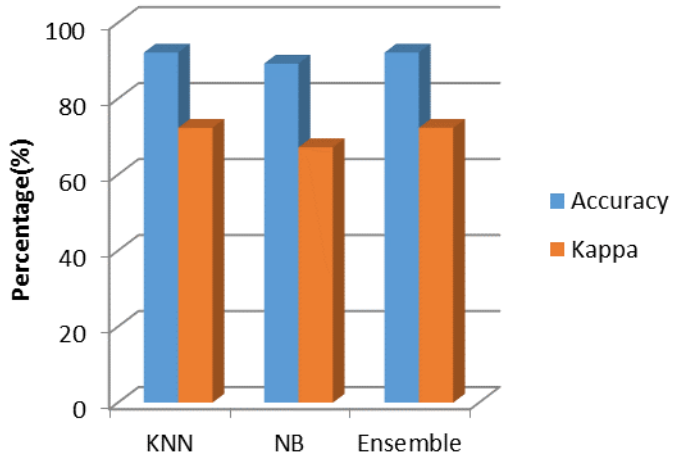


Figure 3. Accuracy and Kappa statistic of the ensemble classification module

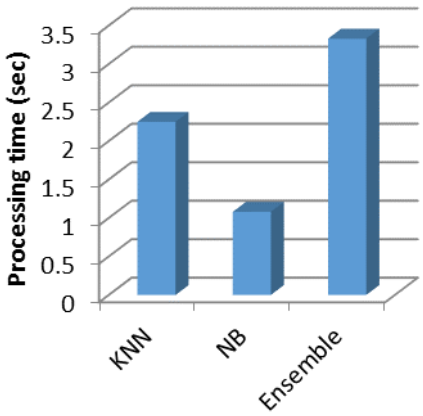


Figure 4. Processing time of the ensemble classification module

Naive Bayes started achieving good performance after reaching 25,111 instances, which indicates that indeed a large number of label samples are needed to effectively train data stream mining algorithm. However, KNN reached 23,908 instances before achieving over 90% accuracy. These results are shown in Figure 5 and Figure 6.

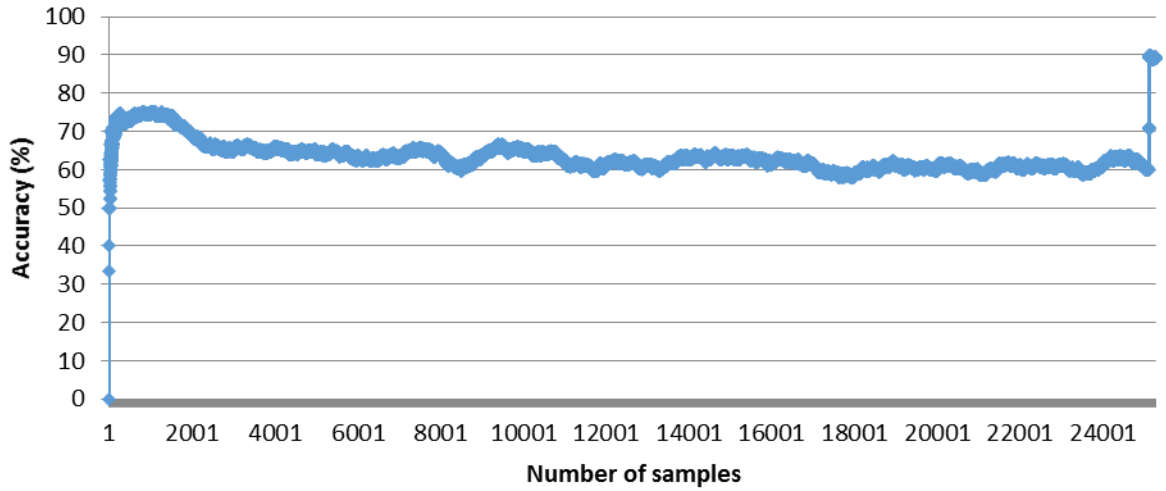


Figure 5. Accuracy of Naive Bayes on the data stream

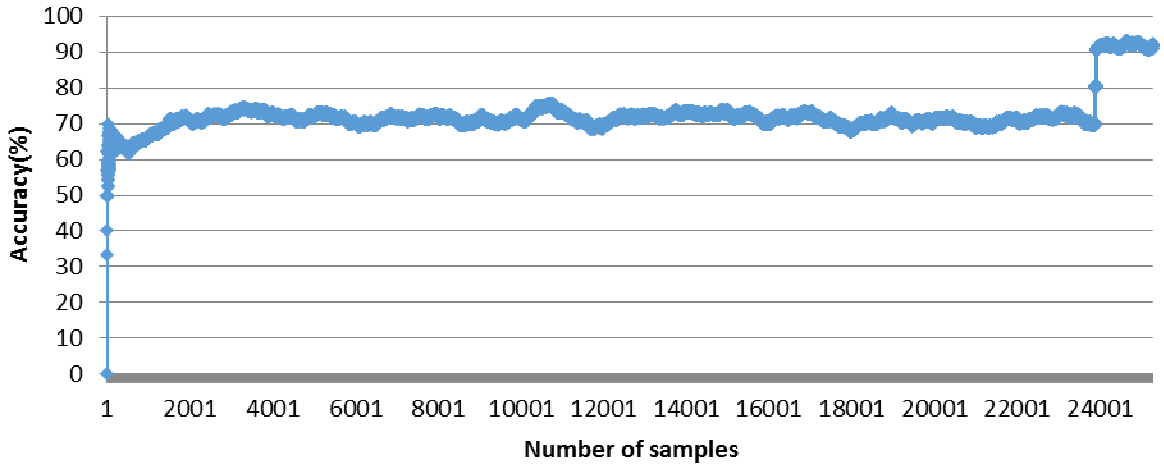


Figure 6. Accuracy of KNN on the data stream

The Streaming K-means was evaluated using F1-score, precision, recall, sum of squared (SSQ) error, and processing time. Streaming K-means took 1.12 seconds to generate 10 clusters with 0.1548 SSQ. This shows that the classification and clustering modules took 4.45 seconds to complete the operation of the entire ensemble framework based on the dataset utilized. Figure 7 shows the result of F1-score, precision, and recall.

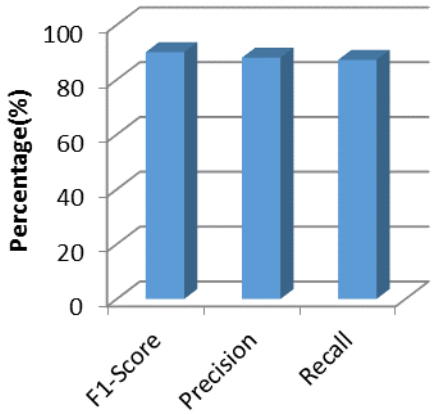


Figure 7. Performance of Streaming K-means with 10 clusters

The subsequent section describes the result of the second experiment, which evaluates the proposed ensemble approach with batch-learning models. For this experiment, two well-known batch-learning classifiers were selected: Support vector machine (SVM) and Multilayer perceptron (MLP). These two algorithms have been used for spam and fake profile detection (Adikari & Dutta, 2014; Soman & Murugappan, 2014).

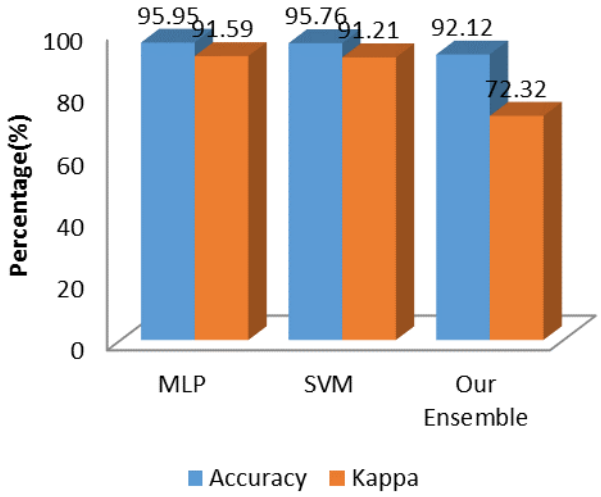


Figure 8. Comparison of our approach with batch-learning models using Accuracy and Kappa

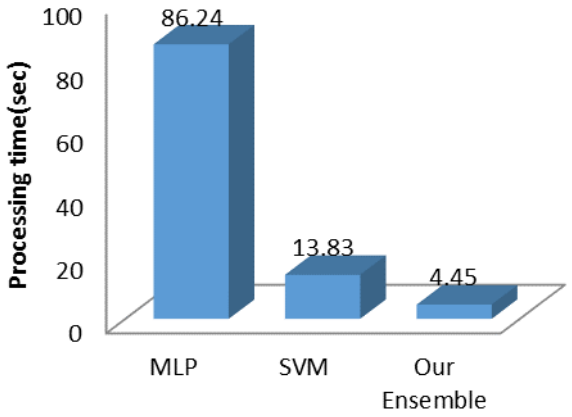


Figure 9. Comparison of our approach with batch-learning models using processing time

As seen from Figure 8, the proposed ensemble-based approach decreased in accuracy (92.12%) and Kappa (72.32%) when compared with MLP and SVM classifiers. However, in Figure 9 the framework achieved better performance in terms of processing time indicating that the proposed approach can scale well and still maintain a significant performance accuracy as compared with the batch learning models.

5 CONCLUSION AND FUTURE WORK

Spam detection problem is a continuous fight between spammers and spam filter. Spam problems have surfaced from different domains and several techniques have been used to address them. To date, existing spam filters for microblogging social network focus on classifying messages as spam or legitimate and they base their learning principle on batch learning approach. The problem with this model is that the cost of retraining the

classifier is high, coupled with an increased demand for memory and inability to scale on large training data.

This paper proposed a framework based on data stream mining, which does not only detect incoming message as spam or legitimate but also determines the risk associated with such message. To achieve the aim of this framework, this study proposed an ensemble based streaming algorithm, which combines Multinomial NB with KNN algorithm to compute the risk associated with spam messages. A real-time detection and training procedure using incremental learning approach is adopted. In addition, this study proposed Streaming K-means algorithm to detect the campaign of spam messages. Different experiments were conducted to demonstrate how well the proposed ensemble approach can scale using over 25K labelled samples from the Twitter network. Although the proposed approach achieves better performance in terms of processing time, indicating that the proposed framework can scale well with a large volume of data. However, the accuracy of the proposed model needs to be improved in the future study. In addition, the proposed framework needs to be further evaluated using more label data.

REFERENCES

Aburrous, M., Hossain, M. A., Dahal, K., & Thabtah, F. (2010). Intelligent phishing detection system for e-banking using fuzzy data mining. *Expert Systems with Applications, 37*(12), 7913-7921.

Adikari, S., & Dutta, K. (2014). *Identifying fake profiles in LinkedIn.* In: PACIS.

Aggarwal, A., Rajadesingan, A., & Kumaraguru, P. (2012). *PhishAri: Automatic realtime phishing detection on twitter.* In: eCrime Researchers Summit (eCrime), 2012.

Benevenuto, F., Magno, G., Rodrigues, T., & Almeida, V. (2010). *Detecting spammers on Twitter.* In: 7th Annual Collaboration, Electronic Messaging, Anti-Abuse and Spam Conference, CEAS 2010.

Bhat, S. Y., Abulaish, M., & Mirza, A. A. (2014). Spammer classification using ensemble methods over structural social network features. *2014 IEEE/Wic/Acm International Joint Conferences on Web Intelligence (Wi) and Intelligent Agent Technologies (Iat), Vol 2*, 454-458. doi: 10.1109/wi-iat.2014.133

Bifet, A., Holmes, G., Kirkby, R., & Pfahringer, B. (2010). MOA: Massive online analysis. *The Journal of Machine Learning Research, 11*, 1601-1604.

Choi, H., Zhu, B. B., & Lee, H. (2011). *Detecting Malicious Web Links and Identifying Their Attack Types.* In: WebApps.

Chu, Z., Wang, H., & Widjaja, I. (2012). *Detecting social spam campaigns on Twitter* (Vol. 7341 LNCS).

Cresci, S., Di Pietro, R., Petrocchi, M., Spognardi, A., & Tesconi, M. (2017). The paradigm-shift of social spambots: Evidence, theories, and tools for the arms race. *arXiv preprint arXiv:1701.03017*.

DMR. (2015). By The Numbers: 150+ Amazing Twitter Statistics. from http://expandedramblings.com/index.php/march-2013-by-the-numbers-a-few-amazing-twitter-stats/10/

Echeverría, J., & Zhou, S. (2017). TheStar Wars' botnet with> 350k Twitter bots. *arXiv preprint arXiv:1701.02405*.

Egele, M., Stringhini, G., Kruegel, C., & Vigna, G. (2015). Towards Detecting Compromised Accounts on Social Networks. *IEEE Transaction on Dependable and Secure Computing*. doi: 10.1109/TDSC.2015.2479616

El-Alfy, E.-S. M., & AlHasan, A. A. (2016). Spam filtering framework for multimodal mobile communication based on dendritic cell algorithm. *Future Generation Computer Systems*.

Grier, C., Thomas, K., Paxson, V., & Zhang, M. (2010). @spam: the underground on 140 characters or less. *Proceedings of the 17th ACM conference on Computer and communications security*, 27-37.

Hershkop, S., & Stolfo, S. J. (2005). *Combining email models for false positive reduction.* In: Proceedings of the eleventh ACM SIGKDD international conference on Knowledge discovery in data mining.

Hu, X., Tang, J., Zhang, Y., & Liu, H. (2013). *Social spammer detection in microblogging.* In: Proceedings of the Twenty-Third international joint conference on Artificial Intelligence.

Kuncheva, L. I. (2004). *Combining pattern classifiers: methods and algorithms*: John Wiley & Sons.

Lee, S., & Kim, J. (2014). Early filtering of ephemeral malicious accounts on Twitter. *Computer Communications, 54*, 48-57.

Li, Y., Xiao, R., Feng, J., & Zhao, L. (2013). A semi-supervised learning approach for detection of phishing webpages. *Optik-International Journal for Light and Electron Optics, 124*(23), 6027-6033. doi:http://dx.doi.org/10.1016/j.ijleo.2013.04.078

Liu, D., Mei, B., Chen, J., Lu, Z., & Du, X. (2015). Community Based Spammer Detection in Social Networks. In X. L. Dong, X. Yu, J. Li & Y. Sun (Eds.), *Web-Age Information Management* (Vol. 9098, pp. 554-558).

Ma, J., Saul, L. K., Savage, S., & Voelker, G. M. (2009). *Identifying suspicious URLs: an application of large-scale online learning.* In: Proceedings of the 26th annual international conference on machine learning.

Martinez-Romo, J., & Araujo, L. (2013). Detecting malicious tweets in trending topics using a statistical analysis of language. *Expert Systems with Applications, 40*, 2992-3000. doi: 10.1016/j.eswa.2012.12.015

Metsis, V., Androutsopoulos, I., & Paliouras, G. (2006). *Spam filtering with naive bayes-which naive bayes?* In: CEAS.

Nguyen, H. (2013). Research report 2013 state of social media spam.

Ostrow, A. (2009). Koobface virus gets smarter; targets Twitter and Facebook user. from http://mashable.com/2009/08/06/koobface-twitter-facebook/#zs_M9yTXKEqc

Sadan, Z., & Schwartz, D. G. (2011). Social network analysis of web links to eliminate false positives in collaborative anti-spam systems. *Journal of Network and Computer Applications, 34*(5), 1717-1723.

Shindler, M., Wong, A., & Meyerson, A. W. (2011). *Fast and accurate k-means for large datasets.* In: Advances in neural information processing systems.

Soman, S. J., & Murugappan, S. (2014, 10-12 April 2014). *Detecting malicious tweets in trending topics using clustering and classification.* In: Recent Trends in Information Technology (ICRTIT), 2014 International Conference on.

Statista. (2016). Leading social networks worldwide as of April 2016, ranked by number of active users (in millions). from http://www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users/

Zainal, K., & Jali, M. Z. (2015). A Perception Model of Spam Risk Assessment Inspired by Danger Theory of Artificial Immune Systems. *Procedia Computer Science, 59*, 152-161.

A NON-COOPERATIVE SPATIAL MANAGEMENT GAME FOR HIGH EFFICIENCY WLAN (IEEE 802.11ax)

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ABSTRACT

IEEE 802.11ax has been identified to be a major player in next generation communication. However, the ubiquitous deployment of WLANs worsens the issue of channel interference which has dare consequences on throughput and latency. Previous techniques used to spatial coordination in dense networks have not properly addressed this issue. This paper extends non-cooperative games for spatial coordination in densely deployed WLANs via an AP administrator which is dynamically selected. Specifically, Kakutani's fixed point theorem has been used as the metrics to prove that there is a fixed point which is the unique Nash equilibrium. Simulation results show the effectiveness of the strategy in reducing interference. The administrator allocates channels to the APs and enhances spatial reuse with minimum interference level of 6dB.

Keywords*: Non-cooperative games, spatial reuse, WLAN, IEEE 802.11ax.*

1. INTRODUCTION

WLAN – Wireless local area network, popularly known as Wi-Fi (Wireless Fidelity) uses the IEEE 802.11 standards. Wi-Fi is aimed at use within the unlicensed spectrum (2.4 GHZ, 5 GHZ). Several factors have contributed to the success of the IEEE802.11 family of standards, the most important are: *interoperability, ease of use, and flexibility.* The IEEE 802.11ax was initialized in 2016 and intended to be released in 2019.

The IEEE802.11ax amendment will be the IEEE802.11 response to the challenges of future dense and high-bandwidth demanding WLAN scenarios [1]. To achieve this goal, some new features like Dynamic channel bonding, Multi-user Uplink MIMO, Full-duplex wireless channel, efficient and robust hand off between APs in the same administration domain[2], device-to-device communication (D2D) [3]will be incorporated into the WLAN devices.

There is high demand on the Access points because of voice calls, HD video streaming, etc done over Wi–Fi [4]. Also, the access points' coverage areas overlap one

another leading to high interference and making Wi-Fi Usage very difficult**.** The number of connected users keeps increasing right from inception till date because of its ease of usage and freedom in operation. The number of connected Wi-Fi devices in 2020 is estimated to be approximately 38.5 billion[3].

Considering this future dense network, the issue of spatial coordination becomes a major issue that needs to be addressed else, the aim of IEEE 802.11ax (High efficiency WLAN) will not be achieved. In order to achieve dynamic spatial coordination in such scenario, research has shown that coordination of access points is the next big challenge [5] and for high efficiency WLANs, coordination is one of the new features to be incorporated [1].

Many approaches have previously been employed to mitigate interference in the present WLAN. For example, beam forming was used to increase spatial reuse by using directional antennas [6]. After studying a number of alternatives configurations, they discovered that directionality on both APs and clients can significantly improve performance but this fails to maximize spatial reuse where both APs and clients are deployed more chaotically. However, our approach maximizes spatial reuse regardless of the number of APs so as long as the minimum reusable distance is satisfied.

The use of power control was also employed to tune power levels on wireless devices by designing a power control algorithm that uses Gibbs sampler[7]. OPNET simulation and experiment demonstrate that in a dense scenario the power control algorithm yields significant improvement in client throughput. This approach poses some design challenges like choosing the right power levels and choosing the right MAC protocol. Our approach does not require the configuration of the AP to be altered nor is there any need to tune the power levels. Hence, no difficulty in choosing MAC protocol and power levels.

In addition, research proved that available solutions to mitigate interference may be ineffective in the future dense network because of their limitations in accommodating large numbers of APs due to too much leverage in usage. Hence, the need to coordinate the APs using an AP administrator.

In this work, effective spatial coordination is achieved by the formulation of a non-cooperative game that coordinates spatial management among the players (APs). The strategy ensures maximizes spatial reuse regardless of the number of APs so as long as the minimum reusable distance is satisfied. In addition, it is not MAC specific and does not impose power level alteration which can reduce the energy efficiency of the end devices.

Therest of this paper is organized as follows: In section II, We present non-cooperative games theory as the mathematical model formulated to coordinate the APs. In Section III, we present the channel allocation scheme as the strategy; AP separation Metric Assertion (ASMA) and the interference matrix as the outcome of the game. The solution to the game i.e. proof of existence of Nash equilibrium is presented in Section IV. Matlab simulation results is presented in section V and Finally, the paper is concluded in section VI.

2. COORDINATING THE ACCESS POINTS.

The APs are coordinated using non-cooperative game theory as a mathematical model formulated to have a coordinator as part of a group of WLANs whose coverage areas overlap one another.

Game Theory is a collection of mathematical tools to study the interactive decision problems between the rational players [8]. Games are broadly classified as co-operative and non-cooperative games. Unlike co-operative game which is a competition between coalitions of players, rather than between individual players; non cooperative game theory.

Investigates answer for selecting an optimum strategy for a player to face his/her opponent who also has a strategy of his/her own. Hence, the use of NON COOPERATIVE games is considered.

The components of games and their elements are given below:

Players: Access point.

A set of Strategy: Channel allocation scheme.

A set of payoffs: interference level, throughput, etc.

3. APPLICATION OF THE GAME.

Actions in the game

Each player is assigned a channel to transmit with interference probability guided by the spatial reusable distance which satisfies the separation metric equation given below.

$$\frac{\Sigma_{i,j=1} SEP\ (i,j)}{2*N*(N-1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

When a WLAN device is connected, it transmits beacon frame which contains all the necessary information such as the location of the AP and the number of wireless clients associated with each AP. The administrator accesses the APs and gets all the information about the AP via the **beacon** frame transmitted. It ascertains the distance (using the separation metric equation above) from its neighboring APs and consequently allocates channels with respect to the value of separation metric. i. e, if the distance between two APs is less than the minimum frequency reusable distance, different channels are allocated to them otherwise, channels are reused.

4. CHANNEL ALLOCATION: AP SEPERATION METRIC ASCERTION (ASMA) STRATEGY.

The separation metric can be determined by a simple algorithm using the flow chart below after receiving the beacon frame:

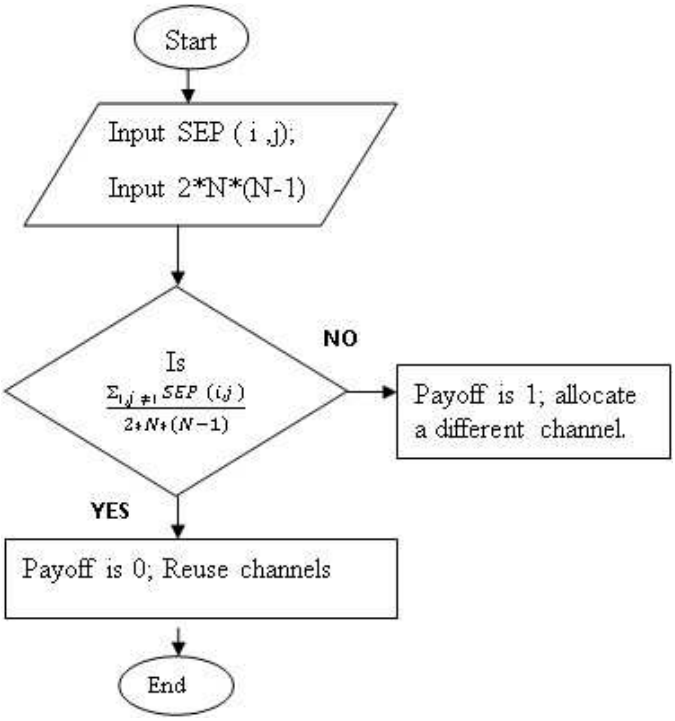


Fig 1: An algorithm for channel allocation. (ASMA)

EXAMPLE OF THE GAME

Consider an N access points, When a player is assigned a suitable transmission probability qi so that player iachieves its target rate $y_i, \forall_i \in N = \{1, 2, ..., N\}$, with the least interference occurrence. The target rate combination is; $y = [y_1, ..., y_N]$. When the target rate y_i is achieved, we have the equation given below:

$$yi = \Pi(1 - qj), \qquad \forall i \in N.$$

$a_{ij}=1$

The equation above indicates that for a successful transmission for player i, all those players which will interfere with its transmission (player j where $a_{ij}= 1$), should be allocated a different frequency.

Now consider three access points whose interference relations can be characterized by an interference matrix shown below; i.e. the outcome of the above strategy (ASMA).

Player 1(AP 1) and player 3(AP 3) can transmit simultaneously without collisions but neither of them can transmit together with player 2 (AP 2) using the same frequency.

Players one and three transmit with same frequency while player two will be assigned a different frequency.

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$$

Fig 2: Interference matrix.

5. PROOF OF EXISTENCE OF NASH EQUILIBRIUM: SOLUTION TO THE GAME

Theorem *A:* John Nash

Every game with finite number of players and finite number of action profiles has at least one Nash equilibrium (John Nash, 1951). From this theorem, it is evident that this game has a unique Nash equilibrium because it has a finite number of nodes (players) and a finite number of assigned channels (action profiles) and hence there exist a solution to the game.

To further proof that there is an equilibrium point i.e. solution to the game. We use Kakutani fixed point theorem to show that there is a least fixed point and this point is the unique Nash equilibrium.

Theorem B: Kakutani fixed point theorem*:* A correspondence r: X → X has a fixed point x ϵ X such that x ϵ r (x) if

1. X is a compact, convex and non-empty subset of $\Re^N$

2. r (x) is non-empty for all x.

3. r (x) is convex for all x.

4. r has a closed graph

Min. q_i (target rate: transmitting without interference)

$y_i = q_{ij}\pi_{a_{ij}} = 1(1 - q_j)$..... (1)

Each player is assigned a channel to transmit with the interference probability

$q_{i\epsilon[0,1],\forall i=\epsilon N}$

If a solution

$q_s = [q_s, 1, q_s, 2, \ldots\ldots\ldots\ldots q_s, N]$Exists, ...(2)

It should satisfy

$q_{s,j}$ =Min.$[\frac{y_i}{\pi_{alj=1}(1-q_{s,j})}, 1]$, $\forall i \in N$ .....(3)

We specify N-dimensional vector function:

G = $(g_1, g_2, \ldots\ldots\ldots g_N)^T$ .....(4)

Whose component

g_i is defined as a real function given by

$g_i(q) =$Min.$[\frac{y_i}{\pi_{\forall ij=1}(1-q_j)}, 1], \forall i \in N$ ..... (5)

The function $g_i$maps q = [q_1, ...q_N]$\in [0,1]^N$ into the i^{th}component of the vector function G. From the definition, the fixed point of the vector function G, $q_s = [q_s, 1, q_s, 2, \ldots\ldots\ldots q_s, N]$ is given by solving G (q_s) = q_s or $g_i(q_s) = q_{s,i}, \in$ N.
Fixed points are proper only if they exist in $[0,1]^N$.
Now, we show that G (q_s) = q_s satisfies all the conditions of Kakutani fixed point theorem.

Kakutani condition 1: X is a compact, convex and non-empty subset of$\Re^N$.

X IS COMPACT:

PROOF: A set A$\subseteq \Re^N$is compact if it is both closed and bounded. The set [0, 1] is both closed and bounded but the sets [0,∞) is only closed but unbounded, and (0, 1] is bounded but opened. Hence, [0, ∞) and (0, 1] are not compact while [0, 1] is compact.

X IS CONVEX:

PROOF: A set A$\subseteq \Re^N$is convex if for any two points *x, y* $\in$Athe straight line connecting these two points lies inside the set as well. Formally,
$\lambda x + (1 - \lambda) y \in A$ for all $\lambda \in [0, 1]$
For this work, λ is either 1 or 0.
If λ=0, we have $0 \times x + (1 - 0)y$ ..... (6)
Simplifying equation 6, we get y.
Also, if λ=1, we have $1 \times x + (1 - 1)y$ .....(7)
Simplifying equation 7 we get x. thus the straight line connecting the points lie in the set and hence, G (q_s) = q_s is convex.

X IS A NON-EMPTY SUBSET OF$\Re^N$:

PROOF: for unit interval [0, 1], there is no discontinuity. In order words, A function is continuous and always defined within the closed unit interval. Hence, the function is a non- empty subset of $\Re^N$.

KAKUTANI CONDITION 2: X HAS A CLOSED GRAPH.

For the function T: X$\rightarrow$ Y, the graph of T is defined to the set, $\{(x, y) \in x \times y / Tx = y\}$.

In point – set topology, the closed graph theorem states that, if x is a topological space and y is a compact Hausdorff space, then the graph of T is closed if and only if T is continuous.
The function is continuous because, for the closed unit interval, [0, 1] every defined function within it is continuous. Hence the function has a closed graph.
From above we have shown that the game has a fixed point and that fixed point is the unique Nash equilibrium.

6. SIMULATION RESULTS

The number of players is represented by k, the strategies are given by the utility function, $U_k$and the payoff is the graph.

The throughput for any packet oriented transmission [21] is

$$t_k(s) = t\,(1 - \exp\{-\gamma k(s)\})^L$$

where, γ=SINR

L=no of information bit per packet=20

Strategies[21], $U_k = t_k(s)/s_k$

Using the equation for throughput, the graph below was developed as shown in fig. 3

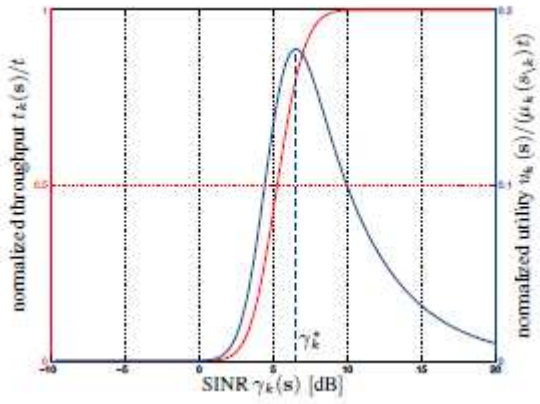


Fig. 3: Simulation Results

From the fig above, it is clear that using normal transmission, without the game, maximum throughput is achieved at a higher SINR of about 9dB. But with the game, the max throughput can be achieved at about 6dB. This confirms that there is reduced interference when game theory is applied.

7. CONCLUSION

With the present interference level within the APs and among the APs, and given the predicted future dense network, it is evident that there is every need for an improved network with the capabilities that will meet up these challenges. Hence the initialization of IEEE802.11ax: High efficiency WLANs (HEW) and the need for coordination as one of the features required to be incorporated to achieve the goal of 802.11ax. Coordination using the non-cooperative games has been used to allocate channels and enhance spatial reuse to mitigate interference.

Further work will focus on implementation of simulation model on efficient and robust hand off between APs in the same administration domain to further reduce interference level and achieve a higher through put.

REFERENCES

[1] Boris B., Luciano B., Raffaele B., Andreas K., (2016) "Next Generation IEEE 802.11 Wireless Local Area Networks: Current status, future directions and open challenges," *Computer communication,* pp. 1-25.

[2] E.H.Ong, Performance analysis of fast initial link setup for IEEE802.11ai WLANs, in: Proceedings of IEEE PIMRC'12, IEEE,2012, pp.1279–1284

[3] D.Camps-Mur, A.Garcia-Saavedra, P.Serrano, Device-to-device communications with Wi-Fi Direct: overview and experimentation, IEEE Wireless Communication. 20(3) (2013).

[4] Timo V., (2013) "Wi-Fi Capacity Analysis for 802.11ac and 802.11n: Theory & Practice" ekahau, pp 1-21

[5] B.Bellalta, IEEE820.11ax: high efficiency WLANs, IEEE Wirel. Commun. (2015). arXiv: 1501.

[6] Xi L., Anmol S., Michael K., Konstantina P., Srinivasan S., Peter S.,(2010) "Pushing the Envelope of Indoor Wireless Spatial Reuse using Directional Access Points and Clients" Carnegie Mellon University, pp. 1-12.

[7] Vivek P. Mhatre, Konstantina Papagiannaki, Francois Baccelli, (2007) "Interference Mitigation through Power Control in High Density 802.11 WLANs" pp. 1-9

[8] Mehta S., Kwak K. S. (2015) "Application of Game Theory to Wireless Networks" *Inha University Korea* , pp1-17

[9] Boris Bellalta, (2016) "Future Dense Wireless Networks", pp1-24.

[10] JiangbinLyu, Yong Huat Chew and Wai-Choong Wong, (2013) "Aloha Games with Spatial Reuse", pp1-10

[11] Allen B. MacKenzie, Stephen B. Wicker., (2001)"Selfish Users in Aloha: A Game-Theoretic Approach", pp1354-1356.

[12] Dawei G., Miao Z., Yuanyuan Y., (2013) "Channel Assignment in Multi-Rate 802.11n WLANs" pp1-6

[13] Eitan A., Rachid E., Tania J., (2010)"Slotted Aloha as a stochastic game with partial information", pp1-10

[14] Eric P., (2014) "Games theory through examples" Franklin University Switzerland, pp 10-47

[15] F. Xue, P. R. Kumar, (2003)"The number of neighbors needed forHigh Density 802.11 WLANs" pp 1-9

[16] Imad Jamil, (2015) " Improving spatial reuse in future dense high efficiency Wireless Local Area Networks, Networking and Internet Architecture" [cs.NI]. INSA de Rennes, pp 10-11.

[17] Mark F., Jean P., (2007)"Game Theory in Wireless Networks: A Tutorial" , pp1-15.

[18] Saloni M. et al (2010) "Application of game theory to wireless local area network" pp 1-17

[19] Srinivasan S, Peter S., David A., Konstantina P., Carnegie M., (2011) "Maximizing Spatial Reuse In Indoor Environments", pp 1 -21

[20] M.X.Gong, B. Hart, S. Mao, Advanced wireless LAN technologies: IEEE802.11ac and beyond, ACMSIG MOBILE Mob. Comput. Commun. Rev.18 (4) (2015) 48–52.

[21] F.Meshkati, H. V. Poor, and S. C. Schwartz, "Energy-efficient resource allocation in wireless networks," IEEE Signal Process.Mag., vol. 24, no. 3, pp. 58–68,May 2007.

[22]MansoorAlicherry, Randeep Bhatia, and Erran Li. Joint channel assignment and routing for throughput optimization in multi-radio wireless mesh networks. In *Proc. ACM MOBICOM*, pages 58–72, August 2005.

STEGANOGRAPHY: INCREASING THE SIZE OF HIDDEN MESSAGES

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ABSTRACT

Encrypting data has been the most popular approach for protecting information but this protection can be broken with enough computational power. An alternate approach to encrypting data is steganography which hide data behind another data/ information called cover file. In this way only receiver would realize its true content. In particular, if the data is hidden in an image then everyone would view it as a picture while the receiver could still retrieve the true information. The two concern of steganography Security – is the hidden data perceptible by either a person or a computer, and Capacity – how much data can be hidden in a given cover file. These are the two primary goals of steganography. These two goals are often in competition. The more data you hide, the more likely it is to be found i.e it has less security and vice versa. There is need to develop a better approach to hide more information without compromising security and integrity. This study investigates an approach to increase the capacity of data that can be hidden in an image without compromising the security and integrity of the data. An algorithm that modifies image files to accommodate more data was proposed. The proposed approach has been used to prove that image can be compressed to give more space for more file to be hidden and it has been experimented.

***Keyword**: steganography, security, images*

1. INTRODUCTION

With the development of computer and expanding its use in different areas of life and work, the issue of information security has become increasingly important. One of the grounds discussed in information security is the exchange of information through the cover media. To this end, different methods such as cryptography, steganography and coding have been used (Ibrahim & Kuan, 2010).

The method of steganography is among the methods that have received attention in recent years. One of the reasons that intruders can be successful is that most of the information they acquire from a system is in a form that they can read and comprehend. Intruders may reveal the information to others, modify it to misrepresent an individual or organization, or use it to launch an attack. One solution to this problem is, through the use of steganography.

Steganography is the art of hiding the fact that communication is taking place by hiding information within other information. Steganography as a term is derived from the Greek word

Stegos which means covered and Graphia which means writing. Using steganography, you can embed a secret message inside a piece of unsuspicious information and send it without anyone knowing of the existence of the secret message. Many different carrier file formats can be used, but digital images are the most popular because of their frequency on the internet. The major distinction between steganography and other information security such as cryptography is that in cryptography the encoded information can be seen but not comprehensible but in steganography, the existence of the information in the sources will not be noticed at all (Bhat, Krithi, Manjunath, Prabhu, & Renuka, 2017). Steganography become more important as more people join the cyberspace revolution. The growing possibilities of modern communications need the special means of security especially on computer network. The network security is becoming more important as the number of data being exchanged on the internet increases. Therefore, the confidentiality and data integrity are required to protect against unauthorized access and use also ensure data are not altered (Ahvanooey, Li, & Shim). This has resulted in an explosive growth of the field of information hiding (Mandal & Sengupta, 2011). Steganography has two primary goals: 1) Security: – is the hidden data perceptible by either a person or a computer and 2) Capacity: – how much data that can be hidden in a given cover file. These two goals are often in competition, the more data you hide, the more likely it is to be found i.e it has less security and vice versa (Johnson & Jajodia, 1998). The third goal is robustness which is what separates steganography from watermarking. Information hiding is a technique of hiding secret using redundant cover data such as images, audios, movies and documents (Evsutin, Kokurina, & Meshcheryakov, 2018). This technique has recently become important in a number of application areas such as digital video, audio, and images that are increasingly embedded with imperceptible marks which may contain hidden signatures or watermarks that help to prevent unauthorized copy (Johnson & Jajodia, 1998). This study focus on the increase of the capacity of data that can be hidden in an image without compromising the security and integrity of the data.

Steganography is the art and science of invisible communication. This is accomplished through hiding information in other information, thus hiding the existence of communication itself. Thus image steganography is a better approach than cryptography. Purpose of image processing is to make the quality of an image better so that the required operations can be easily performed on it. Image steganography is performed on the desired formats which are suitable. Steganography includes the concealment of information within computer files. In digital steganography, electronic communications may include steganographic coding inside of a transport layer, such as a document file, image file, program or protocol. Media files are ideal for steganographic transmission because of their large size. As a simple example, a sender might start with an innocuous image file and adjust the color of every 100th pixel to correspond to a letter in the alphabet, a change so subtle that someone not specifically looking for it is unlikely to notice it. Fig. 1 depicts the different kind of steganography (Mehboob & Faruqui, 2008).

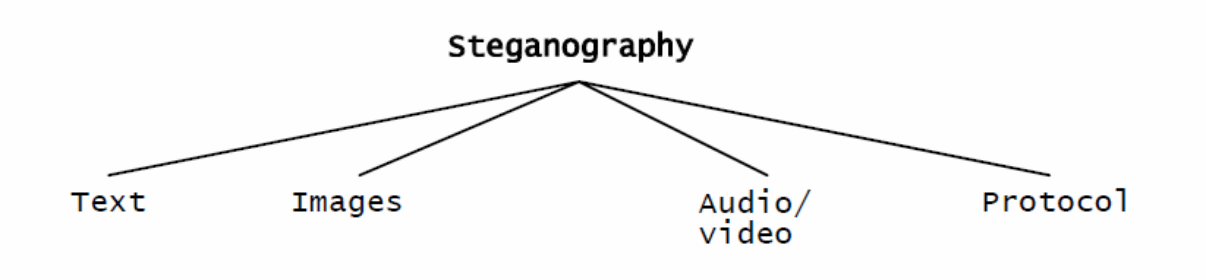


Fig. 1: Steganography

The first recorded uses of steganography can be traced back to 440 BC when Herodotus mentions two examples of steganography in *The Histories of Herodotus* (Mehboob & Faruqui, 2008). Demaratus sent a warning about a forthcoming attack to Greece by writing it directly on the wooden backing of a wax tablet before applying its beeswax surface. Wax tablets were in common use then as reusable writing surfaces, sometimes used for shorthand. Another ancient example is that of Histiaeus, who shaved the head of his most trusted slave and tattooed a message on it. After his hair had grown the message was hidden. The purpose was to instigate a revolt against the Persians. Fig. 2 illustrate a modern steganography where Alice and Bob are communicating with each other using secret message exchanging.

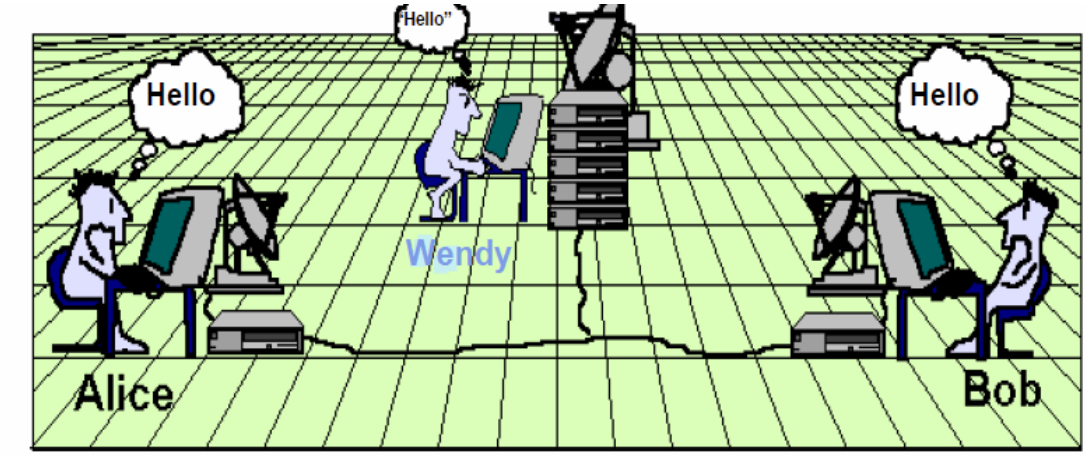


Fig. 2: Modern Steganography—THE PRISONER`S PROBLEM:

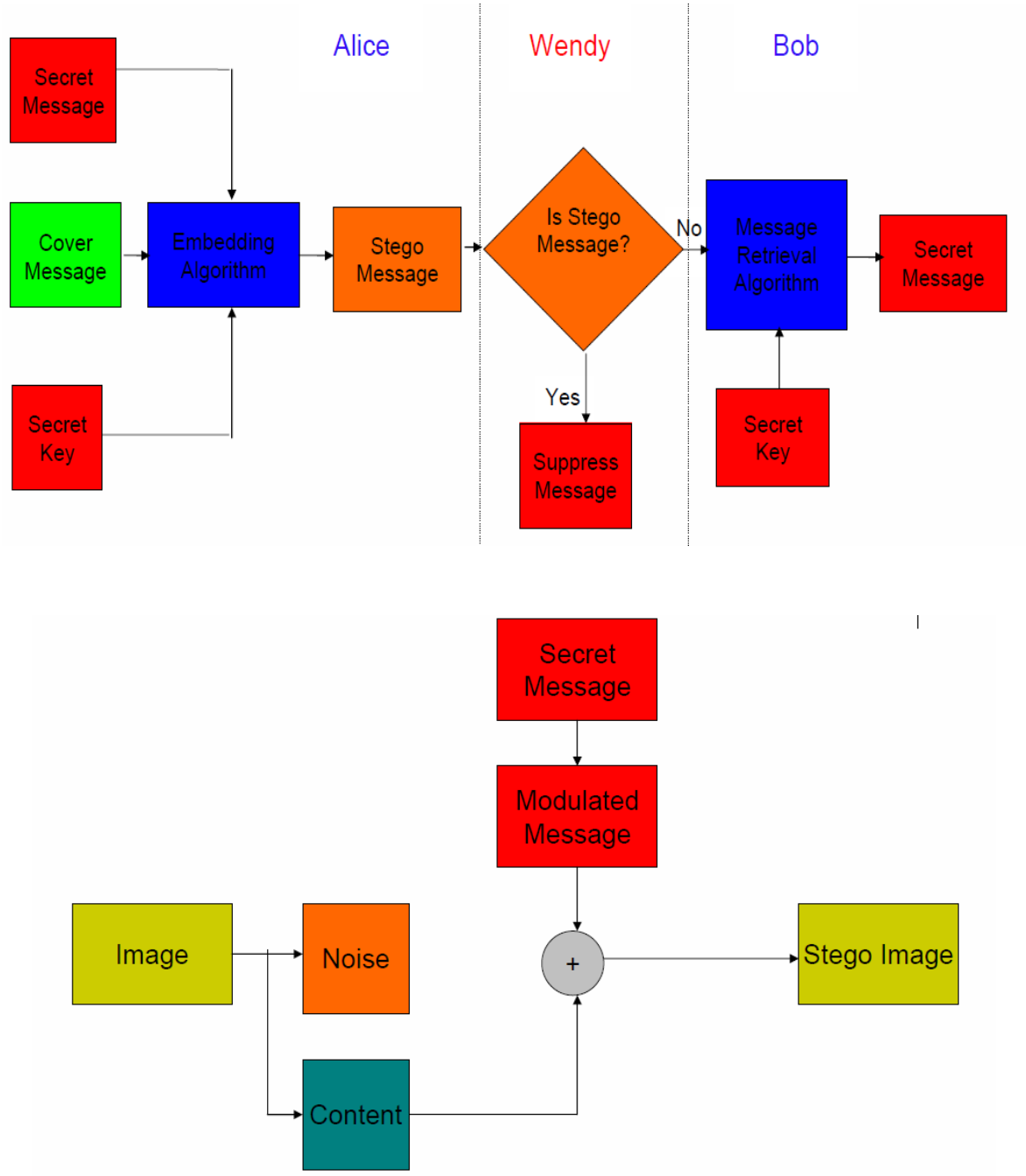


Fig. 3: Steganography in practice

Steganography is a special case of data hiding. But data hiding cannot always be steganography. In fig. 3, the steganography flowchart is to hide information from Wendy when Alice and Bob are communicating with each other (Saravanan & Neeraja, 2013).

2. IMAGE AND ITS PROCESSING

An image is an array or a matrix of square pixels (picture elements) arranged in columns and rows. Pixel is known as the smallest unit of a digital image or graphic that can be displayed and represented on a digital display device, it is represented by dot or square on a computer monitor display screen.

In a (8-bit) grayscale image each picture element has an assigned intensity that ranges from 0 to 255. A grayscale image is called a black and white image but the name emphasizes that such an image will include many shades of grey. A normal grayscale image has 8 bit color depth = (256 grayscales). A "true color" image has 24 bit color depth of 8 x 8 x 8 bits = 256 x 256 x 256 colors approximately 16 million colors (Roy and Parekh 2011).

There are two general groups of 'images': vector graphics (or line art) and bitmaps (pixel-based or 'images'). Some of the most common file formats are:

i) GIF: — an 8-bit (256 colour), non-destructively compressed bitmap format. Mostly used for web. It has several sub-standards one of which is the animated GIF.
ii) JPEG: — a very efficient (with. much information per byte) destructively compressed 24 bit (16 million colours) bitmap format. Widely used, especially for web and Internet (bandwidth-limited).
iii) TIFF: — the standard 24 bit publication bitmap format, compresses non-destructively, for instance, Lempel-Ziv-Welch (LZW) compression.
iv) PS: — Postscript, a standard vector format. It has numerous sub-standards and can be difficult to transport across platforms and operating systems.
v) PSD: – a dedicated Photoshop format that keeps all the information in an image including all the layers.

The proposed system requires JPEG image file and the information or message that is to be hidden in text format. Images are composed of picture elements, i.e. pixels.

Fig. 4 depict the color code for different kind of images and the combination of the color code there are three major classes of image:

i) Black and white: – In this class, each pixel is composed of a single bit and is either a zero or a one representing either white or black;

ii) Grayscale: – In this class, each pixel is composed of 8 bits (in rear cases, 16 bits) which defines the shade of grey of the pixel from zero (black) to 255 (white);

iv) Full color – Also known as 24-bit color. There are 3 primary colors (red, green, blue), each of which is defined by 8 bits. The 24 bit color was considered in this study which has 255 color models. The study will reduce the 255 color model in other to allow higher quantity of information to be hidden in the image file without compromising the quality of the image.

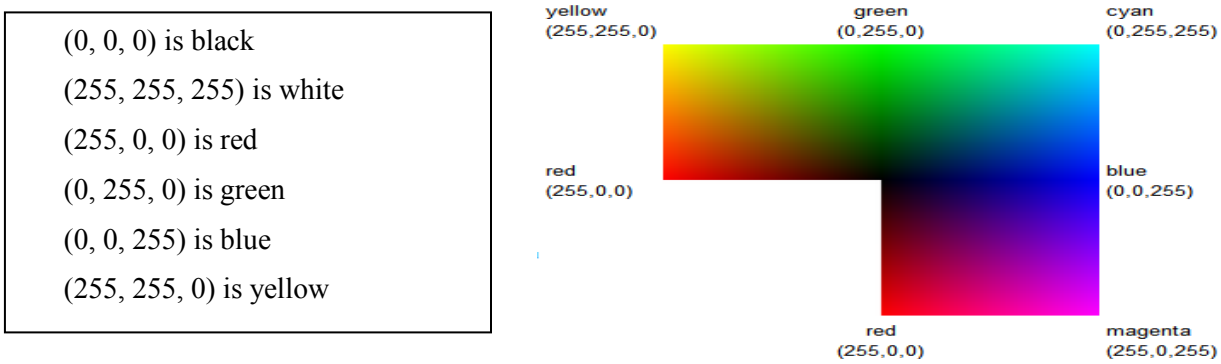


Fig. 4: Classes of image and the color code.

3. RELATED WORKS

Studies have been done in hiding messages, information and even images behind other images often referred to as the cover image.

Akhtar, Johri, & Khan (2013) implemented a variation of plain Least Significant Bit (LSB) algorithm in which the quality of the stego-image was improved by using bit-inversion technique. To improve the robustness of steganography, RC4 algorithm was used to randomly hide message bits into cover image pixels instead of storing the message bits sequentially. This method randomly disperses the bits of the message in the cover image and thus, harder for unauthorized people to extract the original message. The presented method shows good enhancement to Least Significant Bit technique in consideration to security as well as image quality.

Prabakaran, Bhavani, & Rajeswari (2013) proposed a multi secure and robust medical image based steganography scheme for securing sensitive information of medical patients it provides secure storage mechanism for medical images. The study used Integer Wavelet Transform (IWT) to protect Magnetic Resonance Imaging (MRI) medical image as a single container image. Patient medical image and the secret container on which Arnold Transform is applied to obtain a scrambled secret image. The scrambled image is embedded into a dummy container image. The quality parameters are improved with acceptable Peak Signal to Noise Ratio (PSNR) which is an engineering term for the ration between the maximum possible power of a signal and the power of corrupting noise that affects the fidelity of its representation.

Thenmozhi & Chandrasekaran (2013) presented a novel scheme which embeds data in integer wavelet transform coefficients by using a cropping function in an 8×8 block on the cover image. The optimal pixel change process was applied after embedding the message. The study employed the frequency domain to increase the robustness of the steganography scheme. IWT avoid the floating point precision problems of the wavelet filter. Result shows that the method outperforms adaptive steganography technique based on the integer wavelet transform in terms of PSNR and capacity.

Das & Tuithung (2012) proposed a technique for image steganography based on Huffman Encoding using Two 8 bit gray level image of size M X N and P X Q as cover image and secret image respectively. Huffman Encoding is performed over the secret message before embedding and each bit of Huffman code of secret message is embedded inside the cover image by altering the LSB of each of the pixel's intensities of cover image. The size of Huffman encoded bit stream and Huffman Table are also embedded inside the cover image, to make the Stego-Image becomes standalone information to the receiver.

Reddy, Sathisha, Kumari, & Raja (2012) worked on Secure Steganography using Hybrid Domain Technique (SSHDT). Considering cover image of different formats and sizes resized to dimensions of power of 2. The Daubechies Lifting Wavelet Transforms (LWT) is applied on cover image to generate four sub bands XA, XH, XV and XD. The XD band is considered and divided into two equal blocks say upper and lower for payload embedding. The payload of different formats are considered and resized to dimensions of power of 2. The payload is fragmented into four equal blocks. The Decision Factor Based Manipulation (DFBM) is used to scramble further stego object to improve security to the payload. Dubechies Inverse LWT (ILWT) is applied on XA, XH, XV and XD stego objects to obtain stego image in spatial domain.

Hemalatha, Acharya, & Renuka (2015) proposed a very secure and robust steganography system using a key to hide information through IWT. The information hidden is secure and cannot be lost due to noise or any signal processing operations. Result shows very good PSNR, which is a measure of security. In this method the secret information is hidden in the middle bit-planes of the integer wavelet coefficients in high frequency sub-bands.

Hamid, Yahya, Ahmad, & Al-Qershi (2012) has presented an overview of image steganography technique, In this paper the author have given brief description of images and some related concepts. The study also gives an overview of steganography techniques applicable to specific image formats and describes a performance measure for the distortion caused by embedding data in an image. Various transform domain techniques use to hide information and spread spectrum technique, statistical method and distortion methods, pallete methods are defined. The author combines the various techniques to attain steganography process which reflects efficiency in the result.

Bhattacharyya, Das, Bandyopadhyay, & Kim (2009) has presented paper on text steganography, a novel approach consisting of a security model proposed which imposes the concept of security over privacy for text messages. The model proposed combines cryptography, steganography and along with that an extra layer of security has been imposed in between them.

4. OVERVIEW OF THE EXISTING SYSTEM

Cryptography is a technique for securing the secrecy of communication. Many different encrypt and decrypt methods have been implemented to maintain the secrecy of the message, it may also be necessary to keep the existence of the message secret. Steganography is the art and science of invisible communication of messages. It is done by hiding information in other information, i.e. hiding the existence of the communicated information. In image steganography

the information is hidden in images. Today steganography is mostly used on computers with digital data being the carriers and networks being the high speed delivery channels. The difference between Steganography and Cryptography is that the cryptography focuses on keeping the message content secret whereas in steganography focus on keeping the existence of a message secret. Steganography and cryptography are the ways for protecting information from unwanted parties (El-Emam 2007). The both method of securing data are used together for majority of the existing steganography.

The existing system consist of information and the cryptography process that makes the information encrypted and also the image plus the steganography process that provide the hidden the information.

5. PROPOSED APPROACH

The system requires JPEG image file and the information or message that is to be hidden in text format. Images are composed of picture elements, i.e. pixels.

The system was developed using new process of steganography which involves compression of an image in jpeg format to reduce the size of the image so as to give chance for more information in text format to be hidden without compromising the quality of the image and without third party having a view of the communication going on. The image and the information will undergo steganography process to produce a stego-image.

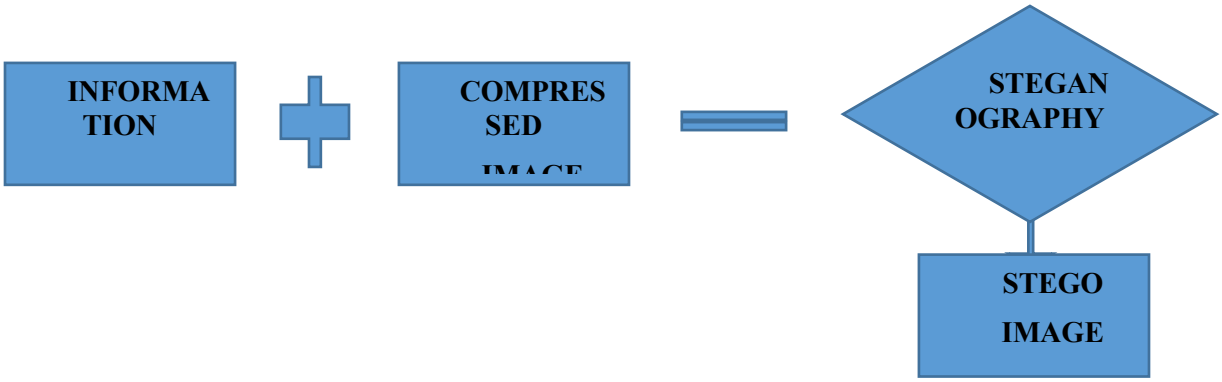


Fig. 5: Implementation of steganography process

Fig. 5 shows how the steganography process will be implemented. The study is to increase the size of information to be hidden in jpeg file this can be achieved through the use of Microsoft image compression method to compress the original image by converting the color range model to a binary bit and reduce the necessary color model without compromising the quality. The algorithm makes use of JPEG image file as a cover media (cover image) to hide a secret message. It utilizes the LSB approach, which is a simple way of steganography where it replaces one or more of the LSBs of the image pixels with bits from the secret message. We take the binary representation of the hidden data and overwrite the LSB of each byte within the cover image. The information will be embedded inside the planes of the pixels of the cover image by minimizing the variation in colors that is created. Each color channel in the data image is

assigned a zero or one and this value is then embedded. The algorithm used for the steganography procedure is as follows

Algorithm to hide information in an Image without image compression

Step 1: Accept the original Image file and all its attributes from the user.

Step 2: Get the Image file size.

Step 3: Read the cover image and the text message which is to be hidden in the cover image.

Step 4: Convert the text message to binary format.

Step 5: Calculate the LSB of each pixel of the cover image.

Step 6: Replace the cover image of the LSB with each bit of secret message one by one.

Step 7: Write stego image.

Step 8: Calculate the Mean square Error (MSE) and the Peak signal to noise ratio (PSNR) of the stego image.

Step 9: Save the stego image in Jpeg format.

Step 10: Save successfully.

Algorithms to Compress an Image:

Step 1: Accept the Image file and all its attributes from the user.

Step 2: Get the Image file size.

Step 3: Get the desire percentage the image will be compressed to.

Step 4: Launch image encoder parameter and codec process for the image compression procedure.

Step 5: Image compressed successfully.

Step 6: Save the compressed image in Jpeg format.

Step 7: Specify the directory path to save the image in Jpeg format.

Step 8: Save and open the directory of the compressed image to affirm the compression process.

Step 9: Image compressed, saved and confirmed successfully.

Algorithm to Hide Information in compressed Image:

Step 1: Accept the compressed Image file and all its attributes from the user.

Step 2: Get the compressed Image file size and its entities.

Step 3: Read the compressed cover image and the text message which is to be hidden in the compressed cover image.

Step 4: Convert the text message to binary format.

Step 5: Calculate the LSB of each pixel of the compressed cover image.

Step 6: replace the LSB of the cover image with each bit of secret message.

Step 7: Accept large file size to be hidden in the compressed image.

Step 8: Write the compressed stego image.

Step 9: Calculate the Mean square Error (MSE) and the Peak signal to noise ratio (PSNR) of the compressed stego image.

Step 10: Save the compressed stego image in Jpeg format.

Step 11: Save successfully.

Algorithm to retrieve the text message:

Step1. Convert the image to bmp format first.

Step2. Import from file location.

Step 3: Read the stego image.

Step 5: Calculate LSB of each pixels of stego image.

Step 6: Retrieve bits and convert each 8 bit into character.

Step 7: Choose the location to decode the image and information.

Step 8: Decode successfully.

Step 9: Save the retrieved information for further use.

6. RESULTS AND DISCUSSION

The first step in steganography is to embed and hide information, which is achieved by passing both the secret message and the cover message in to the encoder. The encoder implements several protocols to embed the secret information into the cover message. A key is needed in the embedding process which is used to reduce the chance of third party attackers getting hold of the stego object and decoding it to find out the secret information.

The developed steganography software was used to process different samples of image to analyze the effectiveness and efficiency of the developed software for the users. The first sample of image used is displayed in fig. 6. The original file size for the image is 36.9KB before

embedding text or compression, the file properties which entails the size of the image is also shown in fig. 7. Steganography procedure was initialized on the image and a sample text of 5.08KB with 676 characters was hidden in the image without compression, the text file properties including the file size is presented in fig. 8. The stego-image (i.e after the text is hidden in the image) is 768KB, the file properties of the stego-image is shown in fig. 9. However, the image "lena.jpg" is compressed to 50% (i.e 18KB) of the original image size to reduce the image quality and size in order to embed more text in the compressed image, the compressed image file size and properties is shown in fig. 10. The same sample text was embedded in the compressed image of the lena.jpg and the file size is 113KB which is lower compared to when the lena.jpg image was not compressed, thus indicating that more text can be embedded in the image. The compressed image with embedded sample text (i.e compressed stego-image) file properties including the file size is shown in fig. 1.



Fig. 5: An image of the sample (lena.jpg) used for the steganography procedure.

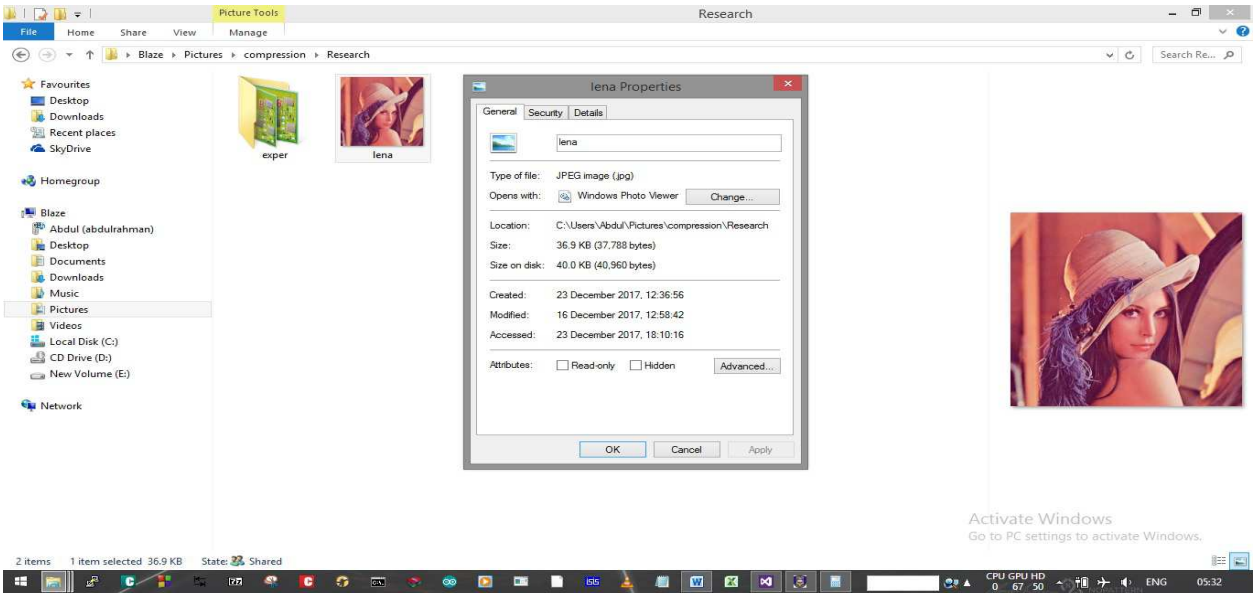


Fig. 6: Illustration of the Sample Image File Properties

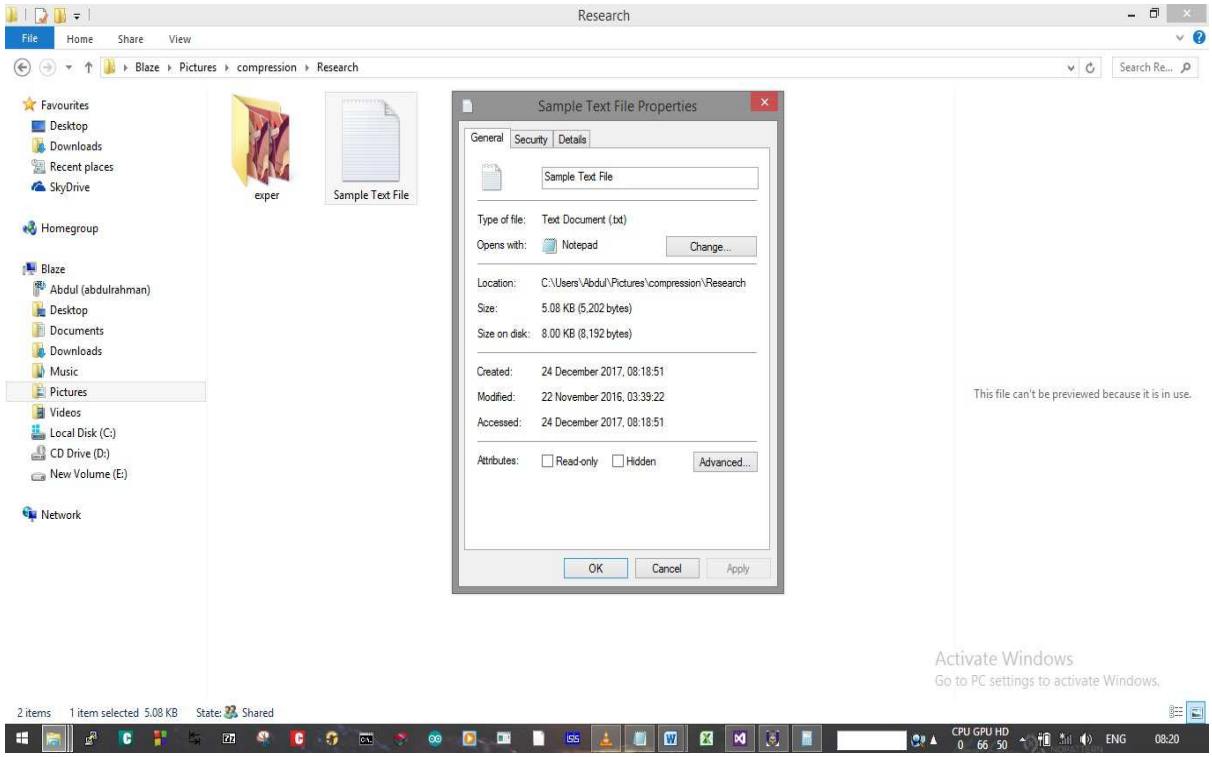


Fig. 7: Sample Text File Properties

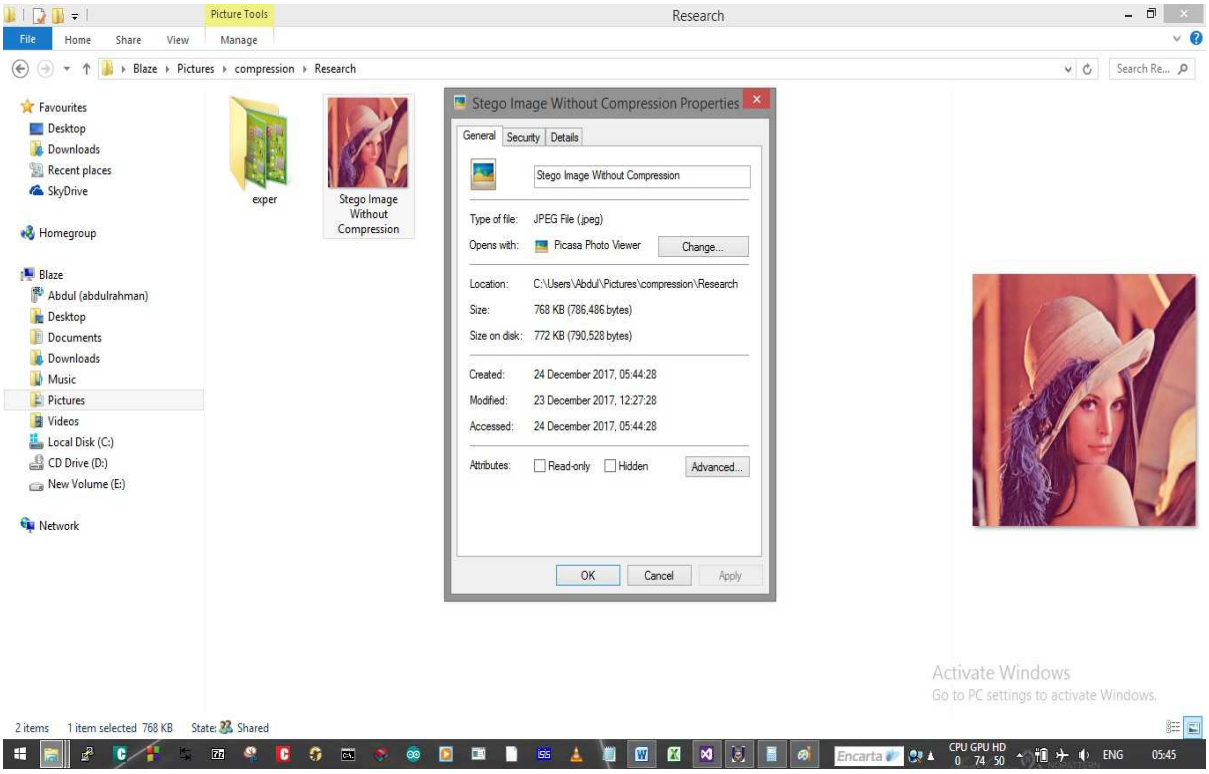


Fig. 8: Stego-Image File Properties

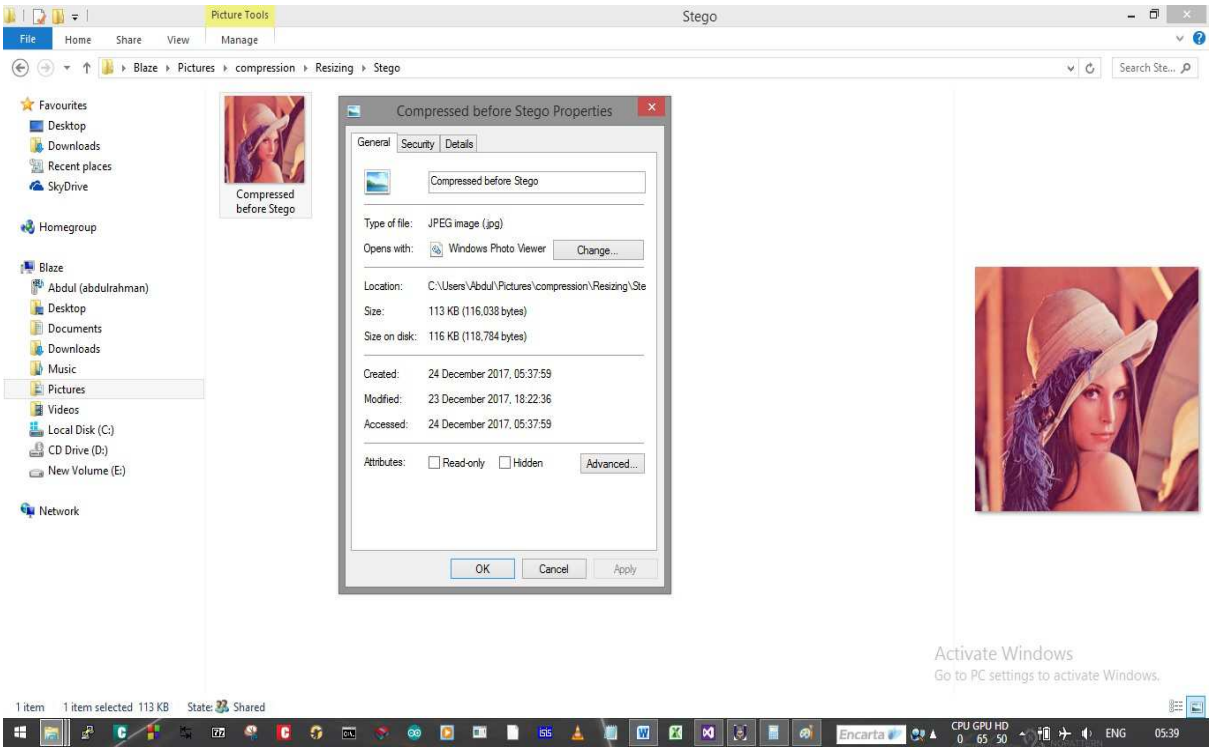


Fig. 9: Compressed Image and Hidden with Text

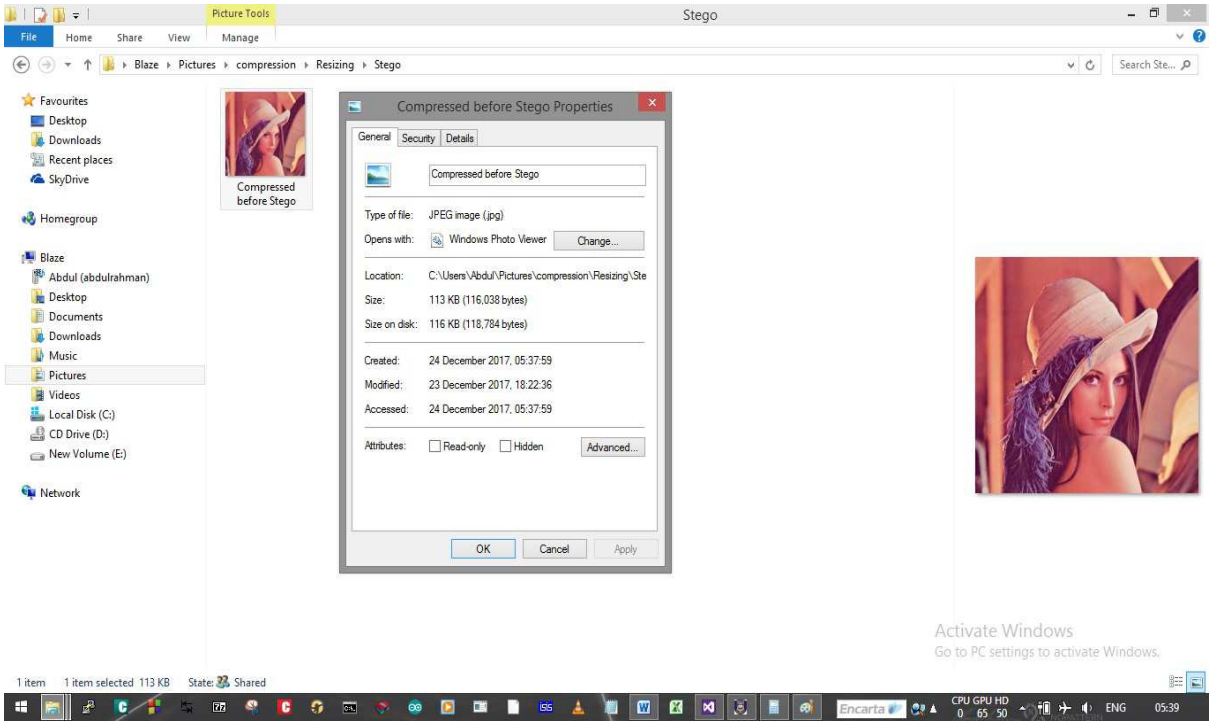


Fig. 10: Compressed image and hidden with text

7. CONCLUSION

The hurried development of multimedia and internet allows wide distribution of digital media data. It becomes much easier to edit, modify and duplicate digital information. In addition digital document is also easy to copy and distribute, therefore it may face many threats. It became necessary to find an appropriate protection due to the significance, accuracy and sensitivity of the information. Nowadays, protection system can be classified into steganography (hiding of information behind a cover image), Cryptography (encryption of information) and combination of both. This approach proposed a new steganography algorithm with 2 layers of security. A Steganography Imaging System has been developed using the proposed algorithm. We tested few images with various sizes of data to be hidden. With the proposed algorithm, we found that the stego image does not have a noticeable distortion on it (as seen by the naked eyes). We also tested our stego images using peak to signal noise ratio value (i.e PSNR). Based on the PSNR value of each images, the stego image has a higher PSNR value. Hence this new steganography algorithm is very efficient to hide higher data file size inside the compressed image. It utilizes the Least Significant Bits (i.e LSB) approach which is a simple way of steganography where it replaces one or more of the LSBs of the image pixels with bits from the secret message. The binary representation of the hidden data is used to overwrite the LSB of each byte within the cover image. The information will be embedded inside the planes of the pixels of the cover image by minimizing the variation in colors that is created. Each color channel in the data image is assigned a zero or one and this value is then embedded.

This study has proposed a new and efficient method for embedding larger size of data in images; the three layer approach extends the size of message storage. The following are the contribution to knowledge:

i. An achievement was made on the image to be used for the steganography process.
ii. More space was created for more data to hidden in the compressed stego image.
iii. Regardless, the size of the image as long as it black and white, text or image cannot be hidden in the Image.

Further research will be carried out to determine the threshold for the maximum level of data that can be hidden in stego-images and also there should be more research on how more data can be hidden in monochrome image and how it can be retrieve successfully.

REFERENCES

Ahvanooey, M. T., Li, Q., & Shim, H. J. A Comparative Analysis of Information Hiding Techniques for Copyright Protection of Text Documents.

Akhtar, N., Johri, P., & Khan, S. (2013). *Enhancing the security and quality of LSB based image steganography.* Paper presented at the Computational Intelligence and Communication Networks (CICN), 2013 5th International Conference on.

Bhat, D., Krithi, V., Manjunath, K., Prabhu, S., & Renuka, A. (2017). *Information hiding through dynamic text steganography and cryptography: Computing and Informatics.*

Paper presented at the Advances in Computing, Communications and Informatics (ICACCI), 2017 International Conference on.

Bhattacharyya, D., Das, P., Bandyopadhyay, S. K., & Kim, T.-h. (2009). Text steganography: a novel approach. *International Journal of Advanced Science and Technology, 3*(1).

Das, R., & Tuithung, T. (2012). *A novel steganography method for image based on Huffman Encoding.* Paper presented at the Emerging Trends and Applications in Computer Science (NCETACS), 2012 3rd National Conference on.

Evsutin, O., Kokurina, A., & Meshcheryakov, R. (2018). Approach to the selection of the best cover image for information embedding in JPEG images based on the principles of the optimality. *Journal of Decision Systems*, 1-9.

Hamid, N., Yahya, A., Ahmad, R. B., & Al-Qershi, O. M. (2012). Image steganography techniques: an overview. *International Journal of Computer Science and Security (IJCSS), 6*(3), 168-187.

Hemalatha, S., Acharya, U. D., & Renuka, A. (2015). Wavelet transform based steganography technique to hide audio signals in image. *Procedia Computer Science, 47*, 272-281.

Ibrahim, R., & Kuan, T. S. (2010). *Steganography imaging system (SIS): hiding secret message inside an image.* Paper presented at the Proceedings of the World Congress on Engineering and Computer Science.

Johnson, N. F., & Jajodia, S. (1998). *Steganalysis of images created using current steganography software.* Paper presented at the International Workshop on Information Hiding.

Mandal, J., & Sengupta, M. (2011). *Steganographic technique based on minimum deviation of fidelity (STMDF).* Paper presented at the Emerging Applications of Information Technology (EAIT), 2011 Second International Conference on.

Mehboob, B., & Faruqui, R. A. (2008). *A stegnography implementation.* Paper presented at the Biometrics and Security Technologies, 2008. ISBAST 2008. International Symposium on.

Prabakaran, G., Bhavani, R., & Rajeswari, P. (2013). *Multi secure and robustness for medical image based steganography scheme.* Paper presented at the Circuits, Power and Computing Technologies (ICCPCT), 2013 International Conference on.

Reddy, H. M., Sathisha, N., Kumari, A., & Raja, K. (2012). *Secure steganography using hybrid domain technique.* Paper presented at the Computing communication & networking technologies (ICCCNT), 2012 third international conference on.

Saravanan, V., & Neeraja, A. (2013). *Security issues in computer networks and stegnography.* Paper presented at the Intelligent Systems and Control (ISCO), 2013 7th International Conference on.

Thenmozhi, S., & Chandrasekaran, M. (2013). *A novel technique for image steganography using nonlinear chaotic map.* Paper presented at the Intelligent systems and control (ISCO), 2013 7th international conference on.

INFLUENCE OF ONLINE GAMBLING ON ACADEMIC PERFORMANCE OF STUDENTS: A CASE OF UNIVERSITY OF ILORIN, ILORIN, NIGERIA

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ABSTRACT

The digital natives' society are technologically inclined, so they spend quality time surfing the internet. This study described the influence of online gambling on academic performance of students in University of Ilorin, Ilorin, Nigeria. It determined the effect of online gambling on learning; found out learners attitude towards online gambling; examined learners' control over the time spent on online gambling and determined the gender influence on online gambling towards students' academic performance. The study adopted a descriptive survey method. Sample of the study consisted 199 undergraduate students in which questionnaire was used for the data collection. Response from questionnaire were analyzed, frequency and percentage were used to answer the research questions and Chi-square to interpret hypotheses using SPSS version 21.0. The research revealed that students spent less activities related to their course; students have positive attitude towards online gambling; student lack proper time management since they spend a lot of time gambling online; there is no significant difference between male and female students' attitude towards online gambling with a chi-squared value of X-squared (199) = 0.450, p (0.9297) > 0.05; and there is no significant difference between the time spent online and students' academic performance with a chi-squared value of X-squared (199) = 7.338, p (0.602) > 0.05. Based on the findings, it was recommended that, the school authority should monitor online gambling participation through blockage of website that promotes online gambling, the governments should be made aware of the risks of online gambling and School counselors should include online gambling education program into existing programs, amongst others.

Keywords: *Influence, Online Gambling, Problem Gambling and Academic Performance*

1. INTRODUCTION

Information and Communication Technologies (ICT) are digital tools that involve the integration of technological devices. ICT as described by Bandele (2006) is a revolution that involves the use of computers, internet and other telecommunication technology in every aspect of human endeavor. These include: Internet access, electronic mail, CD-ROMS, telephone, online databases, library services and fax machines (Nwosu & Ogbomo, 2012).

Internet use is increasing globally as a result of readily available high-speed, low-cost, Internet access and Internet-enabled technology. During the last two decades, the way students live and work has changed due to the developments in the communication and information industries (Unsal, Ruzgar, & Ruzgar, 2008). Worldwide internet consumption is constantly on the rise, with studies as far back as year 2011, showing that there were more than 2.4 billion internet users in the world (De Leo & Wulfert, 2013). Durkee and Mandelli, (2012) opined that majority of Internet users are adolescents and young people. The Internet has become an

important part of students' lives and most significantly to University of Ilorin's students. Students use Internet because it is the easiest way to get information and however, if the Internet is not wisely used, it may affect their studies, health, and social relationship.

Chen and Fu, (2009) showed that Internet could be both harmful and helpful to adolescents' academic performance. That is, if Internet is used to search for information, it could be beneficial to academic performance. However, if the Internet is used to either socializing or online gambling it could have a negative effect on students' academic performance. Although the Internet could be somewhat beneficial to students' academic performance, the disadvantages seemed to outweigh the benefits (Englander, 2010).

The gambling industry has expanded its opportunities on Internet. At the same time there has been an exponential growth on Internet and people's desire to gamble. Therefore, it is not surprising that there has been an increase in the numbers of online gambling and betting opportunities. In 1997, there were approximately 30 gambling Web sites available, ten years later this number had increased to around 3,000 (Matthews, Farnsworth, & Griffiths, 2009). However, with the increasing Interest and demand for online gambling, there came difficulties such as reliability, transparency and many more. The competition got fierce and organizations began fighting against the gambling Web sites, claiming there's a relationship between online gambling and compulsive gambling or problem gambling (Matthews, Farnsworth, & Griffiths, 2009, Eklund, 2012, Smed and Hakonen, 2003).

Gambling is understood as the established practice of staking money or other valuables on games or events of an uncertain outcome (Binde, 2005). Gambling is rarely presented in a realistic way rather, gambling is presented either very positively with few, if any, references made to negative consequences or accurate probabilities of winning with gambling depicted as socially rewarding, or very negatively, resulting in viewing gambling problems as so severe that individuals have lost their homes and families. Nigeria youth especially undergraduates are engaging themselves in gambling as a means of surviving, this is an intricate issue of special concern as this behavior may predispose them to pathological and compulsive gambling (Oyebisi, Alao, & Popoola, 2012).

For most individuals, gambling provides a harmless and entertaining diversion to everyday life. Along with the growth of the gambling industry and corresponding increase in approval and convenience, there has also been a rise in the prevalence of pathological and problem gambling, with the rate of disordered gambling among adults having risen significantly from 1977 to 1993 (Williams, 2006). Both problem and pathological gambling are characterized by destructive behaviors that can disrupt or damage careers, personal relationships, and families and the human costs and suffering prove most difficult to quantify. Although, problem gambling exists in all age categories, university students are particularly vulnerable, as going to university often represents the first move away from a student's family with fewer associated restrictions on their activities (Shaffer, Donato, LaBrie, Kidman, & LaPlante, 2005).Governments throughout the world view gambling as a relatively easy way to increase revenues with only minimal attention being paid to the societal costs.

The acceptance of gambling as a harmless form of entertainment vastly underestimates the risks involved such as time management, gender attitude and many more. Time management for students can be one of the most important and difficult skills to learn during university years. Lucier, (2013) argues that with so much going on, having strong time management and control can sometimes seem impossible. However, there are time management options that can help students take control of their life instead of getting exhausted and behind in academics. There is

connection between how much time was spent on the Internet and the grades students got. The more time students spent online, the worse the impact was on their academic performance (Englander, 2010, Summerfield & Loo, 2010).

Gender differences have been reported in several studies. Males are described as engaging in gambling more frequently than females (Walker, Courneya, & Deng, 2007). This stronger drive to gamble could be related to the adventurous characteristic of stereotypical male behavior or the social drive to compare oneself with other influential males (Walker, Courneya, & Deng, 2007). There are differences with preferences for type of gambling, gender differences found in gambling behavior reveals that males students were more likely to engage in playing cards, betting on sports, and games that involved skills while females students were more likely to be involved with gambling at casinos, playing slot machines or bingo (Engwall, Hunter, & Steinberg, 2004).

Numerous studies have documented that college and university students have the highest rates of gambling and problem gambling (Shaffer, Forman, Scanlon, & Smith, 2000). Several studies recommend the need for gambling educational programs, similar to current alcohol and drug education awareness seminars currently offered in many colleges and universities (Shaffer, LaBrie, Kidman, & LaPlante, 2005). The fact that students could get addicted to Internet use much like drug addiction, online gambling has fueled considerable controversy and debate. However, existing literature has clearly indicated that users are experiencing negative consequences from the time they spent online (Anderson, 2001). However, the paramount issue of managerial concern is how to manage online gambling among students' population and to minimize its impact on academic performance. Macan, Shahani, Dipboye, and Phillips, (2013) opined that one potential coping strategy frequently offered by university counseling services is time management.

By comparing the impact thereof upon gambling attitudes and time control, college administrators may be better able to design effective education-based interventions. Moreover, there has been little research documenting whether online gambling has any influence on students' attitudes and academic performance. Hence, there remains a void for studies related to these factors.

This study discovered if online gambling has an effect that could potentially benefit the academic performance of the university student. However, the study specifically:

i) determined the effect of online gambling on learning;
ii) found out learner's attitude towards online gambling;
iii) examined learners' control over the time spent on online gambling; and
iv) determined the gender influence on online gambling towards the students' academic performance.

The study specifically provided answers to the following research questions.

i) How does online gambling affect learning?
ii) What attitude does learners have towards online gambling?
iii) How can learners control the time spent on online gambling?
iv) What is the influence of gender on online gambling towards the students' academic performance?

The following two null hypotheses were tested:

Ho_1: There is no significant difference between male and female students' attitude towards online gambling.

Ho_2: There is no significant difference between the time spent on online gambling and students' academic performance.

2. METHODOLOGY

This study is a descriptive research of the survey type. A researcher designed questionnaire was used to gather relevant information on influence on Online gambling on academic performance of students in University of Ilorin, Ilorin, Nigeria (Unilorin). The population for the study was University of Ilorin while the target population was all undergraduates. Two hundred (200) respondents were purposively selected from seven (7) faculties within the University. The sample was based on the premise that they all have Internet access provided by the University or their Mobile data. These students are selected purposively because they share similar characteristic which is online gambling and also due to the research design. The selected Faculties are: Social Sciences, Life Sciences, Physical Sciences, Education, Engineering and Technology, Environmental Sciences and Arts. The instrument was validated by three experts for face, value and content validity. The data obtained through the questionnaire were subjected to descriptive and inferential statistics. The descriptive analysis such as frequency count and percentage were used to answer the research questions 1-4, Chi-square was used to analyse research hypotheses 1 and 2 using Statistical Package for Social Sciences (SPSS) version 21.0 for windows at 0.05 level of significance.

3. RESULTS

The analysis of the data gathered and the corresponding results are thus presented.

Table 1:

Percentage Distribution of Respondents by Faculty

Faculty	Frequency	Percentage (%)	Cumulative (%)
Social Sciences	28	14.1	14.1
Physical Sciences	27	13.5	27.6
Life Sciences	30	15.1	42.7
Education	31	15.6	58.3
Environmental Sciences	31	15.6	73.9
Arts	28	14.1	88
Engineering &Technology	24	12.0	100
Total	199	100%	100%

Table 1 showed the percentage distribution of respondents by faculty. Faculty of Social Sciences 28 (14.1%), Faculty of Physical Sciences 27 (13.5%), Faculty of Life Sciences 30 (15.1%), Faculty of Education 31 (15.6%), Faculty of Environmental Sciences 31 (15.6%), Faculty of Arts 28 (14.1%), Faculty of Engineering and Technology 24 (12%) the total number of respondents is one hundred and ninety-nine (199).

Table 2:
Percentage Distribution of Respondents by Level

Level	Frequency	Percentage (%)	Cumulative (%)
200	43	21.6	21.6
300	88	44.2	65.8
400	66	33.2	99.0
500	2	1.0	100
Total	199	100%	100%

Table 2 showed the percentage distribution of respondents by level. 200 Level 43 (21.3%), 300 Level 88 (44.2%), 400 Level 66 (15.1%) and 500 Level 2 (1%).

Table 3:
Percentage Distribution of Respondents by Gender

Gender	Frequency	Percentage %	Cumulative %
Female	44	22.1	22.1
Male	155	77.9	100
Total	199	100%	100%

Table 3 showed that 44 of the respondents (22.1%) are Female while Male are 155 representing 77.9% of the total respondents.

Table 4:
Percentage Distribution of Respondents by Age Range

Age Range	Frequency	Percentage%	Cumulative%
14-19	43	21.6	21.6
20-25	140	70.4	92.0
26-31	13	6.5	98.5
32 and Above	3	1.5	100
Total	199	100%	100%

Table 4 showed that the respondents that fall within ages 14 – 19 years are 43 (21.6%), 20 – 25 years are 140 (70.4%), 26 – 31 years are 13 (6.5%), while the remaining respondents 3 (1.5%) are 32 years and above.

Table 5:
Percentage Distribution of Respondents by Internet Connectivity

Item	Frequency	Percentage %
Unilorin Wi-Fi	100	50.3
Personal modem	79	39.7
Cyber café	114	57.3
Mobile data	148	74.4

Table 5 showed the percentage by which the respondents connect to the internet. 50.3% connect via Unilorin Wi-Fi, 39.7% connect via personal modem while 57.3% connect via cyber café and 74.4% connect via modem data.

Table 6:
Percentage Distribution of Respondents' Devices

Item	Frequency	Percentage %
Personal computer	119	59.8
Smart Phone	168	84.4
tablet	90	49.2
IPad	16	8

Table 6 showed that 119 (59.8%) uses personal computer, 168 (84.4%) uses smart phone, 90 (49.2%) uses Tablet and 16 (8%) uses iPad to connect to the internet.

Table 7:
Percentage Distribution of Respondents' Influence of Online Gambling Towards Students' Academic Performance

S/N	Item	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly disagree (%)
1	Internet facility is best used for gambling than for learning activities.	56 (28.1%)	43 (21.3%)	69 (34.7%)	31 (15.6%)
2	I prefer to gamble online for monetary gain than to do my school assignments.	35 (17.6%)	82 (41.2%)	58 (29.1%)	24 (12.1%)
3	I skip lectures, test and school activities to have more time for online gambling.	43 (21.6%)	48 (24.1%)	61 (30.7%)	47 (23.6%)
4	I think about winning odds while sitting in the classroom.	58 (29.1%)	73 (36.7%)	47 (23.6%)	21 (10.6%)
5	I prefer to invest my money on gambling to buying learning materials.	51 (25.6%)	60 (30.2%)	61 (30.6%)	27 (13.6%)
6	I think more about my gaming result than school result.	43 (21.6%)	59 (29.6%)	62 (31.2%)	35 (17.6)
7	Online gambling seems effortless compared to reading.	94 (47.2%)	63 (31.7%)	28 (14.1%)	14 (7.0%)

Table 7 showed influence of online gambling towards students' academic performance. Item 1 shows that 49.4% representing 99 respondents agreed that internet facility is best used for gambling than for learning activities while 50.3% (100 respondents) disagreed with the statement. Item 2 shows that 58.8% representing 117 respondents agreed that prefer to gamble online for monetary gain than to do their school assignments while 41.2% (82 respondents) disagreed with the statement. Item 3 showed that 45.7% representing 91 respondents agreed that they skip lectures, test and school activities to have more time for online gambling while 54.3%

(108 respondents) disagreed with the statement. Item 4 showed that 65.8% representing 131 respondents agreed that they think about winning odds while sitting in the classroom while 34.2% (68 respondents) disagreed with the statement.

Item 5 showed that 55.8% representing 111 respondents agreed that they prefer to invest their money on gambling to buying learning materials while 44.2 % (88 respondents) disagreed with the statement. Item 6 showed that 51.2% representing 102 respondents agreed that they think more about their gaming result than school result while 48.2% (97 respondents) disagreed with the statement. Item 7 showed that 78.9% representing 157 respondents agreed that they think about winning odds while sitting in the classroom while 21.1% (42 respondents) disagreed with the statement.

Research Question 1:
How does online gambling affect learning?

Table 8:
How Online Gambling affect Learning

Items	Frequency	Percentage %	Cumulative %
Less than an Hour	99	49.7	49.7
1-3 Hours	70	35.2	84.9
3-4 hours	21	10.6	95.5
5 Hours & Above	9	4.5	100
Total	199	100%	100%

Table 8 showed that 99 (49.7%) respondents spend less than an hour on learning activities,70 (35.2%) respondents spend 1-3 hours, 21(10.6%) respondents spend 3-4 hours and 9 (4.5%) respondents spend 5 hours and above on learning activities. It also showed that student spend their time online doing other activities that is not related to learning.

Research Question 2:
What attitude does learners have towards online gambling?

Table 9:
Students' Attitude towards Online Gambling

S/N	Item	Strongly Agree (%)	Agree (%)	Disagree (%)	Strongly disagree (%)
1	Monetary loss or gain can determine the frequency of my online gambling.	118 (59.3%)	65 (32.7%)	14 (7.0%)	2 (1%)
2	The time I spend online increases my chance of winning.	82 (45.2%)	90 (45.2%)	23 (11.6%)	4 (2%)
3	I derive pleasure from gambling online.	67 (33.7%)	98 (49.2%)	26 (13%)	8 (4%)

4	I prefer gambling online to face to face interaction.	87 (43.7%)	86 (43.2%)	21 (10.6%)	5 (0.5%)
5	Online gambling improves my personal income	77 (38.7%)	91 (45.7%)	28 (14.1%)	3 (1.5%)
6	I am depressed and anxious when I don't win.	110 (55.3%)	77 (38.7%)	11 (5.5%)	1 (0.5%)

Table 9 showed Students' attitude towards online gambling. Item 1 showed that 92% representing 183 respondents agreed that monetary loss or gain determine the frequency of their online gambling while 8 % (16 respondents) disagreed with the statement. Item 2 showed that 86.4% representing 172 respondents agreed that the time spent online increases their chance of winning while 13.6% (27 respondents) disagreed with the statement. Item 3 showed that 82.9% representing 165 respondents agreed that they derive pleasure from gambling online while 34% (27 respondents) disagreed with the statement. Item 4 showed that 86.9% representing 173 respondents agreed online gambling improves their personal income while 13.1% (26 respondents) disagreed with the statement.

Item 5 showed that 84.4% representing 168 respondents agreed that online gambling improves their personal income while 15.6 % (31 respondents) disagreed with the statement. Item 6 showed that 94% representing 187 respondents agreed that they are depressed and anxious when they don't win while 6.0% (12 respondents) disagreed with the statement.

Table 9 also showed that students spend more time gambling online (see item 2). Also, they gamble online for pleasure and monetary gain which seems to reinforce their participation (see item 3 and 1 respectively). Online gambling highly affects students' emotional state (that is depression and anxiety) when they don't win (see item 6).

Research Question 3:

How can learners control the time spent on online gambling?

Table 10:
Students' Time Control on Online Gambling

Items	Frequency	Percentage %	Cumulative %
2-3 times/week	76	38.2	38.2
4-7 times/week	73	36.7	74.9
3-4 times/week	31	15.6	90.5
Once/month	19	9.5	100
Total	199	100%	100%

Table 10 showed that 76 (38.2%) respondent gambles online in 2-3 times per week, 73 (36.7%) respondents' gamble online in 4-7 times per week, 31 (15.6%) respondent gambles online in 3-4 times per week and 19 (9.5%) gambles online once in a month.

Research Question 4:

What is the influence of gender on online gambling towards the students' academic performance?

Table 11:
Gender Influence on Online Gambling

Gender	Strongly agree	Agree	Disagree	Strongly disagree
Female	22(11.1%)	25(12.55%)	4(2.0%)	1(0.5%)
Male	61(30.7%)	67(33.7%)	16(8.0%)	3(1.5%)

Table 11 showed that 47 (23.65%) female respondents agree on the influence of online gambling on students' academic performance while 5 (2.5%) disagree with the statement.128 (64.4%) male respondents agreed on the influence of online gambling on students' academic performance while 19 (9.5%) disagreed with the statement.

Hypotheses One:

There is no significant difference between male and female students' attitude towards online gambling

ariable	N	X squared	Df	P value	Remark
Female	44				
		0.450	197	0.930	Do not reject
Male	155				

Table 11 showed that df (197), p = 0.9297. This means that the hypothesis is accepted. This is as a result in the significant p value of 0.930 which is greater than 0.05 alpha levels. This implies that, the stated hypothesis establishes that, there is no significant difference between male and female students' attitude towards online gambling. It is proven from the tested hypothesis that gender has no influence on the students' attitudes towards online gambling.

Hypotheses Two:

There is no significant difference between the time spent on online gambling and students' academic performance

Table 12:
Time Spent on Online Gambling

Items	N	X squared	Df	P value	Remark
Less than an Hour	99				
1-3 Hours	70				

3-4 hours	21	7.338	197	0.602	Do not reject
5 Hours & Above	9				

Table 12 shows that df (197), p = 0.602. This means that the hypothesis is accepted. This is as a result in the significant p value of 0.602 which is greater than 0.05 alpha levels. This implies that, the stated hypothesis establishes that, there is no significant difference between the time spent on online gambling and students' academic performance.

The findings of this study based on the research questions and hypotheses formulated were summarized as follows:

1) the result showed that students spend less time doing activities related to their course;
2) students have positive attitude towards online gambling;
3) student lack proper time management since they spend a lot of time gambling online;
4) male students engaged in online gambling compared to the female students;
5) there is no significant difference between male and female students' attitude towards online gambling; and
6) there is no significant difference between the time spent on online gambling and students' academic performance.

4. DISCUSSIONS

Research Question One sought information on how online gambling affects learning. The frequency and percentage showed that students spend less time online doing activities related to their course. However, the internet contains a wide pool information in which students can benefit from when accessed for learning purpose.

Students' attitude towards online gambling was revealed in Research Question Two. The result of the percentage showed that students have positive attitude towards online gambling. Also risk taking, monetary gain and pleasure seems to reinforce students' attitude towards online gambling.

Research Question Three examined how learners control the time spent on online gambling. Results and findings showed that students spend most of their time on online gambling. It is also noted that students lack time managerial skill and they get carried away with online gambling activities.

Research Question Four showed the influence of gender on online gambling towards the students' academic performance. The frequency and percentage shows that males students gambles more than female students. Also online gambling influences the male students' academic performance compared to the female students'. Wood and Williams (2009) carried out a research based on gender which suggests that online gambling in Australia is more frequently used by males.

The findings of this study imply that both male and female have positive attitude towards online gambling. More so, monetary gains motivate the students to gamble online and students spend less time online learning but spend more time on online gambling.

5. CONCLUSIONS

The result obtained from data gathered and analyzed in this study indicated that students spend less than doing activities related to their course. Students have positive attitude towards online gambling. Student lack proper time management since they spend a lot of time gambling online. Male students engage in online gambling compared to the female students. There was no significant difference between male and female students' attitude towards online gambling and there was no significant difference between the time spent on online gambling and students' academic performance.

Based on the findings and conclusions of this study, the following recommendations were made:

1. the school should monitor online gambling participation through blockage of website that promotes online gambling and also create balanced approach to the online gambling issue through counseling, seminars and orientation;
2. it is important that the government should be aware of the risks of online gambling. With regards to students, community educators should have the specific aims of increasing awareness that students are at a risk, and more generally they should inform individuals of the purpose and risks of online gambling free credit trials;
3. school counselors should include online gambling education program into existing programs about other risk-taking behaviors, such as drinking and smoking; and
4. parents should also help to imbibe socially and morally acceptable behavior into students.

6. REFERENCES

Anderson, K. J. (2001). Internet addiction among college students: An exploratory study . *Journal of American College Health*, 50, 21-26.

Bandele, S. (2006). *Development of modern ICT and internet system. In Agagu AA (ed). Information and communication technology and computer Applications.* Abuja: Panof Press.

Binde, P. (2005). Gambling across cultures: mapping worldwide occurrence and learning from ethnographic comparison. International Gambling Studies.

Bryce, J., & Rutter, J. (2003). Gender dynamics and the social and spatial organisation of computer gaming. In *Leisure studies* 22:1-15.

Chen, S. Y., & Fu, Y. C. (2009). Internet use and academic achievement: Gender differences in early adolescence, Adolescence. *College Student Journal*, 44(176), 255-257.

Choi, B., Huang, J., Jeffrey, A., & Baek, Y. .. (2013). *Development of a Scale for Fantasy State in Digital GamesComputers in Human Behavior* 29(5).

Corpus, J., McClintic-Gilbert, M., & Hayenga, A. (2009.). *Within-Year Changes in Children's Intrinsic and Extrinsic Motivational Orientations: Contextual Predictors and Academic Outcomes," Contemporary Educational psychology* (34).

De Leo, J. A., & Wulfert, E. (2013). *Problematic internet use and other risky behaviors in college students: An application of problem-behavior theory. Psychology of Addictive Behaviors,.*

Durkee, T. K., & Mandelli, L. (2012). *Prevalence of pathological internet use among adolescents in Europe: Demographic and social factors.*

Eklund, L. (2012). *The Sociality of Gaming : A mixed methods approach to understanding digital gaming as a social leisure activity (Ph.D. thesis).* Stockholm: Stockholm University.

Englander, F. T. (2010). Internet use among college students: Tool or toy? Educational Review. In F. Englander, R. A. Terregrossa, & Z. Wang, *Internet use among college students: Tool or toy? Educational Review* 62(1), 85–96.

Engwall, D., Hunter, R., & Steinberg, M. (2004). Gambling and other risk behaviors on university campuses,. . *Journal of American College Health*, 52(6), 245-255.

Lucier, K. (2013). *Guide to Time Management for Students Tips and Tricks on Everything You'll Need to Manage Your Time Wisely*. Retrieved from http://collegelife.about.com/od/ Time-Management/a/Guide

Macan, T., Shahani, C., Dipboye, R., & Phillips, A. (2013). *College Students' Time ManagementCorrelations with Academic Performance and Stress. American Psychological Association*. Retrieved from http://psycnet.apa.org/

Matthews, N., Farnsworth, B., & Griffiths, M. (2009). "A Pilot Study of Problem Gambling among Student Online Gamblers: Mood States as Predictors of Problematic Behavior",. *CyberPsychology & Behavior,*, 741-745.

Nwosu, O., & Ogbomo, E. F. (2012). *ICT in Education: A Catalyst for Effective Use of Information .The official publication of the Pacific Northwest library Association PNLA Quarterly. : as a catalyst for effective.* Retrieved from Retrieved from http:// www.ict in education

Oyebisi, A., Alao, D. & Popoola, G. (2012). *Prevalence And Determinants Of Gambling Behaviour Among Undergraduate Students (A Case Study OF Federal University of Oye-Ekiti). EBOH VIVIAN CHIMEZIE.*

Shaffer, H. D., LaBrie, R., Kidman, R., & LaPlante, D. (2005). The epidemiology of college alcohol and gambling policies. *Harm Reduction Journal*.

Shaffer, H., Donato, A., LaBrie, R., Kidman, R., & LaPlante, D. (2005). The epidemiology of college alcohol and gambling policies. *Harm Reduction Journal*, (2), 1.

Shaffer, H., Forman, D., Scanlon, K., & Smith, F. (2000). Awareness of gambling related problems, policies and educational programs among high school and college administrators. *Journal of Gambling Studies*, (16) , 1, 93.

Smed, J., & Hakonen, H. (2003). *Towards a definition of a computer game.* University of Turku, Department of Information Technology., Finland.

Stoeber, J., Harvey, M., Ward, J., & Childs, J. (2011). Passion, craving, and affect in online gaming: Predicting how gamers feel when playing and when prevented from playing. In *Personality and Individual Differences* (51) 991–995).

Summerfield, M., & Loo, W. (2010). *Online Gaming: A Gamble or a Sure Bet?* London: KPMG International.

Unsal, F., Ruzgar, N., & Ruzgar, B. (2008). *An Empirical Study of Internet Usage, OnlineShopping, and Online Banking Behaviour of Turkish University Students.* The Berkeley Electronic Press.

Walker, G., Courneya, K., & Deng, J. (2007). Ethnicity, gender, and the theory of planned behavior: The case of playing the lottery. *Journal of Leisure Research*, 38(2), 224-249.

Williams, R. C. (2006). Does learning about the mathematics of gamblingchange gambling behavior? Psychology of Addictive Behaviors.

Wood, R., & Williams, R. (2009). *Internet Gambling: Prevalence, Patterns, Problems, and Policy Options. Final Report Prepared for the Ontario Problem Gambling Research Centre.* Ontario, Canada.

Wood, R., & Williams, R. (2009). *Internet gambling: Prevalence, patterns, problems, and policy options. Final report prepared for the Ontario Problem Gambling Research Centre.* Ontario Canada.

ANALYSIS OF HUFFMAN AND RUN-LENGTH ENCODING COMPRESSION ALGORITHMS ON DIFFERENT IMAGE FILES

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ABSTRACT
Viewing and downloading uncompressed images from the internet on mobile devices might take a longer time. This makes the data plan costly and brings unpleasant user experience. Usually, when virtual server is hired to host a website with images, money is paid for the amount of storage and the amount of data that the server sends and receives over a period of time. Image compression allows streaming more compressed images to viewers without paying more for the bandwidth used.For this purpose, this paper studied and implemented two compression algorithms i.e. Run-length encoding(RLE) and Huffman on fourimage file formats;Joint Photographic Experts Group(JPEG), Bitmap Image File (BMP),Graphics Interchange Format (GIF), Portable Network Graphics (PNG) using C#.Experimentally, results show that RLE performs better than Huffman in compressing GIF, BMP, JPG, and PNG images, with very low compression ratio and high saving percentage. The only instance where Huffman performed better was on a BMP file with less repeating strings. Run-length also compresses in a minimal amount of time compared to Huffman. It is recommended that Huffman and RLE algorithms can be used when lossless compression is required. When Huffman and RLE are the options available for compression, RLE could be considered, but for complicated images with possibilities of less repeating strings, Huffman should be considered.
***Keywords**: Run length Encoding (RLE), Huffman Coding (HC), Image Compression, Image files.*

1. INTRODUCTION

Pictures have been with us since the dawn of time. However, the way that pictures have been represented and displayed has changed greatly. Originally, every picture is unique, being both represented and displayed in a physical way, such as paint on a cave wall or etchings on the stone. The use of digital images has increased at a rapid pace over the past decade due to computer generated (synthetic) images, particularly for special effects in advertising and entertainments (Shankar, 2010).Image compression playsa major role in a digital domain. The more the image is compressed, the less amount of storage is required (Mahmud, 2012).

Data compression is the science of reducing the amount of data used to convey information. It relies on the fact that information, by its nature, is not random but exhibits order and patterns. If that order and patterns can be extracted, the essence of the information can be represented and transmitted using less data than what would be needed for the original. Then, at the receiving end the original can be intimately or closely reconstructed (David and Giovanni,2010).Basically, data compression is performed by a program that uses a formula or algorithm to determine how to shrink the size of a particular data (Joshi,Raval, Dandawate, Joshi, Metkar,2014)).These programs find the common pieces ofdata blocks that can be omitted, shrunk, removed or substituted with smaller patterns. The more of the repeated blocks it finds, the more it can compress (David and Giovanni,2010). Nonetheless, compressing data can save storage capacity,

speed file transfer, and decrease costs for storage hardware and network bandwidth (Joshi etal,2014).).

Images are composed of pixels and each pixel represents the color at a single point in the image; an image will therefore consist of millions of pixels. The richer the image, the more pixels and the bigger the size, the more bandwidth and space required. An uncompressed image, that is, an image in its raw form is quite expensive in terms of space and bandwidth requirements. Hence, image compression thatwill permanently get rid of some information in the image to save storage space and ease transfer is needed.

Compression techniques can be categorized into two types i.e. lossless or lossy. Lossless compression enables the original data to be reconstructed the same as it was before compression without the loss of a single bit of data. It is usually used for text, executable files, medical field, where the loss of words or numbers could change the information or could be harmful (Mozammil, Zakariya and Inamullah, 2012). Lossy compression on the other hand, permanently eliminates bits of data that are redundant, unimportant or imperceptible. Lossy compression is used in graphics, audio, video, and images, where the removal of some data bits has little or no discernible effect on the representation of the content (Joshi*etal*, 2014,). This paper presents a comparative analysis between two lossless compression algorithm; Huffman and Run-length encoding on various image file formats such as JPEG, BMP,GIF,PNGusing C#.

2. RELATED WORK

Often times when it comes to comparison between RLE and Huffman encoding, it is usually on text, they are scarcely compared on images. In this work, the comparison analysis will be based on their performance on a different image file format. Sharma (2010) studied various compression techniques and compared them based on their usage in different applications and their advantages and disadvantages. It was concluded that Huffman is easy to implement, produces optimal and compact code, relatively slow, depends upon statistical model of data,decoding is difficult due to different code lengths, it has an overhead due to Huffman tree, always used in JPEG. Run-length coding is simple to implement, fast to execute; compression ratio is slow as compared to other algorithms, used mostly for TIFF, BMP and PCX files.

Ibrahim and Mustapha (2015) compared Huffman and RLE using C++ program to compress a set of text files and the results show that Huffman performs better than RLE on all types of text file. Shankar (2010) compared Run-length coding and Huffman on asingleimage, based on the results, it was concluded that RLE is very easy to implement, but would not necessarily reduce the size of image and greater compression ratio can be achieved in a crowded image. Huffman coding can provide optimal compression and error free decompression.

Al-Laham*and ElEmary,* 2007, a comparative study between various compression algorithms on different files (text and image files) .The results show that Huffman performed better than RLE on text files and images but not as good as RLE on colored images.

Kodituwakku*et al,* 2010 and Maan, 2013 opined that in most cases Huffman perform better than RLE on text files and images.The interest of this work is to see on what image file format Huffman outperforms RLE.

3. METHODOLOGY

In this work, two popular data compression algorithms are implemented, analyzed and compared. For measuring the performance, the following parameters are used: compression ratio, saving percentage, computational time and the file formats are JPEG, BMP, GIF, and PNG.

3.1 Rle Algorithm (Run Length Encoding)

Run-length encoding is a data compression algorithm that is supported by most bitmap file formats, such as TIFF, BMP, and PCX. RLE is suited for compressing any type of data regardless of its information content, but the content of the data will affect the compression ratio achieved by RLE. Although most RLE algorithms cannot achieve the high compression ratios of the more advanced compression methods, RLE is both easy to implement and quick to execute, making it a good alternative to either using a complex compression algorithm or leaving your image data uncompressed. RLE works by reducing the physical size of a repeating string of characters. This repeating string, called a run, is typically encoded into two bytes(Ibrahim and Mustapha, 2015).

3.2 Pseudo Code for Encoding and Decoding RLE Algorithm

Get two bytes, if they are equal output both of them, and then count how many bytes equal to the first, then output this value, and continue encoding, repeated bytes need to be discarded. If the bytes not equal, then output the first, make the second first, and get the next byte as a second, and start.

3.2.1 Encoding:

Get two bytes

Loop

Are they equal?

Yes

Output both of them

Count how many bytes repeated we have

Output that value

Update pointer to the input file

Get next two bytes.

Repeat

No

Output the first byte

put the second as first

Get a byte for the second one

Update pointer to input file

Repeat

3.2.2 Decoding:

Get one byte, put it to the output file, and now it's the 'last' byte.

Loop

Get one byte

Is the current byte equal to last?

Yes

Now get another byte, this is 'counter'

Put current byte in the output file

Copy 'counter' times the 'last' byte

Put last copied byte in 'last' (or leave)

Repeat

No

Put current byte to the output file

Now 'last' is the current byte

Repeat

(Mozammil,ZakariyaandInamullah,2012)

Huffman Algorithm

The Huffman Algorithm generates variable length code in such a way that high frequency symbols are represented with a minimum number of bits and low frequency symbols are represented bya relatively high number of bits (Yadav, 2006). Huffman coding is an entropy encoding algorithm used for lossless data compression in computer science and information theory. The term refers to the use of a variable-length code table for encoding a source symbol (such as a character in a file) where the variable-length code table has been derived in a particular way based on the estimated probability of occurrence for each possible value of the source symbol.

Steps Of Huffman Algorithm

The following are the steps of Huffman Algorithm:

Step 1: Compute or collect the total number of symbols and their relative frequency

Step 2: Arrange all the symbols in decreasing order of their frequencies

Step 3: Construct Huffman Tree from the list of symbols

Creating the tree:

1. Start with as many leaves as there are symbols.

2. Enqueue all leaf nodes into the first queue (by probability in increasing order so that the least likely item is in the head of the queue).

3. While there is more than one node in the queues:

1. Dequeue the two nodes with the lowest weight.

2. Create a new internal node, with the two just-removed nodes as children (either node can be either child) and the sum of their weights as the new weight.

3. Enqueue the new node into the rear of the second queue.

4. The remaining node is the root node; the tree has now been generated.

Step 4: Assign the code.

4. RESULT AND DISCUSSION

Table 1: Compression rate for Huffman Coding

S/N	File Name	File Type	File Size (kb)	Huffman Output File Size (kb)	Huffman Compression Ratio	Saving Percentage (%)	Decomp-ression size (kb)
1	05 TIFF1d	Jpg	147	105	0.71	28.6	147
2	Bison Teton	Jpg	93	75	0.81	19.4	93
3	Yoyin	Jpg	2470	2250	0.91	8.9	2470
4	Sciurus vulgaris	Png	1599	205	0.13	87.2	1599
5	Lady	Png	514	51	0.1	90.1	514
6	latest-1	Png	81	15	0.19	81.5	81
7	Tiger-1	Bmp	655	67	0.1	89.8	655
8	Hildebrantmed	Bmp	470	204	0.43	56.6	470
9	Adafruit	Bmp	226	56	0.25	75.2	226
10	Earth	Gif	1319	15	0.01	98.9	1319

11	PeterPan	gif	380	11	0.03	97.1	380
12	SpongeBob	gif	48	9	0.19	81.3	48

Table 2: Compressionrate for Run-length Encoding

S/N	File Name	File Type	File Size (kb)	RLE output file size (kb)	RLE Compression Ratio	RLE Saving Percentage (%)	RLE Decompression Size
1	05 TIFF1d	jpg	147	21	0.14	85.7	147
2	BisonTeton	jpg	93	24	0.26	74.2	93
3	Yoyin	jpg	2470	243	0.1	90.1	2470
4	Sciurusvulgaris	png	1599	33	0.2	97.9	1599
5	Lady	png	514	15	0.03	97.1	514
6	latest-1	png	81	7	0.09	91.2	81
7	Tiger-1	bmp	655	17	0.03	97.4	655
8	Hildebrantmed	bmp	470	381	0.81	18.9	470
9	Adafruit	bmp	226	11	0.05	95.1	226
10	Earth	gif	1319	13	0.01	99	1319
11	PeterPan	gif	380	9	0.02	97.6	380
12	SpongeBob	gif	48	8	0.12	83.3	48

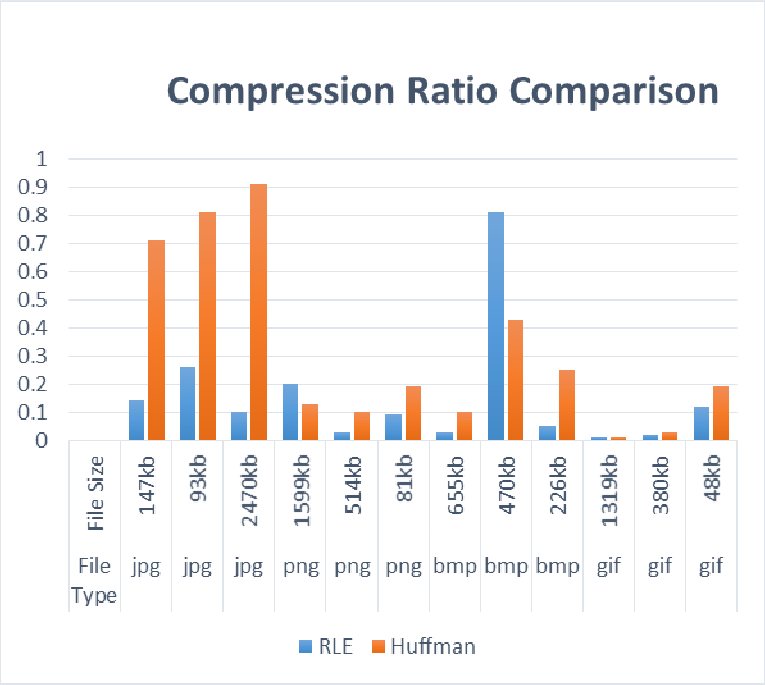


Figure 1: Compression ratio comparison between RLE and Huffman

The lower the compression ratio, the better and the more it performs. RLE has a very low compression ratio on image files except for the Hildebrantmed.bmp file that has very high compression ratio for RLE and very low for Huffman.

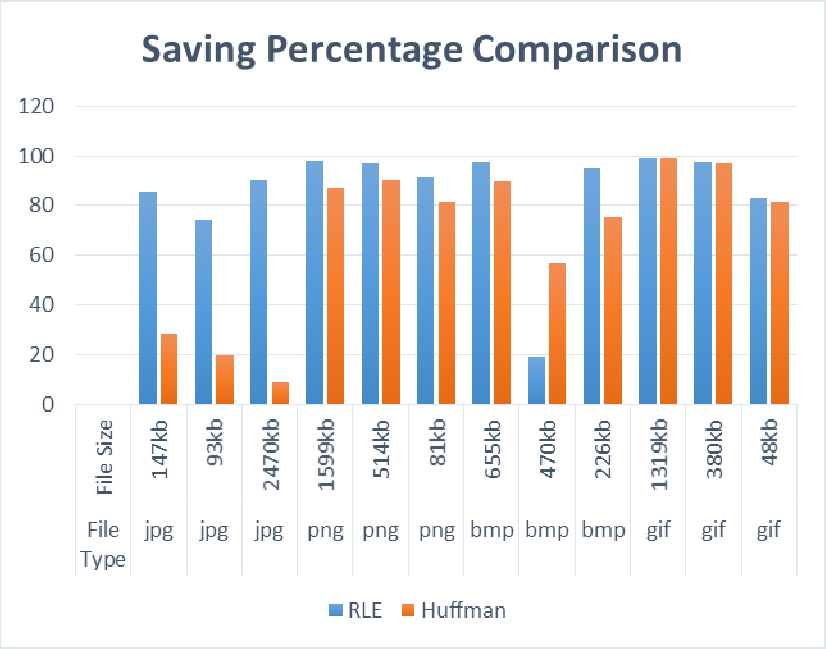


Figure 2: Saving Percentage comparison between RLE and Huffman

From figure 2, RLE has better saving percentage compared to Huffman, although Huffman is running neck to neck with it on some image file formats which are the GIF images. That is, they both do great on GIF images. Huffman does terribly on JPEG images compared to RLE. The saving percentage increases when the file size after compression is far smaller than the original file size. That is, the smaller the difference between file size before and after compression, the lesser the saving percentage. The Hildebrantmed.bmp is still the only image that gives Huffman algorithm advantage over RLE

Table 3: Compression time forRLE and Huffman

S/N	File Type	File Size (kb)	RLE Compression Time (Secs)	HUFFMAN Compression TIME (Secs)
1	Jpg	147	7	25
2	Jpg	93	4	23
3	Jpg	2470	264	587
4	Png	1599	6	125
5	Png	514	3	22
6	Png	81	2	5

7	bmp	655	5	14
8	bmp	470	4	37
9	bmp	226	2	7
10	Gif	1319	2	8
11	Gif	380	2	7
12	Gif	48	1	4

Table 3 displays the compression comparison between both algorithms. And as it can easily be depicted, RLE compresses faster than Huffman on all image files of different sizes, even faster than it on the BMP file that Huffman works better. It is not that Huffman doesnot have a reasonable compression time; in fact, it does really good on GIF images but not good as RLE still.

Table 4: Compression Output File size by both RLE and Huffman

S/N	File Type	File Size (kb)	RLE Output File size (kb)	Huffman Output File Size (kb)
1	Jpg	147	21	105
2	Jpg	93	24	75
3	Jpg	2470	243	2250
4	Png	1599	33	205
5	Png	514	15	51
6	Png	81	7	15
7	bmp	655	17	67

8	bmp	470	381	204
9	bmp	226	11	56
10	Gif	1319	13	15
11	Gif	380	9	11
12	Gif	48	8	9

Table4 shows the compressed size files of the compression analysis. The table simply depicts that RLE clearly compresses better than Huffman techniques, except on the large complicated image and with less repeating strings, where Huffman does better by compressing 470kb file to 204kb, while RLE compresses the same picture to 381k. The output for the compressed files for both algorithms on .gif image types are very close, compared to the difference in both algorithms on the other image file types.

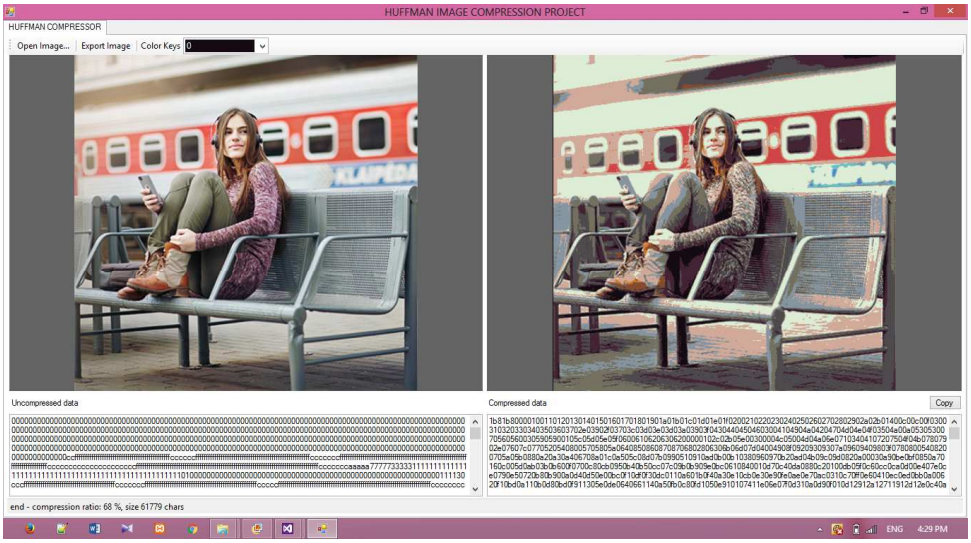


Figure 3:jpg image after compression and decompression with Huffman



Figure 4: Bmp image after compression and decompression with RLE

5. CONCLUSION

This paper thoroughly studied and implemented two well-known compression algorithms named Run-length Encoding (RLE) and Huffman Coding(HC), both Algorithms were tested on the following type of image file GIF, BMP, JPG, and PNG .Experimentally, results show that RLE performs better than Huffman in compressing GIF, BMP, JPG, and PNG images, with very low compression ratio and high saving percentage. The only instance or case where Huffman performed better was on a BMP file with less repeating strings. RLE also compresses in a minimal amount of time compared to Huffman. All things being equal, it is concluded that RLE performs better than Huffman based on the stipulated parameters which are compression ratio, saving percentage, compressed file size, and compression time. In the future, we intend to implement the two algorithms on various video file formats.

REFERENCES

David S and Giovanni M. (2010). *Handbook of Data Compression*. New York: Springer.

Ibrahim, A. M. A., & Mustafa, M. E. (2015*). Comparison between RLE and Huffman Algorithms for Lossless Data Compression.* IJITR, 3(1), 1808-1812.

Mozammil, S. M. Zakariya and M. Inamullah. (2012). *Analysis of Video Compression Algorithms on Different Video Files*. Fourth International Conference on Computational Intelligence and Communication Networks, 257-261.

Joshi, M. A., Raval, M. S., Dandawate, Y. H., Joshi, K. R., & Metkar, S. P. (2014). *Image and Video Compression: Fundamentals, Techniques, and Applications*. CRC Press.

Shankar, U. B. (2010). *Image compression techniques*. International Journal of Information Technology and Knowledge Management, 2(2), 265-269.

Yadav, D. S. (2006). *Foundations of Information Technology*. New Delhi: New Age International.

Mahmud, S. (2012). *An Improved Data Compression Method for General Data*. International Journal of Scientific & Engineering Research , Volume 3, Issue 3.

Al-Laham, M., & El Emary, I. M. (2007). *Comparative study between various algorithms of data compression techniques*. IJCSNS International Journal of Computer Science and Network Security, 7(4), 281-291.

Ibrahim, A. M. A., & Mustafa, M. E. (2015). *Comparison between (RLE and Huffman) Algorithms for Lossless Data Compression*. IJITR, 3(1), 1808-1812.

Kodituwakku, S. R. (2010). *Comparison of lossless data compression for text data.* Indian Journal of Computer Science and Engineering, 418.

Maan, A. J. (2013). *Analysis and comparison of algorithms for lossless data compression.* International Journal of Information and Computation Technology, 3(3), 139-146.

Sharma, M. (2010). *Compression Using Huffman Coding*. International Journal of Computer Science and Network Security, 133-14

COMPARATIVE ANALYSIS OF DISCRETE COSINE TRANSFORM AND DISCRETE WAVELET TRANSFORM ON DIFFERENT IMAGE FILES

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ABSTRACT

The process of reducing the quantity of data used in representing certain information content without excessively reducing the quality of the original data is known as compression. It is useful in reducing memory space and time for an information to be transmitted. Data compression can be divided into two classes: lossless and lossy. It is lossless, if no information is loss during compression process. A compression is lossy if the reconstructed image or data is not exactly the same as the original. This paper presents comparative analysis between two lossy compression algorithms – Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) on images of different sizes with different file formats - JPG, PNG, BMP using Matlab. Important parameters such as compression ratio, compression efficiency, pre-compression and post compression sizes are considered. Experimentally, result shows that DWT performed excellently better than DCT with better compression ratio and higher saving percentage.

***Keywords**: Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), Compression ratio, Image Compression, Image files.*

1. INTRODUCTION

The process of reducing the quantity of data used in representing certain information content without excessively reducing the quality of the original data is known as compression. The basic idea behind compression is to reduce the number of bits required to store and/or transmit digital media in a quality and cost-effective manner. Excessive information is removed from the data to reduce its size, hence, the goal of data compression is to represent a source in digital form with as few bits as possible while meeting the minimum requirement of reconstruction of the original (Grgic and Grgic, 2001).

The exponential growth observed in the demand for the use of technology necessitates the need to manage data, especially images more efficiently. Individuals and some corporate organizations like health industries, retail stores, and Federal Government Agencies depend to a large extent on image processing in their day-to-day activities. For high speed and accuracy, computer applications designed for image processing need to reduce these images to smaller sizes for easy transmission. Hence, the need for image compression cannot be deemphasized (Michael Chui et al., 2012).

The compression and decompression techniques are being used for variety of applications like facsimile, printer, document storage and retrieval, teleconferencing, multimedia messaging

systems. Therefore, available bandwidth, be it on LAN, WAN, MAN, or Internet needs appropriate compression techniques for reliable communications (Steinmetz, 1994).
Data compression can be divided into two classes: lossless and lossy. It is lossless, if no information is loss during compression process. A compression is lossy if the reconstructed image or data is not exactly the same as the original. In a study carried out by (Jeengar, Omkar, Singh, Yadav & Keshri, 2012), the authors made an assertion that DCT and DWT algorithms have been found in literature as the backbones of image compression industry, this is because majority of algorithms are based on them. Besides, DCT and DWT based image codecs are widely embraced in image compression due to its overwhelming improved performance and efficiency (Banday and Shah, 2013).

Therefore, the merits and reliable performance in the functionalities of both algorithms guided us to make investigative analysis of the two, as this paper presents comparative analysis between two lossy compression algorithms – Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) on images of different sizes with different file formats - JPG, PNG, BMP on Matlab.

This paper is structured as follows: Section II presents the related work, section III states the methodology adopted for the study, experimental results and discussion are presented in section IV. Finally, section V concludes the research work.

2. RELATED WORK

Jasmeet and Sharma (2012) worked on video compression with scalability factor by combining DCT-DWT. In their research, they found out the types of redundancies present in the video frame and how many scenes are correlated in a video for higher compression ratio. Eman and rusulzehwar (2014) examined the color image of size 24-bits/pixel by comparing Fractal Color Image. The compression was done using YIQ and YUV color model. To take the benefit of existing spectral correlation and spatial resolution of human vision system, data of color component are transformed to YIQ color space to enhance more compression and the chromatic components (I.Q) was utilized to increase the compression ratio without making any significant distortion. Rani and Arora (2011) presented a comparative analysis between DCT and DWT techniques of image compression. It compared DCT and DWT by using Mean Square Error(MSE) between the original image and compressed image. MSE value is represented on graph. Their result showed that the quality of DWT is better than DCT while DCT is better than DWT in terms of performance.

Grgic and Grgic (2001) proposed new features of wavelet transform in compression of an existing image. The paper discussed how to check the number of wavelet functions implemented in an existing image compression system to highlight the benefit of newly invented transform methods.

3. METHODOLOGY

3.1 Transformation Based Coding Techniques

To compress images using present day image processing applications, there is a need to exploit correlations between adjacent pixels which is domiciled in transformation coding (Sousa, 2011). According to Salomon (2004), transformation coding constitutes an integral element of contemporary image/video processing applications. Transformation coding relies on the premise that pixels in an image exhibit a certain level of correlation with their adjoining pixels.

Consequently, these correlations can be exploited to predict the value of a pixel from its respective neighbors.

The neighboring pixels of the image are projected with highest level of accuracy. After the implementation of transformation coding, image information is observed to be more competent rather than the original image (Banday and Shah, 2013). Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) are two widely used transformation techniques.

3.2 Discrete Cosine Transform

A transformation is to map the spatial data into transformed coefficient through a mathematical function. The Discrete Cosine Transform (DCT) attempts to decorrelate the image data. Further, each transformation coefficient could be encoded independently with no loss of compression efficiency (Fracastoro, Fosson, & Magli, 2017).

3.3 Dct Perfomance Evaluation

The decorrelation characteristics of DCT do render a decrease in the entropy of an image, while decrease in the entropy is proportional to the reduction in the average number of bits required for a particular image. The reduction in bits required for particular image in using DCT algorithm is achieved via image transformation into frequency domain with the removal of higher frequency components that of less sensitive to human sight (Banday and Shah, 2013).

3.3 Discrete Cosine Transform Process

A typical image transmission system is outlined in Figure 1. The objective of the source encoder is to exploit the redundancies in image data to provide compression. On the contrary, the channel encoder adds redundancy to the output of the source encoder to enhance the reliability of the transmission. Obviously, both these high-level blocks have contrary objectives (Salomon, 2004).

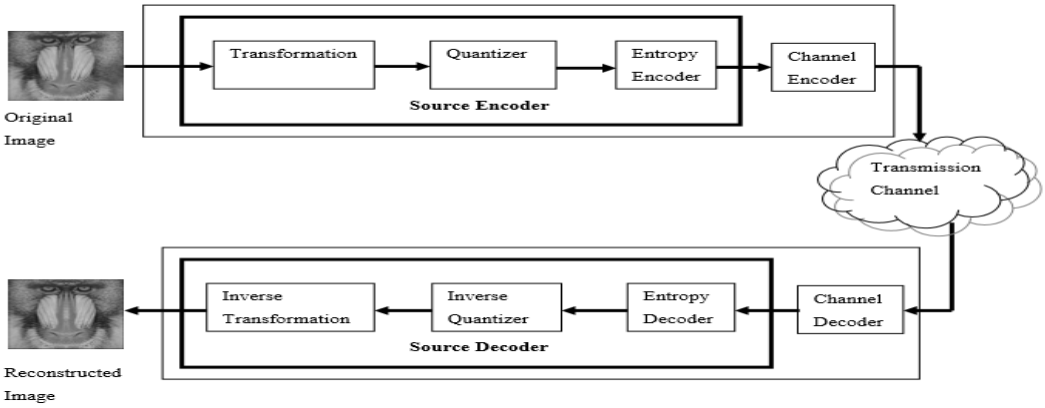


Figure 1: Components of a typical image transmission system (Salomon, 2004)

To achieve better compression, each sub-block in the source encoder exploits some redundancy in the image data. The transformation sub-block decorrelates the image data to reduce or eliminate inter pixel entropy. Being a lossless operation, the inverse transformation outputs an admirable reconstruction of the original image.

While considering dimensionality, DCT can be mainly divided into two: one dimensional and two dimensional.

3.3.1 One-Dimensional DCT

The most common DCT definition of a 1-D sequence of length L is - If the input sequence has more than L sample points; then it can be divided into sub-sequences of length L where DCT is applied to each independently. While in each such computation, the values of the basis function points would remain unchanged. As a matter of this DCT merit, basic functions can be pre-computed offline and then-after multiplied with the sub-sequences, which subsequently reduces the number of arithmetic operations thereby rendering computation efficiency (Salomon, 2004).

3.3.2 Two Dimensional DCT

The 2-D DCT is a direct enhancement of the 1-D. 2-D basis functions can be generated by multiplying the horizontally oriented 1-D basis functions with vertically oriented set of the same functions (Shandilya and Singh, 2015). Again, it can be noted that the basic functions exhibit a progressive increase in frequency both in the vertical and horizontal direction. Hence, this function assumes a constant value and is referred to as the DC coefficient.

3.3.3 Image Compression Using DCT

DCT separates images into divisions of dissimilar frequencies where less important frequencies are eliminated through quantization and significant frequencies are used to retrieve the image at decompression process. Compared to other input dependent transforms, DCT has many advantages such as - implemented in single integrated circuit; ability to pack most information in fewest coefficients; minimizes blocking artifact.

3.3.4 Steps Using Dct

Summary of the DCT process as highlighted by Salomon, 2004 is enlisted below:

(i.) Original image is divided into blocks of 4-by-4 or 8 x 8.
(ii.) Pixel values of a black and white image range from 0 - 255 but DCT is designed to work on pixel values ranging from -128 to 127.
(iii.) Equation (1) is used to calculate DCT matrix.
(iv.) DCT is applied to each block by multiplying the modified block with DCT matrix on the left; while transpose of DCT matrix on its right.
(v.) Each block is then compressed through quantization.
(vi.) Quantized matrix is then entropy encoded.
(vii.) Compressed image is reconstructed through reverse process.
(viii.) Inverse DCT is used for decompression

4. DISCRETE WAVELET TRANSFORM

A wavelet transform decomposes a signal into component wavelets, which aids coefficients of the wavelets to be decimated. As very small wavelets could separate the fine details in a signal; very large wavelets can identify coarse details. In addition, there are many different wavelets to choose from such as – Haar and Daubechies. It is worthy to note that a particular wavelet may generate a more sparse representation of a signal than another, so different kinds of wavelets must be examined to see the most suitable for image or video compression (Malik and Verma, 2012).

DWT is a frequency domain image transform method used to split the information of any digital media into approximated and detailed sub signals respectively. The main objective of DWT technique is to hide data in the form of coefficients as DWT is analyzed on filter bank. In digital image / video processing, two types of filters are extensively used - High and Low pass filters to keep high and low frequency information respectively.

In DWT, signal energy concentrates to specific wavelet coefficients. This characteristic is useful for compressing images and videos. DWT converts the image into a series of wavelets that can be stored more efficiently compared to pixel blocks. It also has rough edges enhancing it to render images better by eliminating the blocky form (Bute, Mandawi, and Sakure, 2013).

4.1 Haar Wavelet Transform

A Haar wavelet is the simplest type of wavelet. In its discrete form, it is related to a mathematical operation referred to as Haar transform. This Haar transform serves as a prototype for all other wavelet transforms as it equally decomposes a discrete signal into dual sub-signals of half its length. One sub-signal is a running average or trend while the other half is a running difference or fluctuation (Gupta and Choubey, 2015).

4.2 Daubechies Wavelet Transform

The Daubechies wavelet transforms are similar to Haar wavelet transform by computing the running averages and differences via scalar products with scaling signals and wavelets. The only difference between them is how these scaling signals and wavelets are defined. This wavelet type has balanced frequency responses but non-linear phase responses. Daubechies wavelets use overlapping windows, so the high frequency coefficient spectrum reflects all high frequency changes. Therefore, Daubechies wavelets are useful in compression and noise removal of audio signal processing (Bute, Mandawi, and Sakure, 2013).

5. EXPERIMENTAL RESULTS AND DISCUSSION

In this research, compression methods based on DWT and DCT algorithms had been undertaken using MATLAB. A set of image files such as JPEG, PNG and BMP of different sizes are used to justify the efficiency and effectiveness of both algorithms. The uncompressed image of each format is subjected to three stages of compression; this is to reliably determine the best algorithm for compression. It should be noted that 8 x 8 block division method was adopted for this work.

Table 1: Results Comparing Dwt And Dct Image Compression

Name	Original size (KB)	Size after 1st level DCT Compression (KB)	Size after 1st level DWT Compression (KB)	1st level DCT Compression ratio	1st level DWT Compression ratio	Saving percentage of DCT Compression (%)	Saving percentage of DWT Compression (%)	DCT compression time (seconds)	DWT Compression time (seconds)
Large JPG	1873.92	34	44.7	5.45	41.92	81.6	97.6	19.82	10.91
Small JPG	100	93.2	41.3	1.07	2.42	6.8	58.7	4.98	3.21

Large BMP	2304	769	40.1	2.996	57.46	66.62	98.3	27.3	15.61
Small BMP	147	50.3	40.1	2.92	3.67	65.7	72.7	5.23	7.83
Large PNG	1720.32	657	40.4	2.618	42.58	61.8	97.7	23.02	9.37
Small PNG	240	115	51.4	2.09	4.67	52.08	78.6	11.52	6.03

Table 1 shows the experimental results of both algorithms and it can be deduced that DWT has a better compression ratio and higher saving percentage than DCT for all the image formats chosen as depicted graphically in figures 2 and 3 respectively.

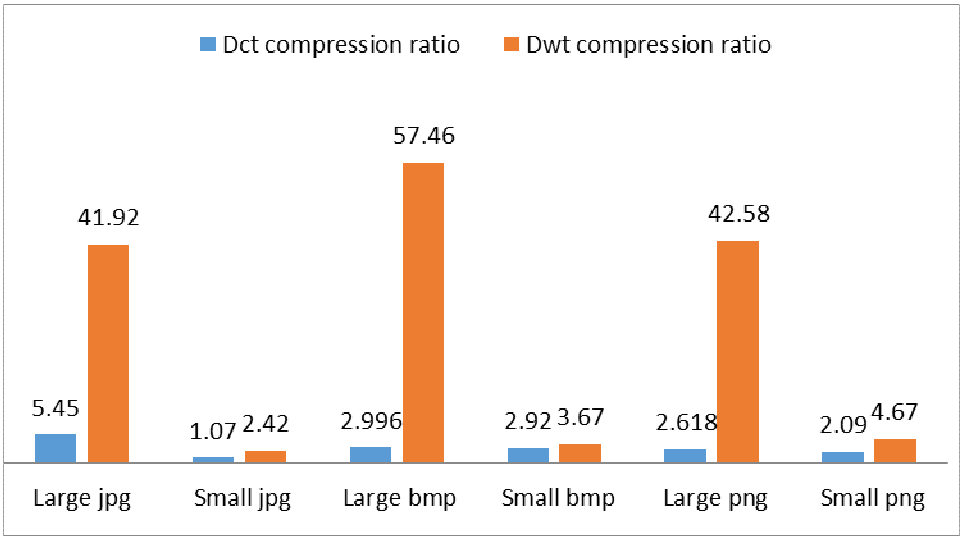


Figure 2: Chart Displaying both DCT and DWT compression ratio

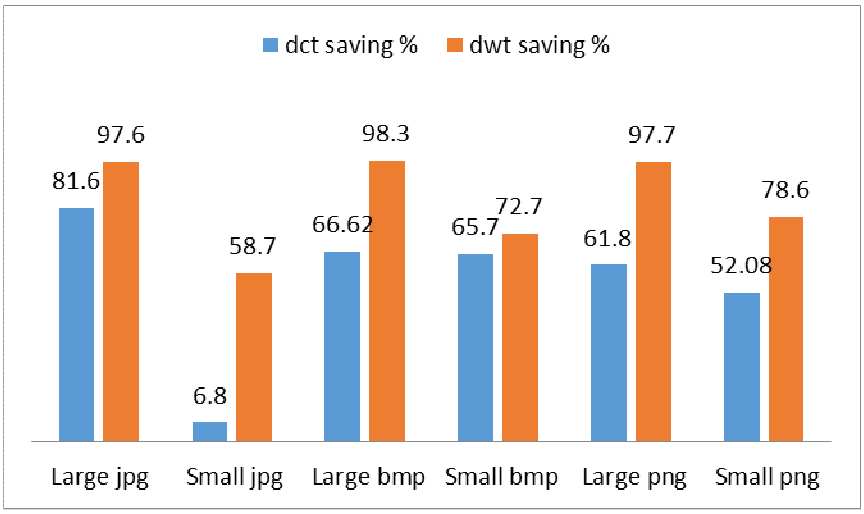


Figure 3: Chart Displaying both DCT and DWT saving percentage.

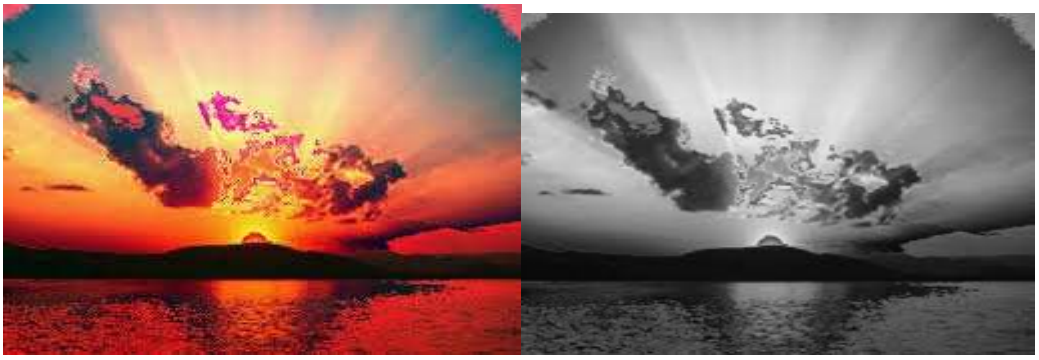


(a) **(b)**

Figure 4: Showing results of DWT algorithm on JPG image files
(a) Large files Original Image (b) Large files Compressed image

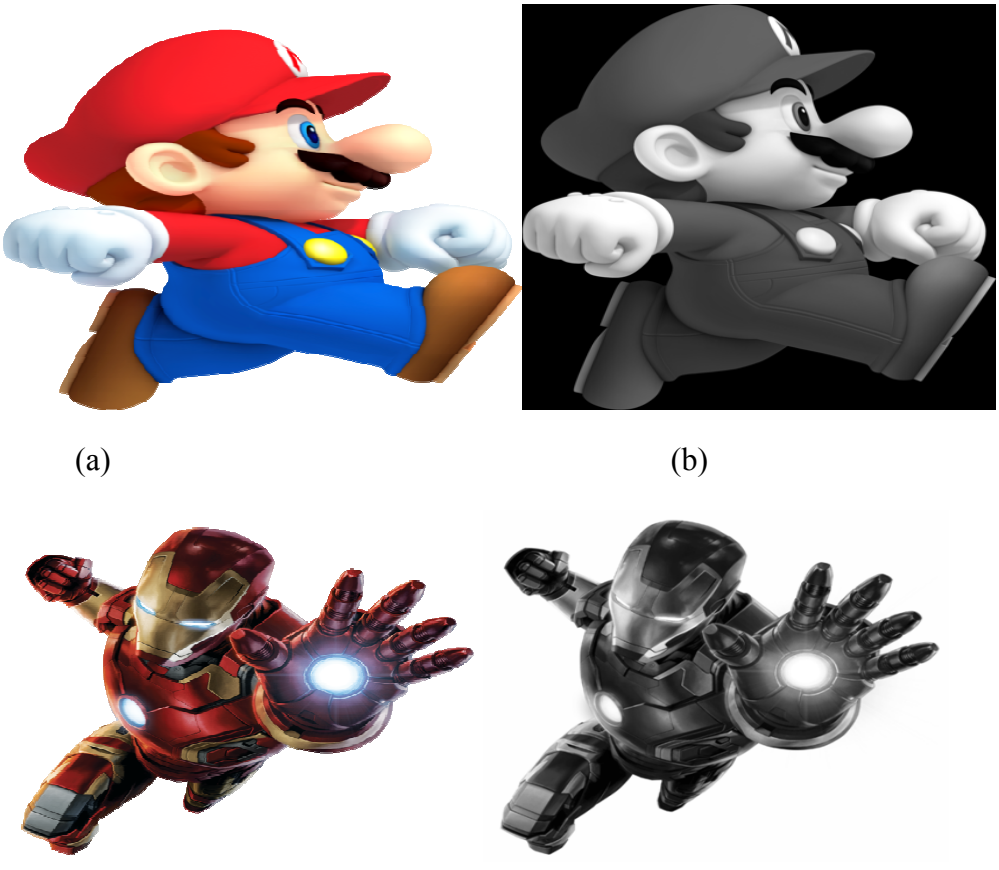


(a) (b)



(c) (d)

Figure 5: Showing results of DWT algorithm on BMP image files
(a) Large files Original Image (b) Large files Compressed image
(c) Smaller files Original Image (d) Smaller files Compressed image



(a) (b)

(c) (d)

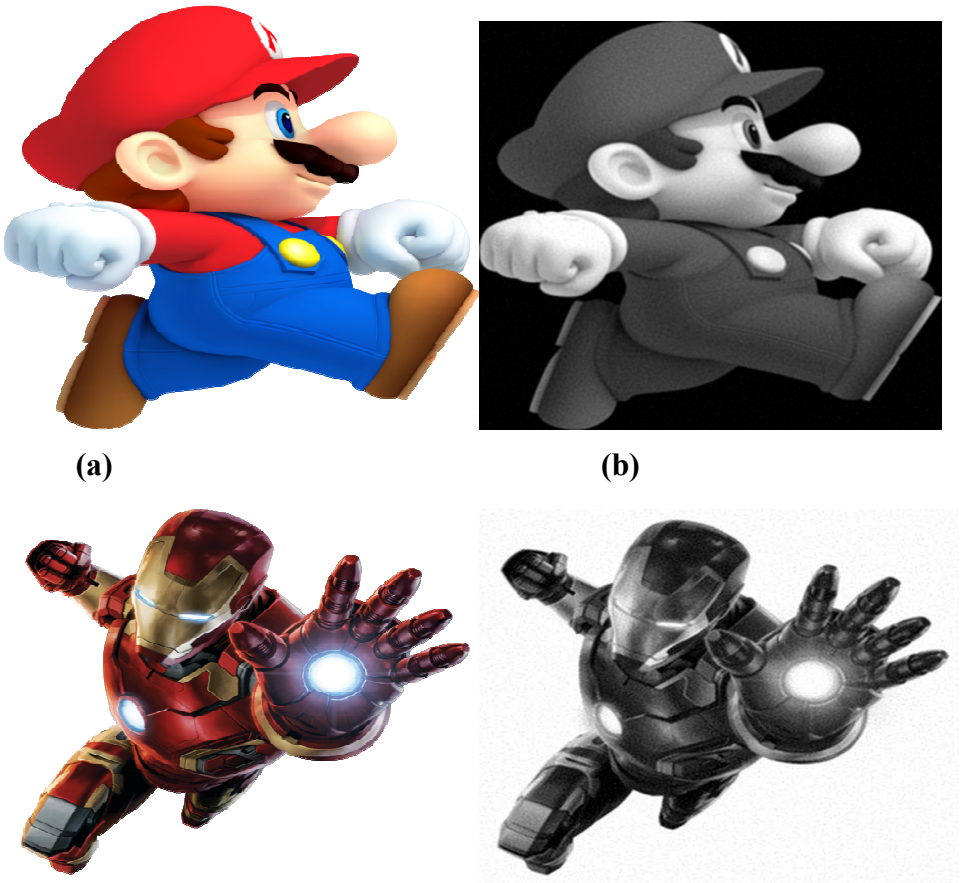
Figure 6: Showing results of DWT algorithm on PNG image files
(a) Large files Original Image (b) Large files Compressed image

(c) Smaller files Original Image (d) Smaller files Compressed image



(a) (b)

Figure 7: Showing results of DCT algorithm on JPG image files
(a) Large files Original Image (b) Large files Compressed image

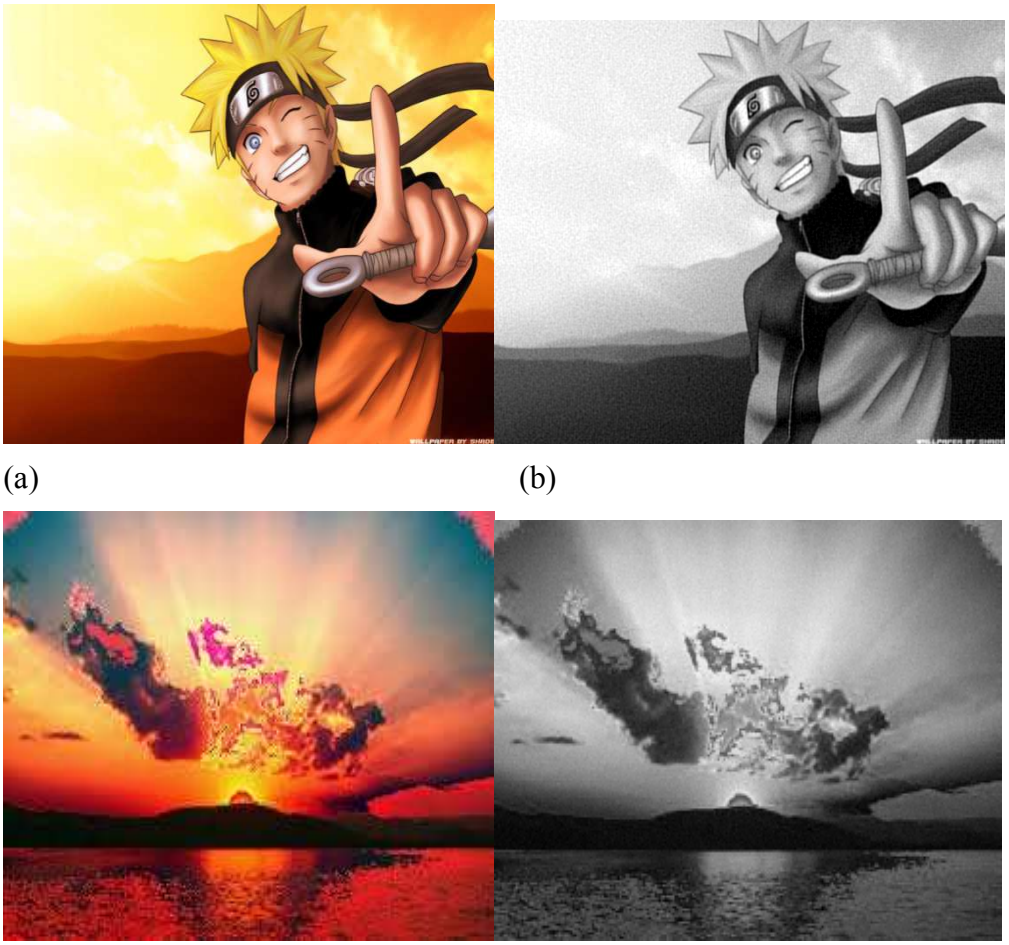


(a) **(b)**

(c) **(d)**

Figure 8: Showing results of DCT algorithm on PNG image files

(a) Large files Original Image (b) Large files Compressed image
(c) Smaller files Original Image (d) Smaller files Compressed image



(a) (b)

(c) (d)

Figure 9: Showing results of DCT algorithm on BMP image files
(a) Large files Original Image (b) Large files Compressed image
(c) Smaller files Original Image (d) Smaller files Compressed image

6. CONCLUSION

In this paper, a comparative analysis between two compression algorithms; Discrete Cosine Transform (DCT) and Discrete Wavelet Transform (DWT) have been studied and implemented on various image files such as JPG, PNG, BMP using Matlab. The results show that discrete wavelet transform is better than discrete cosine transform for image compression using the parameters compression ratio and saving percentage.

REFERENCES

Al-Hilo, E. A. & Zehwar, R (2015). *Comparison Fractal Color Image Compression using YIQ and YUV Color Model. (IJACSA)*. International Journal of Advanced Computer Science and Applications,Vol. 6, No. 5.

Banday, M. T. & Shah, T. J. (2013). *A Comparative Study of Image Compression Techniques*. 9th J&K Science Congress and Regional Science Congress, 1-3 October, 2013, pp.1-4

Bute, Y. S., Mandawi, I., & Sakure, S. (2013). *Architecture of Discrete Wavelet Transform Processor for Image Compression*. *Int. J. Computer Science and Mobile Computing.*, *2*(6), 41-45.

Chui, M., Manyika, J., Bughin, J., Dobbs, R., Roxburgh, C., Sarrazin, H., & Westergren, M. (2012). *The social economy: Unlocking value and productivity through social technologies*. McKinsey Global Institute, *4*, 35-58.

Fracastoro, G., Fosson, S. M., & Magli, E. (2017). *Steerable Discrete Cosine Transform*. IEEE Transactions on Image Processing, *26*(1), 303-314.

Jeengar, V., Omkar, S.N., Singh, A., Yadav, M.K., & Keshri, S. (2012). *A Review Comparison of Wavelet and Cosine Image Transforms*. I. J. Image, Graphics and Signal Processing, 2012, 11, 16-25

Gupta, D., & Choubey, S. (2015). *Discrete wavelet transform for image processing*. International Journal of Emerging Technology and Advanced Engineering, *4*(3), 598-602.

Grgic, S., Grgic, M., & Zovko-Cihlar, B. (2001). *Performance analysis of image compression using wavelets.* IEEE Transactions on industrial electronics, *48*(3), 682-695.

Kaur, J., & Sharma, R. (2012). *A Combined DWT-DCT approach to perform Video compression base of Frame Redundancy.* International Journal of Advanced Research in Computer Science and Software Engineering, *2*(9), 325-332.

Malik, M. S., & Verma, M. V. (2012). *Comparative analysis of DCT, Haar and Daubechies wavelet for Image Compression.* International Journal of Applied Engineering Research, *7*(11), 2012.

Rani, P., & Arora, A. (2015). *A Survey on Comparison between DCT and DWT Techniques of Image Compression*. International Journal of Science and Research (IJSR) Volume 4 Issue 3

Roma, N., & Sousa, L. (2011). *A tutorial overview on the properties of the discrete cosine transform for encoded image and video processing*. Signal Processing, 91(11), 2443-2464.

Salomon, D. (2004). *Data compression: the complete reference*. Springer Science & Business Media.

Shandilya, S., & Singh, K. (2015). *A Review Paper on Image Compression Unit Using DCT*. International Journal of Emerging Trends in Science and Technology, 2(05).

Steinmetz, R. (1994). *Data compression in multimedia computing—principles and techniques.* Multimedia Systems, 1(4), 166-172.

DEVELOPMENT OF A SYSTEM FOR EXTRACTION OF PATIENT DRUG PRESCRIPTION FROM CLINICAL NOTES

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ABSTRACT

Doctors are saddled with the challenges of writing clinical notes which serve as a form of documenting the patient's clinical histories and at the same time write a drug prescription for pharmacy to dispense. This manual process of documentation and writing of prescription is very tedious, stressful, involves duplication and time consuming, most especially for hospital that have hundreds of patients that needs diagnosis. This paper deals with the extraction of drugs prescribed by doctors in the clinical note of the patient. The developed system was designed using MySQL and Visual Basic.NET. The system also takes into considerations the registration of patients, diagnosis by the Doctor and reports on patient's history. A total number of 50 drugs and illness were generated in the library used and four different samples of clinical notes were collected from Doctors to test run the system. It was able to extract the drug prescribed as written in the clinical notes successfully.

Keywords: Clinical Notes, Prescription and Extraction

1. Introduction

The truth is that the world is fast becoming a global village, as a result of development in Information and Communication Technology (ICT). The key instrument in this globalization is the computer. Computer mediated communication is increasingly becoming the fact of every life, particularly in the developed and some developing countries. In these countries, information technologies have changed how people live, work and play, of which Medical sector is not left out of this ware of change (Berenfed, 1999). Since the emergence of ICT which is regarded as the bedrock of national survival and development in a rapidly changing global environment, every progressive country has a national IT policy and an implementation strategy to respond to the emerging global reality and thus avert becoming a victim of digital divide (Mustapha, Ayokunle & Salihu, 2013).

Clinical note are the part of a medical record where healthcare professionals record details to document a patient's clinical status or achievements during the course of hospitalization or over the course of outpatient care(Rector, Glowinski, Nowlan & Rossi-Mori,1995).

Clinical note which is sometimes called Progress notes, are written in a variety of formats and details, depending on the clinical situation at hand and the information the Doctor wishes to record. One example is the Subjective, Objective, Assessment and Plan (SOAP) format, where the note is organized based on this four sections. Another example is the DART format, it is organized into Description, Assessment, Response, and Treatment. Documentation of care and treatment is an extremely important part of the treatment process in a hospital. Clinical notes or

Progress notes are written by both physicians and nurses to document patient care on a regular interval during a patient's hospitalization (Nygren & Henriksson, 1994). Progress notes serve as a record of events during a patient's care, it allows physicians to compare past status to current status, serve to communicate findings, opinions and plans between physicians and other members of the medical care team, and allow retrospective review of case details for a variety of interested parties (Huff, Rocha, Bray, Warner & Haug, 1995).

Every clinical note should be readable, easily understood, complete, accurate, and concise. They must also be flexible enough to logically convey to others what happened during an encounter, e.g., the chain of events during the visit, as well as guaranteeing full accountability for documented material, e.g., who recorded the information and when it was recorded. Physicians are generally required to generate at least one clinical note for each patient encountered. This documentation is then included in the patient's chart and used for medical, legal, prescription and billing purposes (Nygren & Henriksson, 1994).

Once the patient comes to the hospital, the doctor will diagnose, write a clinical note and at the same time write the prescription details for the pharmacy, this prescription details is usually among what the Doctor has written in the clinical notes. Then, the patient will go to the pharmacy and the pharmacist will view the prescription details and dispense the drug. After that, the patient will pick the drug(s) and leave the clinic.

Patients diagnosis is done manually where doctor will write the report on the sheet of paper known as clinical notes, write the prescription form and then send it to the pharmacy, the pharmacist will have to read through the paper in order to get the drug(s) prescribed by the doctor. In other words, the existing method requires the Doctor to pass through the stress of writing the clinical notes and at the same time write the prescriptions form for the pharmacy; with the aid of the proposed system, the doctor will only type the clinical notes while the system will extract the prescription details from the clinical notes and send it to the pharmacy to dispense the drugs.

This Extraction of Patients Drug Prescription from Clinical Notes (EPDPCN) will be beneficial to both the clinic and the doctor because it will reduce the stress the doctor is passing through in diagnosing the patient, documents the illness and treatment and at the same time write the drug prescribed to the pharmacy for dispensing. This paper intends to use the benefits of Computer as one of the ICT tools to show case how important is the wonders of ICT in our day to day activities. This proposed system is developed using Visual Basic.NET and MySQL to extract the prescriptions details in the clinical notes.

2. RELATED WORK

Clinical notes contain rich medical information, such as the patient's symptoms, current medication prescriptions, examination findings, lab/x-ray results, etc. In recent years, many systems have leveraged Natural Language Processing (NLP) technologies to extract information embedded in clinical notes. Some of the related works are:

2.1 Medical Language Extraction and Encoding System (MedLEE)

The goal of MedLEE is to extract, structure, and encode clinical information in textual patient reports so that the data can be used by subsequent automated processes (Carol, Lyudmila, Socrates and Xiao, 1996). This system is developed based on NLP approach to automatically encode data that is in textual form.

2.2 Annotation Analysis for Testing Drug Safety Signals using Unstructured Clinical Notes

This system is based on using the rich contents of Clinical notes to prevent adverse drug events. The symptoms recorded in the clinical notes are used to test the drug safety of a patient. The system describe the application of simple annotation tools on clinical text and the mining of the resulting annotations to compute the risk of getting a myocardial infarction for patients with rheumatoid arthritis that take Vioxx. The analysis clearly reveals elevated risks for myocardial infarction in rheumatoid arthritis patients taking Vioxx (Paea, Srinivasan, Cedrick & Nigam, 2012).

2.3 Apache Clinical Text Analysis and Knowledge Extraction Systems (cTAKES)

The cTAKES is a modular system of pipelined components that combines rule-based and machine learning techniques aiming at extracting information from the clinical narrative. The gold standard datasets for the linguistic labels and clinical concepts are created on content that is a subset of clinical notes from the Mayo Clinic Electronic Medical Records (EMR). Standard evaluation metrics are used to measure the quality of the gold standards and cTAKES performance. It is experimented on a large open source EMR and the system is build based on Natural Language Processing (Guergana et al., 2010).

Another work that extracts information from clinical note is AMBIT (Acquiring Medical and Biomedical Information from Text), it was developed within the context of two e-science projects: Clinical E-science Framework (CLEF) and myGrid. The myGrid project aims to present research biologist with a single unified workbench through which component bioinformatics services, including services for text mining over biomedical abstracts, can be accessed using a workflow model. The goal of CLEF project is to provide a repository of structured and well-organized clinical information which can be queried and summarised for .0biomedical research and clinical care. Specifically, it extracts information regarding the treatment of cancer patients. The treatment of such patients may extend over several years and the resulting clinical record may include many documents, such as case notes, lab reports, discharge summaries, etc, we aim to identify a number of significant classes of entities. Including patients, drugs, problems (i.e., symptoms and diseases), investigations and interventions, and relationships between such entities, e.g., that an investigation has indicated a particular problem, which, in turn, has been treated with a particular intervention (Gaizauskas et al., 2003; Harkema et al., 2005).

Most of the systems reviewed are based on large systems which used Natural Language Processing (NLP) and Text mining approach to information from clinical notes, but the proposed system is developed to extract illness and drugs prescribed, provide a brief overview of patient information and then create a library of drugs and illness from which the system is used to build the extraction system.

3. METHODOLOGY

3.1 System Design

For the purpose of extracting this drugs properly, the system designs entails the Doctor, Pharmacy, Nurses and Patients to fill some forms in other to get registered and have an

identification number. Most of these forms are: Login Form, Patients Form, Diagnosis form and Pharmacy form.

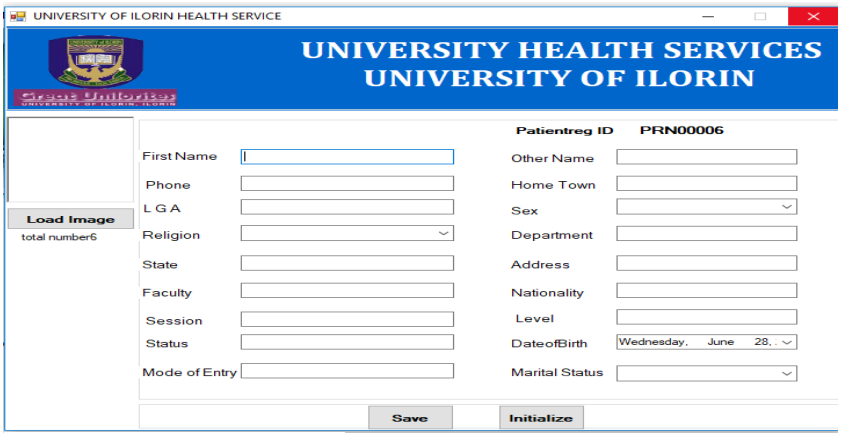
Login Form

The login form is a very important form, it is a form that allows the authorised user login to the system and performs defined activities. Figure 1 is a sample of the Login form



Patient Form

The patient form will allow patient to fill their details and be able to gain admission into the hospital for proper registration process. The Patient Form is an important prerequisite for patient diagnosis in the Hospital Activities. It also allows the Hospital staff to monitor, supervise and pay close attention to patients even after they have been discharged.



Diagnosis Form

The Diagnosis form is to be filled by the doctor who performs the diagnosis on the patient. After the diagnosis must have been completed and prescription has been made, the doctor can then perform the summary and save record into the database. This is a form that has replaced the manual clinical notes of the patient.

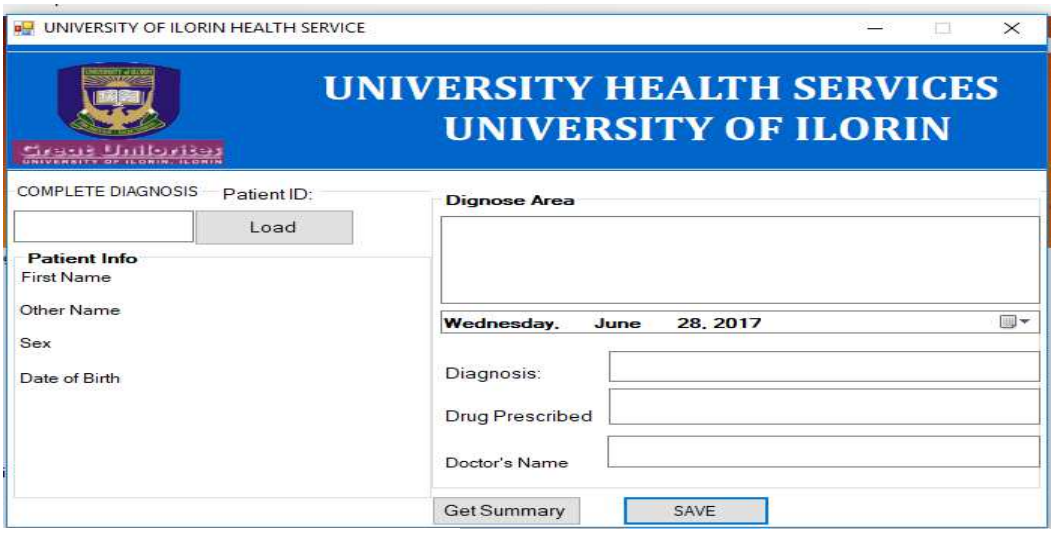
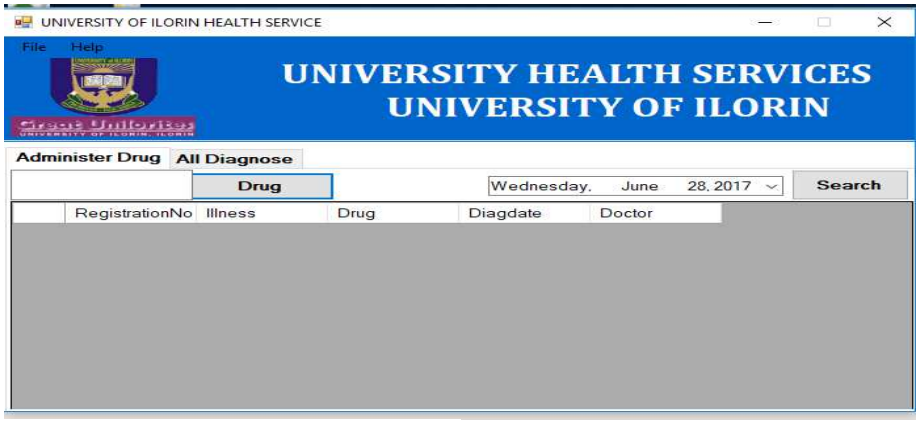


Figure 3: Diagnosis Form

Prescription Form

The prescription form is a form that can be viewed by the pharmacist, it displays the summary of the details of a patient diagnosed, display the illness and the prescribed drug(s) to the pharmacist. This is a form that serves as the prescription form in the manual process.



3.2 Database Design

MySQL database was used for this system because of its simplicity, readily available and easy to use as well as the language program used is attached with it already. MySQL performs the following functions:

Table 1 declares the various field for the data type as it is used to fill in the patient description and stored in the database and the structure of its length and width.

Table 1: Registration Table

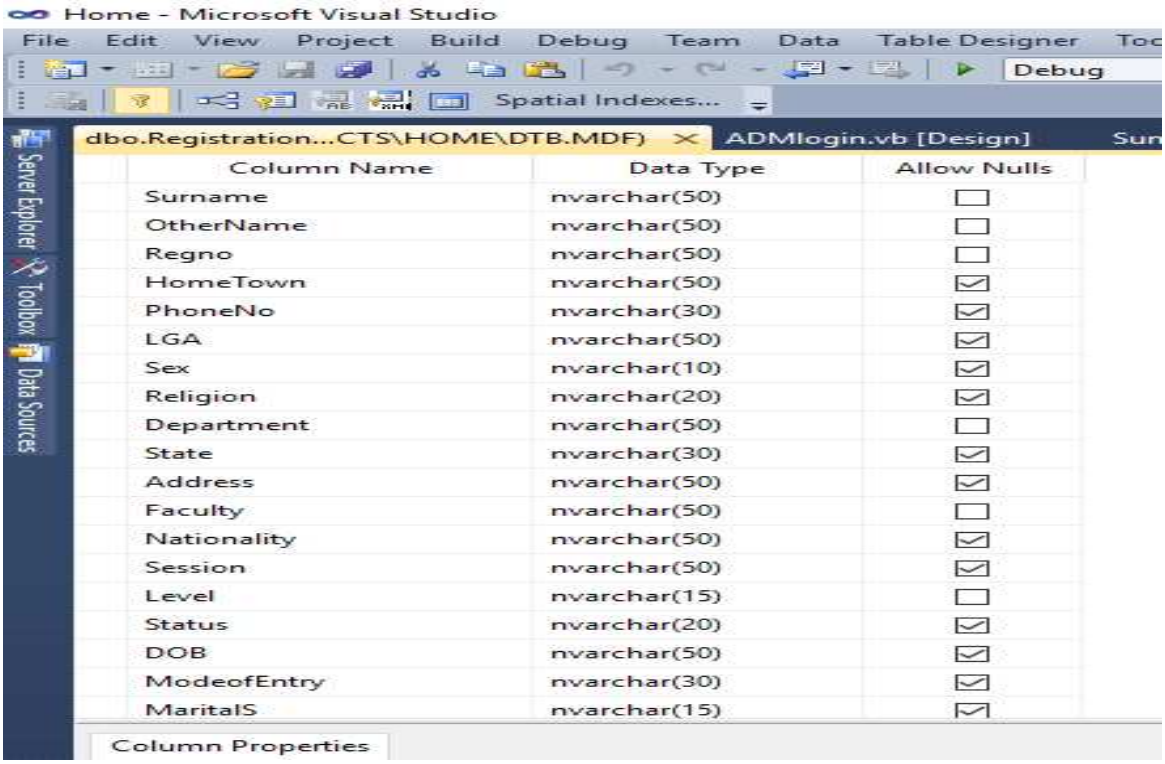


Table 2 declares the various field for the data type as it is used to fill in the patient diagnosis form and stored in the database and the structure of its length and width.

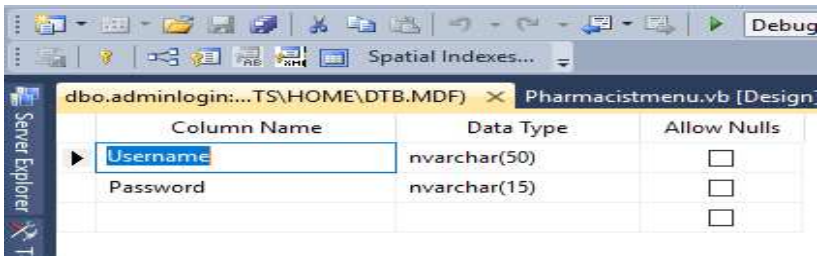
Table 2: Diagnosed Table

dbo.DiagnosedTa...TS\HOME\DTB.MDF) ADMlogin.vb [Design]

Column Name	Data Type	Allow Nulls
id	int	☐
RegistrationNo	nvarchar(20)	☐
Surname	nvarchar(50)	☑
OtherName	nvarchar(50)	☑
Sex	nvarchar(15)	☑
PDDate	nvarchar(20)	☑
ComplainBox	nvarchar(MAX)	☑
Diagdate	nvarchar(20)	☑
Illness	nvarchar(30)	☑
Drug	nvarchar(30)	☑
Doctor	nvarchar(50)	☐
		☐

Table 3 requires parameters for user login

Table 3: Login Table



4. RESULTS AND DISCUSSIONS

In other to experiment the developed system, real clinical notes obtained from Doctors were used to test run the system. Figure 5 is the result of a doctor diagnosing a patient.

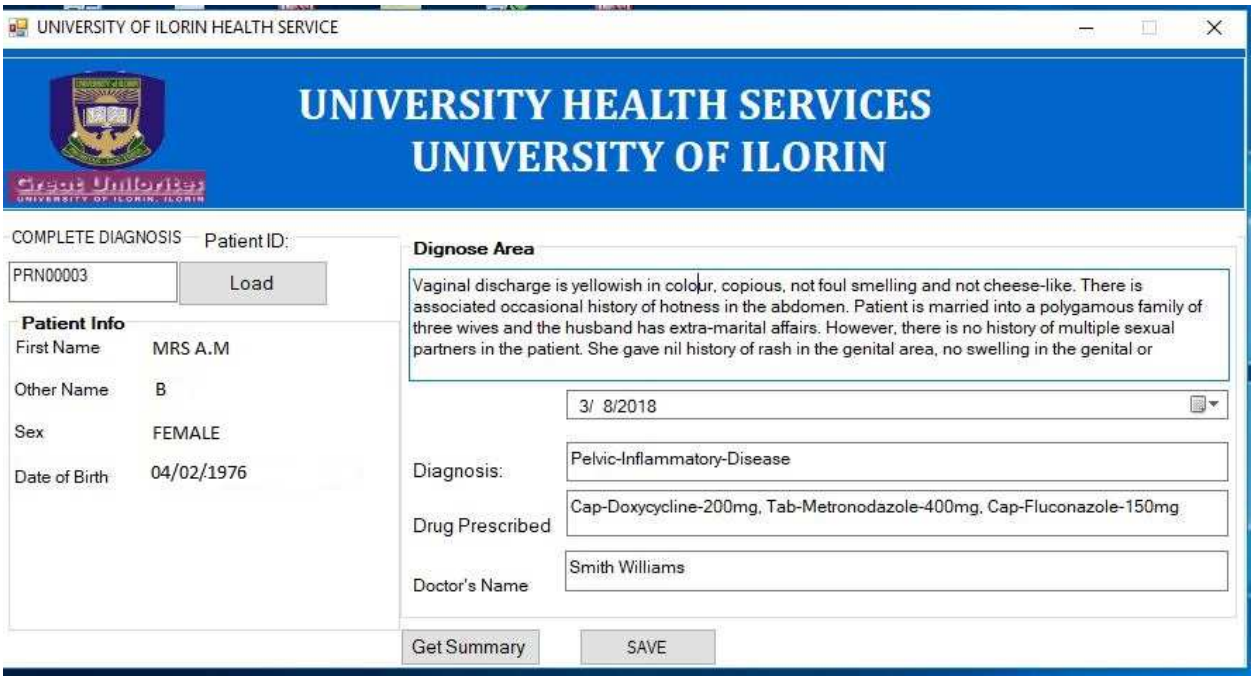


Figure 5: Diagnosis Result

The diagnosis area is the clinical notes typed by the Doctor.



Figure 6: This is the prescription form that will be sent to the pharmacy for drug dispensation.

Figure 7 is a report form that displays the information of all patients that have registered with the clinic

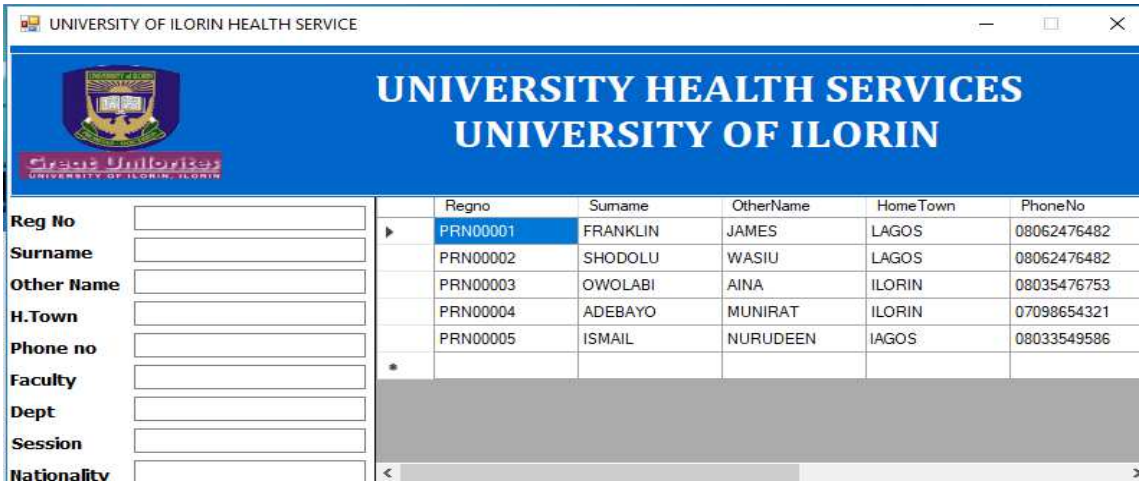


Figure 7: Sample Report

The results obtained shows that prescription details from clinical notes is possible even without using NLP and Text mining approach. The samples result in figures 5 and 6 shows how the drug and the illness extracted from the clinical notes is seen on the prescription form for pharmacy to dispense.

5. CONCLUSION

Based on the objectives of this study and the various analysis made, it is hereby concluded that the important of Information Technology (IT) cannot be underrated as far as medical management is concerned. The system developed is able to reduce the stress the Doctors are passing through in writing clinical notes and at the same time writes the prescription details for patients. The work can be extended to have more drugs and illness in the library and also experiment it with a large system.

REFERENCES

A.L. Rector, A.J. Glowinski, W.A. Nowlan, A. Rossi-Mori (1995): Medical Concept Models and Medical Records: An approach based on GALEN and PEN&PAD. Journal of the American Medical Informatics Associations (JAMIA) 2, 19-35.

Berenfed, B. (1999): The Internet in our Classroom: Teaching Tomorrow's World. In Sylvia, A.W. (Ed) Science and Environment Education Views from Developing Countries. Washington DC: The World Bank, 251-234

Carol Friedman, Lyudmila Shagina, Socrates A. Socratous, and Xiao Zeng(1996): In Proceedings of American Medical Informatics Association (AMIA) Annual fall symposium p 938-939.

E. Nygren, P. Henriksson: Reading the Medical Record I. Analysis of physician's ways of reading the medical record. Yearbook of Medical Informatics, 1994, Schattauer, Germany.

Guergana K Savova, James J Masanz , Philip V Ogren, Jiaping Zheng , Sunghwan Sohn , Karin C Kipper-Schuler and Christopher G Chute (2010): Journal of the American Medical Informatics Association, 17(5), pp 507–513

Gaizauskas R, Demetriou G, Artymiuk PJ and Willett P. (2003): Protein structures and information extraction from biological texts the PASTA system. Bioinformatics 19(1):135-143.

Henk Harkema, Andrea Setzer, Robert Gaizauskas, Mark Hepple, R. Power, and J. Rogers. Mining and Modelling Temporal Clinical Data. In Proceedings of the 4th UK e-Science All Hands Meeting, Nottingham, UK, 2005.

Mustapha, K., Ayokunle, B.T, Salihu, S.A. (2013): Integrating ICT into classroom in Tertiary Institutions: Implications and Statues, The International Journal of Engineering and Sciences. *(THEIJES)*. Vol 2 No 12 pp 56-67.

Paea LePendu, Srinivasan V Iyer, Cédrick Fairon and Nigam H. Shah (2012): Annotation Analysis for Testing Drug Safety Signals using Unstructured Clinical Notes. Journal of Biomedical Semantics, 3(Suppl 1): S5.

S.M. Huff, R.A. Rocha, B.E. Bray, H. Warner, P.J. Haug (1995): An event Model for Medical Information Representation. Journal of the American Medical Informatics Associations (JAMIA) 2, p 116-134.

DIGITAL REVOLUTION AND NATIONAL SECURITY: DYNAMICS OF INFORMATION COMMUNICATION TECHNOLOGY IN SUSTAINABLE DEVELOPMENT IN NIGERIA

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ABSTRACT

There have been serious threats to Nigerian security architecture, in recent times both print and electronic media are fraught with reports of criminalities. This is a pointer that the conventional security apparatus of the country has been beaten by the criminals. Hence, this paper examines digital revolution and national security as dynamics of information communication technology in sustainable development in Nigeria. The study applied theoretical and literary approaches; data was obtained through internet, newspaper and textbooks. The study anchored on routine activity, structural-functionalist and evolutionary theories. Findings shows that there are many insecurity challenges in Nigeria among them are kidnappings, herdsmen attacks and terrorism in which many lives and properties have been lost. As a result of these insecurities, the attainment of sustainable development goals is under serious threats. Hence, this paper recommends adoption of digital revolution to national security system to compliment the conventional security entity. The adoption of modern digital revolution like Closed Circuit-Television Cameras (CCTV), Global Positioning System (GPS); with an inbuilt 24/7 tracking systems, will strengthening our security structures and the activities of these criminals will be put under control. There should be concerted efforts to sustain the current Nigerian Communication Satellite- NigComSat-1R to prevent the failure of the first Nigerian satellite NigComSat-1. Terrorism is major global security challenge; all the available technologies should be redeployed to fight it to standstill. This study will be useful to Nigerian Communication Commission, Ministries of Science and technology, Federal Ministry of Interior and all security organizations. The researchers in the field of information communication technology and national security can pick-holes from the research and initiate research from it.

***Keywords**: Digital Revolution, national security, information communication, sustainable development, Nigeria, NigComSat-1R*

1. INTRODUCTION

What is permanent in life is change, every aspect of live is experiencing positive change, hence, security of life property could not be left behind, so, as criminals device modern ways of unleashing atrocities on the human societies. According to (Bojanova, 2014). The digital revolution is the movement from mechanical and analogue electronic technology to digital electronics, this started in 1950s to the late 1970s with the introduction, usage and widespread of

digital computers and digital record keeping. That persists till present, precisely, the term also refers to the drastic improvement brought about by digital computing and communication technology during (and after) the latter half of the 20th century. Analogous to the Agricultural Revolution and Industrial Revolution, the Digital Revolution marked the beginning of the Information Age Central to this revolution is the mass production and widespread use of digital logic circuits, and its derived technologies, including the computer, digital cellular phone, and the Internet. These technological innovations have transformed traditional production and business techniques. The information revolution is a phenomenon that defies simple characterization. Its origins lie in the not-so-distant past—the British code breakers at Bletchley Park during World War II created "Colossus," the world's first working computer.. (Freeman and Louçã, 2002) That crude appliance is now outperformed by a hand-held calculator. Yet the origins of the information revolution really go further back to the inventions of the radio, the telephone, and even the telegraph. In many ways, information has been making the world a smaller place since the invention of the printing press. But the digital revolution, as it is commonly understood today, is heralded as the greatest global transition since the Industrial Revolution. It is transforming the world's most advanced nations from industrial societies to technology-based societies. Increasingly on high-speed and high-quality information to conduct their daily functions and operations.(Shannon, Claude, Weaver & Warren, 1966*)*.Pieces of data have become the building blocks of many modes of human interaction and activity. The revolution is perhaps best illustrated by its results .The speed and volume of computing power have increased exponentially while costs have been dramatically reduced, bringing personal computers to half of all American homes.(Markoff,2002) maintains that revolution has created the internet, which from its origins as a secure, nuclear-proof communications system for the military has become a true global information system, home to more than 40 million web sites with more than 800 million pages of information, accessed by more than 165 million users. The digital revolution is moving beyond computer networks; even small countries like Finland have gone wireless—more than 80 telecom service providers service the two-thirds of all Finns who own .The promise of economic growth and development applies elsewhere a well; technological advances are allowing the least developed countries to leapfrog ahead in time, cost, and technology, from having no telephones to acquiring wireless telecommunications. Improved person-to-person contact and understanding—thanks to new communications technologies resulting in the creation of a "global village"—seem to offer hope that the use of military force may become far less necessary in the future. Advances in technology and communications are also revolutionizing other areas a typical example is the security of life and property.

Table 1: Crime Casualties Statistics in Nigeria from (2007-2017)

Year	Terrorism Boko-Haram	Kidnapping	Arm-robbery	Rape	Herdsmen Attacks	Fraud
2007	16890	277	2327	1032	2888	3010
2008	17901	309	2340	1119	3010	2841
2009	10133	401	1181	1008	2991	3132
2010	10217	341	1012	1003	2011	2591
2011	24538	281	1722	2088	22003	2747
2012	26511	294	1011	2111	23121	2921
2013	28973	201	1001	2155	24010	1198
2014	20811	292	942	2299	35121	3411
2015	23149	103	845	2310	61932	1219
2016	18214	99	891	2401	76121	2110
2017	15607	54	801	2510	86,500	3128
Total	212,944	2,652	14,073	19,107	373,108	28,308

Source: Crime Watch, the Vanguard, the Punch and the Guardian (2007-2017

1.2 DEFINITIONS OF CONCEPTS:

1.2.1 Digital Revolution: According to (William, 2014) Digital Revolution refers to the advancement of technology from analog electronic and mechanical devices to the digital technology available today. The era started to during the 1980s and is ongoing. The Digital Revolution also marks the beginning of the Information Era. The Digital Revolution is sometimes also called the Third Industrial Revolution. As the world is becoming a global village, computer innovation is no left out, and its applications cover vast areas of human endeavors. One significant area of application of products of digital revolution is the security of lives and properties. It is about evolving for better tomorrow

1.2.2 National Security:(Ripsman, Norrin& Paul, 2010) maintained that national security is the measurable state of the capability of a nation to overcome the multi-dimensional threats to the apparent well-being of its people and its survival as a nation-state at any given time, by balancing all instruments of state policy through governance... and is extendable to global security by variables external to it." National and international security] may be understood as a shared freedom from fear and want, and the freedom to live in dignity. (Scherer &Lauri, 2010).It implies social and ecological health rather than the absence of risk... and is a common right." National security is an appropriate and aggressive blend of political resilience and maturity, human resources, economic structure and capacity, technological competence, industrial base and availability of natural resources and finally the military National security is all encompassing so for any nation to advance in all reams of human activities.(Farah and Paolo,2015)

1.2.3 Sustainable Development Goals: Sustainable development is systemic ways of meeting human development goals while at the same time sustaining the ability of natural systems to provide the natural resources and ecosystem services upon which the economy and society

depend.(*Turner& Kerry ,1988)* asserted that the desired result is a state of society where living conditions and resource use continue to meet human needs without undermining the integrity and stability of the natural system. The sustainable development can be classified as development that meets the needs of the present without compromising the ability of the future generation. (Mohamed-El-Kamel, 2013) The Sustainable Development Goals (SDGs) are a range of seventeen (17) global goals established by the United Nations. The broad goals are interrelated though each has its own targets to achieve. The total number of targets is 169. The SDGs cover a broad range of social and economic development issues. These include poverty, hunger, health, education, climate change, gender equality, water, sanitation, energy, environment and social justice. The SDGs are also known as "Transforming our World: the 2030 Agenda for Sustainable Development" or 2030 Agenda in short. The goals were developed to replace the Millennium Development Goals (MDGs) which ended in 2015. Unlike the MDGs, the SDG framework does not distinguish between "developed" and "developing" nations. Instead, the goals apply to all countries.(Borowy, 2014)

Table 2: The Sustainable Development Goals.

S/N	GOAL
1.	Poverty Eradication
2.	Zero Hunger
3.	Good Health and Wellbeing
4	Quality Education
5.	Gender Equality
6.	Clean water and sanitation
7.	Affordable clean energy
8.	Decent water and economic growth
9.	Industry, innovation and infrastructures
10.	Racial inequality
11.	Sustainable cities and communities
12.	Responsible consumption and production
13.	Climatic Action
14.	Life below water
15	Life on land
16	Peace justice and strong institutions
17	Partnership for development

Source: https://en.wikipedia.org/wiki/Sustainable_Development_Goals, modified by the author.

1.3 History of Digital Revolution

As affirmed by(Hughes & Lorna 2004) the development and advancement of digital technologies started with one fundamental idea: The Internet. Here is a brief timeline of how the Digital Revolution progressed:

1.3.1 1947-1979 - The transistor, which was introduced in 1947, paved the way for the development of advanced digital computers. The government, military and other organizations made use of computer systems during the 1950s and 1960s. This research eventually led to the creation of the World Wide Web.

1.3.2 1980s - The computer became a familiar machine and by the end of the decade, being able to use one became a necessity for many jobs. The first cell-phone was also introduced during this decade.

1.3.3 1990s - By 1992, the World Wide Web had been introduced, and by 1996 the Internet became a normal part of most business operations. By the late 1990s, the Internet became a part of everyday life for almost half of the American population.

1.3.4 2000s - By this decade, the Digital Revolution had begun to spread all over the developing world; mobile phones were commonly seen, the number of Internet users continued to grow, and the television started to transition from using analog to digital signals.

1.3.5 2010 and beyond - By this decade, Internet makes up more than 25 percent of the world's population. Mobile communication has also become very important, as nearly 70 percent of the world's population owns a mobile phone. The connection between Internet websites and mobile gadgets has become a standard in communication. It is predicted that by 2015, the innovation of tablet computers will far surpass personal computers with the use of the Internet and the promise of cloud computing services. This will allow users to consume media and use business applications on their mobile devices, applications that would otherwise be too much for such devices to handle. (McQuail, 2000)

2. METHODOLOGY

The study applies theoretical and literary approaches; the data was sourced through secondary means like newspaper, internet and textbooks.

3. SECURITY SITUATIONS IN NIGERIA

Nigeria is currently facing serious internal security challenges, the most serious ones being the Boko Haram insurgency in the northeastern states of Borno, Yobe and Adamawa; and the Niger Delta militancy and piracy in the south-south geopolitical zone, comprising Bayelsa, Delta and Rivers.(Olarimoye,2010).Additionally, there are security challenges posed by violent crimes, ethno-religious conflicts, resource-based conflicts, trans-border criminal activities, and election-induced violence. All these security challenges undoubtedly pose some threats to the social, economic and political stability of not only Nigeria, but also of the African continent, especially the West African sub-region, where more than half the population comes from Nigeria. While several factors could have contributed to Nigeria's security situation today, there is no doubt that poor governance and lack of effective leadership at all levels of governance are central in attempting to explain the problem.(Sen, 2008) About fourteen years after the return of democracy in 1999, Nigeria's democratic transition does not appear to be consolidating due to lack of transparency, accountability, rule of law, and the genuine demonstration of leadership capacity to protect fundamental human rights. It is also evident that most of the key government institutions are weak, enabling corruption to thrive with impunity. Herdsmen attack various

communities in which many lives have been lost to their iniquities.(Mallam, 2009) Itemizes the current security situations in Nigeria:

4.1 Kidnappings; kidnapping is common security challenge in Nigeria, the most painful one was the kidnapping of over 250 Chibok Secondary Girls in 2015, this month, 110 Government Girls Science Secondary School girls were kidnapped in Dapchi, Yobe State. The kidnapping of prominent personalities is rampant. (Abdullateef, 2010) The Lagos State Model School Igbonla in Epe is still fresh in our memory, Oniba of Ibaland, Ojo, in Lagos was kidnapped and realized on ransom, and five students on the Nigerian Turkish International College, in Ogun State were kidnapped and later released last year.

4.2 Herdsmen Attacks: Another insecurity challenge in Nigeria is the problem of cattle-rarer who has turned to killers, in recent times the atrocities created by cattle rustlers. The reports from news-papers reveal that many lives have been lost; about 3,000 lives have lost to activities of Fulani herdsmen.(Akinloye, 2011) Former head of state, General Abdulsalami Abubakar, addressed a one-day forum organized by a group known as the Search for Common Ground on his farm October 30. In it, he released some grim statistics about the killings and maiming in clashes between Fulani herdsmen and peasant farmers in four states – Plateau, Nasarawa, Kaduna and Benue – in just one year. These figures are certain to chill your bones and make your eyes go rheumy for the present and the future of our country .Here are the details he gave for 2016 only: 2,500 people killed; 62,000 people displaced; $13.7 billion lost to the clashes and 47 per cent of the internally-generated revenue in the affected states lost. (The Guardian, March, 2017)



Figure 1: Herdsmen with Weapons

Source: https://guardian.ng/opinion/fulani-herdsmen-here-are-the-grim-statistics/ retrieved, 2018, 18 March 2018

4.3 Terrorism

The 2017 Global Terrorism Index, GTI, has been released, and Nigeria for the third year running remains the third most terrorized nation in the world. The country, which has been battling the Boko Haram insurgency in the North-east for many years occupied the same ranking in 2015 and 2016. It was ranked fourth in 2014.(Akinloye, 2011) Like Nigeria, Iraq and Afghanistan have not had their ranking changed in the past three years. The two countries are ranked first and second respectively in the 2017 GTI. Among the first 10 countries that suffered the greatest impact of terrorism in 2016, according to the report, are Syria, fourth; Pakistan, fifth; Yemen, sixth; and Somalia, seventh. India, Turkey, and Libya are ranked eighth, ninth and 10th respectively. The GTI, which is in its fifth edition, is produced annually by the Institute for Economics & Peace, an independent, non-partisan, non-profit think tank with offices in Sydney, New York and Mexico City. The GTI monitored and measured the impacts of terrorism in 163 countries, which covers 99.7 per cent of the world's population.(Ardo, 2000)

4.4 Theoretical Underpinning of the Study:

4.4.1 The Evolutionary Theory: (*Hoskin, Conrad J.; Higgle, Megan; McDonald, Keith R.; Moritz, Craig , 2005).*The theory of evolution by natural selection, first formulated in Darwin's book "On the Origin of Species" in 1859, is the process by which organisms change over time as a result of changes in heritable physical or behavioral traits. Changes that allow an organism to better adapt to its environment will help it survive and have more offspring. Evolution by natural selection is one of the best substantiated theories in the history of science, supported by evidence from a wide variety of scientific disciplines, including paleontology, geology, genetics and developmental biology. The theory has two main points, said Brian Richmond, curator of human origins at the American Museum of Natural History in New York City. "All life on Earth is connected and related to each other," and this diversity of life is a product of "modifications of populations by natural selection, where some traits were favored in and environment over others," he said. More simply put, the theory can be described as "descent with modification," said Briana Pobiner, an anthropologist and educator at the Smithsonian Institution National Museum Natural History in Washington, D.C., who specializes in the study of human origins. The theory is sometimes described as ``the survival of the fittest`` but that can be misleading, Pobiner said. Here, "fitness" refers not to an organism's strength or athletic ability, but rather the ability to survive and reproduce. For example, a study on human evolution on 1,900 students, published online in the journal ``personality and individual differences`` in October 2017, found that many people may have trouble finding a mate because of rapidly changing social technological advances that are evolving faster than humans. "Nearly 1 in 2 individuals faces considerable difficulties in the domain of mating," said lead study author Menelaus Apostolou, an associate professor of social sciences at the University of Nicosia in Cyprus. "In most cases, these difficulties are not due to something wrong or broken, but due to people living in an environment which is very different from the environment they evolved to function in.(*Maynard, (1993)*

4.4.2 Routine Activity Theory

The Routine Activity Theory by Cohen and Felson 1979 in (Miller, 2006). They argued that for a crimininality to take place three requirements needed to be present; a motivated offender, a suitable target, and absence of capable guardians. *(*Pratt, Travis C.; Holtfreter, Kristy; Reisig, Michael D. (2010).The theory contends that crime is normal and relies on the opportunities available. If a target is not protected enough, and if the reward is worth it, crime will happen. Crime does not need hardened offenders, super-predators, convicted felons or wicked people. Crime just needs an opportunity. It states that for a crime to occur, three elements must be present at the same time and in the same space when any crime is committed:

- **i.** A suitable target is available
- **ii.** There is the lack of a suitable guardian to prevent the crime from happening
- **iii.** A likely and motivated offender is present.(Smith, Frazee, & Davison, 2000).

The theory is relevant to this study in the sense that it provides significant understanding to why people engage in criminality. Criminality has more to do with the effectiveness of indirect guardianship; as such, a motivation for such crime to take place. Also, the Global Information Infrastructure (GII) is open and immoderate, and the mechanisms of the Internet are designed to transfer data, not to examine the data. The criminality that are been committed in Nigeria are due to these factors, kidnappers found that there are possible targets for them to commit their criminalities, they orchestrate their plans with the aims of getting huge ransom from the their victims. (Stuart, 2008)

4.4.3 Functionalist Perspective

The functionalist perspective is based largely on the works of Herbert Spencer, Emile Durkheim, Talcott Parsons, and Robert Merton. According to functionalism, society is a system of interconnected parts that work together in harmony to maintain a state of balance and social equilibrium for the whole. For example, each of the social institutions contributes important functions for society: Family provides a context for reproducing, nurturing, and socializing children; education offers a way to transmit a society's skills, knowledge, and culture to its youth; politics provides a means of governing members of society; economics provides for the production, distribution, and consumption of goods and services; and religion provides moral guidance and an outlet for worship of a higher power.(Beven, 2006).

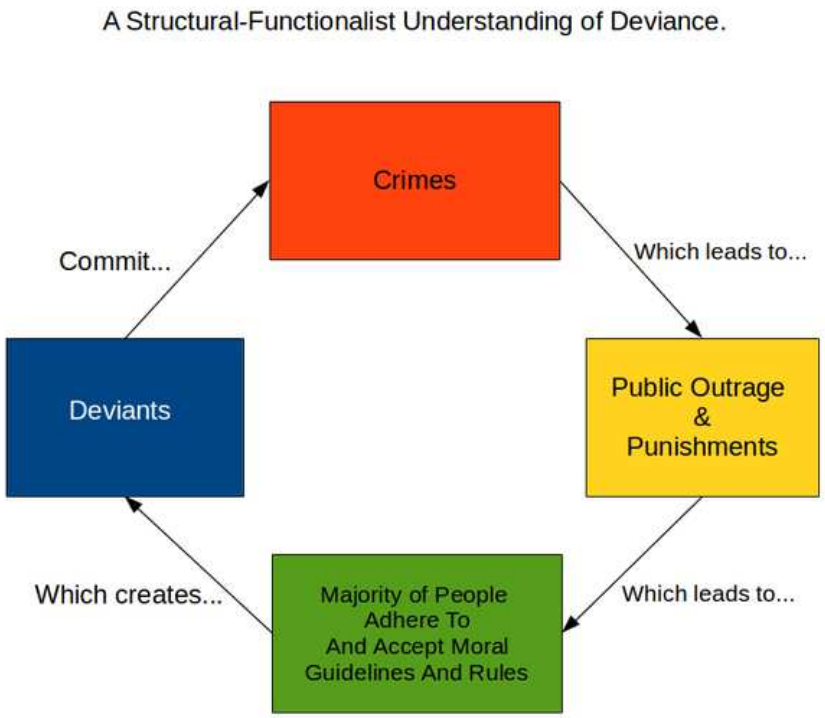


Figure 2: Structural Functionalist Theory Schema

(Source:https://www.google.com.ng/search?q=structural+functionalist+theory+diagrams&client=firefoxb)

4.5 EFFECTS OF INSECURITY ON SUSTAINABLE DEVELOPMENT GOALS

Insecurity of all kinds has negative influences on sustainable development. It aggravates poverty level in Nigeria; as result of insecurity people are unable to work, schools will be shut down. Hence, poverty situation aggravates. It reduces foreign and local investment in the country, one of the demerits of insecurity is that it limits opportunities for local investments in the countries, investment could not thrive there peace and harmony are absent. (Edigheji, 2005) No rational investment wants to put his or money in an atmosphere where there is no rest of mind, hence, insecurity scares away valuable economic opportunities for the countries, hence the national income is n negatively affected. Another adverse effect of insecurity is that it creates state of fear in the people; people will not have trust in the government. It has places extra burden on the government because huge cost maintaining people that are displaced by the insecurities like terrorism and herdsmen attacks.(Soeze, 2012).Through terrorism and other forms of insecurities many lives are lost many experts and trained personal who possess the technological. At the national level, kidnapping became a mean to an end: of negotiating and extraction of money and leverage from families, groups or classes of people and institutions of the Nation-State. In other words, kidnapping is carried out with the specific aim of getting an unwarranted reward from the families of the victims, the groups or classes to which these victims belong in society and finally the institutions of the Nation-State through their involvement in rescue missions or intermediation/negotiation .Mobile communication aided the evolution of kidnapping and shaped it as it facilitates easy contact with the families or employers of the victims via mobile telephone communications.(Daily Trust, Sunday22 October, 2017) Negotiation for payment of ransoms follows quickly with or without the intervention of the law enforcement authorities. Negotiation

can drag for several days, weeks or even months before agreements are finally reached between the kidnappers, the victims, their families and/or go-betweens. In most cases, victims are kept out of the negotiation loops as their involvements are considered detrimental to the final settlements. Mobile telephone even makes it possible for both parties not to meet physically as their negotiations can be carried out on phone. Insecurity is major impediment to the realization of the sustainable development goals in Nigeria. (Adebayo, 2013)

4.6 APPLICATIONS OF DIGITAL REVOLUTION TO COMBAT INSECURITY

4.6.1 Electronic surveillance. According to (William,2013) electronic surveillance is the monitoring of a home, business, or individual using a variety of devices such as CCTV, legal wiretapping, cameras, digital video equipment, and other electronic, digital, and audio-visual means.OSS approach to physical security encompasses facilities, equipment, personnel and property and ensures that all appropriate security controls are in place for comprehensive loss prevention, including unauthorized access, theft, damage or destruction. (William,2013).We employ access control and CCTV electronic surveillance systems, sophisticated locks, protective barriers and many other technologies to prevent and detect intrusion attempts and to activate appropriate incident responses. Key questions we help address include:

4.6.2 The Global Positioning System (GPS) is actually a constellation of 27 Earth-orbiting satellites (24 in operation and three extras in case one fails). The U.S. military developed and implemented this satellite network as a military navigation system, but soon opened it up to everybody else. Each of these 3,000-to 4,000-pound solar-powered satellites circle the globe at about 12,000 miles (19,300 km), making two complete rotations every day. The orbits are arranged so that at anytime, anywhere on Earth, there are at least four satellites "visible" in the sky. A GPS receiver's job is to locate four or more of these satellites, figure out the distance to each, and use this information to deduce its own location. (Erik, Conway, Rick & Sturtevant ,2008).A GPS tracking unit is a device that uses the Global Positioning System to determine the precise location of a vehicle, person, or other asset to which it is attached and to record the position of the asset at regular intervals. The recorded location data can be stored within the tracking unit, or it maybe transmitted to a central location database, or internet-connected computer, using a cellular (GPRS), radio, or satellite modem embedded in the unit (see Figure 1). This allows the asset's location to be displayed against a map backdrop either in real-time or when analyzing the track later, using customized software. A GPS tracking system uses the GNSS (Global Navigation Satellite System) network.(Ripsman, Norrin M., and T. V. Paul,2010). This network incorporates a range of satellites that use microwave signals which are transmitted to GPS devices to give information on location, vehicle speed, time and direction. So, a GPS tracking system can potentially give both real-time and historic navigation data on any kind of journey. A GPS tracking system can work in various ways. From a commercial perspective, GPS devices are generally used to record the position of Objects e.g vehicles as they make their journeys. Some systems will store the data within the GPS tracking system itself (known as passive tracking) and some send the information to a centralized database or system via a modem within the GPS system unit on a regular basis (known as active tracking).

4.6.3 Forms of GPS Tracking System: (Akinode, Alawode andOjuawo, 2013) identified the following forms of tracking system

4.6.4 An Active GPS Tracking System. Active System is also known as a real-time system as this method automatically sends the information on the GPS system to a central computer or system in real-time as it happens.(Michael, McNamee & Michael 2006). This kind of system is usually a better option for commercial purposes such as fleet tracking and individual vehicle tracking as it allows the company to know exactly where their vehicles are, whether they are on time and whether they are where they are supposed to be during a journey. This is also a useful way of monitoring the behaviour of employees as they carry out their work and of streamlining internal processes and procedures for delivery fleets.

4.6.5 A Passive GPS Tracking System.(Craddock, 2004) affirmed that passive system monitors location and stores its data on journeys based on certain types of events .So, for example, this kind of GPS system may log data such as turning the ignition on or off or opening and closing doors.(Gak, 2007) The data stored on this kind of GPS tracking system is usually stored in internal memory or on a memory card which can then be downloaded to a computer at a later date for analysis. In some cases the data can be sent automatically for wireless download at predetermined points/times or can be requested at specific points during the journey.

5. CONCLUSION

The findings from the study show that; kidnappings, herdsmen attacks and terrorisms are among various insecurity challenges facing the country, and their perpetrators continue to unleash terror on the innocent citizenry. The paper recommends application of digital revolutions like GPS tracking system, CCTV camera monitoring and other electronic devices as improvement on the current security configuration of the country as calculated synergy to curb the menace of these criminals. The scholars in the field ICT and national security will find this study useful, also national security planners and various ministries, police, army and other security intelligence will benefit immensely from the outcomes of this study. The application of digital revolution into the Nigerian security system is exigent for national development.

REFERENCES

Abdullateef, U., (2010), Dividend of Democracy in Nigerian Issues and Challenges for National Growth and Development.

Abdulsalami, A., (2004).”The Challenges of Security in Nigeria“, Excerpts of Lecture at NIPSS Kuru.

Adebayo, P.N., (2013).Corruption and Insecurity in Governance. Journal of Psychological and Social Issues 100: 85-150 Akinloye, L,. (2011) *Nigerias 2012 Budget: Consolidation, Growth and Employment*. Think Africa. Article 15.December

Ardo, U., (2000).*Democracy and Africa: A Historical overview*. In the Journal of Human Rights,Democracy and Good Governance. Ahmadu Bello University Zaria

Bardhan, P,.(2002).*“Decentralization of Governance and Development”*.Journal of Economic Perspectives, 16(4): 185-205

Beven, K. (2006). A manifesto for the equifinality thesis. Journal of hydrology, 320(1), 18-36.

Bojanova, Irena. "The Digital Revolution: What's on the Horizon?". IT Professional Jan.-Feb. 2014). **16** (1): 8–12.

Borowy, I.,(2014).Defining Sustainable Development for Our Common Future. A history of the World Commission on Environment and Development (Brundtland Commission), Milton Park: Routledge, .

Craddock, R.J.,(2004**).**"Locating and Tracking People and High-value Assets using RF Tags",Thales Research and Technology (UK) Limited Worton Drive, Worton Grange Reading, Berkshire, RG2 0SB,UK.

Edigheji, O., (2005). A Democratic developmental State in Africa. A Research Report 105, Centre for Policy Studies. Johannesburg, South Africa

Erik M. Conway, Rick W. Sturtevant (2008)"Satellites and Security: Space in Service to Humanity

Farah, Paolo Davide (2015). "Sustainable Energy Investments and National Security: Arbitration and Negotiation Issues".JOURNAL OF WORLD ENERGY LAW AND BUSINESS.**8** (6).

Freeman and F. Louçã,(2002).As Time Goes By: From the Industrial Revolutions to the Information Revolution, Oxford University Press, USA

GakGyu (2007)"Locating and Tracking Assets using RFID, TexasUniversity, U.S.A. culled from www.dawodu.com

Garofalo, J. (1987). Reassessing the lifestyle model of criminal victimization. Beverly Hills, California: Sage.

Hoskin, Conrad J.; Higgle, Megan; McDonald, Keith R.; Moritz, Craig (October 27, 2005). "Reinforcement drives rapid allopatric speciation". Nature. London: Nature Publishing Group. **437** (7063): 1353–1356.

John, M.,(2002). "Pentagon Plans a Computer System That Would Peek at Personal Data of Americans". *The New York Times*

Mallam, B., (2009). National Security as a tool for Sustainable Democracy in Nigeria: An

Assessment of Nigerian Police Force. Paper presented at National Conference on

Security and Nigeria's Quest for Development. Organized by the Kaduna State

University Kaduna

Maynard Smith, John (1993). The Theory of Evolution (Canto ed.). Cambridge; New York: Cambridge University Press.ISBN 0-521-45128-0.LCCN 93020358.OCLC 27676642.

McQuail, D., (2000). McQuail's Mass Communication Theory (4th edition), Sage, London, pp. 16--34

Michael K, McNamee A,M.,Michael M.G., (2006)."The Emerging Ethics of Humancentric GPS Tracking and Monitoring", School of Information Technology and Computer Science, University of Wollongong, Australia.

Mohamed El-Kamel.(2013). "Globalization and Sustainable Development: False Twins?." New Global Studies 7.3: 23-56. ISSN (Online) 1940-0004, ISSN (Print) 2194-6566, DOI: 10.1515/ngs-2013-02.

Olarimoye, O., (2010).*Democracy, Participation and Development.*in Nigeria's Fourth Republic 1999-2003, in Turkish Journal of Politics Vol. 1 No. 2

Pratt, Travis C.; Holtfreter, Kristy; Reisig, Michael D. (2010). "Routine Online Activity and Internet Fraud Targeting: Extending the Generality of Routine Activity Theory". Journal of Research in Crime and Delinquency.**47**: 267–296.

Ripsman, Norrin M., and T. V. Paul.(2010). Globalization and the National Security State. Oxford: Oxford University Press, 2010.

Scherer, Lauri S., (2010). National Security.Detroit: Greenhaven Press

Shannon, Claude E.; Weaver, Warren (1998). The mathematical theory of communication (print. ed.). Urbana: University of Illinois Press. p. 144.ISBN 0252725484.

Smith, W. R., Frazee, S. G., & Davison, E. L. (2000).Furthering the integration of routine activity and social disorganization theories: Small units of analysis and the study of street robbery as a diffusion process. *Criminology*, *38*(2), 489-524

Soeze, C.I (2012). Nigeria at 52:Rocked by Corruption and Insecurity Saturday Tribune. Thursday, October 25.

Stuart, Douglas T. (2008).Creating the National Security State: A History of the Law That Transformed America. Princeton, N.J.: Princeton University Press,ISBN 9781400823772

Turner, R. Kerry (1988). "Sustainability, Resource Conservation and Pollution Control: An Overview".In Turner, R. Kerry.Sustainable Environmental Management. London: Belhaven Press.

Daily Trust, Sunday22 October, 2017 https://guardian.ng/opinion/fulani-herdsmen-here-are-the-grim-statistics/ retrieved, 2018, 18 March 2018

https://en.wikipedia.org/wiki/Sustainable_Development_Goals,

https://upload.wikimedia.org/wikipedia/commons/5/5d/General_Diagram_of_Structural-Functionalism.png

INSTITUTIONAL POLICY IMPLEMENTATION AND ADOPTION OF LEARNING MANAGEMENT SYSTEM IN OSUN STATE UNIVERSITIES

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ABSTRACT

Information and Communication Technology (ICT) has launched all sectors of the society into the 21st century by changing every institution, business and individual in profound ways; as such, there is the need for the changing nature in the demands for the teaching principles and methods from lecturers. This research was carried out to determine the relevance of Institutional Policy Implementation towards adoption of Learning Management System (LMS) in Government-owned universities in Osun state, Nigeria. The specific objectives of the study were: (i) investigate the availability of ICT facilities in the selected universities; (ii) determine the relationship between Institutional Policy Implementation and Adoption of LMS. The study adopted quantitative research approach using survey type. The population comprised of 1,373 lecturers in the selected universities. Purposive and random sampling techniques were employed in choosing institutions and respondents to arrive at 165 lecturers as against the required 159. The research instrument used for the study was researcher-designed questionnaire. Collected data were analyzed with the use of descriptive mean and correlation analysis was used for answering the research questions. The findings of the study revealed that: The mean values of above 4.0 in all cases except item 10 indicated a positive response for availability of ICT for accessing educational materials, downloading and uploading electronic resources, effective teaching and research collaboration, multimedia support, information exchange, managing learning processes; Institutional Policy Implementation and Adoption of LMS had a positive significant relationship (correlation coefficient of .258 at $p< 0.05$). The study concluded that Institutional Policy Implementation determines the adoption of LMS in government-owned universities in Osun state, Nigeria. Thus, the implementation of institutional policy on ICT with adequate. ICT facilities can guarantee successful adoption of LMS. Based on the findings and conclusion, it was recommended among others that there should be functional ICT policy document on LMS implementation in Nigerian universities.

Key words: *Institutional policy implementation; Learning management system; Adoption; Universities*

1. INTRODUCTION

No doubt, the introduction of Information and Communication Technologies (ICTs) has changed the traditional approaches in virtually all sectors so as to increase efficiency. Educational institutions are not left out in this regard. Previous researches in the field of education have revealed that the required skills and knowledge in the 21st century cannot be delivered without the use of appropriate technologies (Alabi, 1999; Yusuf, 2005; Farell, 2007; Angaye, 2013; Ojo, 2014). Similarly, Fasasi (2011) revealed that there are inadequacies in the provision of facilities

and instructional materials in Nigerian higher institutions. Therefore, institutions of higher learning are incapacitated to deliver the 21st century skills and knowledge.

Historically, pedagogy in education reveals a strong connection between the mode of delivery and the current technology, as there is strong link between the mode of delivery and the learning outcome (Bell, 2013; Montanini, 2013). Therefore, the emerging technology must be integrated for educational institutions to become relevant and develop fully its educational potentials. Likewise, it becomes eminent on higher institutions of learning to operate in a rapidly changing and challenging technological environment so as to bring out the required educational innovations (Rosenberg, 2001; Yusuf, 2005; Ojo, 2014). This therefore, accounts for the changing nature in the demands for teaching principles and methods from lecturers. Thus, there is need for supportive institution policy to achieve successful integration of ICT, particularly in higher institutions (Yusuf, 2005).

Starting from 19th Century, there has been a paradigm shift in the education offered by higher education institutions of learning with the emergence of eLearning. Subsequently, the adoption of eLearning technologies has impacted the planning, learning design, management and administration of the learning process and delivery of learning content to the students, thereby promoting combined eLearning. Currently, the combined eLearning in higher institutions encompasses the use of a mix of improved course delivery strategies during face-to-face classroom teaching with live eLearning, self-paced eLearning facilitated by Virtual Learning Environments. Such environments include Learning Management Systems (LMS) such as Moodle, WebCT, and Blackboard as well as Web 2.0 technologies which have become enablers for collaborative learning amongst students and lecturers, online discussions and distance learning. Over 80% of higher institutions in the developed world are actively engaged in the use of eLearning systems for supporting their teaching and learning, with 97% of Universities reported to be using one or more forms of Virtual Learning Environments (Britain & Liber, 1999).

In a bid to eradicate clogs from the developmental wheels of higher education system, higher education institutions in Nigeria are showing interest in adopting LMS. In the meantime, the adoption of LMS in higher institutions can fail either partially or totally (Ssekakubo et al., 2011; Unwin et al., 2010). This is due to the fact that the Nigerian universities are yet to aptly benefit from the numerous advantages of LMS as a result of certain factors such as lack of technological infrastructures, negative perception of faculty members and uncooperative attitudes of decision makers (Yusuf, 2005; Agabi & Uche, 2006; Angaye, 2013).

LMS is relatively a new idea, which is often confused with other concepts like eLearning, digital learning, virtual learning and distance learning (Kritikou et al., 2008). In most cases, all of these ideas represent modern advancements in education process, which involve the utilization of ICT tools and technologies (Albirini, 2006). LMS is thus, an online system that allow users to share educative contents and collaborate online.

Also, LMS is perceived as a software application that uses the internet as a medium to support education and learning process (Cavus & Momani, 2009). Particularly, LMS could be utilized by educational institutions as well as corporate organizations with a major focus on managing the education process rather than merely delivering course and training materials electronically. Similarly, it is synonymous to eLearning in terms of using the web inside classrooms to enhance the learning process (Sridhar, 2005).

Indeed, LMS provide vital benefits to any educational institution. According to Mahdizadeh et al. (2008), it tends to motivate students and teachers which in turn increase

students' participations and interactions inside the classroom. Again, eLearning and LMS are enhanced productivity and cost-effective (Naidu, 2006). In addition, LMS could accelerate the learning processes, and improve the effectiveness of communication among users (educators, staff, and students) (Cavus & Momani, 2009). Also, the use of LMS in education aids the trainer and organization in reducing learning times and increase job retention (Hall, 1997). Naturally, LMS applications enable organizations to manage users, courses and instructors with testing capabilities and ability to generate reports, transcripts and notifications to students (Mahdizadeh et al., 2008). Furthermore, it could assist in effective management of learning process, which was identified as a critical success factor in educational institutions (Fasasi, 2011).

Surprisingly, Nigerian universities are yet to aptly benefit from the numerous advantages of LMS as a result of certain factors such as lack of technological infrastructures, negative perception of faculty members and uncooperative attitudes of decision makers. It is therefore of importance to evaluate the institutional policy implementation towards adoption of LMS so as to identify and measure the efficient use of the system in Nigeria institutions. This study thereby focuses on institutional policy implementation towards the adoption of LMS in Nigeria universities.

2. STATEMENT OF THE PROBLEM

The dictate of the 21st century teaching and learning approach has made the use of technology inevitable (Daniels, 2002; Angaye, 2013). This paved ways for the emergence of eLearning to provide ubiquitous learning opportunities. Previous authors have revealed the necessity of migrating to the emerging trend in the university education (Daniels, 2002; Farell, 2007). All arguments in the literature are in favour of eLearning technology as a promising way of achieving the goal of 21st century education (Rosenber, 2001). However, for successful implementation of eLearning, there is need for a reliable Learning Management system (LMS) as revealed by previous researchers in this domain. A number of previous studies in this domain have considered effect of ICT integration on a number (Alabi, 1999; Falade, 2013 and Ojo, 2014). However, none of these studies among others narrowed down to a specific learning management tool. Having realized full integration and utilization of ICTs in Nigerian institutions, this research is interested in considering the factors that can assist in successful integration of LMS with respect to institutional policy implementation.

2.1 Purpose of the study

The study is set to achieve the following specific purposes to:

(i) determine the adequacy of ICT infrastructures and facilities to support adoption of LMS in Nigerian universities

(ii) determine the relevance of institutional policy implementation in determining the adoption of LMS in Nigerian universities

2.2 Research questions

Based on the specific purposes described above, the following research questions were formulated:

(i) Are present ICT facilities in the universities capable of supporting successful implementation of LMS?

(ii) Does Institutional Policy Implementation determine the adoption of LMS?

2.3 Scope of the study

This study examined institutional policy implementation toward the adoption of LMS in Osun state government-owned universities in Nigeria. Thus, the study covered the two government owned universities in the state. The parameters used for measuring institutional policy implementation include organizational support, technical and training support, motivation, financial support, infrastructural support, legal backing, institutional autonomy and consistent framework. Also, adoption of LMS was measured by performance expectancy and behavioural intention to use LMS.

3. INSTITUTIONAL POLICY AND ADOPTION OF LEARNING MANAGEMENT SYSTEM

According to Nigerian National Policy for Information Technology (IT) document, the vision statement was clearly stated as "To make Nigerian IT capable country in Africa and a key player in the Information Society by the year 2005, using IT as the engine for sustainable development and global competitiveness" (Federal Republic of Nigeria, 2001). Also, in the mission statement of the same policy document, education is the first domain/area where IT is proposed to be used (Federal Republic of Nigeria, 2001). Thus, examining the policy implementation as adoption factor of any IT will be of immense benefit as Baro (2011) revealed that the policy document needs a review to meet the expected dynamism of the IT profession.

There is a significant change taking place in higher education as a result of technological innovations. In the last few years, integrated computer systems known as LMSs have rapidly emerged and are having, and will increasingly have, profound effects on university teaching and learning. LMS are enterprise-wide and internet-based systems, such as WebCT and Blackboard that integrate a wide range of pedagogical and course administration tools. These systems have the capacity to create virtual learning environments for campus-based students, and are even being used to develop fully online virtual universities. They are becoming ubiquitous at universities around the world, adding a virtual dimension to even the most traditional campus-based institutions.

Unlike other financial or human resources management systems recently introduced into universities, online LMS have the potential to affect the core business of teaching and learning in unanticipated ways. Despite this, research into the diffusion of LMS, in particular the educational management issues, is still in its infancy. In spite of widespread levels of adoption, attention has been most often focussed on their technical, financial and administrative aspects. In this study, therefore, it is desirable to explore implications arising from the incorporation of LMS into the management of university teaching and learning.

3.1 Institutional Policy Implementation: This connotes a blue print policy document approved by an institution to assist in maintaining compliance with applicable policy, procedures and laws for the considerations of the use of LMS with respect to organizational support, financial support, technical and training support, motivation, infrastructural support, legal backing and consistent framework.

3.2 Learning Management System Adoption: This refers to the degree at which both institutions and lecturers believe in the integration and implementation of LMS. This is measured by behavioural intention to use LMS based on its performance expectancy.

3.3 Learning Management System: This is a technological innovation implemented by higher education institutions to support their course curriculum with many types of tools such as

discussion boards, forum, chats, online grade posting, online examinations, file sharing, assignment management, schedules, announcements and course plans**.**

4. METHODOLOGY

This study adopted a quantitative research approach to examine the relevance of institutional policy implementation on LMS adoption in Osun State government owned universities. Data was collected, analyzed and interpreted statistically. The survey research method was employed to collect data with the use of a self-administered questionnaire.

The target population for this study constitute the 1,373 lecturers of the selected universities hence, Krejcie & Morgan's (1970) sample size determination criteria was used to determine the representative sample size of 159 for this study. Purposive sampling technique was used to select the universities based on government ownership and location, while Random sampling technique was employed for selecting the sample size for the study.

In this study, questionnaire tagged "Institutional Policy Implementation on LMS Adoption Questionnaire" (IPILMSAQ) was administered o the teaching staff of the selected universities.

The data collected were coded and analyzed with the use of Statistical Package for Social Sciences (SPSS). Descriptive mean was used for measuring the availability of ICT facilities. Bivariate correlation was used to show the relationships and degree of such relationships on the adoption factors involved in the study.

5. FINDINGS AND DISCUSSION

Seventy three (73) respondents (44.2%) fall within the age range of 20 – 39, 58 respondents (35.2%) fall within the age range of 40 – 49, 28 respondents (17.0%) fall within the age range of 50 – 59 while 6 respondents (3.6%) were above 60 years of age. Seventy one (71) respondents (43%) were male and 94 respondents (57%) were female Only one (1) respondent (0.6%) hold Bachelor and Postgraduate Diploma degrees, 94 respondents (57%) hold Master's degree while 69 respondents (41.8%) are Ph.D. holders. One hundred and fifty seven (157) respondents (95.2%) were computer literate while eight respondents (4.8%) were not computer literate. The findings showed that only twelve (12) (3 +9) respondents (7.3%) fall in to the categories of never heard of LMS and not very familiar with LMS, the rest of 153 respondents (92.7%) are familiar with LMS.

5.1 Distributions of Respondents

Answering Research Question 1

i. Are present ICT facilities in the universities capable of supporting successful implementation of LMS?

Availability of ICT Facilities

The mean values of above 4.0 in all cases except item 10 indicated a positive response for availability of ICT for accessing educational materials, downloading and uploading electronic resources, effective teaching and research collaboration, multimedia support, information exchange, managing learning processes as shown in Table 1.

Table 1: ICT Facilities

12	N	Minimum	Maximum	Mean	Std. Deviation
accessing educational materials	165	1	5	4.15	.686
downloading electronic resources	165	1	5	4.10	.700
uploading electronic resources	165	1	5	4.10	.695
achieving effective teaching collaboration	165	2	5	4.13	.616
achieving effective research collaboration	165	2	5	4.27	.588
achieving effective multimedia teaching support	165	2	5	4.22	.606
achieving effective relationship with professional colleagues	165	1	5	4.07	.820
achieving effective information exchange between lecturers and students	165	1	5	4.04	.872
achieving effective usage of electronic manuscripts	165	1	5	4.14	.706
achieving effective platform for managing learning process	165	1	5	3.96	.910
Valid N (listwise)	165				

Answering Research Question 2

i. Does Institutional Policy Implementation determine the adoption of LMS?

The result presented in Table 2 revealed that there is relationship between Institutional Policy Implementation and Adoption of LM (correlation coefficient of .258 at $p< 0.05$). The result indicated that Institutional Policy Implementation influences adoption of LMS.

Table 2: Result of Correlation Analysis

Correlations

		IPI_Mean	LMS_Mean
IPI_Mean	Pearson Correlation	1	.258**
	Sig. (2-tailed)		.000
	N	165	165
LMS_Mean	Pearson Correlation	.258**	1
	Sig. (2-tailed)	.000	
	N	165	165

**. Correlation is significant at the 0.01 level (2-tailed).

6. CONCLUSION

Based on the findings, the study concluded that Institutional Policy Implementation is central to the successful adoption of LMS to cater for all the facilitating conditions for its integration. Specifically, Institutional Policy Implementation has significant relationship with the adoption of LMS.

Based on the findings and conclusions in this study, the following recommendations are made:

(i) There should be a functional policy document and blue prints to give directions, objectives, action plans and necessary evaluation of LMS implementation in Nigerian universities.

(ii) Institutions in Nigeria should be forced to develop suitable plans and strategies in order to encourage the design and delivery of LMS to academics.

REFERENCES

Alabi, A. T. (1999). Effective Utilization of Management Information System (MIS) for decision-making in Nigerian Universities, Unpublished Ph.D Thesis, Department of Educational Management, University of Ilorin.

Agabi, O. G. & Uche, C. M. (2006). Information and Communication Technology Adoption and Information Quality in Effective University Management, *Nigerian Journal of Educational Administration and Planning(NAEAP),* 6(2), 23 - 33.

Albirini, A. (2006). Teachers' Attitudes toward Information and Communication Technologies: The Case of Syrian EFL Teachers. *Computers & Education*, (47), 373-398.

Angaye, C. O. (2013). Information and Communication Technology (ICT): The Hub to National Development in the 21st Century, A Lecture delivered to mark 5th Anniversary, Faculty of Communication and Information Sciences, University of Ilorin on 9th May, 2013.

Baro, E. E. (2011). A Critical Examination of Information and Communication Technology Policies: Effect on Library Services in Nigeria, *Library Philosophy and Practice, 2011.*Retrieved from http://www.webpages.uidaho.edu/~~mbolin/baro.htm

Bell, J. D. (2013). Higher education and economic development, *National Conference of state Legislators,* Western Interstate Commission for Higher Education, Boulder, CO. Retrieved from www.wiche.edu July, 2015.

Britain, S., Liber, O., (1999). A Framework for Pedagogical Evaluation of Virtual Learning Environments. Environments.

Cavus, N. and Momani, A. M. (2009). Computer Aided Evaluation of Learning Management Systems. *Procedia Social and Behavioral Sciences,* 1, 426-430.

Daniels, J. S. (2002). "Foreword" in Information and Communication Technology in Education - A Curriculum for Schools and Programme for Teacher Development. Paris: UNESCO.

Falade, A. A. (2013). Lecturers' Perception of the Integration of Information and Communication Technology into the Distance learning in Nigeria, unpublished Ph.D. Thesis, Faculty of Education, University of Ilorin.

Fasasi, Y. A. (2011). Planning and Development of Higher Education in Kwara State, Nigeria, Academic Research International, 1(3), 125 - 129

Fasasi, Y. A. (2011). Managerial Behaviour in Educational Organization in Nigeria, *International Journal of Academic Research in Business and Social Sciences,* 1, 14- 23

Federal Republic of Nigeria (2001). Nigerian National Policy for Information Technology (IT), retrieved from http://www. functionx.com/nitpa/ITPOLICY.PDF

Krejcie, R. V, & Morgan, D. W. (1970). Determining Sample Size for Research Activities Robert. *Educational and Psychological Measurement*, *38*(1), 607–610. http://doi.org/10.1177/001316447003000308

Kritikou, Y., Demestichas, P., Adamopoulou, E., Demestichas, K., Theologou, M. & Paradia, M. (2008). User Profile Modeling In The Context Of Web-Based Learning Management Systems. *Journal of Network and Computer Applications,* 31, 603-627.

Mahdizadeh, H., Biemans, H. & Mulder, M. (2008). Determining Factors of the Use of ELearning Environments by University Teachers. *Computers & Education,* 51, 142-154.

Montanini, M. (2013). Supporting tertiary education , enhancing economic development. Working paperby

Naidu, S. (2006). ELearning A Guidebook of Principles, Procedures and Practices, 2nd revised edition, Commonwealth Educational Media Center for Asia (CEMCA), New Delhi, India.

Ojo, O. J. (2014). Information and Communication Technology Utilization, Decision-Making Process and Administrative Effectiveness in South-West Nigeria, Polytechnics, Unpublished Ph.D Thesis, Department of Educational Management, University of Ilorin, Ilorin, Nigeria.

Rosenber, M. (2001). ELearning: Strategies for Delivering Knowledge in the Digital Age. new York: McGraw-Hill, p.28

Ssekakubo, G., Suleman, H. & Marsden, G. (2011). Issues of adoption: Have eLearning management systems fulfilled their potential in developing countries? *Proceedings of the South African Institute of Computer Scientists and Information Technologists Conference on Knowledge, Innovation and Leadership in a Diverse, Multidisciplinary Environment,* 231 - 238, Cape Town, South Africa.

Sridhar, S. (2005). E-government – A Proactive Participant For eLearning in Higher Education. *Journal of American Academy of Business,* 7(1), 258- 268.

Unwin, T., Kleessen, B. Hollow, D., Williams, J., Oloo, L. M., Alwala, J. & Muianga, X. (2010). Digital learning management system in Africa: Myths and realities of open learning. *Journal of Open and Distance Learning,* 5(1), 5 - 23.

Yusuf, M. O. (2005). Information and communication technology for education: Analyzing the Nigeria policy for information technology. *International Education Journal,* 6(3), 316-321.

STUDY OF DOWNLINK SCHEDULING ALGORITHMS FOR REAL-TIME MULTIMEDIA SERVICES IN LTE NETWORKS.

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ABSTRACT

Long Term Evolution (LTE) is one of the fastest growing technologies which supports variety of applications like video conferencing, video streaming, VoIP, file transfer, web browsing etc. In order to support multiple applications, Radio Resource Management (RRM) procedure is one of the key design roles for improving the system performance. LTE system effectively utilizes the resources by dynamically scheduling the users in both frequency and time domain. However, scheduling algorithms are not defined in the Third Generation Partnership Project (3GPP) specifications. Therefore, it becomes one of the special interests for service providers. In this paper, Radio Resources Management in LTE networks was studied and presented. Also, a study on three existing downlink scheduling algorithms that mainly focus on real-time multimedia services was carried out.

Keywords: *LTE, Downlink Scheduling, Radio Resource Management, Real-Time Multimedia*

1. INTRODUCTION

The emerging applications with different throughput, delay, Packet Loss Rate (PLR) and bandwidth requirements emphasize the need of a network capable of supporting range of services. To achieve this aim, Long Term Evolution (LTE) was introduced by Third Generation Partnership Project (3GPP) (3GPP Specification, 2003) . The main objective of the LTE network is to enhance the data rate so as to provide the radio resources for variety of highly demanded services, while taking into consideration a satisfied level of Quality-of-Service (QoS) to all active users. Packet scheduler at radio base station (evolved Node B (eNB) in LTE specification) is responsible of assigning portions of spectrum shared among users. The performance of the network can differ according to the algorithms used by the scheduler. Therefore designing an effective scheduler is an important task in order to differentiate the performance of one network from another. The packet scheduler is aimed at maximizing the spectral efficiency and make the negative impact of channel quality drop into negligible (Sulthana & Nakkeeran, 2014). Different scheduling algorithms has been proposed to support different class of services. Some of these algorithms consider a special kind of traffic and most of them focus on real-time multimedia services.

The continuous rise of real-time multimedia services in the Internet and the need for an ubiquitous access to them are driving the evolution of cellular networks. Beside the huge bandwidth requirements, real-time multimedia flows need to be treated differently from other ones in order to achieve a target quality-of-service (Piro et-al, 2011). In general, the most important objective of a multimedia service is the satisfaction of end users, i.e., the quality-of-experience (QoE). This is strictly related to the system ability to provide to application flows a suitable QoS (Khirman & Henriksen, 2002), generally defined in terms of network delivery capacity and resource availability, i.e., limited packet loss ratio and delay. As example, a limited packet loss ratio enhances the quality of a reconstructed video, limiting distortions due to lack of video data packets, while a low delay allows to reproduce multimedia content at receiver side in real-time, i.e., with a small *playout delay*. In real-time multimedia services, such as VoIP or video-conference, end-to-end delay constraints in content delivery have to match the requirements related to the human perception of interactivity. For the Internet telephony, a delay of 100 ms is considered as the limit for a good perceived quality, while the delay has to be less than 300 ms for a satisfactory quality (Na & Yoo, 2002). In order to respect audio/video synchronization, also for video delivery, the delay bounds have to be the same. Su et-al (2007) for example, a delay of 200 ms is considered for video interactive applications. Once the video decoding process starts with a playout delay chosen in this range, the respect of this deadline becomes mandatory for every encoded packet. Every packet will be decoded with a playout delay after its generation time and, if the packet does not arrive within the deadline, it will be considered lost. In this regard, in multimedia services, granting bounded delivery delays actually means lowering packet losses. In this paper, a review and study of three different existing downlink scheduling algorithms for real-time multimedia services is presented. The rest of the paper is organized as follows: In section II: Overview of LTE networks, Section III: Resources Management in LTE networks, Section IV: Downlink scheduling algorithms for real-time multimedia services, Section V: Conclusion and Section VI: References.

2. OVERVIEW OF LTE NETWORK

For the purpose of supporting wide variety of different applications, LTE network is designed with challenging requirements that overtakes the features of 3G networks mainly designed for voice services (3GPP Tech Sepcification). LTE system uses Orthogonal Frequency Division Multiple Access (OFDMA) technology in the Downlink (DL) and Single Carrier-Frequency Division Multiple Access (SC-FDMA) in the Uplink (UL). The OFDMA technology divides the available bandwidth into multiple sub-carriers and allocates a group of sub-carriers to a user based on its QoS requirements. It provides spectrum flexibility where the transmission bandwidth can be selected between 1.4 MHz and 20 MHz depending on the available spectrum. The peak data rate, which is the important parameter by which different technologies are usually compared, generally depends on the amount of spectrum used. The allowed peak data rate for the DL and UL is equal to 100 Mbps and 50 Mbps respectively. LTE targets to provide spectral efficiency two to four times better than 3G systems (15 bps/Hz in DL and 3.75 bps/Hz in UL).

LTE is flat, Internet Protocol (IP) based architecture with respect to the previous 3G systems (Sulthana & Nakkeeran, 2014). In previous system, separate Radio Access Network (RAN) that consists of Radio Resource Control (RRC), Radio Link Control (RLC) and Medium Access Control (MAC) protocols is used to interface with User Equipment (UE). But in LTE, eNB takes care of the above mentioned protocol functions. So it requires lesser number of nodes that reduces the system latency and improves overall performance (Kumar, Sengupta & Liu, 2012). The network architecture of LTE consists of core network called Evolved Packet Core (EPC) and access network called Evolved-Universal Terrestrial Radio Access Network (E-UTRAN) as shown in Figure 1 below:

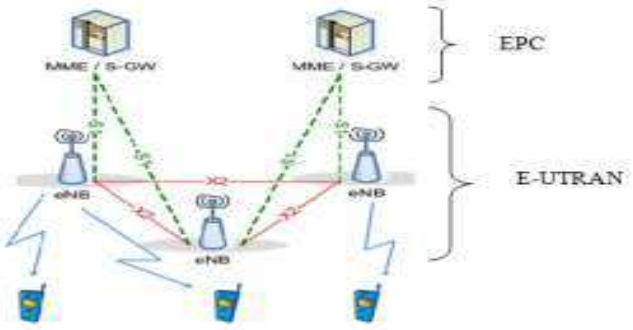


Figure 1: System Architecture of E-UTRAN

The responsibility of eNB in the access network is to ensure that the necessary QoS for a bearer over the interface is met. Each bearer has an associated QoS Class Identifier (QCI) (3GPP Tech Specification, 2003) and each QoS class is characterized by priority, tolerable packet loss, and tolerable delay.

Generally bearers can be classified into two categories based on the nature of the QoS they provide: Guaranteed Bit-Rate (GBR) bearers which are real time bearers and non-GBR bearers which are non-real time bearers as shown in Table 1.

At the physical layer, LTE supports both Time Division Duplex (TDD) and Frequency Division Duplex (FDD) modes. OFDMA is chosen as the DL access technology. The available bandwidth is divided into multiple Resource Blocks (RBs) based on time and frequency domains [9].

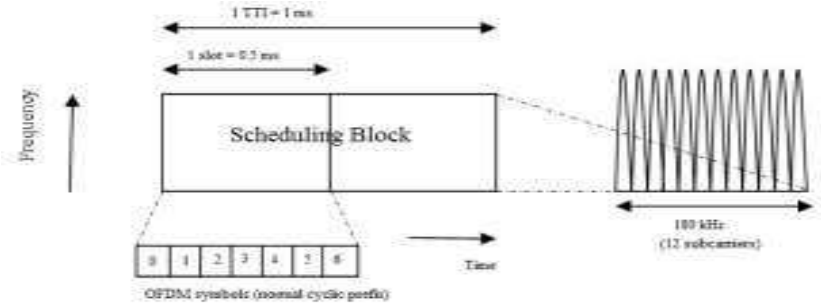


Figure 2: LTE Downlink resource block structure.

A RB is the smallest allocation unit in LTE which can be modulated independently. In the frequency domain the RB consists of 12 consecutive subcarriers and in the time domain it is made up of one time slot of 0.5 ms duration and adopts two slots as allocation period. The scheduling period is called as one Transmission Time Interval (TTI) and it lasts for 1 ms duration as shown in Figure 2.

Table 1: Standardized QCI for LTE

QCI	Resource Type	Priority	Packet Delay Budget [ms]	Packet Loss Rate	Example services
1	GBR	2	100	10^{-2}	Conversational voice
2	GBR	4	150	10^{-3}	Conversational video (live streaming)
3	GBR	5	300	10^{-6}	Non-Conversational video (buffered streaming)
4	GBR	3	50	10^{-3}	Real time gaming
5	non- GBR	1	100	10^{-6}	IMS signalling
6	non- GBR	7	100	10^{-3}	Voice, video (live streaming), interactive gaming
7	non- GBR	6	300	10^{-6}	Video (buffered streaming)
8	non- GBR	8	300	10^{-6}	TCP based (e.g., WWW, e-mail), chat, FTP, P2P file sharing
9	non- GBR	9	300	10^{-6}	

3. RESOURCE MANAGEMENT IN LTE NETWORKS

The scheduler which is found in the eNB, controls the assignment of RBs to UEs to avoid intra-cell interference. In general the function of scheduler is to find the optimal allocation of the resource unit (time, frequency, power etc) to UEs such that QoS requirements of users are satisfied.

The scheduler selects the UE to be scheduled and number of RB to be assigned based on two factors: the channel quality and the QoS requirements. In DL, the scheduler can assign any random set of RBs for a particular UE whereas in the UL the RBs allocated have to be adjacent to each other because of single carrier property. To facilitate the channel dependent scheduling on DL, the eNB has to get the channel quality reports from the UE. Each UE calculates the signal-to-noise (SNR) ratio based on its channel condition. It sends the Channel Quality Indicator (CQI) value to eNB based on its calculated SNR to choose the appropriate modulation and coding scheme (MCS) (Sulthana & Nakkeeran, 2014).

Resource allocation for each UE is usually based on the comparison of per-RB metric. This metric can be interpreted as the transmission priority of each UE on a specific RB. The scheduling strategies of any wireless network can be broadly classified as shown in Figure 3.

Channel independent scheduling is based on the assumption that channel is time invariant and error-free. Examples of channel independent scheduling are First-in-First-out (FIFO), Round Robin (RR), Weighted Fair Queuing (WFQ), Earliest Deadline First (EDF), Largest Weighted

Delay First (LWDF) etc (Sulthana & Nakkeeran, 2014). In this case, some algorithms satisfy the QoS requirements and some simply schedules. With the help of CQI reports which are periodically sent by UEs to eNB, the scheduler can estimate the channel quality experienced by each UE. The scheduling performed by these schedulers is called channel sensitive scheduling. In this type of scheduling the scheduler may try to maximize the QoS requirements of each UE (QoS aware scheduling) or it may try to provide fairness among UEs (QoS unaware scheduling). Examples of channel sensitive scheduling are Maximum Throughput (MT), Proportional Fairness (PF), Throughput To Average (TTA), Modified- Largest Weighted Delay First (MLWDF), Exponential Proportional Fairness (EXP/PF), Exponential rule (EXP rule), Logarithmic rule (LOG rule) etc. In LTE only channel sensitive scheduling is done based on the CQI reports from the UE.

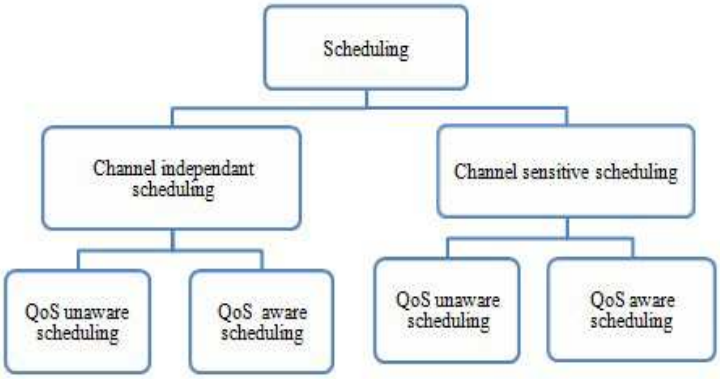


Figure 3: General Classification of Scheduling

Apart from the above mentioned scheduling algorithms, many different types were proposed. In [2], different types were presented as:

a. Delay-based algorithms
b. Power based algorithms
c. QCI feedback based algorithms
d. Service based algorithms
e. Queue based algorithms
f. QoE based algorithms

As stated earlier, this paper will focus on Real-time multimedia service are classified under the Service-based algorithms.

4. DOWNLINK SCHEDULING ALGORTHMS FOR REAL-TIME MULTIMEDIA SERVICES

In this section, a review and study will be presented for three downlink scheduling algorithms for real-time multimedia services. The algorithms are:

a. Two-level downlink scheduling for Real-time multimedia services in LTE networks
b. A delay based Priority Scheduling Algorithm for Downlink Real-Time Traffic in LTE Networks
c. An efficient layered scheduling algorithm for Real Time services in LTE

a. Two Level Downlink Scheduling for Real-time Multimedia services in LTE networks: The algorithm was presented in by (Piro et-al, 2011) and was built on two level as shown in figure 4. These two level interact with each other in order to dynamically assign radio resources to UE. They take into consideration the state of the channel, the data source behaviours and the maximum tolerable delays. At the highest level, an innovative resource allocation algorithm, namely FLS, defines frame by frame the amount of data that each real-time source should transmit to satisfy its delay constraint. Once FLS has accomplished its task, the lowest layer scheduler, every TTI, assigns RBs using the PF algorithm (Brehm & Prakash, 2013) by considering bandwidth requirements of FLS. The lowest layer scheduler, instead, allocates resource blocks in each TTI to achieve a trade-off between fairness and system throughput. It is important to note that FLS does not take into account the channel status. On the contrary, the lowest layer scheduler assigns RBs first to flows hosted by UEs experiencing the best channel quality and then (i.e., when these flows have transmitted the amount of data imposed by FLS) it considers the remaining ones. In particular, the lowest layer scheduler decides the number of TTIs/RBs (and their position in the time/frequency domains) in which each real-time source will actually transmit its packets.

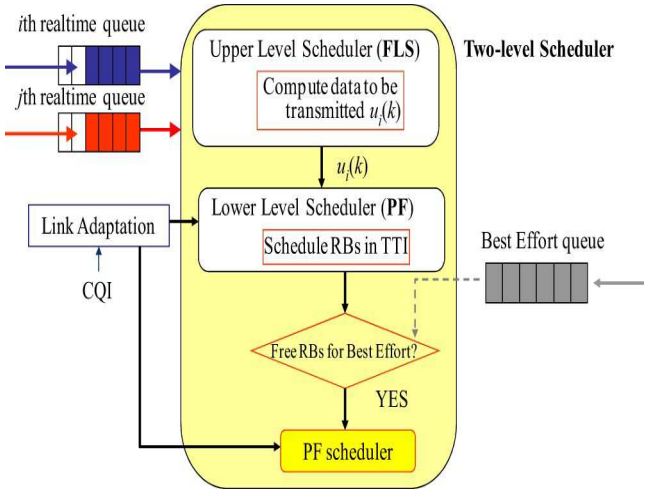


Figure 4: Two-level Scheduling Algorithm

The numerical simulation result showed that, the scheme greatly outperforms some of the existing algorithms especially in the presence of real-time video flow.

b. A delay based Priority Scheduling Algorithm for Downlink Real-Time Traffic in LTE Networks

Delay Priority Scheduling Algorithm for Downlink Real-time Traffic in LTE networks DP-VT-MLWDF was proposed in (Li et-al, 2016). For the reason that RT traffics have a higher demand for real time, clarity and stability than NRT traffics, the PLR should be kept in a lower level and the delay should be less. In order to achieve this goal, the packets whose delay is closer to the threshold should have the higher priority to be transmitted Besides the size of flow buffer, the average throughput of past time and the CQI also has a great of effects in making resource

allocation determination, so the scheduler adopts all the parameters considered by the aforementioned schedulers. Consequently, the main objective of the proposed scheduling algorithm is to optimize the QoS performance of RT services. Meanwhile, the performance of NRT services should remain within an acceptable level.

The proposed algorithm whose main purpose is to ameliorate the QoS performance of RT traffics while sacrifice an acceptable performance of NRT traffics in the network by utilizing a delay priority function. It can achieve an evident improvement of the QoS performance parameters for RT traffics such as PLR, average throughput, fairness index

c. An efficient layered scheduling algorithm for Real Time services in LTE

A novel layered scheduler was presented by (Chen et-al, 2016) It treats the constraint of delay and the object for maximal throughput separately. The Delay Priority Scheduler (DPS) only gives priority to the delay constraint and adopt a greedy strategy to select the RBs for the UEs nearest to their deadline. It is possible that the near sight of the algorithm shall lead to a smaller total throughput. If priority is always given to the UE nearest to his deadline, then the potential pair of UE and RB with bigger transmission rate will be neglected In view of the above, a two layered scheduler for downlink data transmission was presented in (Chen et-al, 2016)

The first layer of the scheduler takes delay constraint into consideration in the same way as the DPS but in this case only the UEs rather near to the deadline e.g. satisfying the below equation (1) are treated in this way.

$$DL(n) - Max\ dl(n) < DPTI, \ldots\ldots\ldots\ldots\ (1)$$

Where *DPTI* denotes the time interval between the generations of two packets. It means that, a user is ready to be scheduled only when the time till the delay threshold of the first packet is less than DPTI. This is because that averagely one packet can be transmitted for each user in every *DPTI*, assuring that the packet delay is under the threshold.it aims to ensure delay, but not to place it at the first place at any time

In the second layer of the scheduler, if there are remaining RBs left, the UEs satisfying the following are considered:

$$Max\ v(n) \leq \theta * data\ size(n) \ldots\ldots\ldots\ (2)$$

This means that if the data size of a UE is much smaller than the transmission rate of the RBs, in order not to waste resources, the UE will choose to wait and leave the resources to other UEs, ensuring the utilization efficiency of the RBs.The value of θ is determined by the relation between the number of users and resources and we can calculate it by simulations with historical records.

To maximize throughput and ensure fairness, a scheduling metric $P(n,r,t)$ is adopted as

$$P(n,r,t) = \frac{v(n,r,t)}{\overline{v_{max}}(n,t)} \quad \ldots\ldots\ldots\ldots\ (3)$$

Then the pair of RB r and UE n with the maximal $P(n,r,t)$ is selected, e.g,, at time t, the rth RB is assigned to transmit the data of UE n. Being similar to the PF, $P(n,r,t)$ can ensure fairness. Moreover, it can also enable a higher throughput.

Finally, the simulation results show that, in comparison to the well known LOG rule, EXP rule and EXPPF algorithms, the LS algorithm can achieve at least the same performance, and sometimes better in fairness, RUR and PLR.

5. CONCLUSION

The 3GPP LTE standards aim to achieve revolutionary data rate, spectral flexibility with seamless mobility and enhanced QoS over the entire IP network. In this paper, a study of downlink scheduling algorithms for real-time multimedia services in LTE networks has been carried out.The first scheme that was considered was the Two Level Downlink Scheduling for Real-time Multimedia services in LTE networks. The scheme significantly outperforms the reference algorithms such as Exponential rule, Logarithmic rule and FLS especially in the presence of real-time video flow. The second scheme that was studied was the Delay Priority Scheduling Algorithm for Downlink Real-time Traffic in LTE networks. The scheme achieves significant improvement in the QoS performance parameters for RT traffics such as PLR, average throughput, fairness index. Lastly, an efficient layered scheduling algorithm for real time services in LTE was reviewed. It was found that, the algorithm can achieve at least the same performance, and sometimes better in fairness, RUR and PLR.

REFERENCES

3GPP, Tech. Specific. Group Services and System Aspects – Policy and charging control architecture (Release 9), *3GPP TS* 23. 203

S. F. Sulthana and R. Nakkeeran (2014): Study of Downlink Scheduling Algorithms in LTE Networks. *Journal of Networks, Academy Publisher, vol. 9(12), pp. 3381 – 3391.*

G. Piro, L. A. Grieco, G. Boggia, R. Fortuna, and P. Camarda (2011): Two-level downlink scheduling for real-time multimedia services in LTE networks. *IEEE Trans. Multimedia, vol. 13, no. 5, pp. 1052–1065.*

S. Khirman and P. Henriksen (2002): Relationship between quality-of-Service and quality-of-Experience for public internet service. *Proc. Passive and Active Measurement PAM, Fort Collins, CO.*

S. Na and S. Yoo (2002): Allowable propagation delay for VoIP calls of acceptable quality. *Proc. 1st Int. Workshop Advanced Internet Services and Applications, Springer-Verlag, London, U.K., 2002, pp. 47–56.*

G.-M. Su, Z. Han, M. Wu, and K. Liu (2007): Joint uplink and downlink optimization for real-time multiuser video streaming over WLANs. *IEEE J. Sel. Topics Signal Process.*, vol. 1, no. 2, pp. 280–294.

Amit Kumar, Jyotsna Sengupta, Yun-fei Liu (2012): 3GPP LTE: The Future of Mobile Broadband" *Wireless Personal Communication*, vol. 62, pp. 671-686.

Michael Brehm, Ravi Prakash (2013): Overload-state Downlink Resource Allocation in LTE MAC Layer. *Wireless Networks*, vol. 19, pp. 913-931.

Yuan-Ping Li, Bin-Jie Hu, Hui Zhu, Zong-Heng Wei and Wei Gao (2016): A Delay Priority Scheduling Algorithm for Downlink Real-Time Traffic in LTE Networks", *Wireless Networks*.

Juan Chen, Wi Zhang, Suixiang Gao and Wenguo Yang (2016): An Efficient Layered Scheduling Algorithm for Real Time Serices in LTE. *Wireless Networks*.

SECURED VOTING SYSTEM IN NIGERIA GENERAL ELECTION

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ABSTRACT

The current voting process in Nigeria is slow. The researchers came up with an electronic voting system using fingerprint biometric technologies. It is a window based application developed with Microsoft visual C#.net 2012 version as the front end while MYSQL was used as the backend of the database. The system has been tested and gives an accuracy of 99.6 per cent for the registered voters, and also an accuracy of 100 per cent for the unregistered voters. The system will enable voters, electoral candidates and parties to register and get accredited. In addition, it allows transparency during voting, counting of votes, collation, verification, authentication and authorization of votes. The system will be able to solve the problem of authentication of voters and will prevent a single voter from voting multiple times.

***Keywords**: Biometrics Authentication, correlation method, minutiae method, Fingerprint Voting System, ballot box*

1. INTRODUCTION

In recent decades, the application of Information and Communication Technology (ICT) to global development has continued to spread to every aspect of life. Whereas, its contribution to democratic system in any country cannot be over emphasized. A voting system is a way by which voters make a choice between list of aspirants, often in a policy referendum or democratic system (Samuel, Leonard & Dilys, 2016). A voting system enforces rules to ensure a free and fair voting system and how votes are aggregated to yield a final result. The election system must be prosperous to withstand a variety of election vices and must be transparent and comprehensible for voters and candidates to accept the election results. In the 1993 election, votes were physically counted at the close of polls and the results declared by electoral officials to electorates and party agents under close supervision of the security agents, both local and international observers. The 2015 general election in Nigeria is an improvement over the election held in the past years because of the use of secured method of biometric authentication. Capturing the fingerprint of all voters commenced in the year 2011 and was implemented in the

2015 general election held in March 28 and April 11. The system allowed all voters to be accredited with their fore-registered permanent voter's cards alone. However, due to some technical challenges arising from its first time use, alternative arrangement was put in place to give room for special accreditation of some unidentified fingerprint (peeled off palm, cut-off fingers) in the process of accreditation. After completing the voters accreditations, the election process progressed to the next phase where only the accredited voters were given the ballot paper to cast their vote for their desired candidate or political parties. Since 1999 till date, Nigerians have been voting in over 120,000 polling units (Mbachu, 2014) with the voting population between 57 million and 73 million ("Presidential elections," 2011).

Habib, Ateeq & Hameed (2013) defined biometrics as methods of uniquely recognizing human beings based on one or more physical or behavioral characteristics or traits. Fingerprint is one of the physical traits that can be used to identify a user. The physiological or physical traits are linked to an individual user and unlike passwords, it cannot be forgotten, stolen, shared or easily hacked (Kumar & Vijayaragavan, 2014). A Finger Print pattern is made up of parallel lines and spaces. These lines are known as the ridges while the spaces between these ridges are known as valleys which are sometimes called furrows. The ridge lines appear dark while the valleys appear bright. Fingerprints contain small or precise details of terminations or discontinuities on ridges and furrows. These unique Terminations and discontinuities are called Minutiae (Maheswari & Chandra, 2012). Types of minutia details or features include bifurcations or branch (where a ridge splits in to two) and ending or termination (where a ridge stops or terminate).Other types of minutiae details are line-unit, eye hook etc. The two methods of capturing fingerprints are, correlation method and Minutiae Method. The correlation-based approach works by comparing patterns of ridges and furrows of the template fingerprint and the live fingerprint to ascertain whether two fingerprints are the same (Ritu & Garg, 2014). The minutiae method are error tolerant and can tolerate missing and spurious minutiae. At the registration or enrollment phase, the minutia points and their directions (correlation based approach) are spotted, together with their relative positions to each other. The fingerprint template generated is then stored and later used in the matching process. At the matching stage, live fingerprint image is taken and processed to extract its minutia points, which are then compared with the registered template. If the live fingerprint supplied matches the template, then authorization is granted to the user, if not, access is denied.

In this research, the developed voting system with the use of biometric fingerprint authentication approach will be an improvement on the 2015 Nigeria general elections. It eradicates the use of the ballot papers system which plays a major role in the traditional voting system where sometimes the ballot papers would have been thumb printed before the time frame scheduled for the voting system to commence.

2. RELATED WORKS

Kuye, Coker, Ogundeinde & Coker (2013) proposed a design and analysis of electronic voting system in Nigeria. The system was developed using a window based application (visual studio 6.0 and Microsoft Access 2003) package. The researchers stated that despite the merits to electronic voting system, faultfinders of electronic voting argue about the security issues and the unsatisfactory literacy levels of the electorate are the major drawbacks to the system. Also, Adam & Metin (2011) researched on a web based secure e-voting system with fingerprint authentication. The research made use of a biometric based e-voting system for providing a secure election on electronic environment for the electors. The researchers stressed that biometrics is also expected to be increasingly used in juxtaposition with other technologies like the knowledge based authentication (e.g. passwords and PIN) on the Internet.

Similarly, Kumar & Begum (2011) presented a novel design of electronic voting system using fingerprint. The new design was analyzed by conducting pilot election among a class of students for selecting their representative.

In related study, Olayemi, Oladiran, Adeoyo, & Elijah (2013) described a secured voting system using multifactor authentication and cryptographic hash function methods. The system eradicated the threat of erring voters authentication and integrity of votes transmitted over an insecure wireless medium.

In addition, Sanjay & Manpreet (2013) presented a framework for electronic voting machine based on biometric verification. The proposed framework ensures secured identification and authentication processes for the voters and candidates through the use of fingerprint biometrics.

3. MATERIAL AND METHODS

The biometrics authentication of the system was made possible with the use of Griaule Biometrics Software Development Kit (SDK) available on http://www.griaulebiometrics.com. The design was accomplished with the use of Microsoft Visual C#.net 2012 for the front end while MYSQL was used as the back end of the database.

3.1 Working of the Proposed Voting System

Step 1: Display the welcome screen

Step 2: Select the mode to display (voting end or administrative end)

Step 2.1: If voting process is selected go to **step 3**

Step 2.2: If admin process is selected go to **step 4**

Step 3: Display list of candidates for a position with fingerprint entry for each candidate

Step 3.1: If candidate has voted already and tries to vote again raise an alarm that "You have already voted"

Step 3.2: Else if candidate is thumb-printing for the first time give a message "Your votes has been captured successfully"

Step 4: Supply login details to confirm authorization

Step 4.1: If login details is correct allow user to access the back end to perform administrative task. (Voters, Parties and electoral candidates' registration and capturing of fingerprint)

Step 4.1.1: Enroll and capture parties

Step 4.1.2: Enroll and capture electoral candidates

Step 4.1.1: Enroll and register voters with fingerprint capturing

Step 4.2: Else if login details is incorrect, go to **step 4**

Step 5: Stop

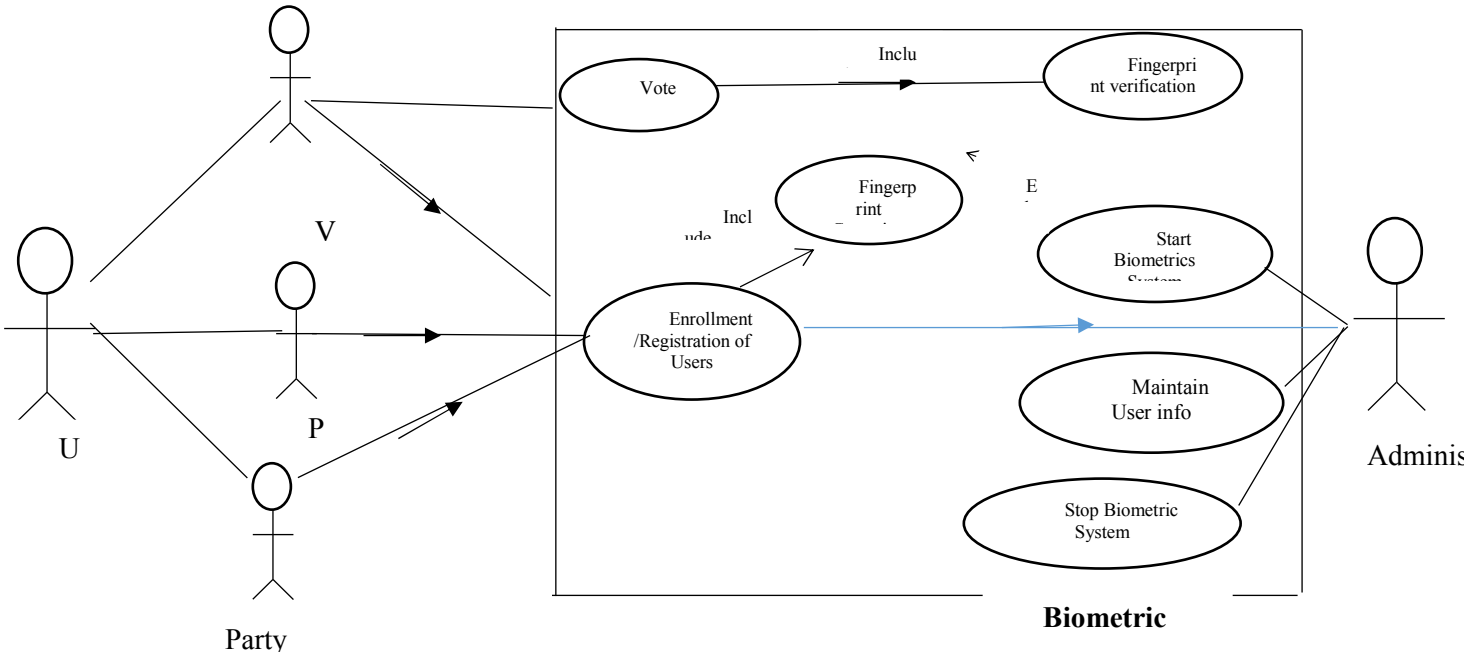


Figure 1: Use Case Diagram of the Overall Architecture

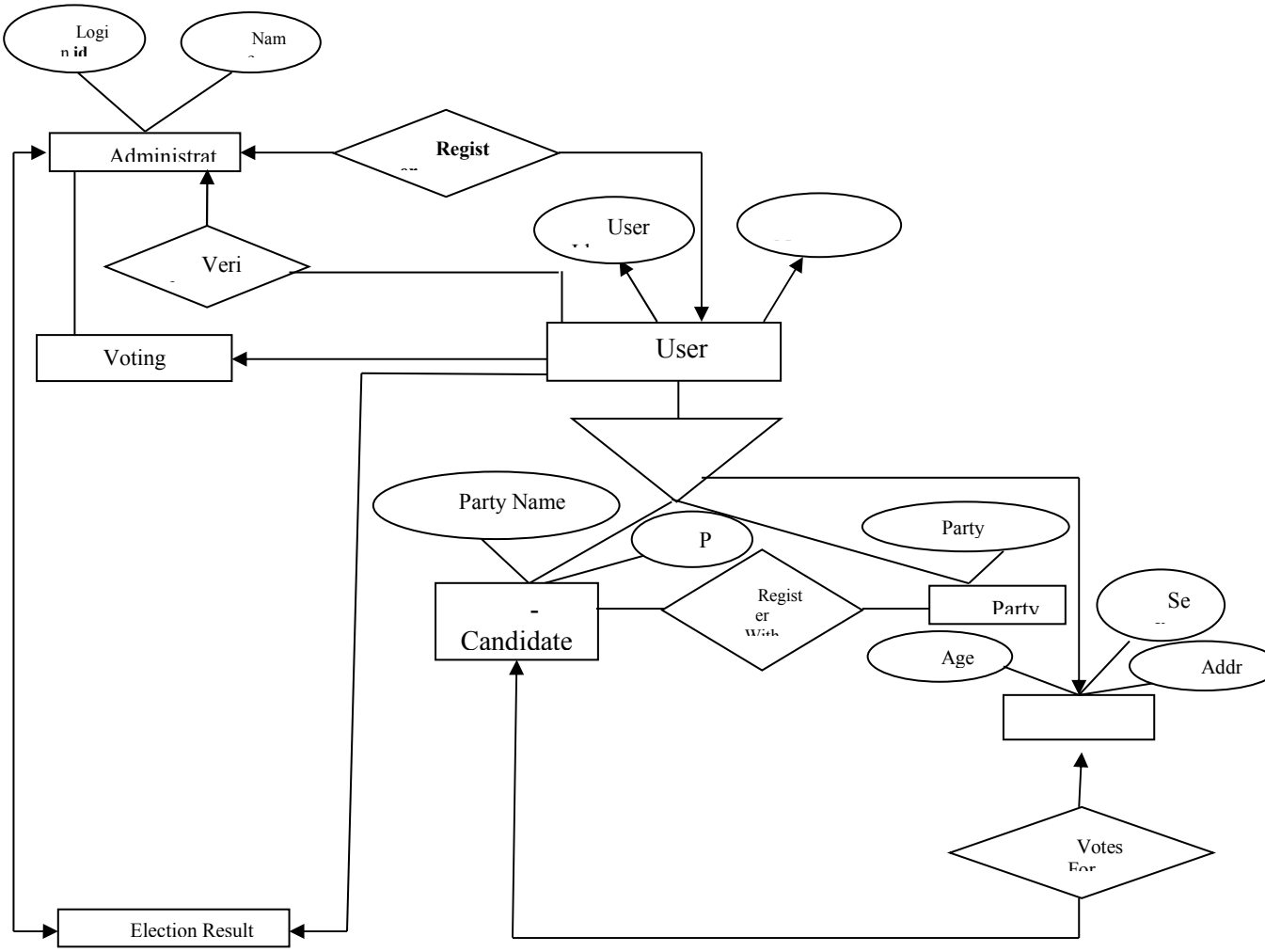


Figure 2: E-R Diagram of the system

In the fig 2 above only the administrator have the ability to register user, verify their identity through matching of their fingerprint and allow each user to proceed or not to proceed to the voting process.

The user identity are in three categories: the candidates, the party and the voters entity. Both the administrator and the user entity has the ability to view the election results at the end of the voting exercise. Apart from user-Id and name that is common to all users, the 3 categories of user has other attributes that are not generally shared.

4. RESULTS AND DISCUSSION

A total of 270 authorized and 10 unauthorized people were used to test the electronic voting system by capturing their fingerprints during enrollment/registration phase and matching the

stored template with their fingerprints during voting process. In totality, 269 registered voters voted successfully and only one voter was unable to access the system due to injury on the finger after the capturing of voters fingerprint which resulted to an accuracy of 99.6%, while access was denied to the 10 unregistered voters giving an accuracy of 100%. The system was also tested as against double voting as access was denied to 20 voters who attempted to vote more than once.



Figure 3: The voting environment using fingerprint

The figure above presented the list of all registered political parties in the election with their respective fingerprint point of selection. It only allows an accredited voter to access this page and this page disappears as soon as an option is selected.

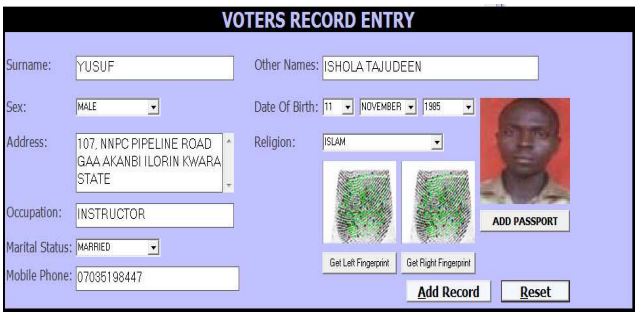


Figure 4: Voters Record Entry including fingerprint and picture

The above figure presented the data entry page to allow all voters record to be registered in the database. It allowed for capturing the details like the name, gender, picture and the fingerprint of such voter.



Figure 5: Party Agent Record Entry including fingerprint and picture

The above figure presented the data entry page to allow the appointed agent of every political party to be registered in the database. It allowed for capturing the details like the name, gender, picture and the fingerprint of such voter.



Figure 6: Administrator Menu of the system

The above figure presented the operation that can be carried out by the administrator to facilitate the operation of the entire system.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

An enhanced security system, if implemented with the use of fingerprint authentication in the Nigerian general elections will ensure an improvement to the 2019 general elections. It will go a long way in solving the problems faced in the current system which include but not limited to snatching of card reader, carting away of ballot box, thumb printing the ballot paper in masses without allowing the accredited voter, since no two (2) persons have the same fingerprint and help to maintain a free and fair democratic system.

5.2 Recommendations

In view of the result from this research, it is hereby recommended that the Independent National Electoral Commission (INEC) should implement the proposed system subsequent general election to improve the Nigerian election system.

REFERENCES

Adem, A.A. &Metin B. (2011) "Web based secure e-voting system with fingerprint Authentication", Scientific Research and Essays Vol. 6(12), pp. 2494-2500, http://www.academicjournals.org/SRE

Awotunde, J.B, Fatai,O.W, Akanbi, M.B, Abdulkadir,I.S & Idepefo, O.F(2014). "A hybrid fingerprint identification system for immigration control using the minutiae and correlation methods", journal of computer science and its applications, 21(2) 97 – 108. www.ncs.org.ng.

Habib, A., Ateeq, I.S & Hameed, K (2013). "Biometric Security System based on Fingerprint Recognition", International Journal of Scientific Engineering and Technology(IJSET) Volume 2(9), 892 - 894.

Kuye, C.O, Coker, J.O, Ogundeinde, I.A & Coker, C.A. (2013), "Design and Analysis of Electronic Voting System in Nigeria", International Archive of Applied Sciences and Technology

Kumar,A.D & Begum, S.U (2011) "A Novel design of Electronic Voting System Using Fingerprint" International Journal of Innovative Technology & Creative Engineering 1(1).

Kumar, K. S & Vijayaragavan, S. (2014)."New Secured Architecture for Authentication in Banking Application", International Journal of Innovative Research in Science, Engineering and Technology(IJIRSET) 3(2), pp 9126 – 9131 available at www.ijirset.com

MbachuG.N, (2014) http://leadership.ng/news/politics/384579/issues-inec-proposes-new-polling-units accessed 26th December 2016

Olayemi, M. O.,Oladiran, T.A., Adeoyo, O., & Elijah, O.O. (2013), "Design of Secure Electronic Voting System Using Multifactor Authentication and Cryptographic Hash Functions", International Journal of Computer and Information Technology (ISSN: 2279 – 0764) Volume 02– Issue 06.

Ritu, & Garg, M. (2014). "A Review on Fingerprint-Based IdentificationSystem", International Journal of Advanced Research in Computer and Communication Engineering, (IJARCCE)Vol. 3, Issue 3,pp 5849 - 5851 www.ijarcce.com

Samuel, C. Q, Leonard, K.A, &Dilys, D."Conceptual Design of E-Voting System for Academic Institution", International Journal for Innovation Education and Research, Vol 4No 12-2016 available on http://www.ijier.net

Sanjay, K., & Manpreet S. (2013), "Design a secure electronic voting system using fingerprint technique"IJCSI International Journal of Computer Science Issues, Vol. 10, Issue 4, No 1, www.IJCSI.org

http://www.griaulebiometrics.com accessed 14th December 2015

Presidential elections 1999-2011 in figures, (April 23, 2011). Vanguard. Retrieved 15th September 2017 (http://www.vanguardngr.com/2011/04/presidential-elections-1999-2011-in-figures)

DETERMINING RISK FACTORS IN THE FORMULATION OF ANFIS MODEL FOR THE SECURITY RISK ASSESSMENT OF SDLC PHASES

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ABSTRACT

In order to ensure the delivery of secured software, developers must strictly adhere to risk management practice in all phases of system development life cycle (SDLC). Since different types of risks are associated with each of these steps hence, it is rather important to focus on the level of exposure to security risk at each stage rather than at the end of the deployment of the system. This study aims at identifying the different risk factors that are associated with the assessment of the security risk at each stage of the SDLC. The identified risk factors were then used to formulate an adaptive neuro-fuzzy inference system (ANFIS) model for each stage of the SDLC. The input and output variables were formulated using the triangular membership function. The results showed that a proportion of the initially identified risk factors from literature were relevant in the Nigerian context for assessing the security risk of the phases of SDLC such that 39 risk factors were selected in all. The results further showed that each risk factor identified was formulated using 2 triangular membership functions in the closed interval [-0.5 1.5] while the output was formulated using 4 triangular membership functions in the closed interval [-0.1 1.0]. The study concluded that by identifying the risk factors at each phase of the SDLC, an ANFIS model for the assessment of security risk at each phase of the SDLC can be proposed.

Keywords: *Security risk assessment, system development life cycle, ANFIS,*

1. INTRODUCTION

With increasing use and adoption of software applications, information communication tools (ICT) and devices that are driven by software applications, security has become an important component to be considered in Software development life cycle (SDLC) (Pooja & Dalwinder, 2013). Also, consciousness about associated security issues will assist in identifying secured software (Krishnan, 2015). To ensure the delivery of secured software, developers must strictly adhere to risk management practice in all phases of SDLC (Gandhi *et al.*, 2014). Software development goes through a consistent life cycle

starting from the Problem Identification, Feasibility Studies, Requirements Analysis, System Design, Implementation, Testing, Deployment and Maintenance (Hijazi, 2012). Different types of risks are associated with each of these steps hence, it is rather important to focus on the level of exposure to security risk at each stage rather than at the end of the deployment of the system (Gandhi *et al.*, 2014). Security is an important concern to software development life cycle in order to improve the quality of the software (Dhalamini *et al.*, 2009). According to Keiski (2013), software security is more than just writing codes since it also includes other activities like designing software architecture, performing system testing and maintenance. As a result of developing software from a security perspective, some of the vulnerabilities are found in source code which is only a small portion of the overall risk since process and people related risks must also be considered. It is therefore important to integrate security into the phases of SDLC because most of the available risk management solutions are too costly and time consuming (Gandhi *et al.*, 2014).

The SDLC consist of different steps or phases depending on the model, but the traditional model is the waterfall model and it consists of the requirement analysis, design, coding, testing, implementation and maintenance phases (Bhatnagar & Singh 2013). Risk management is the process of identifying risk, assessment, risk mitigation and evaluation. However, risk management integration in the SDLC is key to having a secured software development process (Hijazi, 2012). According to Keiski (2013) risk management in software development is challenging, because it is not an exact science and it is still a maturing area and concluded that risk is the net negative impact of the exercise of vulnerability, considering both the probability and impact of occurrence. Applying risk management process to system development enables organizations to balance requirements for the protection of agency information and assets with the cost of security controls and mitigation strategies throughout the SDLC (Unuakhal *et al.*, 2014). A SDLC has three primary objectives which includes ensuring that high quality systems are delivered, providing strong management controls over the projects and maximizing the productivity of the system staff (Unuakhal *et al.*, 2014). Security objectives will be easily met in all system released from development by identifying security requirement early in the development process and incorporating them throughout the SDLC. According to Unuakhal *et al.* (2014), risk management methodology is the same regardless of the SDLC phase for which the assessment is being conducted and expatiated that the intent is not to disturb or add more phases to the SDLC but to incorporate security activities into an existing SDLC methodology.

Software industry is one of the biggest industries around the world with several software projects being developed which vary in size, cost and complexity (Tatar & Tomur, 2013). Producing a secure, quality and error free software within cost estimate and budget has been traced to how well risks are managed during SDLC (Gandhi *et al.*, 2014). Many tools, models and method have been developed in time past to assist

software developer and project manager to carry out risk management activities during SDLC but most of the tools have one limitation or the other ranging from lack of update facility to failure to identify the risk factors associated with software risks. There is a need for an intelligent system that will incorporate or weave risk management activities into all phases of SDLC. Different types of risks are associated with each of these steps and presently, there are few tools or models available which can assist the developers in carrying out risk management activities during SDLC (Gandhi *et al*., 2014). Therefore, an intelligent and efficient web-based software risk management expert system will assist software developers and project managers in carrying out risk management activities and in decision making during SDLC (Dash & Dash, 2010). The purpose of this study is to develop an adaptive neuro-fuzzy web-based risk assessment expert system that will use local software developers to identify how the existing risks factors present at different phases of the SDLC as presented on the software risk factors checklist taxonomy will impact the software project if not mitigated or reduced in Nigeria context.

2. REVIEW OF RELATED LITERATURE

Sharif *et al.* (2014) developed a fuzzy expert system coded using the MATLAB that only calculated the total risk of the project but failed to identify any risk factor. Also, no provision of facilities for adding, deleting, update and risk prioritization of new risk. Another Tool called Project Risk Assessment Decision Support System (PRADSS) was developed for software project based on decision support system which made risks prioritization possible but did not support the identification of risk factors associated with security assessment. Gandhi *et al.* (2014) developed an expert system risk assessment tool using artificial neural network to determine the impact of risk on the software application being developed which failure due to these risks can be minimized. Mitigation steps were made possible. The system was simulated using MATLAB with ten risk factors adopted from software risk factors checklist taxonomy. This cannot help project managers to determine impact of all risks involved in all phases of SDLC because of the limited number of risk factors. According to Pooja and Dalwinder (2013), a combined neuro-fuzzy approach has seen enormous preferences from researchers in different domains by using artificial neural network and fuzzy logic to implement a single model. Hence, a hybrid risk prediction approach for weaving security checks into all stages of SDLC was suggested because it proved to be more accurate than individual approach (Pooja & Dalwinder 2013). This study will extend the previous models by developing an Adaptive Neuro-Fuzzy Inference System (ANFIS) model for assessing the security risk associated with each stage of the SDLC of software development process. Software development life cycle is vulnerable to risks from the start of the project till the final acceptance of the software product. Each phase of the SDLC is susceptible to different sets of threats that might hinder the development process from being completed successfully. This new model will involve local software developers in risk identification

at all stages of SDLC by adapting all the one hundred risks factors available at different stages of SDLC on the risk factors checklist taxonomy as presented in literature. The model will also incorporate facility for updating risk factors.

3. MATERIALS AND METHODS

According to literature, the related works to this study did not consider the assessment of security risk at each step of the system development life cycle (SDLC). This study will involve the development of an Adaptive Neuro-Fuzzy Inference System (ANFIS) model for assessing the security risk associated with each stage of the SDLC of software development process. SDLC is vulnerable to risks from the start of the project till the final acceptance of the software product. Each phase of the SDLC is susceptible to different sets of threats that might hinder the development process from being completed successfully. In order to manage these risks properly, an adequate understanding of the software development process problems, risks and their causes are required. Hence, the first step in managing these risks is to identify them.

Figure 3.1 shows a description of the step by step process that will be involved in the development of the proposed ANFIS model for the assessment of security risk at each stage of the SDLC. This process will consist of a number of stages which are explained as follows. The identification of the risk factors necessary for assessing security risk at each stage of the SDLC and the collection of data about historical security assessment based on the risk factors. The formulation of the ANFIS model based on the risk factors identified. The simulation of the ANFIS model using the MATLAB software will be done based on the historical data collected about security assessments. The implementation of a prototype system with web-based capabilities using the MATLAB Application Programming Interface (API) to integrate the functionalities of the ANFIS model simulated.

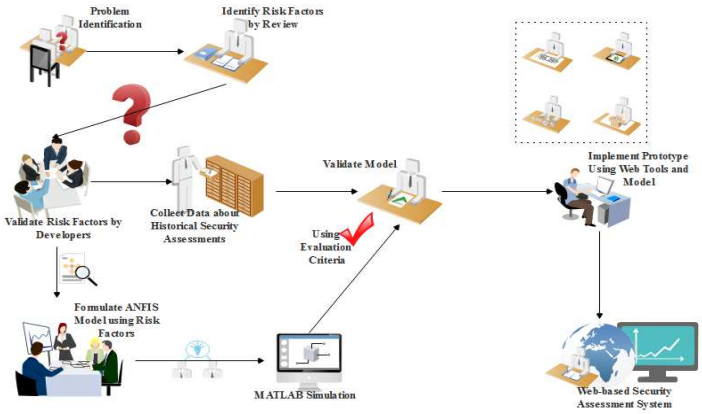


Figure 1: Research Methodology Process

In most security assessment system that has been developed in literature, majority have been focused at assessing security risk at the end of deployment of the system. The

challenge is the inability to identify which stage is attached or directly responsible for contribution to the assessed security risk. System Development goes through a consistent life cycle starting form the problem identification, feasibility studies, requirements analysis, system design, implementation, testing, deployment and maintenance. Each of this stage contributes a great deal to the success of any proposed system and hence it is rather important to focus at the level of exposure to security risk at each stage rather than at the end of the deployment of the system.

3.1 Identification of Risk Factors

In order to shortlist the necessary but important risk factors, questionnaires were designed to determine the risk factors that are relevant in SDLC from Nigerian-based software developers from the initially identified risk factors by Hijazi *et al.* (2014). Each risk factor was assessed based on a relevance scale of either Yes (if considered) or No (if not considered). The questionnaires were designed using Google Forms®, a value-added service provided by Google® for GMail® users for conducting survey. The software developers were selected from the community of Nigerian developers consisting of project managers, system analysts, front-end and back-end programmers and user interface (UI) and user experience (UX) developers. The risk factors as proposed by Hijazi *et al.* (2014) were identified initially according to their respective phase of the SDLC. These initially identified risk factors were proposed to the Nigerian developers from which the risk factors that were most relevant were selected. Table 1 shows a description of the risk factors that were considered in the requirement analysis and definition phase of the SDLC. In all there were 21 risk factors which were categorized into 5 different groups of activity consisting of a number of associated risk factors.

Table 1: Risk Factors of the Requirement Analysis and Definition Phase

S/N	Risk Factor Category	Number of Risk Factors
1.	Feasibility Study Activity	5
2.	Requirements Elicitation Activity	7
3.	Requirements Analysis Activity	5
4.	Requirements Validation Activity	2
5.	Requirements Documentation Activity	2
TOTAL		21

Tables 2, 3, 4 and 5 also show the description of the risk factors that were considered for the system design phase, implementation and unit testing phase, integration and system testing phase and the operation and maintenance phase respectively. Following the identification of the relevant risk factors for SDLC in the Nigerian context from the software developers, a follow up questionnaire will be

constructed to collect information about the risk factors that were considered by the software developers during the process of software development. This information will be used to generate the historical data needed for training the ANFIS needed for model formulation.

Table 2: Risk Factors of the System Design Phase

S/N	Risk Factor Category	Number of Risk Factors
1.	Examining Requirement Documentation Activity	1
2.	Choosing Architectural Design Method Activity	1
3.	Choosing Programming Language Activity	1
4.	Constructing Physical Model Activity	5
5.	Verifying Design Activity	3
6.	Specifying Design Activity	4
7.	Documenting Design Activity	4
TOTAL		19

Table 3: Risk Factors of the Implementation and Unit Testing Phase

S/N	Risk Factor Category	Number of Risk Factors
1.	Coding Activity	13
2.	Unit Testing Activity	10
TOTAL		23

Table 4: Integration and System Testing Phase

S/N	Risk Factor Category	Number of Risk Factors
1.	Integration Activity	3
2.	Integration Testing Activity	5
3.	System Testing Activity	8
TOTAL		16

Table 5: Operation and Maintenance Phase

S/N	Risk Factor Category	Number of Risk

		Factors
1.	Installation Activity	3
2.	Operation Activity	2
3.	Acceptance Testing Activity	6
4.	Maintenance Activity	3
TOTAL		14

3.2 Formulation of ANFIS Model

For the purpose of formulating the ANFIS model for the assessment of security risk, the risk factors that were selected from the aforementioned risk factors for each stages of the system development process were used as inputs. Therefore, the security assessment system consists of five (5) ANFIS models – one (1) for each stage of the SDLC process. The ANFIS model formulated for each stage will accept as inputs, their respective risk factors associated with the level of security risk while the output will be the security risk level at the stage for which the ANFIS model will be formulated. The idea is to propose a step-by-step process of monitoring the security risk assessment at every phase of the system development process. Thus, assuming P is a phase of the system development life cycle and R_i is the array of risk factors associated with security risk assessment at the phase of SDLC. Thus, the security risk assessment (SRA) at each phase S_P is therefore a function of the risk factors associated with it. Therefore the SRA at each phase can be represented using equation (1). The equation shows that SRA can measured as either of the four (4) identified risk levels: No risk, Low risk, Moderate risk and High risk as shown in equation (1).

$$SRA_P = f(R_i)\begin{cases} No\ Risk \\ Low\ Risk \\ Moderate\ Risk \\ High\ Risk \end{cases} \quad (1)$$

The triangular membership function was used to formulate the labels of each risk factor, the labels that were considered in this study are Yes and No – Yes if the risk factor is considered or No if it is not considered. Therefore, each risk factor will be formulated using two (2) triangular membership functions while the SRA will be formulated using four (4) triangular membership functions. At the initial phase for ANFIS development of each phase of system development, a Takagi–Sugeno fuzzy inference system (FIS) will be formulated using the triangular membership function to formulate each label of the risk factors and the SRA variable according to equation (2). The triangular membership function shown in figure 2 gives a graphical description of a triangular membership function for a No label using intervals [-0.5, 0.0, 0.5]. Thus, the value of 0.0 which clearly touches the altitude of the triangle depicts a membership degree $\mu_x = 0.0$ for a No label. For this study, the interval which will be defined for the Yes label is [-0.5 0.0 0.5] and for the No label is [0.5 1.0 1.5] as shown in equations (3) and (4).

$$riskFactorLabel(x;a,b,c) = \begin{cases} 0; x \leq a \\ \dfrac{x-a}{b-a}; a < x \leq b \\ \dfrac{c-x}{c-b}; b < x \leq c \\ 0; x > c \end{cases} \quad (2)$$

$$Yes(x;-0.5,0.0,0.5) = \begin{cases} 0; x \leq -0.5 \\ \dfrac{x+0.5}{0.5}; -0.5 < x \leq 0 \\ \dfrac{0.5-x}{0.5}; 0 < x \leq 0.5 \\ 0; x > 0.5 \end{cases} \quad (3)$$

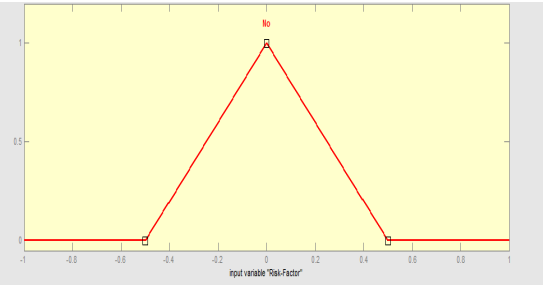


Figure 2: Structure of triangular membership function for [-0.5 0.0 0.5]

$$No(x;0.5,1.0,1.5) = \begin{cases} 0; x \leq 0.5 \\ \dfrac{x-0.5}{0.5}; 0.5 < x \leq 1 \\ \dfrac{1.5-x}{0.5}; 1 < x \leq 1.5 \\ 0; x > 1.5 \end{cases} \quad (4)$$

The Security Risk Assessment (SRA) output class for each phase of the SDLC has four (4) labels, namely: no risk, low risk, moderate risk, and high risk and hence will be formulated using four (4) triangular membership functions – one for each labels within an interval of [0.0, 1.0]. Figure 3 shows a depiction of the graphical representation of the formulation of the four labels for SRA output variable using the triangular membership function.

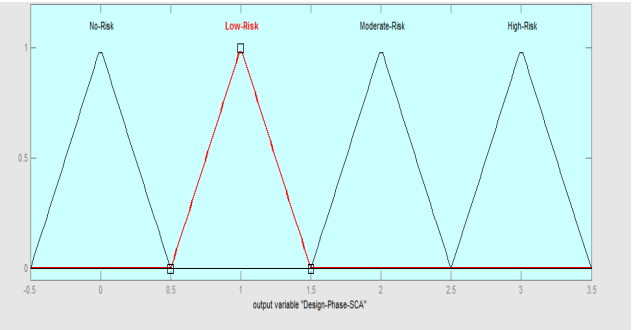


Figure 3: Structure of triangular membership function for the labels of SRA

4. RESULTS AND DISCUSSIONS

The results of the collection and analysis of the SDLC Security Risk Assessment (SRA) data that was collected for the purpose of this study was presented in this section. The results presented the questionnaire that was administered using Google Forms as the instrument of data collection for the identification of the risk factors required for the assessment of the security risk of SDLC. Using the questionnaires, the developers identified the risk factors from the 93 initially identified risk factors based on the context of software development in Nigeria from 31 software developers comprising of front-end and back-end programmers, project managers, system analysts and graphics designers. The results presented the statistical analysis of data collected from the developers considered using frequency distribution tables to describe the responses of the developers for each risk factor. The frequency distribution was used to identify the risk factors that were generally agreed upon by all developers and those that were not generally agreed upon by the developers were analyzed using non-parametric tests for investigating significant differences in the responses of developers. The chi-square non-parametric test was used based on the type of establishment belonged to and the area of specialization of the developers using a p-value of 0.05 from the data collected.

4.1 Results of the Collection of SDLC Security Risk Assessment Risk factors' Data

For the purpose of the identification of the risk factors that were considered by the Software Developers in Nigeria selected for this study, the electronic questionnaire constructed using the Google forms as shown in figure 4 was used. The electronic questionnaire was administered to the software developers by sending the questionnaires directly to their mail as shown in figure 5 or by sending a link to their mail redirecting the mail recipients to the questionnaire using the link shown in figure 6.

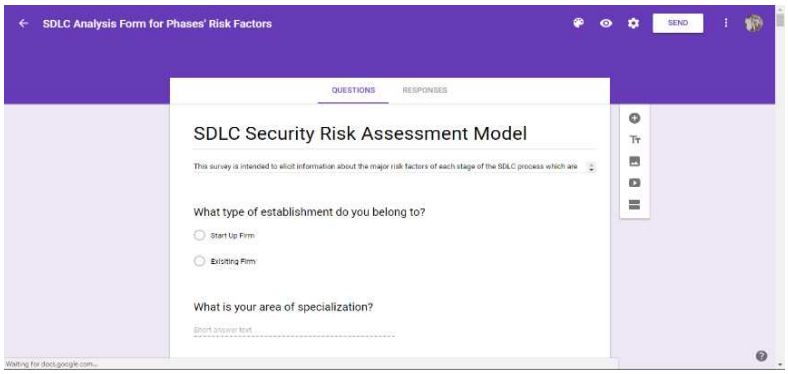


Figure 4: The Electronic Questionnaire constructed using Google Forms

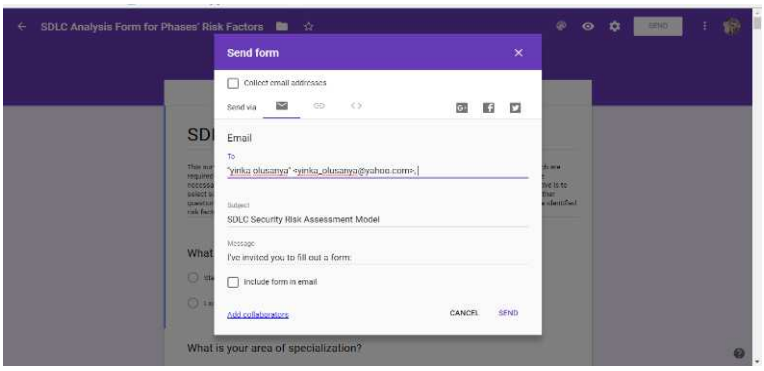


Figure 5: Interface showing the process of sending questionnaire directly to mail

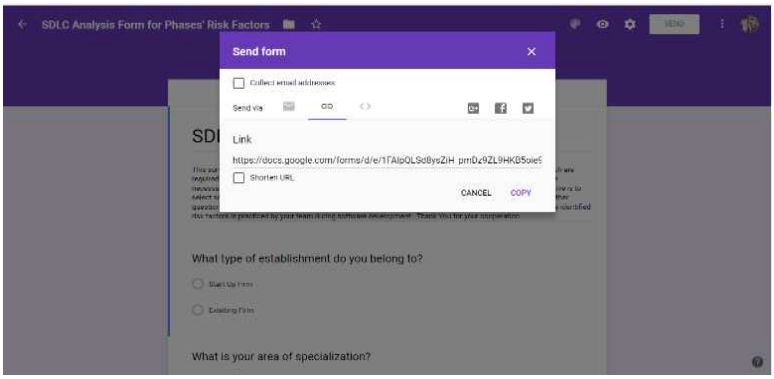


Figure 6: Interface showing the process of sending link to mail

Following the administration of the electronic questionnaire to the recipients, 31 software developers responded to the questionnaire by providing information about the risk factors among the identified ones in the questionnaire that was most appropriate for assessing the security risk of SDLC process in the Nigerian context of software development as shown in figure 7. The responses of the software developers were collected and analyzed with the purpose of identifying the different categories of risk factors. The demographic information provided was analyzed following which of the risk factors agreed upon by all (31) software developers were considered while the other risk factors not generally agreed upon were analyzed for significant differences between the categories of software developers based on type of establishment belonged to and the specialization of the developers. The risk factors that were not considered by the developers were discarded from the list of risk factors.

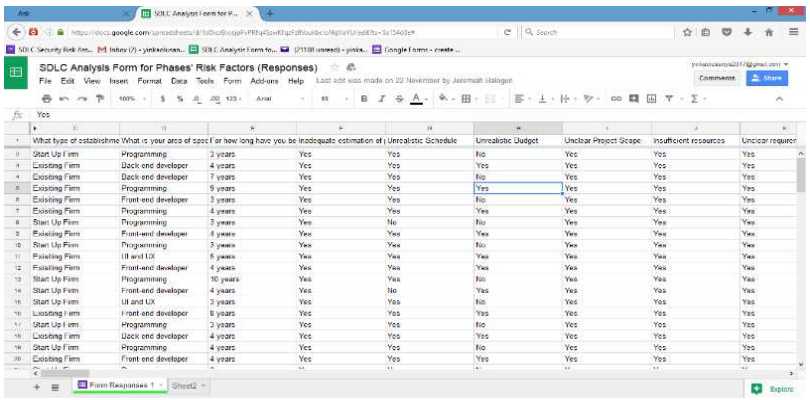


Figure 7: Responses to administered questionnaires via Google Forms

4.2 Results of the Analysis of Demographic Information of Selected Developers

The results of the distribution of the type of establishment to which the developers belonged showed that 51.6% were from start-up companies (companies that had been established in less than 5 years) while 48.4% were from existing companies. The results of the distribution of the specialization of the developers selected for this study showed that majority were system analysts comprising of 41.9% followed by front-end developers comprising of 22.6% and back-end and user interface or user experience (UI) with equal distribution of 12.% of the developers. The results of the distribution of the years of experience of the developers showed that majority had 4 years of experience (38.7%) followed by those with 3 years (25.8%) experience. In general, the least experienced developer had 2 years of experience while the most experienced developer had 11 years of experience.

4.3 Results of Analysis of the Risk Factors of SDLC Security Risk Assessment

The results of the risk factors that were selected by the developers selected for this study is presented in this section by providing information about the frequency distribution of the responses of the developers. The percentage value of the frequency distribution of the number of responses that agree to the identified risk factor was calculated over the total number of developers selected. The risk factors that were not selected were totally removed from the list of selected risk factors for each stage of the SDLC. The results of the number of developers who agree to the section of risk factors for each stage of the SDLC process was used to rank the risk factors into three (3) different categories of risk factors, namely:

i. *High Priority Risk Factors* – those risk factors that were agreed upon by all developers (100%) to be important for assessment of the security risk of the SDLC process, these risk factors were considered and were not analyzed using statistical tests since there were no variation in choice of the risk factors by the developers;

ii. *Low Priority Risk Factors* – those risk factors that were not agreed upon by all of the developers (< 100%) to be important for the assessment of the security risk of the SDLC process, these variables were removed but considered for statistical analysis in order to identify the differences in responses of the developers based on type of establishments and specialization using non-parametric tests; and

iii. *No Priority Risk Factors* – those risk factors that were not agreed upon by the developers selected for this study, these risk factors were removed and thus not considered for statistical analysis.

4.4 Results of the Identified Risk Factors for each Phase of the SDLC

The results of the selection of the relevant risk factors considered during the requirements and definition stage of the SDLC showed that out of the 21 initially identified risk factors, 11 were classified as high priority, 8 were classified as low priority while 2 were classified as no priority risk factors. Based on the results, 11 risk factors were considered for the development of the SDLC security risk assessment model for requirements and definition phase. Following the identification of the high priority risk factors was the analysis of the low priority risk factors that were not totally agreed upon by the developers using non-parametric tests. The results further showed that there is statistical difference in the responses based on the type of establishment regarding the response to the choice of the low priority risk factors except for unrealistic schedule which showed no statistical difference in responses.

The results of the selection of the relevant risk factors considered during the design phase of the SDLC showed that out of the 19 initially identified risk factors, 8 were classified as high priority, 6 were classified as low priority while 5 were classified as no priority risk factors. The results regarding the analysis of the responses of the low priority risk factors for the design phase by the developers showed that there was statistical difference in the variation in responses based on the type of establishment to which they belong but there was no statistical difference in the variation of responses of the developers based on the specialty of the developers.

The results of the selection of the relevant risk factors considered during the implementation and unit testing phase of the SDLC showed that out of the 23 initially identified risk factors, 9 were classified as high priority, 11 were classified as low priority while 3 were classified as no priority risk factors. The results regarding the analysis of the responses of the low priority risk factors for the implementation and testing phase by the developers showed that there was statistical difference in the variation in responses based on the type of establishment to which they belong but there was no statistical difference in the variation of responses of the developers based on the specialty of the developers.

The results of the selection of the relevant risk factors considered during the integration and system testing phase of the SDLC showed that out of the 16 initially identified risk factors, 4 were classified as high priority, 11 were classified as low priority

while 1 was classified as no priority risk factors. The results regarding the analysis of the responses of the low priority risk factors for the integration phase by the developers showed that there was no statistical difference in the variation in responses based on the specialty of the developers belong but there was statistical difference in the variation of some of the responses of the developers based on the type of establishment to which the developers belonged.

The results of the selection of the relevant risk factors considered during the operation and maintenance stage of the SDLC showed that out of the 14 initially identified risk factors, 6 were classified as high priority while 8 were classified as low priority and there were none classified as no priority risk factors. The results regarding the analysis of the responses of the low priority risk factors for the operation and maintenance phase by the developers showed that there was no statistical difference in the variation in responses based on the specialty of the developers belong but there was statistical difference in the variation of some of the responses of the developers based on the type of establishment to which the developers belonged.

4.5 Results of Anfis Model Formulation of SDLC Security Risk Assessment

This section presents the results of the process of the formulation of the Adaptive Neuro-Fuzzy Inference System (ANFIS) model that was proposed for the assessment of security risk at each SDLC phase identified based on the selected risk factors in the previous section. The ANFIS model was used to develop SDLC security risk assessment model for each phase of SDLC identified using the risk factors and required each risk factor to be initially fuzzified before been processed by the ANFIS model. Figure 8 shows the architecture of the ANFIS model that was used for the development of the SDLC security risk assessment model based the identified risk factors for each phase of the SDLC process. The figure presents the flow of information from the point of input (at the bottom) to the ANFIS model to the point of output when the security risk assessment for the phase of concern is determined (at the top).

The results of the formulation of the ANFIS model for security risk assessment (SRA) at each phase of SDLC showed that the requirements and definition stage required 11 risk factors out of 21, system design phase required 8 risk factors out of 19, implementation and unit testing phase required 9 risk factors out of 23, integration and system testing phase required 4 risk factors out of 16 and operation and maintenance phase required 6 risk factors out of 14 which were agreed upon by 100% of the developers selected for this study. Out of the initially identified risk factors, a total of 39 risk factors were selected for the development of the 5 ANFIS models for the SDLC (one for each phase). Table 6 shows the distribution of the risk factors selected for each phase of SDLC security risk assessment (SRA) from the initially identified number of risk factors.

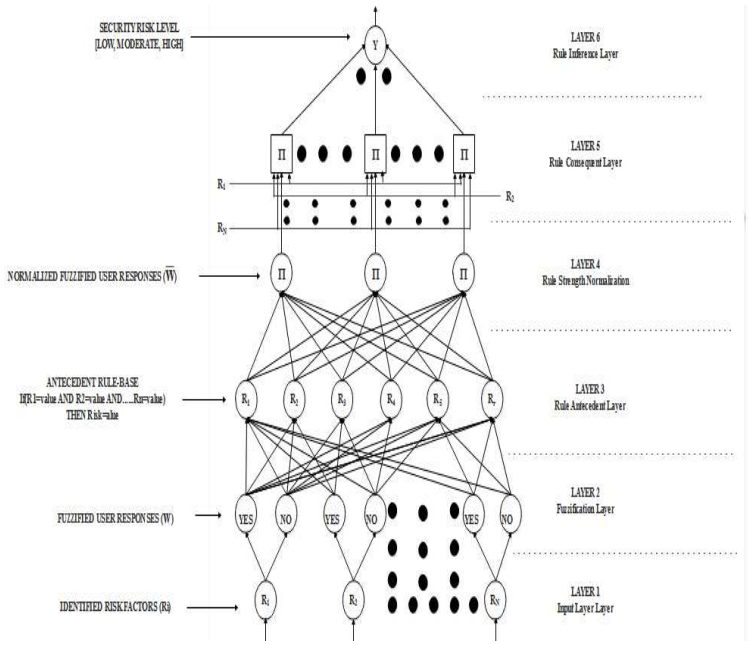


Figure 8: Architecture of ANFIS Model for SDLC Security Risk Assessment

Table 6: Distribution of Risk Factors for each Phase of SDLC Security Risk Assessment
(SRA)

Phase of SDLC Cycle	Initially Identified	Selected Risk Factors	Proportion Selected (%)
Requirement Analysis and Definition Phase	21	12	57.14
Design Phase	19	8	42.11
Implementation and Unit Testing Phase	23	9	39.13
Integration and System Testing Phase	16	4	25.00
Operation and Maintenance Phase	14	6	42.86

4.6 Results of the Formulation of the Selected Risk Factors

The triangular membership function was used to fuzzify the risk factors used as input to the SDLC security risk assessment model developed for each phase of the SDLC process. The risk factors for each phase of the SDLC were required to have either the values Yes or No such that the formulated membership function for each values were based on and interval of [-0.5 0 0.5] and [0.5 1 1.5] respectively. The interval created were the crisp interval of each input with centres 0 and 1 for Yes and No respectively such that whenever a user selects a Yes the input is 0 and if it is a No the input is 1 to the ANFIS model.

The inputs to the membership functions were used to produce the respective fuzzified value based on the equations presented in (5) and (6). Figure 9 shows a

description of the triangular membership function that was used to formulate the inputs of each of the selected high priority risk factors selected by all developers for this study based on the expression in equations (5) and (6) for the values Yes and No respectively.

$$Yes(x; -0.5, 0, 0.5) = \begin{cases} 0; & x \leq -0.5 \\ \dfrac{x + 0.5}{0.5}; & -0.5 \leq x \leq 0 \\ \dfrac{0.5 - x}{0.5}; & 0 \leq x \leq 0.5 \\ 0; & x \geq 0.5 \end{cases} \quad (5)$$

$$No(x; 0.5, 1, 1.5) = \begin{cases} 0; & x \leq 0.5 \\ \dfrac{x - 0.5}{0.5}; & 0.5 \leq x \leq 1 \\ \dfrac{0.5 - x}{0.5}; & 1 \leq x \leq 1.5 \\ 0; & x \geq 1.5 \end{cases} \quad (6)$$

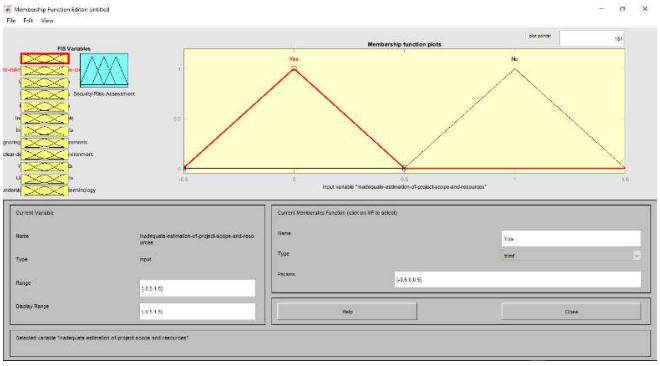


Figure 9: Triangular membership function for formulating risk factors

The results of the formulation of the ANFIS model for security risk assessment (SRA) using the triangular membership functions for the 2 values (yes and No) at each phase of SDLC showed that the requirements and definition stage required 11 input risk factors, system design phase required 8 input risk factors, implementation and unit testing phase required 9 input risk factors, integration and system testing phase required input risk factors and operation and maintenance phase required 6 input risk factors which were agreed upon by 100% of the developers selected for this study.

4.7 Results of the Formulation of the Security Risk Assessment Anfis output

The results of the formulation of the security risk assessment model for each stage of the SDLC process using the ANFIS model required the formulation of the output variable which was used to define the determination of the security risk assessment for each stage of the SDLC process. In order to determine the value of the security risk assessment of each phase of the SDLC, the total sum of the input provided by the user was determined. The higher the value of the sum then the higher the security risk since the value of 1 was applied whenever a user provided a response of No which corresponded to a value of 1.

The highest sum was determined by the number of risk factors considered and was divided into 3 parts which was used to determine the boundary for low, moderate and high risk classes of the security risk as shown in equation (7) while the no risk class was considered to be a value of 0. The different parts will be used to generate an interval which will be recorded as a proportion of the total values for the phase output.

$$SRA_p = f(R_i)\begin{cases} No\ Risk \\ Low\ Risk \\ Moderate\ Risk \\ High\ Risk \end{cases} \quad (7)$$

The results of the SRA output of the requirement analysis and definition phase showed that there were 11 high priority risk factors selected for assessing the security risk at this phase and by dividing this into 3 parts there are 4 units to each part. By dividing 1 into 11 parts (= 0.091) and multiplying each parts by multiples of 4 (i.e. 4, 8 and 12) then the interval for each output class were determined. Therefore, the boundary of No is 0, for Low is 0.33, for Moderate is 0.66 while for High is 1.

The results of the SRA output of the design phase showed that there were 8 high priority risk factors selected for assessing the security risk at this phase and by dividing this into 3 parts there are 2.67 units to each part. By dividing 1 into 8 parts (= 0.125) and multiplying each parts by multiples of 2.67 (i.e. 2.67, 5.34 and 8) then the interval for each output class were determined. Therefore, the boundary of No is 0, for Low is 0.33, for Moderate is 0.67 while for High is 1.

The results of the SRA output of the implementation and unit testing phase showed that there were 9 high priority risk factors selected for assessing the security risk at this phase and by dividing this into 3 parts there are 3 units to each part. By dividing 1 into 9 parts (= 0.111) and multiplying each parts by multiples of 3 (i.e. 3, 6 and 9) then the interval for each output class were determined. Therefore, the boundary of No is 0, for Low is 0.33, for Moderate is 0.67 while for High is 1.00.

The results of the SRA output of the integration and system testing phase showed that there were 4 high priority risk factors selected for assessing the security risk at this phase and by dividing this into 3 parts there are 1.33 units to each part. By dividing 1 into 4 parts (= 0.25) and multiplying each parts by multiples of 1.33 (i.e. 1.33, 2.66 and 3.99) then the interval for each output class were determined. Therefore, the boundary of No is 0, for Low is 0.33, for Moderate is 0.67 while for High is 1.

The results of the SRA output of the operation and maintenance phase showed that there were 6 high priority risk factors selected for assessing the security risk at this phase and by dividing this into 3 parts there are 2 units to each part. By dividing 1 into 6 parts (= 0.17) and multiplying each parts by multiples of 2 (i.e. 2, 4 and 8) then the interval for each output class were determined. Therefore, the boundary of No is 0, for Low is 0.33, for Moderate is 0.67 while for High is 1. Equations (8), (9), (10) and (11) shows the mathematical expressions that were used to formulate the triangular membership functions that were used to formulate each of the four outputs of the security

risk assessment of each phase for no risk, low risk, moderate risk and high risk respectively.

$$No - Risk_{phase}(x; -0.1, 0\ 0.1) = \begin{cases} 0; & x \leq -0.1 \\ \dfrac{x + 0.1}{0.1}; & -0.1 \leq x \leq 0 \\ \dfrac{0.1 - x}{0.1}; & 0 \leq x \leq 0.1 \\ 0; & x \geq 0.1 \end{cases} \quad (8)$$

$$Low - Risk_{phase}(x; 0.1, 0.17, 0.33) = \begin{cases} 0; & x \leq 0.1 \\ \dfrac{x - 0.1}{0.07}; & 0.1 \leq x \leq 0.17 \\ \dfrac{0.33 - x}{0.16}; & 0.17 \leq x \leq 0.33 \\ 0; & x \geq 0.33 \end{cases} \quad (9)$$

$$Mod - Risk_{phase}(x; 0.33, 0.49, 0.67) = \begin{cases} 0; & x \leq 0.33 \\ \dfrac{x - 0.33}{0.16}; & 0.33 \leq x \leq 0.49 \\ \dfrac{0.67 - x}{0.12}; & 0.49 \leq x \leq 0.67 \\ 0; & x \geq 0.67 \end{cases} \quad (10)$$

$$High - Risk_{phase}(x; 0.67, 0.85, 1.00) = \begin{cases} 0; & x \leq 0.67 \\ \dfrac{x - 0.66}{0.12}; & 0.67 \leq x \leq 0.85 \\ \dfrac{1.00 - x}{0.15}; & 0.85 \leq x \leq 1.00 \\ 0; & x \geq 1.00 \end{cases} \quad (11)$$

Table 7 shows the different intervals allocated for each stage of SDLC security risk assessment as a function of the sum of the response provided by a user used to classify the security risk assessment (SRA) of each phase p based on the i risk factors selected. The table also presented the values of the intervals selected for the triangular membership function proposed for each risk factor selected for each stage of the SDLC process.

Table 7: Description of the interval of the fuzzification of the risk factors for each phase of SDLC Security Risk Assessment

Phase of SDLC Cycle	**Risk Factors**	**No**	**Low**	**Moderate**	**High**
Requirement Analysis and Definition Phase	11	[-0.10, 0.10]	[0.10, 0.33]	[0.33, 0.67]	[0.67, 1.00]
Design Phase	8	[-0.10, 0.10]	[0.10, 0.33]	[0.33, 0.67]	[0.67, 1.00]
Implementation and Unit Testing Phase	9	[-0.10, 0.10]	[0.10, 0.33]	[0.33, 0.67]	[0.67, 1.00]

Integration and System Testing Phase	4	[-0.10, 0.10]	[0.10, 0.33]	[0.33, 0.67]	[0.67, 1.00]
Operation and Maintenance Phase	6	[-0.10, 0.10]	[0.10, 0.33]	[0.33, 0.67]	[0.67, 1.00]

5. CONCLUSION AND FUTURE WORKS

This study was aimed at the identification of the risk factors that are associated with the security assessment of each phase of the system development life cycle (SDLC). The study initially identified a number of risk factors based on a review of related works and from these risk factors, questionnaires were distributed among developers for the identification of the most relevant risk factors which are relevant on the Nigerian context for estimating the assessment of security risk at each stage of the SDLC process. Following the administration of the questionnaires, a number of risk factors were identified by the developers and based on their response each risk factors were prioritized. The risk factors were prioritized as high priority, mid priority and low priority. The high priority risk factors were considered since 100% of respondents agreed upon their use while the mid priority risk factors were analyzed using the statistical non-parametric test to examine the variation among responses based on establishment belonged to and specialization of the respondents selected. All low priority risk factors were not considered since they were not selected by the developers.

The study used the triangular membership function for the formulation of the fuzzy logic input and outputs such that the identified high priority risk factors were considered as the inputs which were formulated using two membership functions one for Yes and the other for No. The output function was formulated using four triangular membership function – one for each label of the output variable. In all, five fuzzy inference system were formulated – one for each stage of the SDLC process. Future work is aimed at the collection of feedback regarding the selected risk factors which will be used as the training data required for the formulation of the adaptive neuro-fuzzy inference system (ANFIS). The developed mamdani FIS systems will be converted into Takagi-Sugeno inference systems from which the ANFIS model will be developed based on the training data collected. The ANFIS model will also be validated based on the accuracy, sensitivity, precision and false alarm rate using the data collected. A prototype web-based system will also be implemented which integrates the ANFIS model developed for each stage of SDLC process in order to provide an interface via which the functionality of the ANFIS model can be assessed.

REFERENCES

Bhatnagar, M., & Singh, P.K. (2013).Research Methodology as SDLC Process in Image Processing. *International Journal of Computer Applications, 77*(2), 0975-8887

Dash, D., & Dash, R. (2010). Risk Assessment Techniques for Software Development. *European Journal of Scientific Research*, 42(4), 629–636.

Dhalamini, J., Nhamu, I. & Kachepa, A. (2009). Intelligent Risk Management Tools for Software Development. In *Proceedings of the SACLA 2009* held on June 29 – July 1 at the Mpekweni Beach Resort, South Africa.

Gandhi, A., Naik, A., Thakkar, K., & Gahirwal. (2014). Risk Management in Software Development using Artificial Neural Networks. *International Journal of Computer Applications 93*(19), 22 - 27.

Hijazi, H. (2012). A Review of Risk Management in Different Software Development Methodologies. *International Journal of Computer Applications (0975 – 8887) 45*(7), 1 – 12.

Keiski, T. (2013).Developing Security in the system Life Cycle – Agenteq Solutions OY. . (Master's thesis).University of Applied Sciences, Esko Vainikkas.

Krishnan, S.M. (2015). Software Development Risk Aspects and Success Frequency on Spiral and Agile Methods. *International Journal of Innovative Research in Computer and Communication Engineering 3*(1), 301 – 310.

Pooja, R., &Dalwinder, S.S. (2013) Neuro-Fuzzy based Software Risk Estimation Tool. *Global Journal of Computer Science and Technology Software and Data Engineering, 13*(6)

Sharif, A.M., Basri, S., & Ali, H.O. (2014).Strength and Weakness of Software Risk Assessment Tools. *International Journal of Software Engineering and its Applications, 8*(3), 389-398.

Tatar, E., & Tomur, E. (2013). A secure System Development Framework for SaaS Applications in Cloud Computing. Proceedings of *International Information Security and Cryptology Conference.* Ankara, Turkey.

Unuakhalu, M.F., Sigdel, D & Garikapati, M. (2014). Integrating Risk Management in System Development Cycle. *International Journal of Software and Web Sciences (IJSWS) 8*(1), 1 – 9.

HACKTIVISM OR BLOGGERPRENEURSHIP: A CRITICAL POLITICAL ECONOMY OF THE NIGERIAN BLOGOSPHERE

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ABSTRACT

As formidable alternative discursive space to mainstream media, blogosphere as networks of blogs has been largely feted for offering communicative and dialogic space for individuals, dissents and marginalized groups to articulate their political and cultural view outside the spectrum of acceptable opinion set by the political and economic system within a national milieu. However, relying on theoretical extrapolations of Critical Political economy of communication and culture, the paper challenges this euphoria surrounding the democratization of communication and cultural empowerment of blogging and blogosphere within the Nigerian society and advance that the Blogosphere in the country, largely driven by entrepreneurial spirits among youths and defined by traits such excessive monetization of blogs; mere relay and redistribution of contents from mainstream media, over- focus on entertainment and gossips as well as dependence on Google's adsense, cannot be assumed as an epicentre of anti-hegemonic discursive space. Rather, hyper-commercialism as the overwhelming organizing principle of blogosphere in the country systematically works towards calibrating this dialogical space into consonance with prevailing ideology in the country.

1. INTRODUCTION

In the contemporaneous information age and network society (Castell, 2002), it is arguable that internet now lies at the heart of the socio-economic cum political architecture of many countries of the world. Over the years, the internet and more specifically, the World Wide Web has undoubtedly become the largest available repository of information. The Web has become part and parcel of humanity as its application permeates every strata of human society so much that one cannot imagine a world without it. The web-based social media have also blended into the day –to- day informational needs of large percentage of people. Hence, life without the internet would be tortuous, disconnected and disoriented to people who are familiar with it. While the new media powered by the internet is having great impact across diverse areas, it can be said that the same new media is having greater and wider impact in political communication and democracy generally. Within the view that modern day democracy

is not working (Dahlgren, 2009) and that Citizenry are increasingly disengaging from civic life and political participation (Coleman & Blumler, 2009), internet and its entourage popularly grouped together as new media, has been posited as offering lifelines and prospects to democracy (Cooper, 2006; Dahlberg, 2001; Dahlgren & Sparks, 2005).

Specifically, cyber-optimists see the 'messiah' mission of the internet to the current imbroglio of public communication in its ability to engender a rich and all -inclusive communications environment that helps provide citizens with the motivation, ability, and opportunity to participate in various democratic processes including decision making (Shapiro, 2011). Put differently, internet is seen as a medium poised to decentralize and democratized communication as well as act as formidable alternatives to highly compromised mainstream media (Dahlgren and Sparks, 2005, Papacharissi, 2002). The celebration of alternative power of the internet resonate within the view that various socio, economic and political factors in democratic societies have re-engineered mainstream media to 'elites sphere' (Herman & Chomsky, 2002) and that mainstream media function as handmaid of the ruling elites rather than voices of the masses (Burstein, 2010). In their propaganda model, Herman and Chomsky (2002) powerfully argue that the mainstream media are no longer seen to "represent a wide range of issues from a variety of perspectives and with a diversity of voices" (Fenton, 2004, P.2). Rather, mainstream media are seen to be operating within a varying degree of market and government influences (Bagdikian, 1992; Herman & Chomsky, 2002) in which the ideal 'public arena' imperative of the media have come under interference and shadow gate-keeping. Hence, internet, along with its entourage, is seen and expected by cyber-optimists to upset the mainstream media formation as the people 'no longer need be consumers and passive spectators but can be creators and primary subjects (Benkler, 2006, p.272)

True to expectation, the popularity and wide usage of various social tools of the internet revolution by individuals across the globe has reconfigured the hitherto top-down approach of public communication to an ecology in which the people are mainly the producer of information. Specifically, the web 2.0 applications provide a "communications toolkit that allows anyone to become a journalist at little cost and, in theory, with global reach." (Gilmors, 2004). Consequently, citizen journalism which Gilmors (2004) described as ICT dependent 'grass-root journalism by the people and for the people' now characterized the media landscape of many countries of the world.

Within this media terrain in which citizen journalism is occupying a substantial portion, scholars have beamed a searchlight on Blogs as one of the chief propellants and purveyor of users-generated content within the emerging web 2.0 Cyberculture (Cross, 2011; Blood, 2003; El-Nawawy and Khamis, 2013, Papacharisi, 2007). Blog, contrasted from the root-word *weblog,* refers to "frequently modified webpages containing dated

entries listed in reverse chronological sequence" (Herring el al, 2007). Blogging has become very popular in recent time as it presents a user-friendly, inexpensive, speedy mechanism of publishing online. In starting a blog, all that is needed is to go to a website like blogspot.com, wordpress.com, blogger.com, or tumblr.com and open an account for free. Registering on these already formatted *content management systems* implies that one is setting up a simple website on which one can publish contents or *blog* regularly (Herring el al, 2007). Blogs are also interactive in nature since readers of blog post can also publish their comment and opinions on the same page. The vast and ever-increasing numbers of blogs on the internet has led to a constellation of weblogs commonly refer to as blogosphere or network of blogs (Cooper, 2006; Papacharissi, 2007; Blood, 2003; Cross, 2011).

Basically, blogosphere is seen as an alternative to the hegemonic traditional media since blogs offer 'context, criticism and cynism and challenge the top –down approach of corporate media' (Cooper, 2006). Blogs are also believed to provide opportunity for dissents and marginalized groups to articulate their political and cultural view outside the spectrum of acceptable opinion set by the political and economic system within a national millieu (Dahlberg, 2007; Coleman, 2005). Thus, it is tempting to re-echo that blogs along with other web2.0 formats are engendering the ideal public sphere which is neither hindered by the State or Market forces (Habermas, 1989).

However, a growing body of literature has come to challenge the euphoria surrounding the democratizing and cultural empowerment of blogs and other web 2.0 by analyzing how these new media are embedded and characterized by ideology, class power, domination, and exploitation (Fuchs, 2011; Andrejevic, 2009, Sandoval, 2012). Taking it from the base-superstructure analytical framework, web.20, despites its promises, has been analysed and reduced to "a product, or even a manifestation, of social relations of domination within the society that has both invented it and brought it to use" (Olsson 2012, p.204). Essentially, web 2.0 architecture, largely owned and control by big players such as Google inc. Yahoo inc., Facebook and other minor players, is seen as an extension of corporate logic in which profit motive is the overriding driving force (Fuchs, 2011, Freedman, 2012) within the usual or slightly altered business model of communication and culture. Summing it up, the critical political economy analysis of the web 2.0 platforms see ownership, targeted advertising, commodification of users data and online behaviour, as well as excessive surveillance of users by economic and political elites as issues which parallel the promises of these platforms (Fuchs, 2011; Olsson, 2012).

While critical political economy of the web 2.0 is largely based on theoretical elaborations grounded in the normative observation of production, distribution, and consumption of contents within these platform, it is pertinent to note that the approach offers insights especially in Nigeria where the emerging blogosphere taking shape and

being powered within an entrepreneurship drive by the teeming youths of the country. Hence, the paper looks at the emerging blogosphere in the country within a normative thesis that commercial imperatives as the organizing principle of blogging sites and entrepreneurship as propellant of blogging among largely youths in the country works towards calibrating the Nigeria's blogosphere into consonance with prevailing ideology rather than serving as anti-hegemonic discursive space. As a review paper, pertinent literatures were synthesized to support the argument of the paper. In other words, secondary data were used in stringing up the analsysis.

2. CRITICAL POLITICAL ECONOMY OF WEB 2.0 FORMATS

The rise of transnational informational capitalism (Fuchs, 2011) has necessitated the increasing scrutiny of the new media within the various analytical frameworks. Specifically, the analysis developed by critical political economists to study communication and culture has been instrumental in unearthing the contradictions of web 2.0 participatory architecture.

Rather than looking at the societal impact of the new media, "critical analysis starts from the prevailing distribution of power and inequality and asks whose interests will be best served by these new potentialities" (Wasko, Murdock and Sousa, 2011). Along this perspective, critical political economy approach to web 2.0 dictate that these platforms should be looked at historically, holistically and in relation to the public good (Graham and Murdock, 2005; Wasko, Murdock and Sousa, 2011). Basically, the origin of the internet which dated back to the development of ARPANET in 1960s evolves mainly out of the needs of national security in the USA. Hence, from its origin, Internet is never a common stock or a public good (Fuchs, 2014). More so, the growth of information-based economy as a result of advances in Information and Communication Technologies (ICTs) fired internet from its national security and academic imperatives to the heart of informational capitalism of the 21st century. In explicit term, the development of World Wide Web in 1990s by Tim Berner-Lee (then a staffer of Center for European Nuclear Research) provides a turning point which levels the ground for commercialization of the internet. Within this commercialization of internet, advances and upgrading of web technology web 2.0, characterized by interactive and active users participation, levels the ground for the corporatization of the internet. Web 2.0 as architecture of participation was able to attract vast number of people to the internet as producers/consumers of contents. The availability of this 'market' (people) therefore gingers corporations to develop suitable business models that fit squarely into this participatory cyber-culture. While many of these platforms are free, web 2.0 business model revolves around commodification of users' data as well as target and niche advertising. This view is avidly captured by Fuchs thus; Corporations in the Internet economy make use of gifts, free access, and free distribution in order to achieve high numbers of users, which allows them to charge high advertisement rates and drive up profits. Especially Web 2.0 platforms make use of this model. (2008, p.343).

Within this lucrative business model, many web 2.0 platforms rakes in millions of dollars yearly. Mining users' data for targeted advertising from any online platform available has also act as impetus for Web 2.0 corporations to acquires start-up platforms with prospects. In 2003, Google acquired Bloggers.com from Pyra labs (a start-up owned by two individuals) while Facebook also acquired Instagram in 2012 and whatsapp in 2014. In essence, with capitalism as the organizing principle, "corporations that are profit oriented accumulate capital by online advertising and in some cases by selling special services operate the vast majority of web 2.0 platforms" (Fuchs, 2011. P.280). Apart from the corporatization of the web 2.0, critical political economy also stresses the increasing surveillance of web 2.0 users (Fuchs, 2014; Andrejevic, 2009). Since web 2.0 users must sign up using their personal data, "political and economic elites collect information that facilitates social Taylorism(sic) rather than fostering more democratic forms of shared control and participation' (Andrejevic, 2009, p.257). Critical analysis of the web 2.0 also point that the architecture is based on exploitation of free labour since various corporations running different web 2.0 platforms have licensed themselves via pre-signed terms and agreements as the owners of the uploaded contents (Fuchs, 2011; Terranova, 2004). Consequently, web 2.0 is seen to be full of contradictions and therefore serves the dominants – corporate and political elites – interests (Stanyer, 2009; Cammaerts, 2008)

Within this critical political economy analysis of the web 2.0 of which blog is a subset of, it is easy to see that blog as self-publishing and interactive media is highly commercial in nature. Out of the five most popular blogging sites in the world, four generate revenue via advertisement and selling of customized domain. As such, they can be emphatically be regarded as part of Capitalist media which "are necessarily means of advertising, commodification and spaces of ideology. Advertisement and cultural commodification make humans an instrument for economic profit accumulation" (Fuchs, 2015). In other world, hyper-commercialism serves as the basic impulsion of the web 2.0 architecture and it set the tone for the usage and culture revolving around these communication spaces. Using this theoretical perspective as a lens to view the blogosphere in the Country tend to reveal certain features of the domain which paint a picture of the constellation of blogs whose organizing principles works against the ideals of an open, democratic and anti-hegemonic discursive space most especially among the youth.

3. OVERVIEW OF NIGERIAN BLOGOSPHERE

Blogging and blogosphere in Nigeria developed within the rise of citizen citizen journalism in early 2000s (Dare, 2011). Within an increasing internet penetration, blogging evolved mainly as part of social media usage and adventure among the technological savvy youths in the country. However, it was Linda Ikeji, regarded by many as the queen of blogging (at least independent or individual blogging) that gave blogging a facelift and transform to a trendy enterprenur among youth in the country.

Starting her blog in 2007 to "share things she was interested in with readers" (African Sun Times, 2014), Linda Ikeji's became the one stop site for news and gossips among the burgeoning internet users. With over 40 million Nigerians having access to internet in 2011 (www.Internetworldstat.com), traffic on Linda Ikeji's blog became worthwhile to advertisers. Hence, Linda Ikeji was 'pressured' to monetize her blog via advertising as advertisers kept demanding for her blogs' advert rate (African Sun Times, 2014). Monetizing her blog via advertise placement provided the financial breakthrough for Linda Ikeji and spurned her into limelight as the first Nigerian blogger to be earning millions from blogging. In 2012, "Forbes Africa described her as a success and a case study for the business of blogging" (African Sun Times, 2014).

Over the last few years, the Nigerian blogosphere has expanded with hordes of individuals floating new blogs on daily basis. Largely powered by the youths in the country, blogosphere in the country can boast of hundreds of blogs focusing on diverse areas like politics, entertainment, technology, how-to-do-it and others. However, it is pertinent to note that the Linda ikeji's factor as the role model of blogging in the country has an overbearing influence on the outlook and configuration of the Nigerian blogosphere up till today. Specifically, the highly commercial and monetizing nature of the bulk of the independent blogs constituting the blogosphere in the country copied their template from Linda Ikeji. Hence, the economic logic of blogging in the country has bestowed on the blogosphere specific forms and features the discernible via a political economy of blogosphere.

Appraising it from a normative point of view, the blogging in the country can be said to be propelled by entrepreneurial drive among youths; that blog contents is often relay contents from other sources instead of well researched, critical and utilitarian contents; that Google's Adsense program which allows bloggers to earn dollars from their blogs via advertisement placement often act as primary filter; that entertainments, gossips, and other allied themes dominate the blogospheres at the expense of political, economic and social issues; and that state disposition to bloggers limit their ability to evolve as the fifth estate of the realm. Essential, all these present a view of the country's blogosphere as highly calibrated subaltern public sphere. To better grasp these defining features of the blogosphere in the country and provoke research about them, it is pertinent to elaborate on them one after the other.

4. BLOGGING AS COTTAGE BUSINESS IN NIGERIA

Blogging, especially political blogging, has been seen as a form of *hactivism* in which individuals' voice out largely oppositional frames on issues of common concern (Reese, 2006: El-Nawawy and Khamis, 2013). Within the emerging blogosphere in Nigeria largely powered by the youths, this may not be the reality. This is because blogging, especially the individual bloggers, in the country developed largely within an entrepreneurship drive by the teeming youths in the country. in a country where the number of unemployed youths is on the high side, ability to monetize blogs and earn few

dollars from such small capital investment has always been the raison d'être for the burgeoning blogosphere in the country.

Blogging, which only requires a computer and a modem, promises moderate return on investments (ROI) for individuals venturing into it. Moreover, the success story of Linda Ikeji, the country's foremost blogger, offers the necessary motivation to the teeming *'bloggerprenur'* in the country. Linda ikeji's blog, www.lindaikejiblog.com , is ranked as the 8th most visited website in Nigeria (Alexa.com) attracting up 50,000 visits per day. Hence, her financial success from blogging can be said to have attracted many to the business of blogging despite not having wherewithal to mount a utilitarian blog contributing meaningfully to pressing and defining issues of the time.

The implication of individual *bloggerprenurs* dominating the country's blogosphere is that issues are likely to be framed and presented within the commercial imperatives of the blog (page views, traffic or cost per click ad) rather framing issues in other to generate ctitical rational discourse within an alternative public sphere

5. NIGERIAN BLOGOSPHERE CONTENTS PRODUCTION AS MERE RELAY

Blogs contents in the country are often producing within framework of the economic logic underpinning blogging and blogosphere. Basically, cheapest means of producing contents are often preferred by these bloggers. Hence, rather than original contents that critically look at issues, what is often obtainable from the blogosphere is a mere relay or redistribution of contents from online media. Known as *copy and paste,* relay of contents has engendered consonance rather than diversity of framing and interpretations of politically-consequential issues within the country's blogosphere. This particular trend is accentuated through ownership of multiple blogs by an individual. Basically, a blogger operating a multiple blogs only needs to redistribute content from one blog on other blogs. There is no doubt that the root-cause of this trend lies in the fact that bloggers, most especially, the political bloggers in the country have not transcend from reporting to analyzing news. And since they limited themselves to breaking the news alone in order to pull traffic, they often rely on adapting published contents of the mainstream media. While it is acceptable that bloggers, especially individual bloggers, do not a structure for news gathering, it is pertinent that focusing on providing in-depth analysis of the news and giving it people's centric perspective as it is done in other part of the world would have carved a niche and unique appeal to the blogosphere in the country. Mere relay of information in the blogosphere sharply contradict the perceived fifth estate of the realm (Cooper, 2006) imperatives of blogs. It makes blogosphere a re-diffusion centre of ideology rather than a discursive space where ideologies are dissected and dismantled.

6. GOOGLE ADSENSE AS FILTER

In 2nd quarter of the year 2016, Google's advertising revenue hit a whooping $19.1 billion (www.blomberg.com). The bulk of this income is generated via Google's adword program which involves placing targeted adverts on blog. However, the good news for bloggers is that they can also share from this continuous windfall. Known as Google Adsense program in which Google's publish its clientele's adverts on *approved* blogs and pay the blogger a certain percentage based on the number clicks on the advert. For example, if an advertiser pays $2 on every click on their advert, google will pay the blogger (known as the publisher) 68% of the $2 while retaining the remaining 32% (www.digitalmarketingpro.net) Among bloggers in the country, it is a common knowledge that the most profitable way to monetize your blog is through Adsense Earning Per Click (EPC) . Though there are some other means of monetizing blogs such as local ad (Linda Ikeji is a success story here) and paid/sponsored review of products. Nevertheless, the fact that Adsense remit earnings to bloggers in dollars makes it's the dream of every Nigeria blogger. However, Google's adsense program comes with stringent rules which a blogger must strictly adhere to in order for his/her blog to be approved for the program. Some of these rules relate to content, organization and traffic of the blog. Hence, bloggers are always under pressure to format and even publish contents within the guideline of Google adsense. Relatedly, ability to earn from adsense depends largely on the number of traffic a blogs command. A blog with 50,000. Visit per day will definitely earn more than a blog with 10 or 100 visit per day since the higher the number of traffic, the higher the prospect of individuals clicking on advertisement. Hence, instead of individual bloggers, especially political bloggers, publishing utilitarian commentary or news analysis capable, they tend to publish contents, many of which are hoax, capable of pulling traffic to their blog. In this manner, Adsense acts as filter to what is published and what is not published on blogs. Publishing in the name of pulling traffic in order to get earning per clicks on adverts is a bane of Nigerian blogosphere as it present individuals bloggers in the country as citizen journalist component of the highly poisonous commercial media system shrinking the public sphere to sphere dominated by economic and political elites

7. TAIBLODIZATION OF THE BLOGOSPHERE

While it may be difficult to ascertain the number of blogs within the Nigerian blogosphere, it is possible to hypothesize that blogs on entertainment, lifestyles, gossips and scandals surpass that dealing in serious and critical analysis of political, economic and social issues. This is what I refer to as tabloidization of the blogosphere. Tabloidization, sometimes more colloquially referred to as 'dumping down', "refers to a number of characteristics of contemporary journalism linked to a particular kind of journalism that does appear, or at least assumed to be a successful strategy for keeping audience" (Campbell, 2004). Collin sparks (2000) explains tabloidization thus

Tabloidization is distinct in it emphases, which can be summarized as the devotion of relative attention to politics, economics, and society and relative much attention to diversions like sport, scandals and popular entertainment. It also devote relatively much attention to the personal and private life of people, both celebrities and ordinary people, and relatively little to political processes, economic development, and social change (2000:10)

Since blogging, in its present form, is closely tied to entrepreneurship among youths, it is only logical that strategies and tactics capable of bringing about commercial success of blogs is likely to 'trend' among community of bloggers in the country. Blogging about entertainments, lifestyles, celebrities and other allied diversion is trendy among bloggers in the country. Entertainment blogging provides easy way for bloggers to attract the attention of the technological savvy youths who constitute the greater percentage of internet users in the country. More so, many of the super-bloggers like Linda Ikeji, Noble Igwe, and Uche Eze among others became success story via entertainment blogging. Hence, they have become a form of template for a vast number of Nigerian bloggers.

As a form of diversion, entertainment blogging poses great danger to political and economic consciousness of people as it tend to reroute attentions from defining and burning issues to trivial and politically inconsequential issues.

8. STATE HEGEMONIC DRIVE IN THE BLOGOSPHERE

In a state where the political and economic elites are bent on hegemonic cooptation of the media, blogging outside the accepted spectrum of criticisms against the state and its officials often comes with great repercussion. Hence, few blogs in the country committed to muck-racking have come under intense attacks from apparatuses of the state. In ebbing the flow of unfavourable information that may emanate from the blogosphere, various means have been deployed by the state and political actors. In recent time many bloggers have been arrested by the state while many blogs such as Sahara Reporters have come under various tactical attacks via state or economic elite sponsored cyber-terrorism in which websites or platform of these 'deviant blogs' are hacked or brought down. Another of state hegemonic control of blogosphere means revolves around carrot approach through State's advertisement or direct financial inducement. In the build-up to 2015 general election, it was alleged that one the most famous blogger in the country was allegedly allocated huge sum money by the Goodluck Jonathan's administration via Col. Sambo Dasuki to promote Jonathan's waning popularity on social media. Though the veracity of this claim could not be confirmed, it is highly probable considering the economic logic which forms the 'base' of blogosphere in the country.

Legal framework has also been deployed towards hegemonic control of the blogosphere. Though not specifically meant for blogosphere, the not-too-easy-to –

interpret legalese of the Cyber Crime Act of 2011 has been used to justify arrest of up to three bloggers in the country. In 2015, a bolder step to kowtow deviant segment of the blogosphere was initiated by the on Floor of the Nigerian Senate building. In a bill sponsored and presented by Senator Bala Ibn Na'Allah but which can be said, with little caution, to represent the views of the ruling elites in the country, the State intends to muzzled the blogosphere and other social media blogging by proposing

- Up to seven years in prison or N2 million fine for "anyone who intentionally propagates false information that could threaten the security of the country or that is capable of inciting the general public against the government through electronic message.

- Up to years in prison or $10,000 fine or both for anyone disseminating via text message, Twitter, WhatsApp, or any other form of social media an "abusive statement." (Adigun, 2015, Para.2)

Though the bill was later flushed out following public outcry, the audacity of proponents and supporters of the bill gives a glimpse of the posture of the state and economic elites to segment of the blogosphere as alternative public sphere outside the hegemonic cooptation of the state. More so, the bill on hate speech with its loose definition of 'hate speech' can also become a useful tool to muzzle or bring dissent bloggers to consonance. In essence, various frameworks and policy of the state frowns at a blogosphere that is outside the frequency of state hegemonic control.

9. TOWARDS A RESEACH-BASED MAPPING OF THE NIGERIAN BLOGOSPHERE

In many countries of the world, blogosphere, despite its corporatization of its infrastructure, is evolving as a burgeoning as alternative counter public which is keeping the political elites on their toes. In repressive societies, rich and diversity of information in the blogosphere has become problematic to autocrats bent on consolidating their power through the control of information (El-Nawawy and Khamis, 2013; Cooper, 2006). The societal impacts of blogosphere as a subset of web 2.0 architectures as also led to the burgeoning interest of researchers and academics in empirically mapping out blogosphere (Tremayne, 2007; Papacharisi, 2007). However, within this fertile research field, studies about the social media in Nigerian society focuses on the utilitarian values of these new media without critical assessing how capitalism as their organizing principles limit them as alternative and people-centric media. However, without a critical analysis of the which aims to expose the flaws of these acclaimed participatory media, these platforms, especially blogs and blogosphere may continue to exist in their present form and colouration which is largely detrimental to the ideal of rich, robust, diverse and anti-

hegemonic discursive space necessary for the nurturing and consolidation of democratic culture in the country.

The paper, from normative point of view, hypothesizes that blogosphere in its current form in too neck-deep in the economic system and logic for it to function as a subaltern public sphere. However, without a adequate research designs or extensive data, all conceptual elaborations in the paper is reducible to mere anecdotal evidence and intuition. Hence, the onus is we the researchers to critically examine and map out the limits of the Nigerian Blogosphere within a rich and extensive data analysis. In doing these, research themes should include areas touched in the paper and many more which can illuminate how commercial logic is undermining the blogosphere.

10. CONCLUSION

Within the framework of the critical political economy of culture and communication, it is widely recognized that media system organized along commercial line has little role in serving the public interest. While the idea of blogosphere connotes a discursive space in which citizens are active producers of content outside the power structure of the mainstream media, this is largely a myth in Nigeria as the country's blogosphere through series of mechanism highlighted in the paper is seen to be closely to the economic system. Blogosphere in its current largely kowtow by its economic imperatives cannot be said to be an epicentre of anti-hegemonic discursive space. Nonetheless, a public-service blogosphere is possible in the country, a public service blogosphere is likely to materialize when Citizens who can look beyond commercial interest start contributing meaningful and utilitarian information to their blogosphere.

REFERENCES

Adigun, O. (2015, December 15) Press Freedom, Buhari and Social Media Bill. *Compass Newspaper.* Retrieved online 2nd September 2016 http://www.compassnewspaper.com.ng/2015/12/press-freedom-buhari-social-media-bill/

Ajaero, T.M. (2015) Top Most Inflluential bloggers in Nigeria. Retrieved September 2 2016 www.strategicbuisnessteam.com/top-10-most-influential-bloggers-in-nigeria

Andrejevic, Mark. 2009. Critical Media Studies 2.0: An interactive upgrade. *Interactions*: *Studies in Communication and Culture* 1 (1): 35-5 1

Bagdikian, B. (1992). *The media monopoly* (4th ed.). Boston: Beacon Press.

Benkler, Y. (2006). *The Wealth of Networks.* New Haven, CT: Yale University Press

Blood, R. (2002). Introduction. In J. Rodzvilla (Ed.), *We've got blog: How weblogs are changing our culture*. Cambridge: Perseus Publishing.

Blood, R. (2003). Weblogs and Journalism: Do they connect? *Nieman Reports*, *57*(3), 61–62. Retrieved September 2, 2016, from http://www.nieman.harvard.edu/reports/03-3NRfall/V57N3.pdf.

Boyd, D. M., & Ellison, B. N. (2007). Social network sites: Definition, history, and scholarship.
*Journal of Computer-Mediated Communication*13 (2), 68-73

Cammaerts, B. (2008) Critiques on the participatory potentials of web 2.0 Communication, *Culture & Critique* 1 (4): 358-377.

Campbell, V (2004*). Information Age Journalism: Journalism in International Context*. London: Arnold publisher

Castells, M. (2002) *The Internet Galaxy: Reflections on the Internet, Business and Society*, Oxford: Oxford University Press

Coleman, S & Blumler J. (2009) *The Internet and Democratic Citizenship: Theory, Practice and Policy*. New York: Cambridge University Press

Cooper, S. D. (2006). *Watching the watchdog: Bloggers as the fifth estate*. Spokane, WA: Marquette Academic.

Cross, M. (2011) Bloggerati, Twiterati: How Blogs and Twitter are Transforming Popular Culture. Santa Barbara, California: Praeger

Dahlberg, L.(2001). The Internet and Democratic Discourse: Exploring the prospects of online deliberative forums extending the public sphere', *Information, Communication & Society 4(4): pp 615–633)*

Dahlgren, P. (2005) 'Introduction' in Peter Dalhgren and Collins Parks (eds) Communication and Citizenship: Journalism and the Public Sphere. London: Routledge

Dahlgren, P. (2009) *Media and Political Engagement: Citizens, Communication, and Engagement*. New York: Cambridge University Press

Dare, S. (2011). *The Rise of Citizen Journalism in Nigeria – The Case of Sahara Reporter*. http://reutersinstitute.politics.ox.ac.uk/about/article/the-rise-of-citizen-journalism-Innigeria.html.

El-Nawawy, M. and Khamis, S. (2013) Egyptian Revolution 2.0. New York: Palgrave Macmillan

Fenton, N.(2004) *Journalism and Democracy: Towards a Contemporary Research Strategy in Mexic*o. Retrieved 24/04/2016 online from https://freedomhouse.org/sites/default/files/Journalism%20and%20Democracy_Towards%20a%20contemporary%20research%20strategy%20in%20Mexico.pdf

Freedman, D.(2012). "Web 2.0 and the Death of the Blockbuster Economy." In James Curran, Natalie Fenton, and Des Freedman (eds) *Misunderstanding the Internet*. New York: Routledge.

Fuch, C. (2015) Dallas Smythe Today – The Audience Commodity, The Digital Labour Debate, Marxist Political Economy and Critical Theory. Prolegomena to a digital Labour Theory. In Christian Fuchs and Vincent Mosco (eds) *Marx and the Political Economy of the Medi*a. Leiden: Brill

Fuchs, C. (2008). *Internet and society. Social theory in the information age.* New York. Routledge

Fuchs, C. (2011a) Foundation of Critical Media and Information Studies. New York: Routledge

Fuchs, C. (2011b). The Contemporary World Wide Web: Social Medium or New Space of Accumulation? In Dwayne Winseck and Dal Yong (eds). *The Political Economies of Media. The Transformation of the Global Media Industries*, London: Bloomsbury.

Fuchs, C. (2012). Critique of the Political Economy of Web 2.0 Surveillance. In Christian Fuchs, Kees Boersma, Anders Albrechtslund and Marisol Sandoval (eds) *Internet and Surveillance. The Challenges of Web 2.0 and Social Media*, , 31–70. New York: Routledge.

Gillmor, D (2004) "*We the Media: Grassroots Journalism by the People, For the People*. Sebastopol, California: O' Reilly Media.

Habermas, J. (1989 [1962]). *The Structural Transformation of the Public Sphere.* Cambridge: Polity Press.

Herman, E.S. & Chomsky, N. (2002) *Manufacturing Consent: The Political Economy of theMass Media*., New York: Pantheon Books

Herring, S. C., Scheidt, L.A., Kouper, I., and Wright, E. (2007) 'Longitudinal Content Analysis of Blogs: 2003 – 2004' in Mark Tremayne(ed) Blogging, Citizenship, and the Future. London: Routledge

Internet World Statistics Usage & Population (n.d). Retrieved 16th march 2012 from internet world website, http://internetworldstats.com/stats.htmom

Johnson, L (2016, July 28th) Google's Ad Revenue Hits $19 Billion, Even as Mobile Continues to Pose Challenges. Adweek, Retrieved online September 2nd 2016 http://www.adweek.com/news/technology/googles-ad-revenue-hits-19-billion-even-mobile-continues-pose-challenges-172722

Linda Ikeji: African Richest blogger - Making cool $1 million a Year (2014, April 14th). *The African Sun Times*. Retrieved 2nd September 2016 http://africansuntimes.com/2014/04/linda-ikeji-africas-richest-blogger-making-a-cool-1-million-a-year/

Murdock, G., and Golding, P. (2005) Culture, Communications and Political economy. In James Curran and Michael Gurevitch (eds) Mass media and society.New York: Hodder Arnold.

Olsson, T. (2014) 'The Architecture of Participation: For Citizen or Consumers?.' In Christian Fuchs & Marisol Sandoval (eds) *Critique, Social Media and Information Society*. New York: Routledge

Papacharissi, Z. (2002). The Virtual Sphere, *New Media & Society, 4, 1, 9-27*

Papacharissi, Z. (2007) 'Audience as Media Producers: Content Analysis of 260 Blogs.' In Mark Tremayne (ed) *Blogging, Citizenship, and the Future.* New York: Routledge

Sandoval, M.(2014) Social Media? The Unsocial Character of Capitalist Media. In Christian Fuchs & Marisol Sandoval (eds) *Critique, Social Media and Information Society*. New York: Routledge

Scott, P. R, & Jacka, J. M. (2011). Auditing Social Media: A Governance and Risk Guide. New
Jersey: John Wiley & Sons, Inc.

Sean, A., Farell, H,. Lynch, M., Sides, J., Kelly, J., Zuckerman, E., (2010) Blogs and Bullets: New media In Contentious Politics. Washington: USIS

Shapiro R.Y.(2011)' Public opinion and America Democracy'. *Public Opinion Quarterly*,5 (75) pp.982- 1017

Sparks, C. (2000) *Tabloid Tales: Global debate over Media standards***.** Oxford: Rowman & littlefields.

Stanyer, J. (2009) Web 2.0 and the transformation of news and journalism. In Andrew Chadwick and Philip N. Howard (eds) Routledge handbook of Internet politics. New York: Routledge.

Terranova, T. (2004) Network culture. London: Pluto.

Top Sites in Nigeria.(n.d) Retrieved September 2, 2016 from Alexa website, ://www.alexa.com/topsites/countries/NG

Tremayne, M.(2007) Examining the Blog-Media Relationship. In Mark Tremayne(ed) Blogging, Citizenship, and the Future. New York: Routledge

Wasko, J., Murdock, G., and Sousa, H, (2011) The Political Economy of Communication: Core Concerns and Issues. In Janet Wasko, Graham Murdock and Helena Sousa (eds) Handbook of Political Economy of Communication. Malden: Blackwell Publishing

SOFT-OUTPUT MAXIMUM LIKELIHOOD RECEIVER FOR QUADRATURE SPATIAL MODULATION

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ABSTRACT

Spatial modulation (SM) presents a pragmatic approach for transmitting information, where the modulator uses well known amplitude/phase modulation (APM) techniques such as phase shift keying (PSK) and quadrature amplitude modulation (QAM), but also employs the antenna index to convey additional information. Nevertheless, the spectral efficiency of SM can be further improved. On this note, to further enhance the spectral efficiency of SM, quadrature SM (QSM) modulation was proposed. In coded channels, therefore, typically soft-output detection coupled with soft-input channel decoding yields significant signal-to-noise ratio (SNR) gain. Hence, in this paper, a soft-output maximum-likelihood receiver (SOMLR) for QSM modulated system is proposed. Monte Carlo simulation results demonstrate that the error performances of the proposed SOMLR scheme closely matches with that of its hard-decision maximum-likelihood receiver counterpart in uncoded channels, while significant SNR gains are yielded in coded channels.

Keywords *- Coded spatial modulation, quadrature spatial modulation, soft-output detection, space shift keying, spatial modulation*

1. INTRODUCTION

Currently, much effort is being geared towards 5G in the research community [1]. The major demands of 5G networks are increased capacity and data rates, improved quality of service, reduced latency and energy efficiency [2]. Multiple-input multiple-output (MIMO) systems [3] hold the potential to meet these demands, but not without challenges such as: the need for inter-antenna synchronization (IAS) between transmit antennas, increased form-factor allowing for ideal spacing of transmit and receive antennas,

reduction of inter-channel interference (ICI) at the receiver and large computational complexity overhead. A number of schemes have recently been proposed to address these challenges, while exploiting the advantages of MIMO.

Mesleh *et al.* proposed spatial modulation (SM) in [4]. The key idea in SM is to employ the index of 'one' of the multiple transmit antennas as a means to convey additional information. Information is divided into two parts. The first part is mapped to a chosen symbol from an amplitude and/or phase modulation (APM) signal constellation, while the remaining part determines the transmit antenna that is to be activated for transmission of the APM symbol. It should be noted that the dormant antennas transmit zero power during each and every transmission. As a result, SM completely avoids IAS, ICI at the receiver, and only requires a single radio frequency (RF) chain, which translates into a relatively low-complexity receiver [5].

However, options for decreasing its system complexity exist. On this note, a variant of SM in the form of space shift keying (SSK) [6] was proposed, where only the spatial domain of SM is exploited to relay information. The elimination of the APM results in lowered detection complexity, less stringent transceiver requirements, and simplicity. A criticism of SSK is that large antenna arrays are required to achieve high data rates; and this is addressed by the proposal of bi-space shift keying (Bi-SSK) [7]. Bi-SSK employs dual antenna indices (one associated with a real number and the other with an imaginary number) to carry information. This results in twice the achievable data rate of SSK, while preserving the advantages of the latter.

To improve the data rate of SM, quadrature SM (QSM) was proposed [8]. In QSM, the overall throughput of SM is enhanced by extending its spatial domain into in-phase and quadrature-phase dimensions. In order to allow this, the complex constellation symbol of SM is further decomposed into its real and imaginary parts. The in-phase and quadrature-phase spatial dimensions are orthogonal cosine and sine carrier signals and are used for conveying the real and imaginary parts, respectively, of the APM transmission symbol. This, consequently, allows for an additional base-two logarithm of the number of transmit antennas bits to be transmitted; while other SM advantages, such as the usage of single RF chain at the transmitting end, avoidance of ICI, and low-complexity receiver, are preserved [8].

In practice, the majority of communication systems employ channel coding. Moreover, it has been demonstrated that a combination of soft-output detection with soft-input channel decoding results in a net coding gain compared to the conventional hard-decision detection/decoding [9]. In this paper, therefore, a soft-output receiver for QSM modulated signals is proposed. The new soft-output maximum-likelihood receiver (SOMLR) for QSM is formulated based on the ML principles while Monte Carlo simulations are used to demonstrate its error performances. The remainder of the paper is organized such that: Section 2 presents the QSM system model while the proposed soft-

output receiver is presented in Section 3. Discussion of simulation results is given in Section 4, before conclusions are finally drawn in Section 5.

2. QSM SYSTEM MODEL

The rule governing the transmission of QSM stipulates that a group of $m_{QSM} = \log_2(N_t^2 M)$ information bits can be transmitted simultaneously [8]. A model of the QSM system is depicted as Figure 1. The source information bit sequence is partitioned into three parts, such that $\log_2(N_t)$ bits are used to select the *real* antenna index ($\ell_{\mathcal{R}}$), another $\log_2(N_t)$ bits are used to select the *imaginary* antenna index ($\ell_{\mathcal{I}}$) for $\ell_{\mathcal{R}}, \ell_{\mathcal{I}} \in [1{:}N_t]$. The remaining $\log_2(M)$ bits are used to select an M-ary quadrature amplitude modulation (MQAM) constellation symbol x^q, $q \in [1{:}M]$.

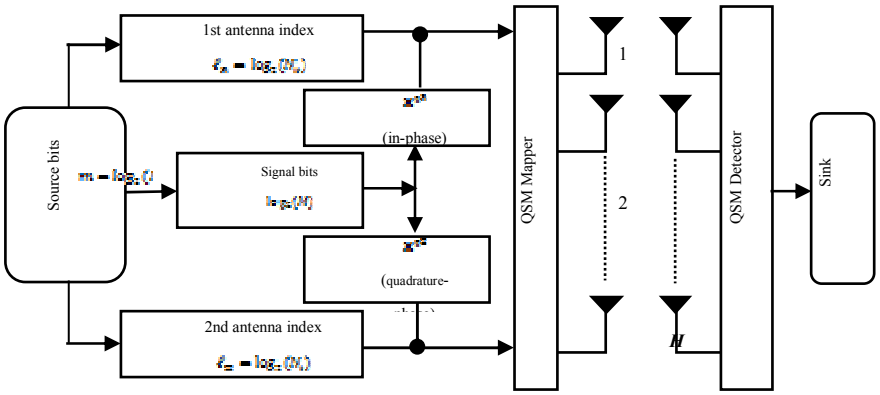


Figure 1: System Model for QSM Modulation

The selected symbol x^q of the complex constellation is further decomposed into its constituent real and imaginary parts $x^{q\mathcal{R}}$, $x^{q\mathcal{I}}$, respectively, and transmitted by the respective antennas. Thus, the signal vector of QSM can be represented as:

$$\boldsymbol{x}_{\mathbf{QSM}} = \boldsymbol{x}_{\ell_{\mathcal{R}}}^{q\mathcal{R}} + j\boldsymbol{x}_{\ell_{\mathcal{I}}}^{q\mathcal{I}} \tag{1}$$

Where $\boldsymbol{x}_{\ell_{\mathcal{R}}}^{q\mathcal{R}}$ and $\boldsymbol{x}_{\ell_{\mathcal{I}}}^{q\mathcal{I}}$ are $N_t \times 1$ vectors, with $x^{q\mathcal{R}}$ and $x^{q\mathcal{I}}$, respectively, representing the non-zero entry placed at the $\ell_{\mathcal{R}}$-th and $\ell_{\mathcal{I}}$-th positions.

An example of the mapping process for QSM modulation, is tabulated in Table 1, considering a 4 b/s/Hz QSM transmission with $\mathbf{N_t = 2}$ and $\mathbf{M = 4}$. In the example, the total number of transmitted information bits per time slot can be calculated as

$m_{QSM} = \log_2(N_t^2 M) = \log_2(2^2 . 4) =$ 4 bits. In accordance with the mapping rules of QSM; the set of 4 bits (b_3 b_2 b_1 b_0) are grouped into three [i.e. $\log_2(N_t) + \log_2(N_t) + \log_2(M)$] such that the first and the second groups are used to active one antenna each while the third selects an APM symbol, respectively. The selected APM symbol is further decomposed to its real and imaginary components such that they are transmitted over the real and imaginary active antennas, accordingly.

Table 1: Mapping illustration for QSM modulation

Bits (b_3 b_2 b_1 b_0)	APM symbol (b3 b2)		Tx pairs (b_1/b_0)		x_{QSM} $\left(x_{\ell_{\Re}}^{q\Re} + jx_{\ell_{\Im}}^{q\Im}\right)$
	q(index)	$x^{q\Re} + jx^{q\Im}$	$\ell_{\Re}$	$\ell_{\Im}$	
[1 1 0 0]	1 1 (4)	$+1 - j$	1	1	$[+1-j \;\; 0]^T$
[1 0 0 1]	1 0 (3)	$+1 + j$	1	2	$[+1 \;\; +j]^T$
[0 0 1 0]	0 0 (1)	$-1 + j$	2	1	$[+j \;\; -1]^T$
[0 1 1 1]	0 1 (2)	$-1 - j$	2	2	$[0 \;\; -1-j]^T$

Note, from the table, that some 12 other possible values of "Bits" have been omitted. Generally, this is done intentionally to save spaces, and because the omitted possibilities can easily be obtained from the given table. For example, when Bits = [0 0 0 1]; the "q" is "00 (1)" and this can be inferred from rows 3 of Table 1, where the same bits, "00", have been considered for "q". In the same way the "$\ell_{\Re}$" and "$\ell_{\Im}$" are "0" and "1", respectively. Their corresponding antennas can also be inferred from row 2 of the table such that the active transmit antenna pair are "1" and "2".

At the output of the channel, the received signal vector may be defined as [8]:

$$\boldsymbol{y} = \sqrt{\rho/\mu}\, \boldsymbol{H}\left(x_{\ell_{\Re}}^{q\Re} + jx_{\ell_{\Im}}^{q\Im}\right) + \boldsymbol{w} \quad (2)$$

Where μ is the scaling factor for the average SNR, such that when $\ell_{\Re} = \ell_{\Im}$, $\mu = 1$, and when $\ell_{\Re} \neq \ell_{\Im}$, $\mu = 2$. $\boldsymbol{H}$ is the wireless channel with a complex channel matrix of dimension $N_r \times N_t$ in the presence of AWGN represented as $\boldsymbol{w} = [w_1, w_2, \ldots, w_{N_r}]^{\mathbf{T}}$. The entries of $\boldsymbol{H}$ and $\boldsymbol{w}$ are assumed to be i.i.d. according to CN(0,1).

The received signal may be simplified as:

$$\boldsymbol{y} = \sqrt{\rho/\mu}\left(\boldsymbol{h}_{\ell_{\mathbb{R}}} x^{q_{\mathbb{R}}} + j\boldsymbol{h}_{\ell_{\mathbb{I}}} x^{q_{\mathbb{I}}}\right) + \boldsymbol{w} \tag{3}$$

Where $\boldsymbol{h}_{\ell_{\mathbb{R}}} = [h_{1,\ell_{\mathbb{R}}}, \ldots, h_{Nr,\ell_{\mathbb{R}}}]^{\mathrm{T}}$ represents the $N_r \times 1$ $\ell_{\mathbb{R}}^{th}$ column of $\boldsymbol{H}$ and $\boldsymbol{h}_{\ell_{\mathbb{I}}} = [h_{1,\ell_{\mathbb{I}}}, \ldots, h_{Nr,\ell_{\mathbb{I}}}]^{\mathrm{T}}$ represents the $N_r \times 1$ $\ell_{\mathbb{I}}^{th}$ column of $\boldsymbol{H}$. Assuming perfect knowledge of the channel at the receiver, the received signals are processed by the optimum ML detector, which searches jointly across all the available antenna combinations and APM symbols. The detector jointly estimates $\hat{\ell}_{\mathbb{R}}$, $\hat{\ell}_{\mathbb{I}}$, $x^{\hat{q}_{\mathbb{R}}}$, and $x^{\hat{q}_{\mathbb{I}}}$, which are used to recover the original message. The detector is given in [8] as:

$$[\hat{\ell}_{\mathbb{R}}, \hat{\ell}_{\mathbb{I}}, x^{\hat{q}_{\mathbb{R}}}, x^{\hat{q}_{\mathbb{I}}}] = \underset{\ell_{\mathbb{R}}, \ell_{\mathbb{I}}, x^{q_{\mathbb{R}}}, x^{q_{\mathbb{I}}}}{\operatorname{argmin}} \left\| \boldsymbol{y} - \sqrt{\rho/\mu}\left(\boldsymbol{h}_{\ell_{\mathbb{R}}} x^{q_{\mathbb{R}}} + j\boldsymbol{h}_{\ell_{\mathbb{I}}} x^{q_{\mathbb{I}}}\right) \right\|_{\mathrm{F}}^{2} \tag{4}$$

3. PROPOSED SOFT-OUTPUT RECIEVER

It is desired that next generation communication systems provide users with high data rates, in addition to ensuring reliability and power efficiency. To achieve this, practical communication systems commonly employ channel coding such that errors induced by noise and unreliable channels are reduced [9]. It has been demonstrated in the literature that soft-output detection coupled with soft-input channel decoding maximizes the coding gain achievable [10]. In [10, 11] soft-output detection has been investigated for SM and generalized SM, respectively. However, no such investigation has been performed for the more recent QSM scheme, which maintain several advantages over SM.

Based on this motivation, SOMLR for the QSM scheme is proposed. To arrive at the targeted improvements in the error performances of the system due to coding gain, the system model of Figure 1 is extended to include channel coding and decoding. For the proposed detection scheme, it is assumed that: i) antenna indices and data symbols are uncorrelated; ii) data symbols are independent and generated with equal probability; iii) antenna bits are independent and generated with equal probability, and iv) full channel knowledge is available at the receiver.

The codewords from the channel encoder are transmitted by QSM modulation, such that the input to our proposed demodulator is given as (2). The demodulator in the proposed SOMLR independently calculates the LLR for the a-th real antenna bit ($\ell_{\mathbb{R}}^{a}$), a-th imaginary antenna bit ($\ell_{\mathbb{I}}^{a}$), b-th real symbol bit ($x_{\mathbb{R}}^{b}$) and b-th imaginary symbol bit ($x_{\mathbb{I}}^{b}$). The a-posteriori log-likelihood ratios (LLRs) [10] may be formulated as follows:

Considering demodulation of the a-th real transmit antenna bit:

$$LLR(\ell_{\mathbb{R}}^{a}) = \log\frac{P(\ell_{\mathbb{R}}^{a}=1|y)}{P(\ell_{\mathbb{R}}^{a}=0|y)} \tag{5}$$

$$= \log\left[\frac{\sum_{\hat{\ell}_{\mathbb{R}}\in\ell_{1_{\mathbb{R}}}^{a}}\sum_{\hat{\ell}_{\mathbb{I}}\in L_{\mathbb{I}}}\sum_{\hat{x}^{q\mathbb{R}}\in\chi_{\mathbb{R}}}\sum_{\hat{x}^{q\mathbb{I}}\in\chi_{\mathbb{I}}}P(y\mid \ell_{\mathbb{R}}=\hat{\ell}_{\mathbb{R}},\ell_{\mathbb{I}}=\hat{\ell}_{\mathbb{I}},x^{q\mathbb{R}}=\hat{x}^{q\mathbb{R}},x^{q\mathbb{I}}=\hat{x}^{q\mathbb{I}})P(\ell_{\mathbb{R}}=\hat{\ell}_{\mathbb{R}})}{\sum_{\hat{\ell}_{\mathbb{R}}\in\ell_{0_{\mathbb{R}}}^{a}}\sum_{\hat{\ell}_{\mathbb{I}}\in L_{\mathbb{I}}}\sum_{\hat{x}^{q\mathbb{R}}\in\chi_{\mathbb{R}}}\sum_{\hat{x}^{q\mathbb{I}}\in\chi_{\mathbb{I}}}P(y\mid \ell_{\mathbb{R}}=\hat{\ell}_{\mathbb{R}},\ell_{\mathbb{I}}=\hat{\ell}_{\mathbb{I}},x^{q\mathbb{R}}=\hat{x}^{q\mathbb{R}},x^{q\mathbb{I}}=\hat{x}^{q\mathbb{I}})P(\ell_{\mathbb{R}}=\hat{\ell}_{\mathbb{R}})}\right] \tag{6}$$

where $\ell_{0_{\mathbb{R}}}^{a}$ and $\ell_{1_{\mathbb{R}}}^{a}$ are vectors of the real antenna indices with '0' and '1', respectively, for the a-th antenna bit position, and $\chi_{\mathbb{R}}$, $\chi_{\mathbb{I}}$ represents the set of all possible $\hat{x}^{q\mathbb{R}}$ and $\hat{x}^{q\mathbb{I}}$, respectively.

On application of the Bayes' theorem, the demodulator output in (6) can be formulated as:

$$LLR(\ell_{\mathbb{R}}^{a}) = \log\left[\frac{\sum_{\hat{\ell}_{\mathbb{R}}\in\ell_{1_{\mathbb{R}}}^{a}}\sum_{\hat{\ell}_{\mathbb{I}}\in L_{\mathbb{I}}}\sum_{\hat{x}^{q\mathbb{R}}\in\chi_{\mathbb{R}}}\sum_{\hat{x}^{q\mathbb{I}}\in\chi_{\mathbb{I}}}\exp(C)}{\sum_{\hat{\ell}_{\mathbb{R}}\in\ell_{0_{\mathbb{R}}}^{a}}\sum_{\hat{\ell}_{\mathbb{I}}\in L_{\mathbb{I}}}\sum_{\hat{x}^{q\mathbb{R}}\in\chi_{\mathbb{R}}}\sum_{\hat{x}^{q\mathbb{I}}\in\chi_{\mathbb{I}}}\exp(D)}\right] \tag{7}$$

where $C = D = \frac{-\left\|y-\sqrt{\rho/\mu}\left(h_{\hat{\ell}_{\mathbb{R}}}\hat{x}^{q\mathbb{R}}+jh_{\hat{\ell}_{\mathbb{I}}}\hat{x}^{q\mathbb{I}}\right)\right\|_{\mathrm{F}}^{2}}{2\sigma^{2}}$, with σ^2 the variance of the AWGN.

Similarly, the a-th imaginary antenna bit is computed and expressed as:

$$LLR(\ell_{\mathbb{I}}^{a}) = \log\left[\frac{\sum_{\hat{\ell}_{\mathbb{I}}\in\ell_{1_{\mathbb{I}}}^{a}}\sum_{\hat{\ell}_{\mathbb{R}}\in L_{\mathbb{R}}}\sum_{\hat{x}^{q\mathbb{R}}\in\chi_{\mathbb{R}}}\sum_{\hat{x}^{q\mathbb{I}}\in\chi_{\mathbb{I}}}\exp(C)}{\sum_{\hat{\ell}_{\mathbb{I}}\in\ell_{0_{\mathbb{I}}}^{a}}\sum_{\hat{\ell}_{\mathbb{R}}\in L_{\mathbb{R}}}\sum_{\hat{x}^{q\mathbb{R}}\in\chi_{\mathbb{R}}}\sum_{\hat{x}^{q\mathbb{I}}\in\chi_{\mathbb{I}}}\exp(D)}\right] \tag{8}$$

where $\ell_{0_{\mathbb{I}}}^{a}$ and $\ell_{1_{\mathbb{I}}}^{a}$ are vectors of the imaginary antenna indices with '0' and '1', respectively, at the a-th antenna bit position. Furthermore, the b-th real symbol bit is computed as:

$$LLR\left(x_{b}^{q\mathbb{R}}\right) = \log\frac{P\left(x_{b}^{q\mathbb{R}}=1|y\right)}{P\left(x_{b}^{q\mathbb{R}}=0|y\right)} \tag{9}$$

$$= \log\left[\frac{\sum_{\hat{x}^{q\mathbb{R}}\in\chi_{1_{\mathbb{R}}}^{b}}\sum_{\hat{\ell}_{\mathbb{R}}\in L_{\mathbb{R}}}\sum_{\hat{x}^{q\mathbb{I}}\in\chi_{\mathbb{I}}}\sum_{\hat{\ell}_{\mathbb{I}}\in L_{\mathbb{I}}}P(y\mid \ell_{\mathbb{R}}=\hat{\ell}_{\mathbb{R}},\ell_{\mathbb{I}}=\hat{\ell}_{\mathbb{I}},x^{q\mathbb{R}}=\hat{x}^{q\mathbb{R}},x^{q\mathbb{I}}=\hat{x}^{q\mathbb{I}})P(x^{q\mathbb{R}}=\hat{x}^{q\mathbb{R}})}{\sum_{\hat{x}^{q\mathbb{R}}\in\chi_{0_{\mathbb{R}}}^{b}}\sum_{\hat{\ell}_{\mathbb{R}}\in L_{\mathbb{R}}}\sum_{\hat{x}^{q\mathbb{I}}\in\chi_{\mathbb{I}}}\sum_{\hat{\ell}_{\mathbb{I}}\in L_{\mathbb{I}}}P(y\mid \ell_{\mathbb{R}}=\hat{\ell}_{\mathbb{R}},\ell_{\mathbb{I}}=\hat{\ell}_{\mathbb{I}},x^{q\mathbb{R}}=\hat{x}^{q\mathbb{R}},x^{q\mathbb{I}}=\hat{x}^{q\mathbb{I}})P(x^{q\mathbb{R}}=\hat{x}^{q\mathbb{R}})}\right] \tag{10}$$

$$LLR\left(x_b^{q_R}\right) = \log\left[\frac{\sum_{\hat{x}^{q_R} \in \chi_{1_R}^b, \hat{x}^{q_I} \in \chi_I} \sum_{\hat{\ell}_R \in L_R, \hat{\ell}_I \in L_I} \exp(C)}{\sum_{\hat{x}^{q_R} \in \chi_{0_R}^b, \hat{x}^{q_I} \in \chi_I} \sum_{\hat{\ell}_R \in L_R, \hat{\ell}_I \in L_I} \exp(D)}\right] \quad (11)$$

where $\chi_{0_R}^b$ and $\chi_{1_R}^b$ are vectors of the real data symbols with '0' and '1', respectively, at the b-th data bit position.

Similarly, the b-th imaginary symbol bit is computed as:

$$LLR\left(x_b^{q_I}\right) = \log\left[\frac{\sum_{\hat{x}^{q_I} \in \chi_{1_I}^b, \hat{x}^{q_R} \in \chi_R} \sum_{\hat{\ell}_R \in L_R, \hat{\ell}_I \in L_I} \exp(C)}{\sum_{\hat{x}^{q_I} \in \chi_{0_I}^b, \hat{x}^{q_R} \in \chi_R} \sum_{\hat{\ell}_R \in L_R, \hat{\ell}_I \in L_I} \exp(D)}\right] \quad (12)$$

where $\chi_{0_I}^b$ and $\chi_{1_I}^b$ are vectors of the imaginary data symbols with '0' and '1', respectively, at the b-th data bit position.

The proposed soft-output receiver achieve an improvement in error performance when the output is fed into a soft-input Viterbi channel decoder [12] and estimates of the transmitted messages are obtained.

4. NUMERICAL RESULTS AND DISCUSSION

Monte Carlo simulations of the proposed receiver were executed in the Matlab environment and are in terms of the average bit error rate (BER) as a function of the average SNR. The termination criterion for simulations was the number of bit errors, set at 3000. Simulations were run until a BER of 10^{-6}. For all simulations, Rayleigh frequency-flat fading channels and the presence of AWGN is assumed. Four (4) antennas are assumed at the receiver. For all coded cases, a ½ rate convolutional encoder was employed to encode the information bits under the constraint length 9 with code generator matrices $g_1 = (561)_{octal}$; $g_2 = (753)_{octal}$ [10, 12]. At the receiver, the proposed detector is employed and its output is fed into a soft-input Viterbi channel decoder [9], in order to obtain estimates of the transmitted messages.

In the following investigations, two spectral efficiencies are considered, viz. 6 b/s/Hz and 4 b/s/Hz. For each of these spectral efficiencies, a configuration is chosen such $m_{QSM} = \log_2(N_t^2 M)$ is satisfied. Note; if no channel coding is employed, the SOMLR is expected to match that of the HDMLR in error performance. This is because both detectors are based on the ML principle and there is no additional coding gain that may be exploited, hence reducing to the same solution [9]. This is also a means of validation.

In Figure 2, the error performances of HDMLR and SOMLR are evaluated, both for coded and uncoded channel conditions for 6 b/s/Hz SSK systems. For uncoded channels, simulation results demonstrate that the proposed SOMLR scheme matches identically with the HDMLR. Hence, the soft-output demodulator has no effect, unless employed in a coded channel and coupled with a soft-input decoder at the receiver [9-11].

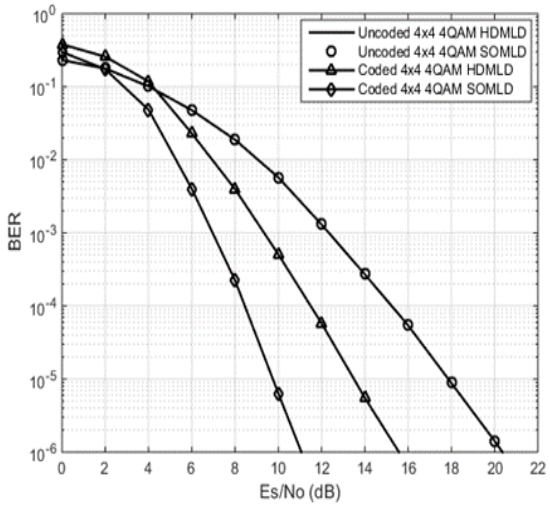


Figure 2: Comparison of error performances for 6 b/s/Hz QSM systems in coded and uncoded channels

In the same figure, it is evident that the coded SOMLR yields significant SNR gains. For example, at a BER of 10^{-6}, an SNR gain of approximately 4.7 dB is achieved over coded HDMLR. Hence, the advantage of soft-output demodulation followed by soft-input decoding is demonstrated. Moreover, for illustrative purposes, by the use of coding, the proposed SOMLR achieves an SNR gain of approximately 8.5 dB over the uncoded HDMLR/SOMLR scheme, at the same BER. This large gain is expected, since coded and uncoded systems are being compared in this instance.

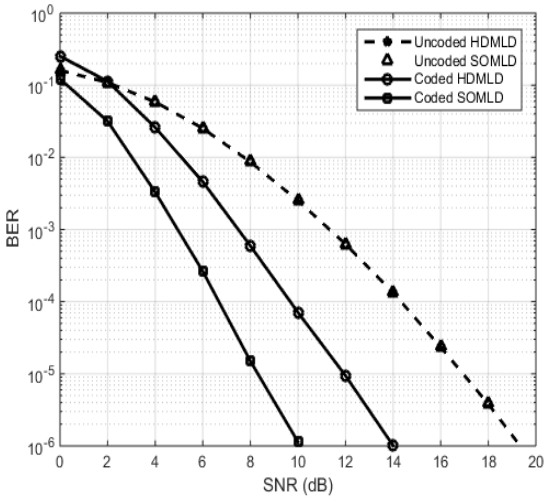


Figure 3: Comparison of error performances for 4 b/s/Hz QSM systems in coded and uncoded channels

In Figure 3; error performances of 4 b/s/Hz QSM (2×4) system is presented. The results are demonstrated under the proposed soft-output receiver as compared to the existing HDMLR in coded and uncoded channels. Similar behaviour as shown for 6 b/s/Hz is evident, in all cases. The uncoded HDMLR and SOMLR curves are identical. When coding is employed, HDMLR yields an SNR gain of 3.9 dB. The proposed SOMLR further enhance the SNR gain by 2.5 dB. The smaller gain realized is due to the use of only two transmit antennas. It should be noted again that the SNR gains achieved by the proposed coded SOMLR for 6 and 4 b/s/Hz systems of QSM over their uncoded HDMLR schemes, are due, not only to the coding introduced, but also to the effectiveness of the soft-decision over the hard decision techniques.

5. CONCLUSION

In this paper, SOMLR for the QSM modulation scheme is proposed. In uncoded channels, the proposed receiver matches the optimal error performance of its HDMLR counterpart. In coded channels, the proposed SOMLR yields significant SNR gains over the corresponding conventional coded HDMLR. In comparison to the HDMLR, the proposed SOMLR imposes no additional computational complexity, since a look-up table [13] can be employed to compute the logarithm. Finally, it is noted that a possible future work is desired to determine analytical bounds for the proposed SOMLR.

REFERENCES

[1] A. Gupta, R.K. Jha, “A Survey of 5G Network: Architecture and Emerging Technologies,” IEEE Access, vol. 3, pp. 1206-1232, 2015.

[2] R.Q. Hu, Y. Qian, “An Energy Efficient and Spectrum Efficient Wireless Heterogeneous Network Framework for 5G Systems,” IEEE Communications Magazine, vol. 52, no. 5, pp. 94-101, May 2014.

[3] E. Telatar, "Capacity of Multi-Antenna Gaussian Channels," European Transactions on Telecommunication, vol. 10, no. 6, pp. 558-595, November/December 1999.

[4] R. Mesleh, H. Haas, C.W. Ahn and S. Yun, "Spatial Modulation - A New Low Complexity Spectral Efficiency Enhancing Technique," in Proceedings of the First

International Conference on Communications and Networking in China, pp. 1-5, October 2006.

[5] J. Jeganathan, A. Ghrayeb and L. Szczecinski, "Spatial modulation: optimal detection and performance analysis," IEEE Communications Letters, vol. 12, no. 8, pp. 545-547, August 2008.

[6] J. Jeganathan, A. Ghrayeb, L. Szczecinski and A. Ceron, "Space shift keying modulation for MIMO channels," IEEE Transactions on Wireless Communications, vol. 8, no. 7, pp. 3692-3703, July 2009.

[7] H-W. Liang, R.Y. Chang, W-H. Chung, H. Zhang and S-Y. Kuo, "Bi-Space Shift Keying Modulation for MIMO Systems," IEEE Communications Letters, vol. 16, no. 8, pp. 1161-1164, August 2012.

[8] R. Mesleh, S.S. Ikki and H.M. Agoune, "Quadrature Spatial Modulation – performance analysis and impact of imperfect channel knowledge," Transactions on Emerging Telecommunications Technologies, November 2014.

[9] T.K. Moon, "Error Correction Coding: Mathematical Methods and Algorithms," Wiley, June 2005.

[10] S.U. Hwang, S. Jeon, S. Lee and J. Seo, "Soft-output ML detector for Spatial Modulation OFDM Systems," IEICE Electronic Express, vol. 6, no. 19, pp. 1426-1431, October 2009.

[11] B. Zheng, X.Wang, M.Wen and F. Chen, Soft Demodulation Algorithms for Generalized Spatial Modulation Using Deterministic Sequential Monte Carlo, IEEE Transactions on Wireless Communications, vol. 16, no. 6, pp. 3953-3967, June 2017.

[12] Q. Tang, Y. Xiao, P. Yang, Q. Yu and S. Li, "A New Low-Complexity Near-ML Detection Algorithm for Spatial Modulation," Wireless Communications Letters, IEEE, vol. 2, no. 1, pp. 90-93, 2013.

[13] P.T.P. Tang, "Table-lookup algorithms for elementary functions and their error analysis," in Proceedings of the 10th IEEE International Symposium on Computer Arithmetic, pp. 232-236, June 1991.

AN ENHANCED FAULT TOLERANT IN WIRELESS SENSOR NETWORK USING INTELLIGENT MULTI-AGENT SYSTEM

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ABSTRACT

Wireless Sensor Networks (WSNs) consist of large numbers of nodes that are dispersed in hostile environment and are prone to failure due to energy depletion, hardware failure, communication link errors, malicious attacks, and so on. These networks are usually deployed in remote places and left unattended, therefore an efficient fault tolerant technique is required to enable WSNs continue operating according to their specifications even if certain faults are present. Fault-tolerance is the property that allows a system to continue operating properly in the event of the failure of some of its components. This paper presents fault tolerant WSNs using intelligent multi-agent technology where the main goal is the conception of software architecture and the network organization dedicated to optimization, monitoring and performance analysis. This system is intended to control, monitor and allows the network to continuously operate, as well as eliminates any downtime due to wireless node power loss. It consists of several agents that are able to communicate with Wireless Sensor Nodes and obtain values from particular sensor nodes implemented on Java Agent Development (JADE) framework platform. JADE was selected as the software framework that facilitates development of interoperable intelligent multi-agent systems and that is distributed under an Open Source License.

Keyword: *Wireless Sensor Network, Fault Tolerant, Multi-Agent System, Clustered, Jade*

1. INTRODUCTION

Wireless Sensor Networks (WSNs) are wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions (Barati, Movaghar & Sabaei, 2014). They are emerging technology that consists of hundreds or thousands of tiny low-cost energy limited nodes that have small capacities of sensing, processing and communication via radio medium (Demigha, Slimane, Bouziani & Hidouci, 2011). Wireless sensor networks (WSNs) do not have a fixed infrastructure and consist of sensor nodes that perform sensing and communicating tasks. The WSNs have large application spectrum such as habitat monitoring, military surveillance, and target tracking, where sensor nodes may operate distributed in highly dynamic environments (Dagdeviren, Korkmaz,

Tekbacak & Erciyes 2014). A WSN node contains several technical components which may include the radio, battery, microcontroller, analog circuit, and sensor interface (Lee, Min, Choi & Lee, 2016, Barati, Movaghar, Modiri & Sabaei, 2014 and Alrajeh, Marwat, Shams & Shah 2015). These kinds of networks use cheap technologies that do not rely on any centralized infrastructure in contrast to high-cost sophisticated surveillance technologies (Demigha, Slimane, Bouziani & Hidouci, 2011).

However, power consumption is one of the biggest challenges in WSNs, because the sensor has a limited source of power which is also hard to replace or recharge after deployment (Demigha, Slimane, Bouziani & Hidouci, 2011, Barati, Movaghar & Sabaei, 2014 and Lee, Min, Choi & Lee, 2016). When designing an error control scheme for WSNs, energy efficiency is critical. To extend battery life, a WSN node periodically wakes up and transmits data by powering on the radio and then powering it back off to conserve limited energy (Barati, Movaghar, Modiri & Sabaei, 2014). Furthermore, faults are unavoidable in the sensor network and it is very necessary to distinguish between faulty and working nodes (Manisha & Nandal, 2015). In order to maintain the network quality of service, it is mandatory for WSN to be able to detect the faults and take appropriate actions to handle them. The use of a specific fault tolerant technique depends on the requirements of the application and the constraints of the WSN.

There are several energy reduction and reliability measures that has been employed; however, it is necessary to find a new solution with low power consumption that simultaneously provides proper reliability in real time wireless sensor networks applications (Barati, Movaghar & Sabaei, 2014 and Barati, Movaghar, Modiri & Sabaei, 2014). Agents are capable of independent and autonomous action, so that they can successfully carry out tasks that have been delegated to them, thus agent-based approaches are very suitable to apply as the solution of the problems occurring in WSNs (Dagdeviren, Korkmaz, Tekbacak & Erciyes 2014). It is generally believed that agents are "software entities" which assist their users and act on their behalf (Garza, 2015). An agent can perceive its environment through sensors and acts upon that environment through effectors (Stuart & Peter, 1995). Agents make life easier, save time, and simplify the growing complexity of the world. An intelligent agent can operate in real time and use natural language to communicate; and, it is able to learn from the environment and be adaptive to user behaviour.

Moreover, computers can be made more reliable by making sure that the computing system remains free of faults (usually referred to as *fault-prevention*) and also to include in the system measures for dealing with faults as they arise (this is called *fault-tolerance)*. Fault is any kind of defect that leads to an error. An error corresponds to an incorrect (undefined) system state. Such a state may lead to a failure. A failure is the (observable) manifestation of an error, which occurs when the System deviates from its specification and cannot deliver its intended functionality. A system is considered fault tolerant if the behaviour of the system, despite the failure of some of its components, is consistent with its specifications (Dagdeviren, Korkmaz, Tekbacak & Erciyes 2014). Fault tolerant systems have the capability to function in

the presence of fault. By employing fault tolerance, many potential failures are averted, thereby increasing the reliability. Another goal of fault tolerance is to increase the system availability, which is, increase the time for which the system is available for user services. Redundant systems are used for achieving this quality (Paul, 2003). In WSNs, fault occurrence probability is very high compare to traditional networking. On the other hand networks maintenance and nodes replacement is impossible due to remote deployment.

Lastly, devising a fault tolerant mechanism in wireless sensor networks is very important due to the construction and deployment characteristics of these low powered sensing devices. This research work is aimed at investigating some possibilities and some strategies of fault detection and correction using intelligent multi-agent technologies. This paper presents fault tolerant WSNs using intelligent multi-agent technology where the main goal is the conception of software architecture and the network organization dedicated to optimization, monitoring and performance analysis. This system is intended to control, monitor and allows the network to continuously operate, as well as eliminates any downtime due to wireless node power loss.

2. REVIEW OF RELATED LITERATURE

Wireless sensor networks (WSNs), containing self-organizing and cooperating low-power sensing nodes have attracted the academia and the industry due to their wide range of large-scale applications in the last decade (Manisha & Nandal, 2015). Wireless Sensor Networks have potential of significantly enhancing our ability to monitor and interact with our physical environment (Manisha & Nandal, 2015)**.** However, a number of researches have been carried out to explore different areas in fault tolerant wireless sensor networks. Those researches have brought new challenges in creating secure and reliable data storage and access facility in WSNs. However, several energy conservation schemes have been proposed aimed at minimizing the energy consumption of the radio interface. The two main approaches are: Duty Cycling and In-Network Aggregation (Anastasi , Conti, Francesco & Passarella, 2007 and Fasolo, 2007). The first approach consists in putting the radio transceiver in the sleep mode whenever communications are not needed. But energy saving is obtained at the expense of an increased node complexity and network latency. The second approach is intended to merge routing and data aggregation techniques aimed at reducing the number of transmissions. Multipath routing algorithms are usually employed. However, multiple paths could remarkably consume more energy than the shortest path because several copies of the same packet could reach the destination. In addition, to increase reliability authors in (Guo, Wang, Xie, Zeng, & Cui, 2009) also observed Automatic Repeat reQuest (ARQ) which requires that the receiver must detect lost packets and then request the sender to retransmit packets. Forward Error Correction (FEC) requires that the aggregator must decode the received data, aggregate them with new data and encrypt them before sending them to sink. They both cause a significant end-to-end delay and high energy consumption which decrease in the network lifetime.

Rachid and Hafid (2014) proposed Distributed Monitoring for WSNs using multi-agent approach where the main goal is the conception of software architecture and the network

organization dedicated to optimization, performance analysis, and monitoring as well as topology control. The main objective is to have a fault-tolerant network and extend its lifetime by optimizing the choice of paths based on changing parent method. The new concept of degree of tolerance was used in the choosing parent and/or neighbour procedure. Castalia simulator which is based on the simulator Omnet++ was used to implement the approach. Dagdeviren, Korkmaz, Tekbacak and Erciyes (2014) also proposed a novel multi-agent fault tolerant system for wireless sensor networks. Multi-agent and mobile agent configuration was used to reduce energy consumption and also to manage WSNs that provide energy-efficient services. The multi-agent system consists of a resource manager, a fault tolerance manager and a load balancing manager, and we also propose fault-tolerant protocols that use multi-agent and mobile agent setups. Java was used to conduct the simulation. Also, Akbulut, Cihangir, Zaim and Yilmaz (2015) presents an agent based routing algorithm for wireless sensor networks, based on the selection of the idea of active nodes. The routing algorithm is related with energy and distance factors of each node. The main objective was to increase the lifetime of a sensor network while not compromising data delivery using JADE was used as agent framework. Kianifar, Naji and Malakooti (2015) proposed multi-agent and clustering based wireless sensor network using two models. The first model was Data aggregation (Multi Agent Controlled Dynamic Routing Protocol -MACDRP) which was done by means of one Base Station in each round; and data direction is changeable. In the second model (Multi-agent and Base Stations Route Clustering -MABCDCP), Cluster Heads select and then sensing nodes send their messages to the Cluster Heads and then Cluster Head sends the collected data to the nearest sink. The proposed models increase security in synchronization, better coverage and increased reliability.

However, Mantill and Marzo (nd) proposed a multi-agent system that will improve the mapping of parameters between heterogeneous networks, call admission control and handover management with the objective of guarantee end-to-end QoS. The main advantage of this framework is an improved performance of the wireless communication because the best network is selected according to the QoS parameters. Lastly, Rachid, Hafid and Pham (2014) applied multi-agent technology to wireless sensor networks domain in order to adapt software architecture, and to optimize its performance in monitoring. Agent-based algorithm for fault tolerance and topology control in a wireless sensor network was proposed. This consists of embedding an agent at each node that is responsible for selecting its parent or the next hop to the sink when transferring packets. The main contribution is the proposal of a new process of changing parent, which is based on the computation of a fault tolerance degree, calculated each time by the agent in cooperation with its neighbouring nodes. Simulation results show that this method of changing parent allows an enhanced lifetime, as well as network fault tolerance, when compared with the collection tree protocol. It is therefore necessary to develop an efficient, fast operation and reliable fault tolerant WSNs while still conserving the limited energy of the network.

3. MULTI-AGENT SYSTEM

An agent is a software entity which functions continuously and autonomously in a particular environment, able to carry out activities in a feasible and intelligent manner that is representative to changes in the environment (Cougaar Software Inc, 2009). Another common definition was given by (Stuart & Peter, 2015), agent performs two tasks: It senses its environment through sensors and performs actions through effectors (figure 1). Agent-based systems play variety of roles in the development of various essential industrial applications such as manufacturing, entertainment, electronic commerce, user assistance, user interface design, service and business management, information retrieval and network management (Lee, Min, Choi & Lee, 2016).

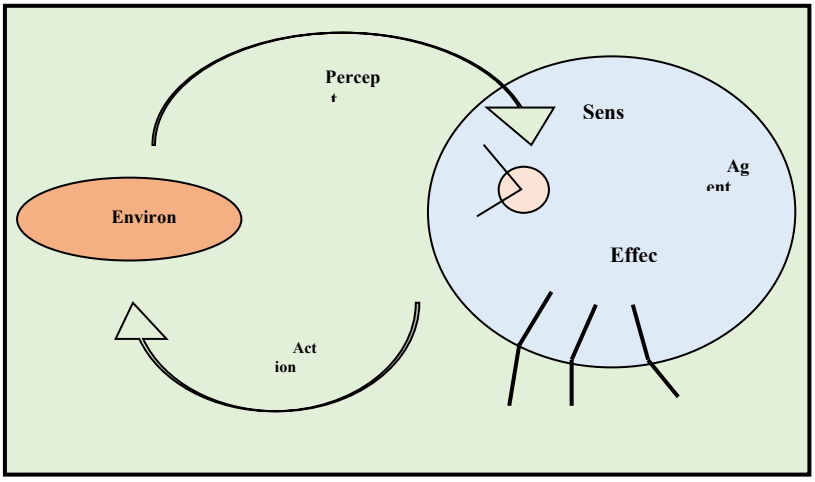


Figure 1: An agent in action (Source: Stuart & Peter, 1995)

A Multi-agent system (MAS) is composed of multiple interacting intelligent agents, within a given environment. These agents co-operate to solve difficulties that are beyond the capability or knowledge of each single problem solver (Arfat & Eassa, 2016). When the single agent is unable to solve a problem because of its inadequate competence and the complexity of the problem, therefore several software agents from a distributed loosely coupled network and work together to solve the problem. A multi- agent system consists of several agents capable of reaching the goal collectively. Intelligent agent is an agent that can adapt to the needs of different users, it can learn new concepts and techniques, it can anticipate the needs of the user, and it can take initiative and make suggestions to the user (Cougaar Software Inc, 2009). Intelligent agents exhibit the following characteristics: autonomy, social ability, reactivity, pro-activeness, mobility, learning, and beliefs. An intelligent agent is an independent entity capable of performing complex actions and resolving management problems on its own [22]. There is high need of agents in computing because of rapid development in computer and data-networking technology to support those needs, and explosion in the variety of equipment and networks.

4. PROPOSED METHODOLOGY

Software agent can be seen as a special computer program that has the ability to decide on the time and the place to migrate between the sensor nodes (Dagdeviren, Korkmaz, Tekbacak & Erciyes 2014). When the agent chooses to migrate to another node in the WSN, it logically transports its state and code to the destination and pursues its objective as keeping on

executing its code on that node. Several architectural topologies can be used to arrange the agents; in any case, software agent is constructed in a place with its code and initial values, and then migrates to the target areas within the WSN. In this research, clustered WSNs approach (figure 2) which will split the entire network into different clusters and then distribute fault management into individual region is adopted.

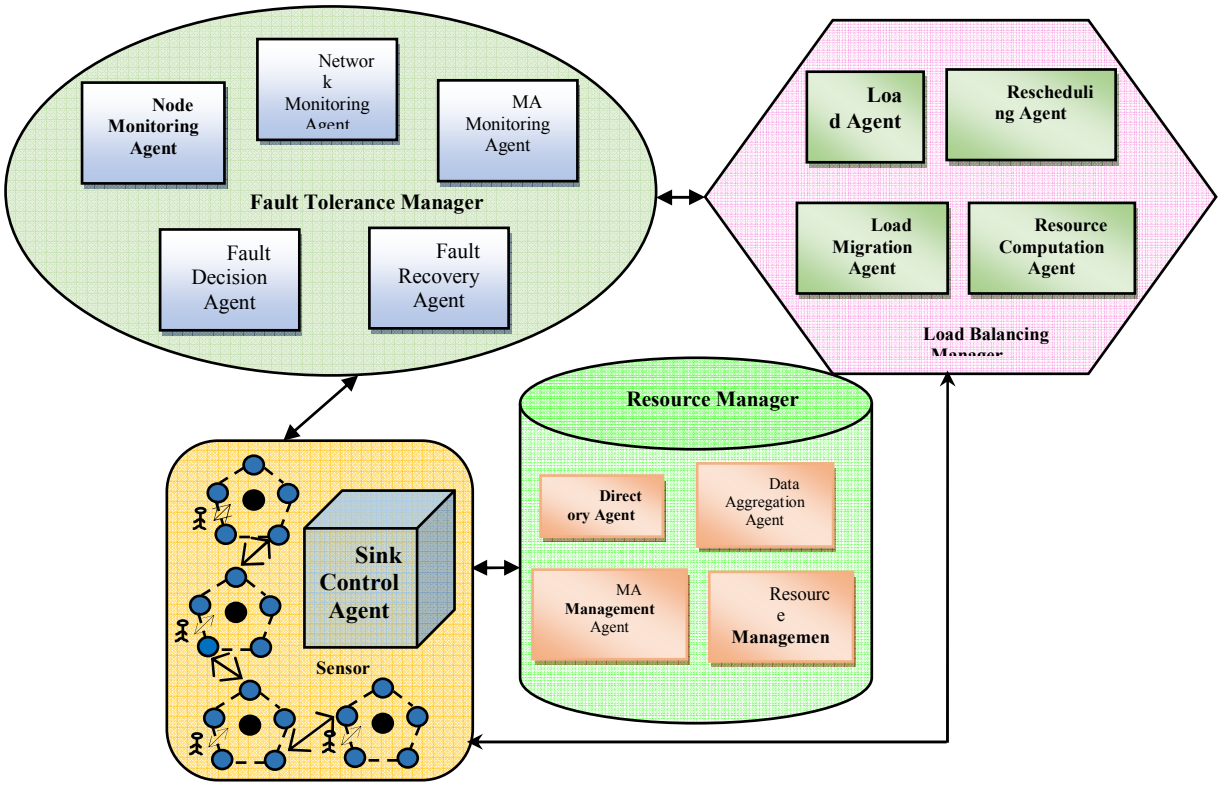


Figure 2: Architecture of Proposed Clustered WSN with Agents

In this approach, agent will be created by the cluster head and sent to other cluster members to collect the possible information. However, the agent will use its specific aggregation functions by migrating between the neighbor members nodes. It is worth mentioning that only one agent may transverse the cluster territory and bring the aggregated sensed data to the leader. The software agent used in WSN reduces the message traffic, efficient memory use in the sensor and reduce energy consumption by each nodes. If a client/server-based messaging approach is used, the communication bandwidth will be consumed inefficiently compared to the agent-based approach.

5. SYSTEM DESIGN

A fault tolerance manager is responsible for monitoring the resources, detect failure, and engage in fault recovery in the WSN. The proposed fault tolerant system consists of the following agents (figure 2):

i. **Node monitoring agent:** The node monitoring agent monitors for a faulty state, normal state, and potential failure in the sensor node and the cluster head. It also monitors the hardware fault-sensor, processing unit, memory, battery level, and radio of a sensor node.

ii. **Network monitoring agent:** The network monitoring agent monitors the communication bandwidth, congestion level, changes in topology, communication latency, partition between the nodes and network disconnection.

iii. **MA monitoring agent:** The MA monitoring agent monitors the state of the mobile agents and classifies the state into a processing state, a stop state, and an unknown state.

iv. **Fault decision agent:** The fault decision agent determines if failure has occurred by analyzing the state information of the node and network monitoring agent as well as identifying the node failure, potential failure, or network failure.

v. **Fault recovery agent:** The fault recovery agent carries out predefined fault tolerance techniques if the fault decision agent determines that a failure occurred. Component replication and migration techniques to conduct the fault recovery were used.

6. SYSTEM IMPLEMENTATION

To manage these sensors and for collecting and storing data in a database, Java Agent Development (JADE) framework platform is used. The dynamic nature and mobility of the agents make them suitable for maintaining these sensors in the WSN. The proposed MAS consists of five menus namely Configure, Create agent, Send Message, Activity Log and Performance (figure 3).

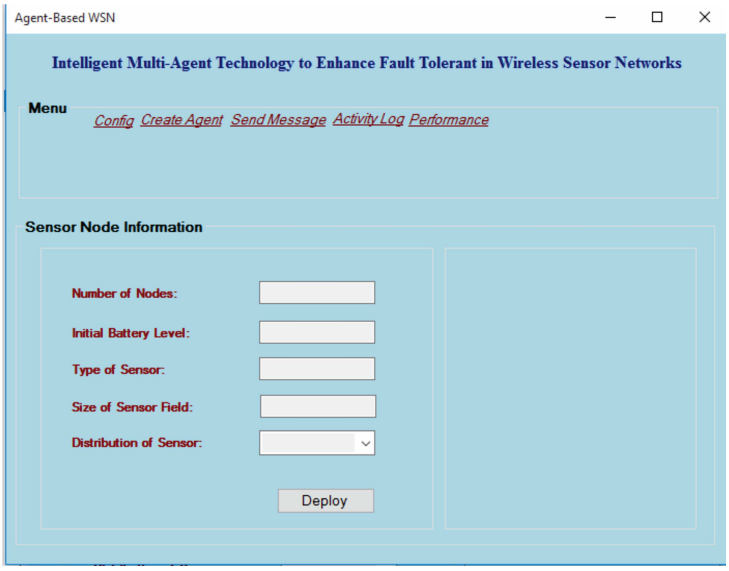


Figure 3: Main Menu and Configuring Sensor Nodes

When the user starts the application, figure 3 above is display where the user can enter the sensor information, configure the sensor nodes and then deploy the sensors (figure 4).

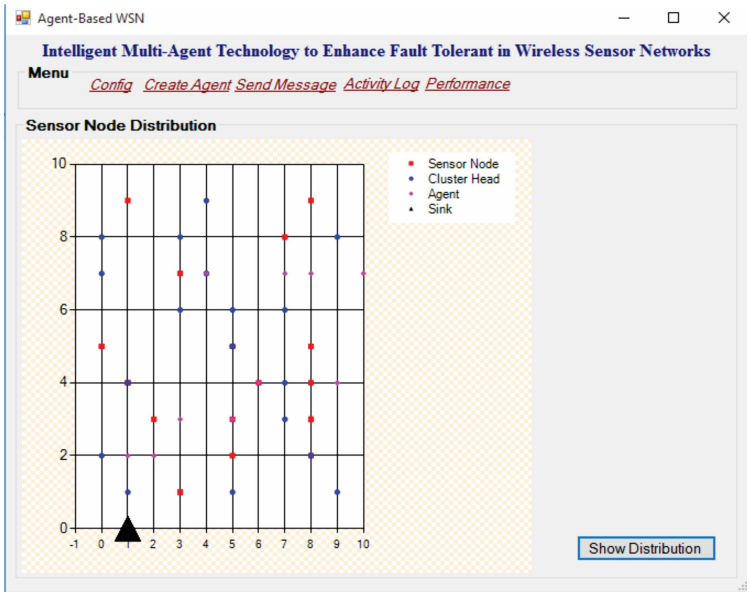


Figure 4: Sensor Node Distribution

Also, figure 5 shows fault tolerant agent creation which comprises of a node monitoring agent, a network monitoring agent, an MA monitoring agent, a fault decision agent, and a fault recovery agent.

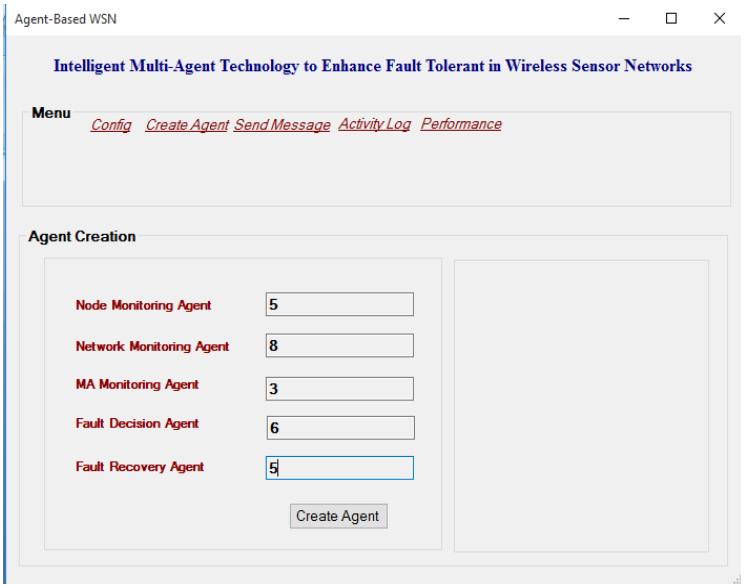


Figure 5: Fault Tolerant Agent Creation

Also, figure 6 and 7 show message transmission when packets are sent from one node to another node before finally arrives at the sink that will process them in some possibly intelligent manner. Figure 8 shows the performance of agent-based and non agent-based techniques.

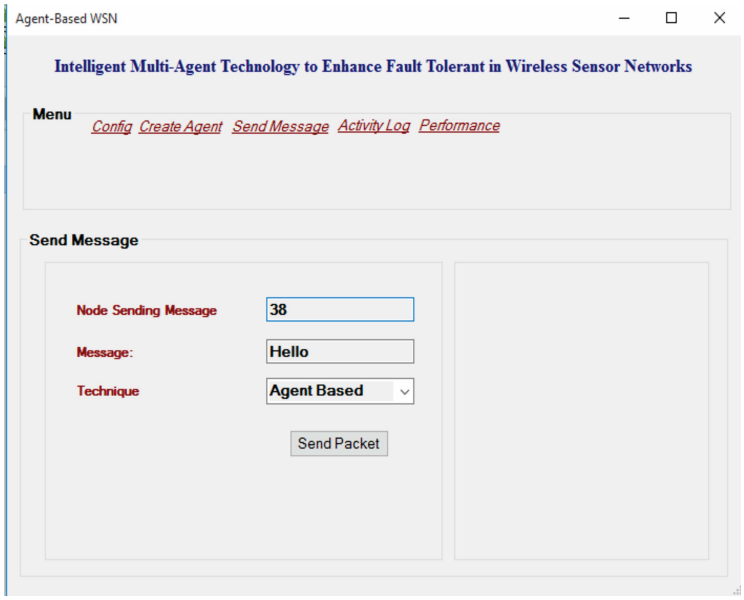


Figure 6: Message Transmission

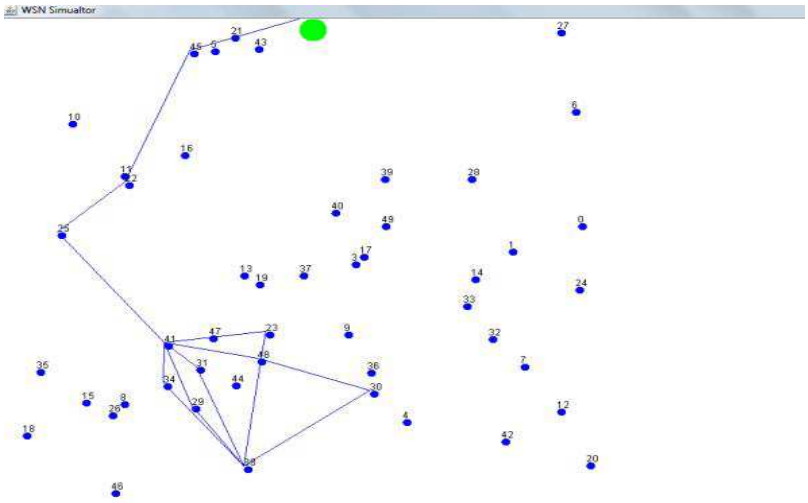


Figure 7: Message transmission using Agent-Based Technique

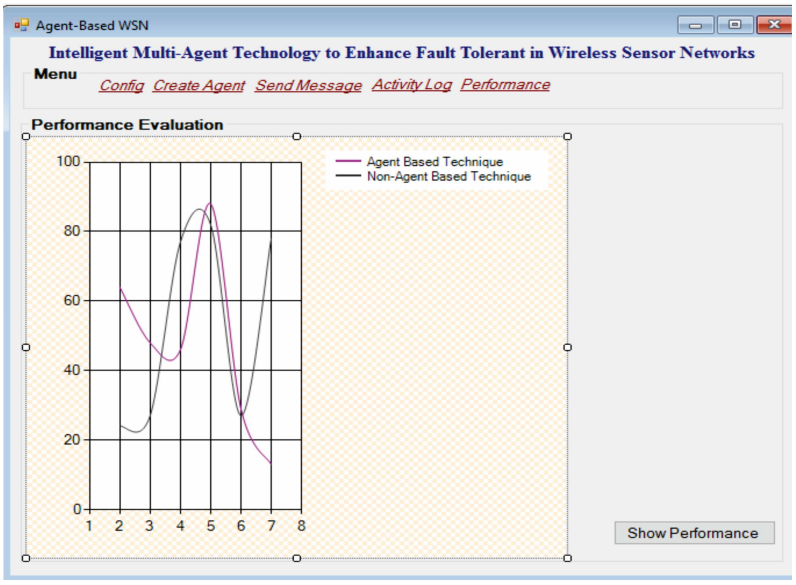


Figure 8: Performance of agent-based and non agent-based techniques

7. DISCUSSION OF RESULTS

The fault tolerance agents of the proposed system works as follows: An agent detects a failure in a particular mobile agent when *a multi agent system* (MAS) fails to receive the registration message and the deregistration message.

1. Assuming a mobile agent arrives at a *processing node,* it registers the message and receives its charge from the previous node's *MAS* running at the cluster head of a subnetwork. Then *A* sends message to *MASi*-1.
2. *MASi*-1 waits for the message for a given timeout interval, and if the timeout interval is reached, it requests MA*Si* to determine the status of the mobile agent.
3. *MASi* searches the database for the registration information*,* when it receives requests from *MASi*-1.
4. If the registration information is found, *MASi* retransmits message registration information in order to recover the lost message. If registration information is not found, *MASi* recovers the mobile agent in the node by asking *MASi*-1 for the checkpoint.
5. If *processing nodei* fails to provide the message, *MASi* requests for the message from the MAS running at base station in the WSN. After the failure recovery procedure is completed, *MASi* retransmits the message registration information.
6. The mobile agent performs the task at the *processing node* and conducts a checkpoint of the status at the *processing node*. Then, it registers the message *deregistration* at the *processing node*.
7. If the checkpoint fails, the process recruits the help of the MA*S* running at the cluster head of a subnetwork, and also recruits the help of the MA*S* at the base station of the network. If it fails again, it aborts the entire task.
8. Before the mobile agent migrates from the *processing node*, it performs appropriate fault tolerant to restore the sent message.

8. CONCLUSION

A novel fault tolerant WSN using intelligent multi agent system (MAS) to manage the sensors for collecting data from them and storing them in a database has been proposed. An agent paradigm and technology that are very suitable for supporting the development of WSNs were used. It is observed that Agents and sensors have many common aspects that can be fruitfully exploited to design efficient agent-based WSNs. The main objective of the proposed system is to have a fault-tolerant network with an extended lifetime by optimizing the choice of paths from the nodes to the sink using multi-agent technology. Java Agent Development (JADE) framework platform is used to create fault tolerant wireless sensor which comprises of a node monitoring agent, a network monitoring agent, an MA monitoring agent, a fault decision agent, and a fault recovery agent. The design and implementation using JADE shows the relevance of multi-agent systems approach compared to non-agent based techniques. The performance evaluation results show that agent-based fault tolerant allows the fault tolerance level of each node leading to a better path selection process, and therefore, a longer lifetime of nodes.

REFERENCES

Akbulut A., P. Cihangir, A. H Zaim and G. Yilmaz (2015). Energy and Distance Factor Based Routing Protocol for Wireless Sensor Networks Using Mobile Agents. *IEEE 2011*.

Alrajeh N. A., U. Marwat, B. Shams and S. S. Shah (2015). Error Correcting Codes in Wireless Sensor Networks: An Energy Perspective, *Applied Mathematics & Information Sciences,* 9, No. 2, 809-818, 2015.

Anastasi G., M. Conti, M. Di Francesco, & A. Passarella (2007). How to Prolong the Lifetime of Wireless Sensor Network. *Handbook of Mobile Ad Hoc and Pervasive Communications. Chapter 6 in Mobile Ad Hoc and* Pervasive Communications, (M. Denko and L. Yang, Editors), American Scientific Publishers, 2007.

Arfat Y. & F. E. Eassa (2016). A Survey on Fault Tolerant Multi Agent System, *International Journal of Information Technology and Computer Science,* 2016, 9, 39-48.

Barati, A. Movaghar and M. Sabaei (2014). Energy Efficient and High Speed Error Control Scheme for Real Time Wireless Sensor Networks. *International Journal of Distributed Sensor Networks*, Volume 2014.

Barati, A. Movaghar, S. Modiri and M. Sabaei (2012). A Reliable & Energy-Efficient Scheme for Real Time Wireless Sensor Networks Applications, *Journal of Basic and Applied Scientific Research,* 2(10)10150-10157, 2012.

Bendjima M. Bendjima and M. Feham (2012). Intelligent Wireless Sensor Network Management based on a Multi-agent System. *International Journal of Computer Science and Telecommunication,* Vol. 3, Issue 2, February 2012.

Cougaar Software Inc (2009).- An Intelligent Agent Technology Company, understanding the Technology series: http://www.coogaarsoftware.com Retrieved on 23/10/2010

Dagdeviren O., I. Korkmaz, F. Tekbacak and K. Erciyes (2014). A Survey of Agent Technologies for Wireless Sensor Networks. IETE Technical Review, Vol. 27, 2010, Pp1-17.

Demigha, O. ,H. O. Slimane, A. Bouziani and W. Hidouci (2011). Energy Efficient Target Tracking in Wireless Sensor Networks with Limited Sensing Range, *The Sixth International Conference on Systems and Networks Communications,* ICSNC 2011.

Fasolo E. (2007). In-network Aggregation Techniques for Wireless Sensor Networks: A Survey. *IEEE wireless communications, Vol. 14, No. 2, 2007, pp 70-87.*

Garza A. A., J. J. Serrano, R. O. Carot, K. Ramirez, J. M. Garcial-Valdez, H. A. & J. Soria (2007). Monitoring and Diagnostics with Intelligent Agents Using Fuzzy Logic. *Advance Online Publication, 2007.*

Guo Z., B. Wang, P.Xie,W. Zeng, and J.-H. Cui (2009). Efficient error recovery with network coding in underwater sensor networks," *Ad Hoc Networks*, vol. 7, no. 4, pp. 791–802, 2009.

Kianifar M. A., D. R Naji and M. V. Malakooti (2015). Multi-Agent and Clustering Based Wireless Sensor Network. Research Journal of Fishery and Hydrobiology, 2015, Vol. 10, Issue 9, Pp 240-246.

Lee H., S. D. Min, M. Choi and D. Lee (2016) Multi-Agent System for Fault Tolerance in Wireless Sensor Networks, *KSII transactions on internet and information systems, 2016, vol. 10, No. 3.*

Maes P. (1995). *Intelligent Software: Program that can act independently will ease the burdens that computer put on people. A Journal of* Scientific American*,* 273(3), 84-86, 1995.

Manisha M. & D. Nandal (2015). Fault detection in wireless sensor networks, *IPASJ International Journal of Computer Science,* ISSN 2321-5992, Volume 3, Issue 3 Pp 5-10, 2015.

Mantill C. A. & J. L. Marzo (nd). A QoS Framework for Heterogeneous Wireless Networks using a Multiagent System.

Olabanji O. T, Gbolagade. A. K and Yunus A. (2016). Redundant Residue Number System Based Fault Tolerant Architecture over Wireless, in the proceedings of Ibadan ACM, Computing Research and Innovation (CoRI'16), Pp 212-216.

Rachid B. & H. Hafid (2014). Distributed Monitoring for wireless sensor Network: Multi-agent Approach. *International Journal of Computer Network and Information Security,* Vol. 10, Pp 13-23, 2014.

Rachid B., H. Hafid & C. Pham (2014). Multi-agent Topology Approach for Distributed Monitoring in Wireless Sensor Networks, *The Tenth International Conference on Wireless and Mobile Communications, CWMC 2014.*

Stuart R. & N. Peter (1995). *Artificial Intelligence: A Modern Approach*, Prentice Hall: Ney York 1995.

REDEFINING THE DIRECTIVITY VALUE OF RADIAL-LINES-SLOT-ARRAY ANTENNA FOR DIRECT BROADCAST SATELLITE (DBS) SERVICE

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ABSTRACT

The mathematical modelling for redefining the directivity for radial line slot array antenna (RLSA antenna) is considered. There exists directivity for RLSA antenna in the literature where this directivity was resulted from a function that is inversely proportional to the product of *3dB HPBW* half power beam width in the electromagnetic plane (Electric field '*E'* and magnetic field '*H*' planes) which was related to slots width of the RLSA antenna alone, however the case for slots length in the mathematical modelling of directivity for RLSA antenna has not been considered. This is seen not to sufficiently address the precise required directivity of RLSA antenna especially in direct broadcast satellite (DBS) service application area. This paper considers that a typical RLSA antenna is a rectangular waveguide that has length and width, which when evaluated would give the surface area of the slots on the radiation surface, and this has critical bearing at arriving at a better directivity for RLSA antenna. Basically, in the quest for the improvement of the RLSA antenna' directivity, slots area (*A*) of RLSA antenna and their corresponding effects on the *3dB HPBW in the electromagnetic plane* will be looked at. A new function describing an improved mathematical modeling for better directivity for RLSA antenna will be formulated. This will be done by looking at the aperture, *3dB HPBW* half power beam width in the *electromagnetic plane (E and H planes), and slot surface area* and will be used in the existing directivity expression for aperture antenna. This will be done to provide a more accurate evaluations of the directivity for RLSA antennas. A new directivity expression suitable for DBS service using RLSA antennas will thus be formulated.

Keyword*— Slots, slot area, slot width, RLSA antenna, 3dB HPBW, E-Plane, H-Plane, radial spacing, directivity, radiation characteristics.*

1. INTRODUCTION

Communication satellites are artificial satellites designed for use in space communication purposes. Its applications include but not limited to the following: telecommunication, broadcasting/multicasting, internet and multimedia service, real time monitoring service, navigation and global positioning system (GPS), tele-presence etc. Communications

satellite provides unparalleled ubiquitous connectivity that no other communication technology can offer, because it has capability to cover large areas of the planet. A communications satellite can cover one-third of the earth planet, while it will take three communications satellites to cover the entire earth planet, irrespective of terrain/topography, political and geographical boundaries. The foregoing make communication satellite an indispensable part of our lives.

One of the applications of satellite communications is broadcasting satellite services. Broadcasting satellite services are intended mainly for direct broadcast to the home, sometimes referred to as direct broadcast satellite (DBS) service [1] in Europe it may be known as *direct-to-home* (DTH) service. An example is what DSTV (Digital Satellite Television) presently offers in Nigeria. Research works have explored how the directivity of satellite antennas can be improved. One of the key areas researchers have studied is the use of slotted waveguide antennas for which radial line slot array antenna (RLSA) is an example. RLSA antenna has been carefully chosen for DBS applications for satellite communication because of all aperture antennas, it is unmatched in terms of better directivity, which is strong enough to overcome path loss, atmospheric degradations, and the distance barrier of satellite communication. RLSA antenna has been considered because of its low cost of production and high efficiency, and the fact that also, there is no aperture blockage with RLSA antenna, as in the case of parabolic reflector antennas.

RLSA antenna has been good candidates for high gain applications since they were firstly proposed in 1980s,[2], [3], they were developed to substitute parabolic dishes in the DBS receivers due to their low profiles and simple configurations which make them suitable for the low-cost production. RLSA antenna being a directional antenna requires good radiated power to be able to overcome the 36,000km distance barrier of satellite communication. The key problem is accurately determining the directivity for RLSA, as the previous directivity for RLSA antenna [4],[5] has only considered the width of the slots in the formulation of the directivity relationship that generated the directivity for RLSA antenna, and has not taken slot area concentration into consideration. And as in the case of RLSA antenna, radiation comes from the slot concentration on the aperture only. It is in view of this problem, this paper proposes to formulate a better directivity model that gives a better directivity of RLSA antenna.

The quest for cost effective antennas with improved performance persists, at the end of 1950s, Kelly came up with the concept of a RLSA where he was able to achieve a constant shaped pencil beam by varying the positions of the feeding structure [6], [7], the authors showed its great applications and benefits in the early 60s [8], [9]. This antenna has the capability to transmit and receive constant-shape pencil beams by means of circular, linear or elliptical polarization. The antenna is made up of concentric annular rings of crossed slots. Fed from a rather complex formation, the aimed polarization was realised by exciting the antenna with the desired polarization modes Linear or orthogonal modes (circular or elliptical). The antenna is flexible, and has the same radiation pattern

for all possible polarizations of interest.

By 1990s, the slotted waveguide theory was accepted and used by Goto and Yamomoto [10],[11],the authors proposed a different slot layout that would make circular polarization to be achieved from a double layered radial cavity, fed by a simple centrally located probe feeding structure. Their proposal simplified the feeding element, but the resulting double layer cavity which was necessary for maintaining constant amplitude aperture illumination made the design difficult to realize and hence makes it expensive to fabricate in communication systems. The slots layouts on the upper cavity surface has the form of a spiral array with each element in the array consisting of two slots spaced so as to be phased in quadrature, thereby forming a unit radiator of circular polarization This proposed antenna had removed the complexity of the feed structure, but added a manufacturing complexity due to its double layered nature, it requires an E-bend to get the radiated field to and from the upper and lower cavities respectively. Further work on this discovery continued with Takahashi et al [12] simplifying the manufacturing complexities encountered by the double layered cavity structure design with the introduction of the single layered structure which produced an intolerably tapered aperture field due to the natural decay of the outward travelling radial wave in the feeding cavity.

Development of the single and double layered versions of the RLSA antenna including circular and linear polarizations cases have been investigated in literatures [12-22] and [23] Advantages of the single layer RLSA antenna which makes it attractive for use in DBS applications include a potentially high radiation efficiency, extremely low profile, ease of installations and immunity to leaf, water and snow build up due to its flat surface. In spite of this outstanding flexibility there is an inherent flaw in this RLSA antenna performance especially when linear polarization is required. Further studies by researchers from Australia in the year 1995 continued in the quest for the design of the linearly polarized radial line slots array antennas LP-RLSA which was to be used for DBS services in Australia due to the launch of Octopus a communication satellite which carried Ku Band transponders along with other payloads to carter for their communication demands. From then Paul Davis successfully designed a 60 cm in diameter linearly polarized radial line slot array antenna in the year 1999 [23-25].

Investigation of the applications of the RLSA antennas for wireless LANs with researchers successfully fabricating a low profiled RLSA antenna at 5.5 GHz resonant frequency and was brought about in the year 2002 by Malaysian and Australian researchers [26]. Islam took the study further by investigating RLSA antenna design and tested it for outdoor point to point applications at 5.8 GHz, remarkably Islam suggested the FR4(Flame Retardant-4) materials to be used in place of dielectric materials at 5.8 GHz resonant frequency for wireless LANs [27], [26]. His discovery was so innovative owing to the fact that he factored in the cost of the material and ease of fabrication. In a bid to maximizing the potential of this remarkable slotted waveguide antenna, research for an innovative dual beam and multi-beamed, circularly polarized RLSA were carried

out [28], [29]

According to [30] comparison was made for 600mm parabolic disc Ku antenna (12.25 - 12.75) GHz, and 600mm RLSA antennas. A radiation efficiency value of about 67% was achieved for RLSA over parabolic dish antenna, furthermore, Relationships between half power beam width (HPBW), slot widths (w) and antenna directivity (D) were studied, a new directivity resulting from the study was formulated for the Ku Band (12.25 - 12.75) GHz[4].

2. SLOT ANTENNAS

Slot Antennas are multiple slots on the metallic structure or surface (copper plate) capable of radiating or receiving Electromagnetic (EM) waves. Radial Line Slot Antenna (slotted waveguide antenna) is the concentric array of slots on the copper surface. The structure is composed of two metal plates that are divided apart by a distance *D*; the radiating surface is the upper metal that carries the slots pair arrangements; the rear plate has no slots on it and serves as the ground plate. Radial guide is the guide between these two plates, it is usually occupied with a slow wave material which represents the dielectric of choice also known as permittivity.

Directivity describes the ability of the antenna to focus its energy strongly in a particular direction. High directivity is required for seamless satellite communications because it is positioned about 36,000km away from sea level.

Associated with the pattern of an antenna is a parameter designated as beam width. The beam width of a pattern is the angular separation between two identical points on opposite side of the pattern maximum. There are a number of beam widths. One of the most widely used beam widths is the Half-Power Beam width (*HPBW*) [31] it is the angle between the two directions in which the radiation intensity is half the value of the beam, it is the defectiveness of a directional antenna [32]. It also means the angle where the transmitted power has dropped by 3 dB from the maximum power on either side of the main lobe of radiation where the intensity falls off by half power it is measured in degrees, as depicted in figure 1 below.

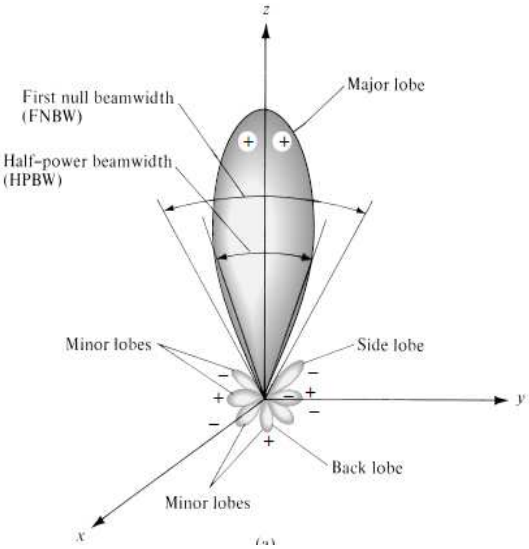


Figure 1 characteristics of antenna [31]

RLSA is a slotted waveguide antenna whose directivity indices is hinged on the contributions of the slots arrays, antenna aperture as well as the *3dB HPBW*. However a careful study by [4], [5] showed that the contributions from individual slot area on the antenna aperture is not considered in the antenna gain and directivity arrived at by previous studies. As a result, the authors in an attempt to consider contributions from the slots arrays only factored in slot width (*w*) and not the individual area occupied by each slot on the aperture and expressed the denominator which is the product of the *3dB HPBW* in *E* and *H*- planes respectively as a function of the slot width *f* (w) as represented in the equation 1 below. Since the slot is rectangular, as depicted in figure 2:

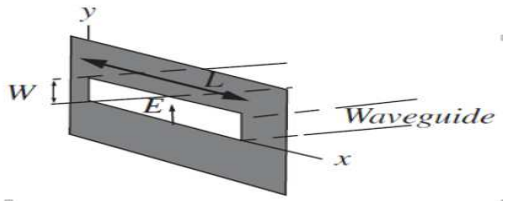


Figure 2 Slot of RLSA antenna [33]

It then implies that it has a length and a width which when evaluated will give the individual slot area. These would be eventually summed up to give a better directivity for RLSA antenna.

3. STRUCTURE OF RLSA ANTENNA

The structure is composed of two metal plates that are divided apart by a distance *D*; the radiating surface is the upper metal that carries the slots pair arrangements, however the rear plate has no slots on it.

Radial guide is the guide between these two plates, it is usually occupied with a

slow wave material which represents the dielectric of choice also known as permittivity, this helps in lessening possible development of grating lobes. Grating lobes happen when the space of the radiating elements is approximately one free space wavelength or even more. Nevertheless, because of the dielectric sandwiched between the separation distance *D* (radial guide) between the plates, the spacing becomes reduced by a factor $\sqrt{\varepsilon r}$ which limits the dangers of grating lobe formation. Illustrative view of the RLSA antenna structure is seen in Fig 3 and Fig 4 respectively.

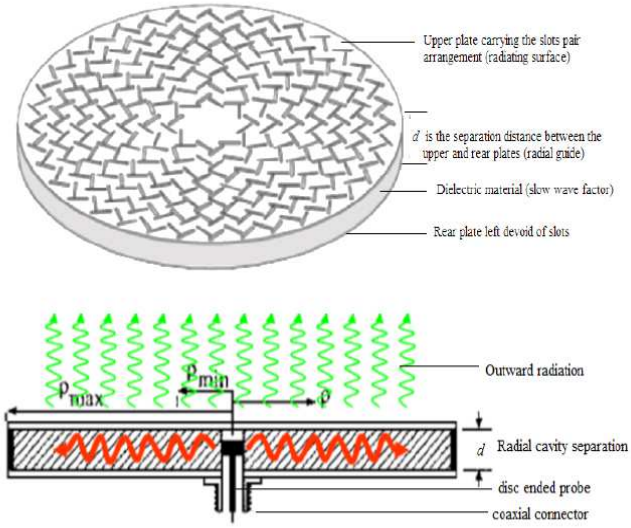


Figure 3 The Single layer of the RLSA Antenna Feeder and Radial guide Adapted from [3].

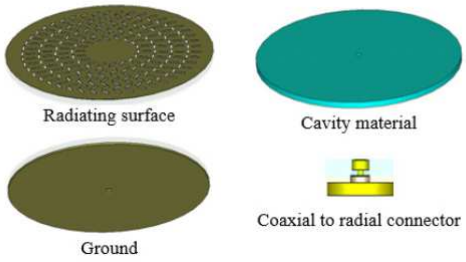


Figure 4 Components of RLSA Antenna [34]

3.1 Principles of Operation of Radial Cavity

To successfully describe how radial cavity works, understanding the role of electromagnetic waves propagating within it is key. The figure 5 below reveals the power flow [35], [36] within the radial cavity for single layered RLSA antenna.

Essentially feed probe plays a significant role in the operation of radial cavity, in that it converts power from the (Transverse Electromagnetic) TEM transmission line mode into a TEM cavity mode that travels inside the radial cavity.

The stabilization requirement of the feed probe is responsible for the reason why region of radius around the feed probe is left devoid of slots.

The configuration of the slots on the upper place surface must be designed in a manner that it couples as much energy in the cavity to forming radiated pencil beam. Energy that is not radiated by the slot will escape through the open edges of the radial cavity. It therefore becomes paramount that the slots on the upper plate be configured and designed to intercept sufficient current so as to produce good radiation irrespective of its polarization.

The magnetic field within the radial cavity can be further investigated. For easiness, the height of the radial cavity, D has to be limited to be less than one half of the guide wavelength.

$$D < \frac{\lambda g}{2}$$

Where D is the height of the radial guide, and λg is the guide wavelength.

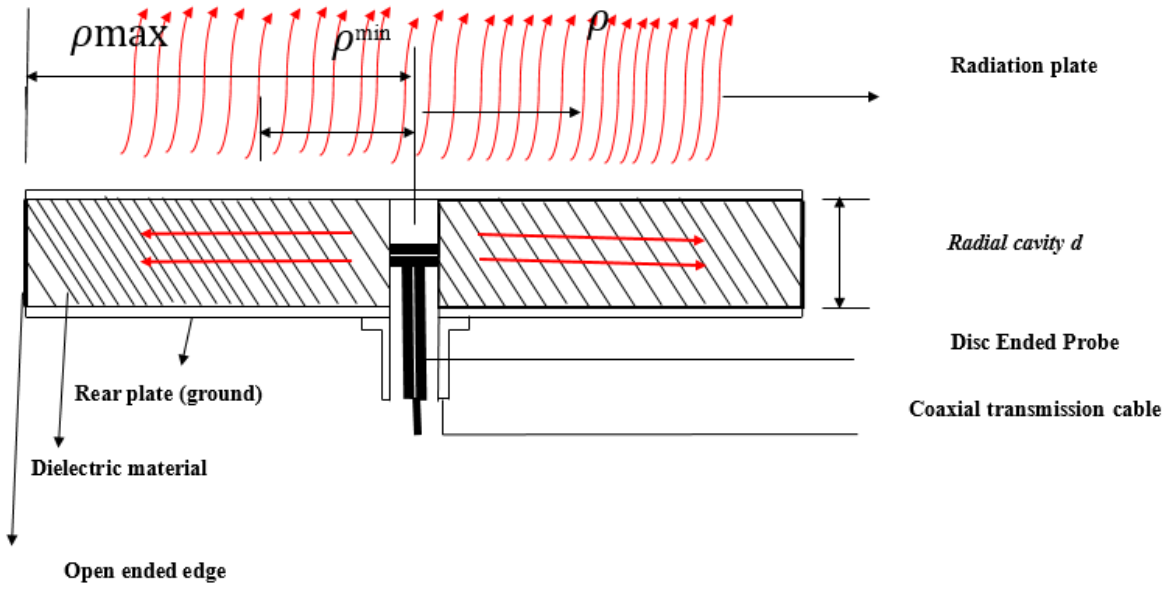


Figure 5: Power Flow within the Radial Cavity

4. FORMULATION OF NEW FUNCTION FOR RLSA ANTENNA (NUMERICAL DERIVATIONS)

Numerical expression for directivity (D_o) as it relates to measured and simulated E and H plane *3dB* half power beam widths (*3dB HPBW*) has been expressed and stated by [4], [5]. It relates product of E and H planes of the *3dB HPBW* as inversely proportional to the antenna directivity, to be a function of sloths width. [4], [5], looked at slots width variation in an RLSA antenna and its effect on the *3dB* half power beam width (*3dB*

HPBW) for which a function was formulated that described the directivity for RLSA antenna. The function was used to study the directivity of the RLSA antenna. In line with these, the minimum number of slots in the first ring (n) =12 were used to manipulate slots concentration on the radiating surface.

RLSA Antenna directivity is thus expressed as:

$$D_o = \frac{32,400}{f(w)}[4] \qquad (1)$$

Where:

$$\Theta_{Hd} = H\_plane\ 3dB\ HPBW\ for\ (n) = 12$$
$$\Theta_{Ed} = E\_plane\ 3dB\ HPBW\ for\ (n) = 12$$

Mathematical formula for this form can be arrived as

$$(\Theta_{Ed}) * (\Theta_{Hd}) = f(w) \qquad (2)$$
$$(\Theta_{Ed}) * (\Theta_{Hd}) = f(w) \qquad (3)$$
$$\Rightarrow f(w) \Leftrightarrow (\Theta_{Ed}) * (\Theta_{Hd}) \qquad (4)$$

This formula of (1) achieved a directivity of [31.94 *dBi*]

Previous work done by [4] arrived at the foregoing directivity for RLSA antenna. However, this directivity was arrived at by considering only the width of a rectangular slot, and the length of the slot has not been considered. This work is therefore motivated by the fact considering the length, and the surface area of the slot would result in a better directivity for RLSA antenna.

In this study, the slot surface area will be considered for all possible number of slots, and for all possible radiation within microwave frequency for any concentric number of slots. The typical slot of an RLSA antenna is rectangular in shape, hence it has width and length, where slot area is mathematically given by:

Slot Area (mm^2) = Slot width * Slot length (5)

4.1 Proposed Function Formulation

Research work is ongoing on achieving better directivity for RLSA antenna, below is the approach we intend to use: first is to study the relationship that was achieved for directivity in the previous studies, and use it to establish a redefined directivity for the new study. For this work to bring about the improved directivity required for RLSA antenna, slot area will be used to improve the previous work for better directivity.

In the (6) below, the surface area of the slot of RLSA antenna is related to be a function of the *3dB HPBW* for E (Electric Field) and H (Magnetic Field) planes respectively as seen below.

$$D_o = \frac{32,400}{f(A)} \qquad (6)$$

$$(\Theta_{Ed}) * (\Theta_{Hd}) = f(A) \Rightarrow f(A) \Leftrightarrow (\Theta_{Ed}) * (\Theta_{Hd}) \qquad (7)$$

$$(\Theta_{Ed}) * (\Theta_{Hd}) = f(A) \quad \text{Equation} \qquad (8)$$

Where:

Θ_{Hd} = H_{-plane} 3dB HPBW

Θ_{Ed} = E_{-plane} 3dB HPBW

A = Slot Area(mm^2)

MATLAB regression tool will be used to generate the requisite function for the *3dB HPBW* for E (Electric Field) and H (Magnetic Field) planes respectively that would be used to eventually compute the new directivity for the RLSA antenna.

5. CONCLUSION

Development of an improved directivity for RLSA antennas–is imperative as the directivity of an antenna is a measure of its performance. Antennas are designed to radiate electromagnetic waves strongly in a single direction or over a narrow angle. This directional pattern ensures that; the power radiated is focussed in the desired direction thus the need to critically ascertain the viability of its value taking into cognisance all the parameters used in the evaluation with the view of achieving accurate value that cannot be misleading.

In view of the fact that the area covered by the concentric array of slots of a typical RLSA antenna has bearing on its directivity description. Essentially the directivity of the antenna remains a significant measure of radiation characteristic of directional antennas, hence it is paramount to have its good description in terms of its value that cannot be misleading.

Further work will involve implementation and validation of the improved RLSA directivity equation.

REFERENCES

[1] Ando, M. New Dbs Receiver Antennas In Microwave Conference, 1993. 23rd European. IEEE 1993.

[2] Md.Rafi Ul Islam (2007). Radial Line Slot Array (Rlsa) Antenna Design For Point To Point Communication At 5.8 Ghz. Msc Thesis Submitted To The Department Of Electrical Engineering, Universiti Teknologi, Malaysia.

[3] Feng Zhuo (2005). Design Of Radial Line Slot Antennas. Msc Thesis Submitted To The Department Of Electrical And Computer Engineering, National University Of Singapore

[4] S. Z. I. E. Al, "Formula For Slots Width, Antenna Directivity, And The 3db Hpbw Of An Rlsa Antenna At 12.4ghz Using Regression Analysis," Arpn Journal Of Engineering And Applied Sciences, Vols. Vol. 9, , No. No. 7, Pp. 1107-1110, July 2014.

[5] I. S. Zakwoi (2015). Optimization Of A Linearly Polarized Radial Line Slot Array Antenna Design For Direct Broadcast Satellite Services. Ph D Thesis Submitted To The Department Of Electrical Engineering, Universiti Teknologi, Malaysia

[6] Davis, P., A Linearly Polarised Radial Line Slot Array Antenna For Direct Broadcast Satellite Services. Ph D Thesis Submitted To The Department Of Computer Science And Electrical Engineering, University Of Queensland, Australia, 2000.

[7] Purnamirza, T., T. Rahman, And M. Jamaluddin, The Extreme Beamsquint Technique To Minimize The Reflection Coefficient Of Very Small Aperture Radial Line Slot Array Antennas. Journal Of Electromagnetic Waves And Applications, 2012. 26(17-18): P. 2267-2276.

[8] Davis, P. And M. Bialkowski. Comparing Beam Squinting And Reflection Cancelling Slot Methods For Reflection Coefficient Improvement In Rlsa Antennas. In Antennas And Propagation Society International Symposium, 1997. IEEE., 1997 Digest.

[9] Herranz, J.I., A. Valero-Nogueira, E. Alfonso And V. Rodrigo : Optimization Of Beam-Tilted Linearly Polarized Radial-Line Slot-Array Antennas. Antennas And Wireless Propagation Letters, IEEE, 2010. 9: P. 1165-1168.

[10] Goto, N., Slotted Waveguide Antenna, 1990, Google Patents.

[11] Yamamoto, T., H., Ono, M. Ando, N. Goto And N. Ishii: Near Field Distributions In Radial Line Slot Antennas For Surface Wave Coupled Plasma Generation. In Antennas And Propagation Society International Symposium, 1999. IEEE. 1999

[12] Takahashi, M., J. I. Takada, M. Ando And N. Goto: A Slot Design For Uniform Aperture Field Distribution In Single-Layered Radial Line Slot Antennas. Antennas And Propagation, IEEE Transactions On, 1991. 39(7): P. 954-959.

[13] Kelly, K. Recent Annular Slot Array Experiments. In Ire International Convention Record. 1957. IEEE 1957. 131

[14] Goebels Jr, F. And K. Kelly, Arbitrary Polarization From Annular Slot Plannar Antennas. Antennas And Propagation, Ire Transactions On, 1961. 9(4): P. 342-349.

[15] Kelly, K. And F. Goebels Jr, Annular Slot Monopulse Antenna Arrays. Antennas And Propagation, IEEE Transactions On, 1964. 12(4): P. 391-403.

[16] Bialkowski, M.E. And P.W. Davis, Radial Line Slot Antenna, 2000, Google Patents

[17] Herranz, J.I., A. Valero-Nogueira, E. Alfonso And V. Rodrigo : Optimized Design Of Beam-Tilted Linearly-Polarized Radial-Line Slot-Array Antennas. In Antennas And Propagation Society International Symposium (Apsursi), IEEE 2010.

[18] Garfagnini, G., M. Cerretelli, R. Serenelli And G. B. Gentili : Dual Circularly Polarized Radial Line Slot Antenna. Attidella Xv Rinem, - Elettromagnetismo.It 2004

[19] Bialkowski, M.E. And P.W. Davis, Analysis Of A Circular Patch Antenna Radiating In A Parallel-Plate Radial Guide. Antennas And Propagation, IEEE Transactions On, 2002. 50(2): P. 180-187.

[20] Ando, M., K. Sakurai, N. Goto, K. Arimura And Y. Ito: A Radial Line Slot Antenna For 12 Ghz Satellite Tv Reception. Antennas And Propagation, IEEE Transactions On, 1985. 33(12): P. 1347-1353.

[21] Ando, M., T. Numata, J. I. Takada And N. Goto,: A Linearly Polarized Radial Line Slot Antenna. Antennas And Propagation, IEEE Transactions On, 1988. 36(12): P. 1675-1680.

[22] Saeki, K., H. Ueda, J. Hirokawa And M. Ando.: Design Of A Linearly Polarized Radial Line Slot Antenna With Reflection-Cancelling Posts. In Proceedings Of The International Workshop On Millimeter Wave Wireless Technology And Applications. 2010.

[23] Davis, P.W. And M.E. Bialkowski, Linearly Polarized Radial-Line Slot-Array Antennas With Improved Return-Loss Performance. Antennas And Propagation Magazine, IEEE, 1999. 41(1): P. 52-61.

[24] Davis, P. And M. Bialkowski. Beam Synthesis In Linearly Polarized Radial Line Slot Array Antennas. In Antennas And Propagation Society International Symposium, 2000. IEEE. 2000

[25] Davis, P.W. And M.E. Bialkowski. The Performance Of A Linearly Polarised Rlsa Antenna For Different Beam Squint Angles. In Microwave Conference Proceedings, 1997. Apmc'97, 1997 Asia-Pacific. IEEE 1997.

[26] Ui Islam, M.R., L. Faisal, And T. Abd Rahman. Simple Integrated System For Wireless Backhaul Networks. IEEE 2008 P 341-345.

[27] Rahman, T.A. Novel And Simple Design Of Multi Layer Radial Line Slot Array (Rlsa) Antenna Using Fr-4 Substrate. IEEE 2008 P 843-846.

[28] Takahashi, M., M. Ando, N. Goto, Y. Numano, M. Suzuki, Y. Okazaki And T. Yoshimoto ,Dual Circularly Polarized Radial Line Slot Antennas. Antennas And Propagation, IEEE Transactions On, 1995. 43(8): P. 874-876.

[29] Sudo, K., J. Hirokawa, And M. Ando. Analysis Of A Slot Pair Coupling On A Radial Line Filled With Double-Layer Dielectric. IEEE 2005 P 724-727.

[30] I. S. Zakwoi, "Optimization Of A Linearly Polarized Radial Line Slot," In Space Science And Communication (Iconspace), 2013 IEEE International Conference On, Melaka, Malaysia, 1-3 July 2013.

[31] C. A. Balanis, Antenna Theory Third Edition, New Jersey: John Wiley & Sons, Inc., Hoboken,, 2005.

[32] Islam., M.R.U., Radial Line Slot Array (Rlsa) Antenna Design For Point Topoint Communication At 5.8ghz. Thesis Submitted To The Faculty Of Of Electrical Engineering, Universiti Teknologi Malaysia, May 2007.

[33] K. B. Yi Huang, Antennas From Theory To Practice, United Kingdom: A John Wiley And Sons, Ltd, Publication, 2008.

[34] S. I. Z. Maina Ibrahim, "Radial Line Slot Array Antenna At 28 Ghz With Modified Coaxial," Journal Of Advanced Research In Applied, Vol. Volume 7, No. Issue 1, Pp. 25-31, 2017.

[35] Davis P. 2000. A Linearly Polarised Radial Line Slot Array Antenna For Direct Broadcast Satellite Services.

[36] A.I.Zagghoul, R.K. Gupta, E.C. Kohls, L.Q. Sun & R.M. Allnutt, (2001). “Low Cost Flat Antenna For Commercial & Military Satcom Terminals,” Lockheed Martin Global Telecommunications (Lmgt) Systems & Technology Clarksburg, Md.

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REVIEW OF SELECTED SPECTRUM OCCUPANCY MODELS

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ABSTRACT

The radio frequency (RF) spectrum is a natural resource that is limited and hence needs to be efficiently managed. Spectrum under-utilization is found to be one of the factors responsible for the scarcity of radio spectrum. Dynamic spectrum access (DSA) scheme is a scheme that is employed as a tool to allow for sharing and management of unused spectrum also called "whitespaces", between the licensed user called "Primary user" and unlicensed user called "Secondary user" without causing harmful electromagnetic interference to the licensed user. To achieve this, accurate spectrum occupancy prediction is very essential. This paper presents a review of selected important spectrum occupancy prediction models that has been used. Their concepts as well as their applications to radio spectrum occupancy prediction are also presented. Merits and demerits of each of the models are also considered in order to identify the most efficient one amongst these models.

Keywords: *Dynamic Spectrum Access (DSA), Primary User (PU), Secondary User (SU), Cognitive Radio (CR), TV White Space (TVWS)*

1. INTRODUCTION

In recent time, the demand for wireless services has increased far beyond earlier predictions and the limited availability, of useable radio frequency, calls for more efficient radio spectrum utilization. Wireless systems have become inevitable in our daily lives; it has been evolving rapidly, bringing about an emergence of a wide range of new wireless services and applications. There are over eight (8) billion mobile connections, about five (5) billion unique mobile subscribers, sixty five percent (65%) global subscriber penetration generating $1.05 trillion total revenues across the world with expectation of an increase in the nearest future [1].

A spectrum hole or whitespace can technically be defined as an idle frequency band that can be used by a secondary user to transmit without causing interference to any primary user. It can be temporal (i.e. times/periods the primary service is off), or spatial (i.e. where frequency signals cannot be successfully received). Space division multiple access technique could be employed to reuse the frequencies of the primary users once the activities (transmission) of the secondary users will not cause severe interference to primary receivers. Several applications have been proposed to be deployed in spectrum holes as reported in [3], these include UMTS and LTE extension, Wi-Fi-2, Wimax and public safety and emergency networks.

The current spectrum management policy focuses on static allocation which protects the primary users who may not necessarily maximize the usage of the spectrum. Despite the limitation of this resource, the present utilization of the spectrum is inefficient with low average occupancy values of less than 10 percent as reported in [4]. Common findings, among spectrum measurements studies conducted in Nigeria [2, 10, 38, 39 and 44] and so many countries like New Zealand, USA [4, 5 and 6], Germany [7], and in Singapore [8] shows that spectrum is underutilized. Regulatory bodies, such as FCC in the United States [8], Ofcom in the UK [9], NCC in Nigeria [10] and MIC in Japan [11] have shown great efforts towards the achievement of optimal spectrum utilization. For this reasons, USA in [12] and UK in [9] have completed a general review of alternative spectrum management models for operating conditions of white space devices (secondary users). Japanese government took a similar step as reported in [11]. The amount of white space that would be free for the secondary users in accordance with the regulatory guidance on interference has been under extensive studies. It has been acquired in several places across the globe, for the United States [13] and for central Europe in [14]. Very few studies exist outside the United States, such as [14], which attempts to quantify TVWS capacity in the United Kingdom in a limited area, [15] for southern Europe, and for Korea [16].

This paper presents a review of selected important spectrum occupancy prediction models that can be employed. Their concepts as well as their applications to radio spectrum occupancy prediction are also presented. Merits and demerits of each of these models are also considered in order to identify the most efficient one amongst these models.

The rest of this paper is organized as follows. Section 2 presents the related works on spectrum occupancy prediction, section 3 introduces the concept of spectrum occupancy. In section 4, selected occupancy prediction models were discussed with their various advantages as well as corresponding disadvantages while section 5 summarizes the work, section 6 concluded it.

2. CONCEPT OF SPECTRUM OCCUPANCY PREDICTION

Radio frequency spectrum includes frequencies between 9,000 Hz to 300 GHz. It is a finitely renewable resource which is not restricted to any national boundaries. Its usage depends solely on national policies and international treaties, it is of an utmost social (TV, Radio, Telecommunication and Internet), security (Military and Paramilitary) and economical (License management) importance.

Spectrum occupancy can be said to be the period of time during which a licensed owner of a frequency band occupy certain premise. A licensed user is otherwise referred to as a primary user and the sole owner of a particular portion of frequency band. Predicting whether a particular band will be occupied by the primary user at a particular time or not, in order to avoid possible interference due to secondary usage of the frequency is very important. Hence, the concept of spectrum occupancy prediction is introduced.

The need to have historical knowledge of primary usage profile of spectrum is an essential factor in predicting the actual amount of available underutilized spectrum. This will in turn prevent any possible interference that might be caused by the secondary co-existence user of spectrum due to cognitive usage activity. Cognitive radio does not only solve the problem of spectrum underutilization but also prevent possible interference to the primary user.

Because the primary users' activity on a frequency channel can be complex and conventional occupancy measurement may not be efficient enough due to change in behavior of the primary user, there was need to employ other means of predicting the activity of the primary license user. Therefore, various spectrum occupancy prediction models were employed [19, 20, 21, 22, 23 and 24].

3. SPECTRUM OCCUPANCY PREDICTION MODELS

So many research works has been done on spectrum occupancy prediction in the past and more still need to be done. This is due to the fact that large amount of spectrum hungry devices and technologies are coming to the fore. The coinage of the cognitive radio idea by Joseph Mitola around 1999 [17] marked the beginning of an everlasting research on cognitive radio networks. Mitola's work emphasized the need to utilize radio frequency spectrum efficiently in order to reduce spectrum underutilization. His idea promises to correct the rigidity involved in the traditional command and control strategy of spectrum allocation and management.

To reduce spectrum underutilization, accurate sensing of the presence of primary user (PU) is essential so as to prevent interference. To achieve this, researchers have proposed

several spectrum occupancy prediction methods. These methods range from artificial intelligence to statistical based models.

In [18], Pattanayak *et al*. proposed an algorithm with artificial intelligence to examine and subsequently predict the status of the channel in the TV band. A neural network model that is capable of predicting the vacancy or occupancy of a channel was designed. Three parameters i.e., channel capacity, spectral efficiency of the scanned channel and distance between the primary base station and secondary base station were used in this work. "1" or "0" is used to represent the status of the channel as occupied or unoccupied.

A neural network based prediction model was proposed in [19]. In the work, channel status was predicted using historical data obtained during a spectrum occupancy measurement campaign. A 12-hour long dataset obtained from measurement activity were used as input to the designed neural network. This work considered only three bands thus: Broadcasting, GSM and 3G Cellular bands.

Bara'u and Najashi [20] also proposed a neural network model using a real set of data obtained from a cooperative spectrum occupancy campaign. An interesting thing about this work is the use of two different sensing devices at the same time to generate the dataset. This was done to minimize problems such as hidden terminal and fast fading which can mislead the secondary users of spectrum and in turn causing interference to the primary user.

Primary users spectrum usage profile can also be modeled by using the two main types of Markov chain i.e., discrete-time Markov chain or continuous-time Markov chain.

A spectrum handoff model based on Hidden Markov model (HMM) was proposed in [21]. This was intended to optimize the spectrum handoff scheme for cognitive radio network by performing a comprehensive analysis of the channel's status.

Hidden Markov Models are proposed in [22] to model the channel usage patterns of primary users as a function of time. In [23], a modified, less complex HMM was proposed and comparison of the prediction accuracy was done between the proposed HMM and the conventional HMM accordingly.

In [24] HMM was trained using the Baum-Welsh algorithm (BWA) and predicted the presence of Primary Users to avoid possible collisions during transmission. Results of simulation of this work shows that the collisions probability improved reasonably compared to the randomly selected channels meant to be sensed by the Secondary User.

Predicting spectrum occupancy using prediction models becomes imperative as repeated conventional spectrum sensing of the wideband can be time consuming and energy inefficient, couple with the fact that, prompt responsiveness to always vacate a spectrum band is an expectation from the secondary user whenever a primary user initiate transmission. The concept of dynamic spectrum access (DSA) aimed at improving spectrum utilization by encouraging cognitive co-existence between both primary

licensed user and secondary opportunistic user. This is usually necessary in order to promote efficient spectrum utilization and correct underutilization created by the current spectrum allocation policy of command and control. Dynamic spectrum access permits a secondary user to exploit vacant frequency channel in a non-interference manner. This concept comes in two forms thus: Underlay and Overlay. The underlay approach does not make use of the spectrum white space but rather, operates at a frequency level below the permitted interference temperature level of a primary user while Overlay exploits the spectrum white space without restriction on the power of transmission of the secondary user. Hence, it require proper spectrum occupancy sensing of the frequency channel.

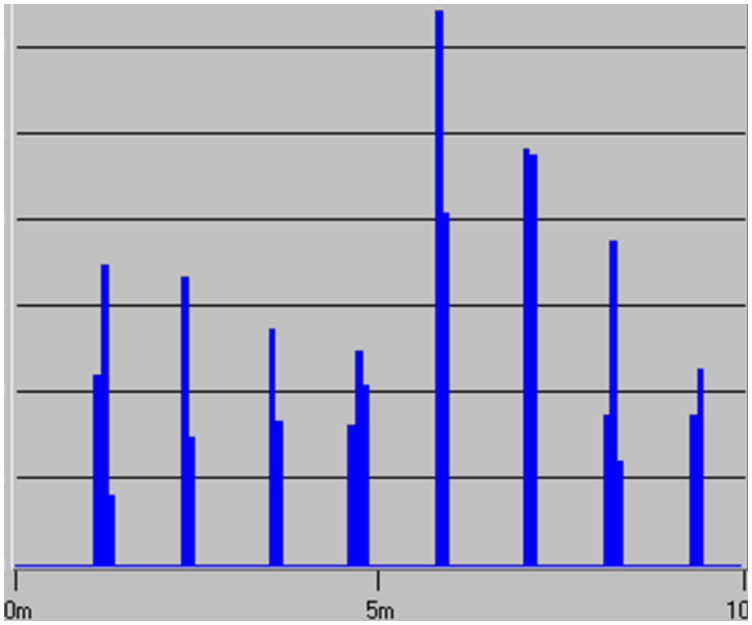


Fig. 1: Typical primary user transmission with DSA opportunity in-between the blue lines

As shown in fig.1, the primary user transmission at a particular period of time creates white space that can be exploited by the secondary user for opportunistic access. This is possible as long as the co-existence does not cause interference to the primary user.

To achieve interference free cognitive co-existence between primary user and secondary user, several spectrum occupancy models have been employed. This section considers some of these models, presents their applications to radio spectrum occupancy prediction, examine their efficacy and highlight their advantages and disadvantages respectively. Models to be considered include:

1. Hidden Markov Model
2. Artificial Neural Network Model
3. Autoregressive Prediction Model

4. Partial Periodic Pattern Mining Model and

3.1 Hidden Markov Model

One of the best known spectrum occupancy prediction models is the Hidden Markov model which was introduced around 1960s, by a Russian mathematician Andrey Markov [43], as a mathematical and/or statistical model. It is an analysis that can be performed on either continuous or discrete process depending on the type of problem to be solved.

For a process to be considered a Markov process, it must meet the following set of conditions:

- The probability of transiting from one state to another must be constant. i.e., Homogeneous. And
- The probability of the future or next state does not depend on the past states, except the current state and not the previous states. This means that the process does not have memory of the previous states i.e., it is memoryless.

In spectrum occupancy prediction, it is possible for a channel or group of channels, especially large and complex ones to be in any number of a state out of possible numbers of states such as occupied, unoccupied and partially-occupied states. A channel can said to be in occupied state if the primary user is making use of it i.e., transmitting and unoccupied state if the primary user is not present on the channel. The state of partial-occupation of channel does not usually happen except when there is a false alarm from the result of channel sensing by the secondary user, a situation whereby it will appear as if the primary user is transmitting and truly not or vice versa.

A channel can change its state i.e., transit from one state to another. It can be in occupied state for a period of time and unoccupied in another. This scenario can be modeled using a discrete-time markov model since the radio channel can either be idle or busy i.e. can be modeled as a probabilistic finite machine [26].

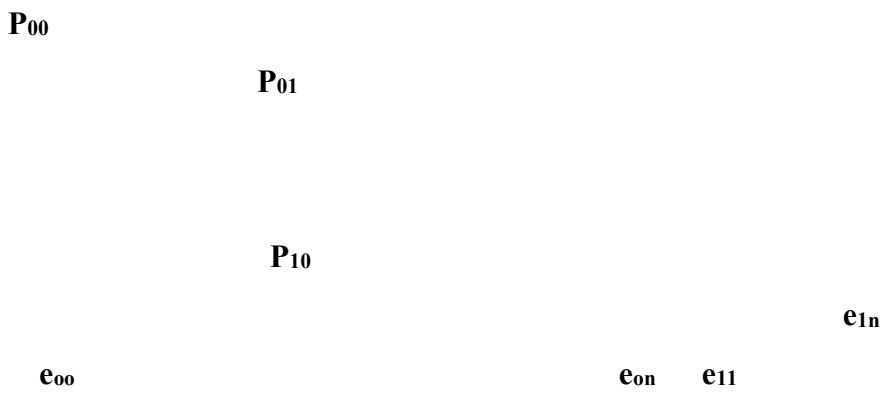


Fig 2: Transition Diagram of a Hidden Markov Model Structure

As indicated in fig 2, a transition diagram representing each of the two possible states of the channel $\mathbf{X_n}$ i.e., $\mathbf{X_0}$ as idle, $\mathbf{X_1}$ as busy state and points (or nodes) as change of states (transition) between the nodes with arrows (or edges). A transition probability is usually assigned to each edge and the probabilities of all edges emanating from a node must be equal to one. Apart from this, there is an initial state probability distribution which usually defines the first state of the markov chain and set of possible output E_n and output emission matrix e_{in} indicating a probability matrix which is probabilities associated with obtaining a certain output provided the model is currently in a true state *Xn*.

Since the status of channel **X(t)** at a particular time **t** can either be $\mathbf{X_1}$ or $\mathbf{X_0}$ denoting the state of the channel as either busy or idle, the state of channel **X(t)** can be indicated mathematically as $\mathbf{X(t) = \{ X_1, X_0\}}$ with $\mathbf{X(t) = X_1}$ showing that the channel is busy or $\mathbf{X(t) = X_0}$ showing channel is idle. Since the channel can be modeled in a probabilistic manner with a set of *n* states and discrete time index *t,* a Markov chain process can be controlled by two parameters as thus:

- State transition probability matrix P, which is an *n-by-n* square matrix indicating change of state from one state to another state. Represented as:

$$P = (P_{ij})mxm \;\; i,j \in X \qquad (1)$$

Equation (1) can be denoted individually by:

$$P_{ij} = P_r(X_n = j | X_{n-1} = i), 2 \leq n \leq t$$

Where t = time or length of period of observation,

i.e. $P_{ij} = P_r(X_1 = j | X_0 = i)$

$$\begin{bmatrix} P00 & P01 \\ P10 & P11 \end{bmatrix}$$

- Emission probability matrix E which is an *m-by-n* matrix representing the probabilities that certain output can be obtained given the process is in a current state X_n. This is represented by,

$$E = (e_{ij})mxn, \;\; i,j \in E \qquad (2)$$

Equation (2) can also be represented individually by:

$$e_{ik} = P_r(X_n = j | y_n = i), 2 \leq n \leq t$$

$$E = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

Whenever hidden Markov model is employed for spectrum occupancy prediction, it is always important to find $P(\boldsymbol{X}|\lambda)$ with λ denoting HMM parameters as $\boldsymbol{\lambda = (P, E, \pi)}$, where π indicates the initial state distribution [27].

Advantages of HMM

Hidden Markov model has been employed as a prediction tool due to the following merits [28]:

- HMM has a very strong statistical foundation.
- HMM has efficient learning algorithm.
- HMM is a flexible generalization of sequence profiles because of its ability to handle inputs of variable length.
- HMM has a wide area of application including data mining, pattern recognition and discovery etc.

Disadvantages of HMM

- Limitation of first order HMM by their corresponding first order markov property.
- Only a small fraction of distributions over the space of possible sequences can be represented by a reasonably constrained HMM
- Dependencies between hidden states cannot be expressed by HMM
- HMM is characterized by plenty unstructured parameters.

3.2 Artificial Neural Network Model

The strife to understand the functionality of the brain was started by Ramon Cajal around 1911 in one of his works, where he introduced neurons as "structural constituents of the brain". A wave of interest did not start until 1943 when McCulloch and Pitts introduced "simplified neurons" [29]. Several other research work followed suit and some of these include but not limited to, Donald Hebb (1949), Karl Lashley (1950), Marvin Minsky (1951), the joint scientists and ambitious students meeting of 1956 at Dartmouth summer research project, Frank Rosenblatt and Charles Wightman (1958), Bernard Widrow and Marcian Hoff (1960), Karl Steinbuch (1961), Nils Nilsson (1965). Researches in this area did not continue until around 1972 when Teuvo Kohonen introduced a model of associative memory. Other research efforts like Christopher Von Der Malsburg (1973), Paul Werbos (1974) and recently John Hopfield (1985) and Rumelhart, Hinton and Williams (1986) created an upswing in research on neural networks.

Artificial neural networks simply referred as neural networks are man-made biological systems created to function like the natural brain but not exactly. They are a massively distributed processor which possesses a natural tendency for storing experiential knowledge and making it available for use [30]. Neural networks usually acquire knowledge through learning process and uses internally connected neurons known as

synaptic weights to store the acquired knowledge. They are also known as parallel distributed processors (PDP) [31].

Due to non-linearity nature of ANN, it is often employed as a prediction tool. Real life problems like spectrum occupancy prediction, weather forecasting, stock exchange prediction etc are non-linear in nature. The power level measured during spectrum measurement campaign is also an example of real life problem. This usually constitutes the data to be used as input to the neural network.

When using ANN as a spectrum occupancy prediction tool, the following are the procedure:

- Identification of ANN architecture to be adopted
- Data processing and conversion
- ANN training
- ANN validation and
- ANN testing

Identification of ANN architecture: Because ANN is made up of large number of interconnected neurons that are working together to solve a specified problems, they are usually exposed to a learning procedure that depend on the purpose the network will serve.

Two distinct neural network architectures are possible i.e., Feed-Forward network architecture and Recurrent architecture

The feed-forward allows data flow from input to output units in a strictly feed-forward manner i.e., the processing elements (neurons) are arranged into distinct layers with each layer receiving input from the previous layer and outputting to the next layer. Signals from a preceding layer cannot be retransmitted back to a previous layer i.e., there is no feedback

The recurrent network architecture is contrary to the feed-forward because there is always feedback between the processing elements. A preceding neuron can communicate backward to a previous one. The weight layer contains input from all other neurons in the network and cannot be easily arranged into layers.

Many research works [18, 19, and 20] have employed the feed-forward architecture in spectrum occupancy prediction.

Data Processing and Conversion: This involves preparation of the dataset obtained from the spectrum measurement campaign. The data is converted to binary series of 0's and 1's by thresholding. When this is done, data is then organized into different services observed. The obtained dataset are used as input data for the ANN training.

ANN Training: Having determined the architecture of the proposed neural network, training of the network will be the next task. Two training types are possible:

1. Supervised training and 2. Unsupervised Training

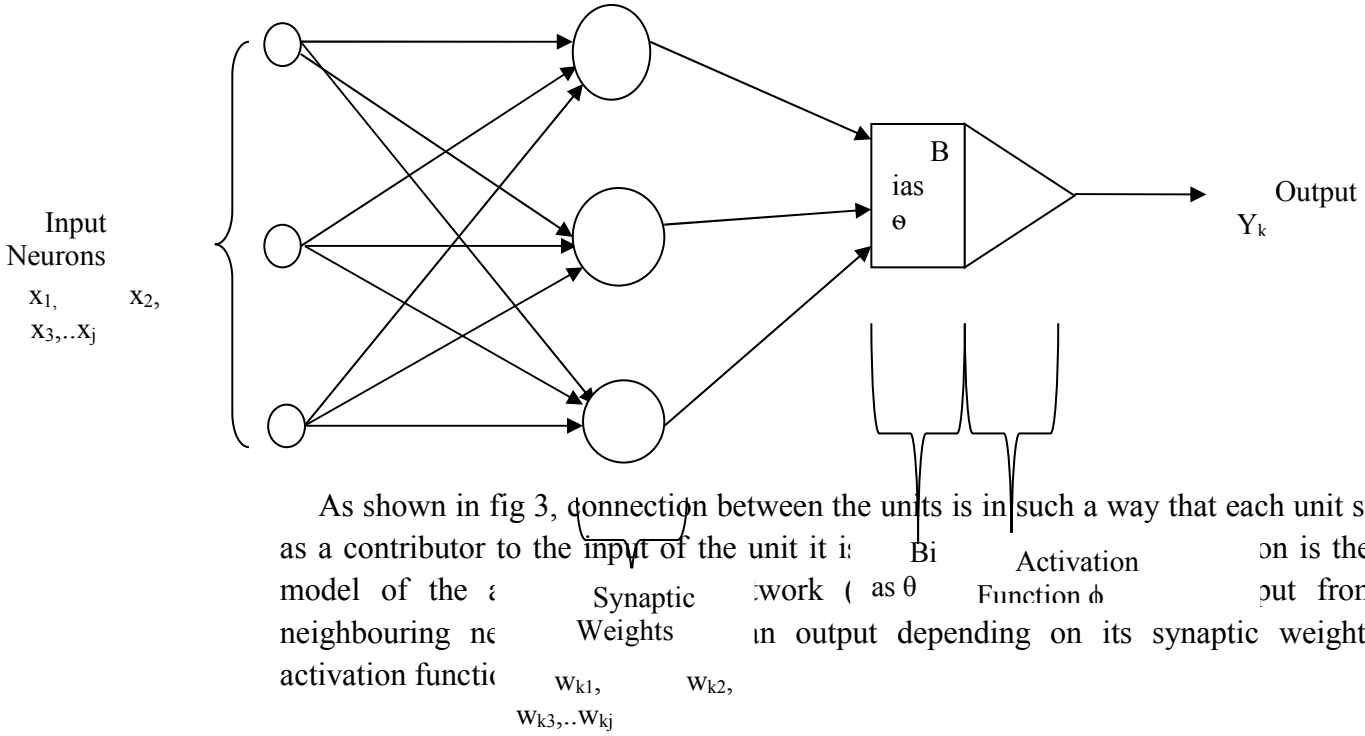
In a supervised training type, the input and output data is provided for the network while in unsupervised training, the network has to make its decision on the input without any provision of the output i.e., self-organisation.

Supervised training type will be adopted for this research and it will be accomplished by adjusting the weights of the artificial neural network (ANN) until the difference between the desire output and the main output of the network is negligible.

Training algorithm is usually selected to modify the weight of the ANN and in turn achieve the set objective. ANN training involves configuring a neural network such that it will accept input data and predicts the desire output based on the pattern of the input fed into the network. Training algorithm is the procedure employed for learning by a neural network. This procedure usually involves adjusting the synaptic weights of the network until a desire output is obtained. Many training algorithm can be used for prediction problem but the most efficient one is the Multi-layered Perceptron (MLP) [32, 33] as it can solve virtually all prediction problems [31], of which spectrum occupancy prediction is one.

ANN Validation: this stage involves verifying the validity of the processed data before it will be used for training the network. Also, the neural network is here validated to ensure functionality of the network.

ANN Testing: After validation, the neural network will be tested using the validated data in order to establish the accuracy of the prediction procedure.



As shown in fig 3, connection between the units is in such a way that each unit serves as a contributor to the input of the unit it i on is the unit model of the a :work (put from all neighbouring ne ın output depending on its synaptic weight and activation functi

Fig 3: Artificial neural network architecture

Some of the activation functions that can be used include; Threshold activation function (McCulloch-Pitts Model), Piecewise-linear activation function, Sigmoid (logistic) activation function, Hyperbolic Tangent function and Softmax activation function.

Artificial neural network (ANN) model for neuron k can be expressed mathematically as:

$$V_k = \sum_{j=1}^{n} w_{kj} x_j \qquad \ldots\ldots (3)$$

$$y_k = \varphi(v_k + \theta) \qquad \ldots\ldots (4)$$

Where x_1, x_2, x_3....x_n are the inputs to the network, w_1, w_2, w_3,...w_{kn} are the synaptic weights to the network, V_k is the linear combiner, θ is the bias and φ is the activation function while y_k is the output of the neuron.

The sigmoid activation function is commonly adopted for artificial neural network spectrum prediction model formulation as well as implementation. This is due to the fact that apart from being the most commonly form of activation function used in the construction of artificial neural network (ANN) models, it always assumes the values of 0 or 1 which can form the basis for occupied-unoccupied (i.e., black or white) spectrum bands. Apart from this, the sigmoid activation function is also differentiable and this is an important feature of neural network theory [30].

Because ANN has less error rate when used for prediction and can learn using previous experiences and/or historical data, it is a suitable cognitive radio (CR) sensing and prediction tool.

Advantages of ANN

- ANN has less error rate when compare to other tools like HMM, Fuzzy logic, partial periodic pattern mining (PPPM) etc.
- It is non-linear in nature. This feature makes ANN a suitable prediction tool as many real life problems are non-linear.
- ANN has high level of adaptivity. It has built-in ability to adapt by adjusting its synaptic weights as its surrounding environment changes.
- ANN is fault tolerant. When ANN is operated under adverse condition, its performance rather degrades gracefully than failing catastrophically.
- ANN does not require continuous training unlike other prediction tools. It is trained once and for all, usually in an offline mode.

Disadvantages of ANN

- ANN has partial optimization problem which usually reduces probability of optimal outcomes
- ANN also suffers from the problem of generalization, a situation where by the input-output mapping by the network does not fully conform to the input/output patterns.

3.3 Autoregressive Prediction Model

This is a time-series model used for approximation of discrete-time random processes. It is a good linear prediction tool for processes that varies with time. ARM as it is commonly referred, employs the principle that predicted output (variable) depends linearly on its previous value as well as a stochastic term (usually an imperfectly predictable term). Autoregressive model (ARM) is also known as a stochastic process used in statistical calculation in which prediction is estimated on a weighted sum of past values.

ARM as a spectrum occupancy tool can be expressed as:

$$X_t = \sum_{i=1}^{p} \varphi_i X_{t-i} + \omega_T + C \qquad (5)$$

Where X_t is Predicted State

φ_i is parameter of the model

X_{t-i} is observation time at time t-i

ω_T is white noise at time T and

C is constant

In using ARM as a prediction tool, it is necessary to estimate the model parameter φ_i by the secondary opportunistic user. This can be done using approaches like, Maximum likelihood estimation, Yule-Alker equation, Maximum entropy estimations etc.

Advantages of Autoregressive Model

- ARM requires data on time series a feature that is beneficial when predicting a large number of time series
- Computation using ARM can be done fast, as there is no need to develop complicated models
- ARM is robust for short-time prediction

Disadvantages of Autoregressive Model

- ARM is generally poor at predicting turning points i.e., it is 'backward looking'.
- Reliability of ARM depends on the experience of the forecaster.

-

3.4 Partial Periodic Pattern Mining Model

Periodic pattern mining is a process of extracting useful information from patterns that repeats itself with a specific period in a give sequence. It is usually carried out on so many datasets some of which include social networks, biological sequences and spatio-temporal data like spectrum usage measurement. In [35], Periodic patterns are classified into two as full periodic (complete periodic) and partial periodic. In full periodic pattern, every position in the pattern exhibits the periodicity. Partial periodic pattern is one in which one or more elements do not exhibit the periodicity. PPPM is tailored to identify naturally irregular realistic patterns. This irregularity can be caused by factors like noise, fluctuation in user's behavior, detection errors etc.

Spectrum occupancy prediction has been done using partial periodic pattern mining (PPPM) as introduced in [34]. In the research, spectrum utilization was considered to be irregular and hence imitates traffic. The algorithm proposed made use of combination of index list structure, the backward-extension rule, Apriori-like property, and gap-constrained pattern growth to achieve reliable and realistic partial periodic pattern mining.

The performance of proposed PPPM was compared with the frequent pattern mining (FPM) algorithm using wireless network activities and data obtained from the paging bands. Results show significant reduction in the miss rate when compared to FPM-based prediction model.

Advantages of PPPM

- PPPM helps in provision of useful information related to regularly occurring events.
- PPPM generates more occupancy patterns thus extra channel states prediction opportunities
- PPPM provides timely estimation of spectrum holes.

Disadvantages of PPPM

- Partial periodic pattern mining usually generates huge number of patterns more than half of which may be irrelevant to the application or user requirements.

4. SUMMARY AND DISCUSSION

In this paper, four (4)spectrum occupancy prediction models were presented. Their concepts, application to radio spectrum occupancy prediction, advantages and

disadvantages of each of the prediction models were also discussed. These models has been applied to occupancy prediction to reduce the time require for the opportunistic secondary user (SU) to sense the channel before cognitive activity will take place. ANN, HMM and PPPM were identified as most efficient with ANN topping the efficiency chart.

ANN is not without limitations. Local convergence and generalization are the major shortcomings of ANN and can be corrected through optimization.

5. CONCLUSION

To avoid harmful interference to the licensed user in a cognitive system, quick and adequate channel status prediction is an important task. It will also save some sensing time, reduce collision probability and power consumption of the opportunistic secondary user (SU). Although there are limitations to the reviewed occupancy models, their applicability to cognitive radio (CR) cannot be overemphasized. In conclusion, to achieve the objectives of novel idea of CR, lots of work is still required especially in the aspect of testing the aforementioned occupancy models with real life spectrum occupancy measurement data as their performance were determined without real data.

REFERENCES

[1] Global Data (2017) "The Mobile Economy, 2017". Available at: https://www.gsmaintelligence.com/research/?file=9e927fd6896724e7b26f33f61db5b9d5&download. Retrieved on 20/03/2017.

[2] Faruk, N., Ayeni, A., & Adediran, Y. A. (2013). "On the Study of Empirical Path Loss Models for Accurate Prediction of Tv Signal for Secondary Users". *Progress In Electromagnetics Research B*, *49*, 155–176. doi:10.2528/PIERB13011306

[3] COGEU, (2012). "Cognitive radio systems for efficient sharing of TV white spaces in European Context" Available on http://www.ict-cogeu.eu/pdf/COGEU_D7.1%20(ICT_248560).pdf [Accessed on 10/04/2012] pp 73-101

[4] McHenry, M. A., Tenhula, P. A., McCloskey, D., Roberson, D. A., & Hood, C. S. (2006). "Chicago spectrum occupancy measurements & analysis and a long-term studies proposal". *In Proceedings of the first international workshop on Technology and policy for accessing spectrum (TAPAS '06)* pp. 1–12. ACM Press New York, NY, USA, 2006. doi:10.1145/1234388.1234389

[5] Chiang, R. I. C., Rowe, G. B., & Sowerby, K. W. (2007). "A Quantitative Analysis of Spectral Occupancy Measurements for Cognitive Radio". *2007 IEEE 65th Vehicular Technology Conference - VTC -Spring*. doi:10.1109/VETECS.618

[6] August, P., & Mchenry, M. A. (2005). "NSF Spectrum Occupancy Measurements Project Summary". pp1–24. Retrieved from http://www.sharedspectrum.com/inc/content/measurements/nsf/NSF_Project_Summary.pdf [Retrieved on 28/09/2012]

[7] Wellens, M., Baynast, A., & Mahonen, P. (2008). "Exploiting Historical Spectrum Occupancy Information for Adaptive Spectrum Sensing". *2008 IEEE Wireless Communications and Networking Conference*. doi:10.1109/WCNC.132

[8] Federal Communications Commission. (2008). "In the Matter of Unlicensed Operation in the TV Broadcast Bands Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band". *ET Docket 08-260* (pp. 1–130).

[9] Ofcom. (2009). "Digital Dividend: Cognitive Access, Statement Licence-Exempt Cognitive Devices Using Interleaved Spectrum". Retrieved from http://stakeholders.ofcom.org.uk/binaries/consultations/cognitive/statement/statement.pdf [Retrieved on 18/01/2012].

[10] NCC. (2007). "Commercial Frequency Management Policy, Administrative Procedures and Technical Guidelines", November, 2007. Available at http://www.ncc.gov.ng/component/docman/doc_download/137-commercial-frequency-management-policy-administrative-procedures-a-technical-guidelines.html [Accessed on 17/08/2012]

[11] MIC. (2010). "Final Report: The research team for a new vision of spectrum utilization" , Press release, July, 2010. Available at http://www.soumu.go.jp/main_content/000077004.pdf [Accessed on 26/07/2012]

[12] FCC. (2003). "Notice of Proposed Rule Making and Order. Communications" *ET Docket No 03-322* (p. 53),. Retrieved from http://www.fcc.gov [Retrieved on 20/06/2012]

[13] Harrison, K., Mishra, S. M., & Sahai, A. (2010). "How Much White-Space Capacity Is There?" *New Frontiers in Dynamic Spectrum, 2010 IEEE Symposium on*. doi:10.1109/DYSPAN. 5457914

[14] Van de Beek, J., Riihijarvi, J., Achtzehn, A., Mahonen, P., & Beek, J. van de. (2011). "UHF white space in Europe; A quantitative study into the potential of the 470&790 MHz band". *2011 IEEE International Symposium on Dynamic Spectrum Access Networks (DySPAN)*, 1–9. doi:10.1109/DYSPAN.5936207

[15] Nekovee, M. (2009). "Quantifying the Availability of TV White Spaces for Cognitive Radio Operation in the UK". *IEEE International Conference on Communications Workshops*. *pp.1-5 doi: 10.1109/ICCW.2009.52080305.* June, 2009.

[16] Kang, K.M., Park. J.C., Chio, S.I., & Jeong, B. . (2011)**.** "Deployment and coverage of cognitive radio networks in TV white space". *IEEE Communications Magazine*, *50*(12), 88–94.

[17] Mitola, J. & Maguire, G. Q. (1999). "Cognitive radio: Making software radios more personal". *IEEE Personal Communication Magazine,* vol.*6 no.*4, pp.13–18.

[18] S. Pattanayak, P. Venkateswaran & R. Nandi. (2013). "Artificial Intelligence Based Model for Channel Status Prediction: A New Spectrum Sensing Technique for Cognitive Radio". *International Journal of Communications*, *Network and System Sciences*, 139-148 http://dx.doi.org/10.4236/ijcns.2013.63017. March, 2013.

[19] Gafai Najashi, Barau, Feng Wenjiang, and Mohammed Dikko Almustapha. "Spectrum Hole Prediction Based On Historical Data: A Neural Network Approach. *International Journal of Computer Science Issues,* 10(4), No. 2, July 2013..

[20] Bara'u Gafai Najashi, W.F., (2014). Cooperative spectrum occupancy based spectrum prediction modeling. *Journal of Computational Information Systems*, *10*(10), pp.4093-4100.

[21] Pham, Chuan, Nguyen H. Tran, Cuong T. Do, Seung Il Moon, and Choong Seon Hong.(2014). "Spectrum handoff model based on hidden markov model in cognitive radio networks."In *Information Networking (ICOIN), 2014 International Conference on*, pp. 406-411. IEEE 2014.

[22] T. Clancy and B. Walker, (2006). "Predictive dynamic spectrum access," in *Proc. SDR Forum Technical Conference*, Orlando, Florida, USA, Nov. 2006. Available at;

[23] Ahmadi, H., Chew, Y.H., Tang, P.K., Nijsure, Y.A. (2011). "Predictive opportunistic spectrum access using learning based hidden markov models". In: IEEE PIMRC'11 (2011).

[24] Candy, J.: Bayesian (2009). "Signal Processing: Classical, Modern, and Particle Filtering Methods". Wiley-Interscience, New York (2009).

[26] I. A. Akbar and W. H. Tranter (2007), "Dynamic spectrum allocation in cognitive radio using hidden markov models: Poisson distributed case," in *Proc. IEEE Southeast Conference*, Richmond, VA, 2007, pp. 196–201.

[27] C.-H. Park, S.-W. Kim, S.-M. Lim, and M.-S. Song (2007), "HMM based channel status predictor for cognitive radio," in *Proc. IEEE Asia-Pacific Microw. Conf.*, Bangkok, Singapore, 2007, pp. 1–4.

[28] P. Joshna Rani (2016), "Advantages and disadvantages of hidden markov model", Available at: https://www.slideshare.net/joshiblog/advantages-and-disadvantages-of-hidden-markov-model. Retrieved on: 30/07/2017.

[29] McCulloch, W. S and Pitts, W. (1943). A logical calculus of the ideas immanent in nervous activity. *Bulletin of Mathematical Biophysics*, 5, 115-133.

[30] Hajek, M (2005) Neural Networks. Available at: https://www.cs.ukzn.ac.za/notes/NeuralNetworks2005.pdf . Retrieved on: 24/06/ 2015.

[31] Ben Krose and Patrick van der Smagt (1996). An Introduction to Neural Networks. University of Amsterdam. Available at: https://www.infor.uva.es/~teodoro/neuro-intro.pdf . Retrieved on: 29/07/2017

[32] Tumuluru, Vamsi Krishna, Ping Wang, and Dusit Niyato. (2010). "A neural network based spectrum prediction scheme for cognitive radio". Communications (ICC), 2010 IEEE International Conference on communication (ICC), 2010.

[33] Tumuluru, Vamsi Krishna, Ping Wang, and Dusit Niyato. (2012). "Channel status prediction for cognitive radio networks". Wireless Communications and Mobile Computing 12.10: 862-874.

[34] Huang, Pei, Chin-Jung Liu, Li Xiao and Jin Chen. (2014) "Wireless spectrum occupancy prediction based on partial periodic pattern mining." Parallel and Distributed Systems, IEEE Transactions on 25.7: 1925-1934.

[35] G.N.V.G. Sirisha, M. Shashi & G.V. Padma Raju. (2013). "Periodic Pattern Mining Algorithms and Applications", Global Journal of Computer Science and Technology Software & Data Engineering, Volume 13 Issue 13 Version 1.0 Year 2013.

[38] Babalola, O., Garba, E., Oladimeji, I., Bamiduro, A., Faruk, N., Sowande, O., Muhammad, M. (2015). Spectrum occupancy measurements in the TV and CDMA bands. Paper presented at the 2015 International Conference on Cyberspace (CYBER-Abuja).

[39] Ayeni, A. A., Faruk, N., Bello, O. W., Sowande, O. A., Onidare, S. O., & Muhammad, M. Y. (2016). Spectrum Occupancy Measurements and Analysis in the 2.4-2.7 GHz Band in Urban and Rural Environments. International Journal of Future Computer and Communication, 5(3), 142.

[40] A. Gorcin, et al., "An autoregressive approach for spectrum occupancy modeling and prediction based on synchronous measurements," in Int. Symp. on Personal Indoor and Mobile Radio Commun., Toronto, 2011, pp. 705-709.

[41] Boyacı, Ali & Akı, Fatma & Yarkan, Serhan. (2015). On error variance for autoregressive process-based spectrum occupancy prediction with energy detector for cognitive networks. 868-873. 10.1109/IWCMC.2015.7289197.

[42] Z. Wang and S. Salous, "Spectrum occupancy statistics and time series models for cognitive radio," J. Signal Process. Systs., vol.62, no.2, pp.145–155, Feb. 2011.

[43] Logofet (2010). Markov chains as models of succession: New perspectives of the classical paradigm. No. 2. Page4659. Available at: https://cyberleninka.ru/article/n/otsenka-strukturnoy-degradatsii-lesnyh-ekosistem-i-ih-vosstanovitelnogo-potentsiala-s-pomoschyu-markovskoy-modeli-suktsessii

[44] AbdulRahman, T.A., Ayeni, A. A., & Faruk, N., (2014). TV Spectrum Usage profile and White Space for Nigeria. International Journal of Information Processing and Communication Vol. 2 No. 1&2 Pg. 129-141.

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THE RELEVANCE OF DATA MINING TECHIQUES IN ALLEVIATING CYBERSECURITY BREACHES IN NIGERIA HEALTHCARE SECTOR

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ABSTRACT

In the face of threat of viruses, malware and spyware almost from the inception of computing, awareness of data security and clarity of computer systems data didn't make a pull until the explosive growth of the Internet. This points to the exposure of so many different organizations' devices on the web which provided an absolute environment for hackers to test their expertise –now called cybersecurity breaches (cybercrimes). Recently, healthcare organizations, clients/payers and regulatory bodies have been exposed to ever-increasing data confidentiality, integrity and security perils affecting their operations and governmental environment as well as patient self-confidence. Cybercrimes are on the rise as healthcare organizations' devices access to internet increases. Healthcare organizations has increasingly moved outside the hospital walls into various homes and communities using consumer-based technologies, thereby building patients' and government confidence in order to secure patient's data and information. Health organizations in Nigeria must balance prudently how to address patient's confidentiality and develop security measures in a cost effective manner. This paper attempt to provide an overview of cybercrimes and cybersecurity in healthcare sector; identify various reasons for cybercrimes and document a propose process of annihilation through the involvement of data mining techniques. In addition, it looks at the approaches of stepping up cybersecurity and recommendations that would help healthcare organizations and government policy makers in checking the increasing rate of cybercrimes.

Keywords: *Cybersecurity, Cybercrime, Healthcare, Internet, Information and communication technology (ICT),*

1. INTRODUCTION

The information and communication technology (ICT) industry has advanced positively and greatly over the last fifty years. This technology is pervasive and increasingly essential and relevant to almost every aspect of contemporary civilization where Healthcare is one prominent industry. Devices and communication components of healthcare ICTs are interdependent and so interruption of one may have either positive or negative impact on others. Concerns of protecting and securing these healthcare ICT systems from internal or external attacks has increased likewise in the last several years. ICT experts have concluded that these might increase in frequency and sternness over the next couple of years. On this wise, the act of protecting these healthcare ICT systems, components and their contents is what is known as *Cybersecurity* (Fischer, 2016; Schaeffer et al., 2009).

These technologies (ICT) have transformed how people interact, socialize, shop, communicate with government and engage in business transactions as well as receive medical attentions. The internet and the World Wide Web have created massive amounts of information communication instantly available, and today smartphones and tablets have supported the duo by bringing the information at our fingertips everywhere we go. Hence, our communication with the outside world is not being altered by the Internet of Things (IoT) (Abomhara & Køien, 2015). Current surveys have estimated the internet users to be around 15 billion of the world populace; and an estimate of 26 billion to 50 billion has been postulated for 2020. Data and information storage is already increasingly ever-changing to the Cloud which is increasing data availability and usefulness but at the same time increasing its intricacy (Cameron F. & Gallagher, 2012; James, 2016; Royal Society, 2016).

Therefore, current cybersecurity practices in healthcare are not up to the task for demanding evidence-based standards of security. This has subjected the healthcare data and information systems to be vulnerable, both to upcoming threats and to those already well understood. Healthcare digital systems are already central to our security, wellbeing and development, but the threats and risks against the healthcare data and information constantly increasing and progressing. Hence, cybersecurity tools, processes and institutions need to draw level and carry on with these threats (CGI, 2015; ESET, 2016).

The healthcare sector, in different under-developed nations such as Nigeria, is confronted with a distinctive set of business, environmental and technical drivers of threat, along with exceptional set of regulations and polices for patients' PHI (Patient Health Information), Electronic Health Records (EHR) and Health Data management (HDM) (Brookson, 2016). Hence, healthcare information technology sectors concentrating on clinical transformation agenda often treat patients' confidentiality as policy thereby subjecting IT security as a secondary function. There are few nations' sectors that need strong cyber security as much as the nation's healthcare. Personal health and lifestyle information is increasingly valued as a product of tool by cyber-attackers. Therefore, from personal medical devices to enterprise-wide platforms, computer systems

are being targeted maliciously with resulting losses of data. Time-consuming compliance are worsened by the scarcity and high cost of skilled confidentiality and security resources, complex and risky information and communication technology (ICT) and ever increasingly dangerous and pervasive cyber threats (Serianu & Paladion, 2016).

In nations around the world, patients are dealing with life threatening conditions, thereby exchanging huge amount of money and financial information (such as bank accounts numbers, social security numbers - SSN and biometric verification number – BVN, in Nigeria) and these must have their confidentiality protected when it comes to medical records. Unfortunately, the healthcare sector is one of the biggest targets for cybercriminals of which Nigeria is not an exception. Efforts has been made by the Nigerian government (with supports from regulatory bodies like Code of Conduct Bureau, Independent Corrupt Practices Commission – ICPC, Economic and Financial Crime Commission, and so on) to checkmate most of the insubordinates in terms of corruption in different sectors like banking, education, including healthcare since the inception of BVN (Serianu & Paladion, 2016). The Nigerian government has mandated the citizens to be enrolled for the BVN and in same vein trying to connect this scheme with the National Identity Cards being controlled by the National Identity Management Commission (NIMC) (ESET, 2016; Serianu & Paladion, 2016)

In 2015 alone, for instance, according to IBM survey, there were over 100 million healthcare breaches of medical records (CGI, 2015). Frequently, healthcare organizations, most especially in Nigeria, do not understand their patient's data and information confidentiality and security risks, or do they know where to commence the improvement of their security stance. Correspondingly, with the increase of amalgamated system access to data and information, many healthcare organizations in Nigeria are not compliance with progressing regulation to protect the confidentiality of their PHI (Fischer, 2016).

According to Jim Finkle of Reuters in CGI (2015), on April 23, 2014, the US Federal Bureau of Investigation (FBI) has cautioned healthcare organizations that "*The healthcare sector is not as resistant to cyber intrusion compared to financial institutions and retail sectors, therefore the possibility of increased cyber intrusion is likely for healthcare sector*". Most healthcare organizations lack the capacity or financial resources to effectively address their increasing challenges in areas such as:

- compliance with patients' confidentiality, consent and other regulatory requirements
- identity and data loss theft
- lack of skilled security professionals
- consumerization of healthcare or BYOD – Bring Your Own Device
- assessing their safeguard effectiveness, and

- improving and maintaining employee confidentiality and security awareness (CGI, 2015)

Cybersecurity has shown to be more than just ordinary policies, security protectors and assessments. But, recently, they have shown to be standing as a solid backbone to support existing and future business growth in a way that is compliant, cost effective and secure. Hence, without a solid data confidentiality and security framework, health organizations in Nigeria will operate with an increasing amount of risk in the nearest future as they attempt to deal with ever rising threats and progressing regulation (Frank & Odunayo, 2013; Schaeffer et al., 2009)

Hence, this paper would address the concept of cybercrimes and cybersecurity measures, identify reasons for imminent cybercrimes in healthcare, those likely to be involved and their involvement, the involvement of data mining methods of stepping up healthcare cybersecurity and suggestion of checkmating the likely increasing rate of cybercrimes. Finally, it would itemize various possible combinatorial data mining techniques for alleviating healthcare cybercrime challenges to their looming threats.

This paper is organized as follows; first section presents the outline of cybersecurity, cyberspace and cybercrimes. Thereafter, classes of cybercrimes is propose then the cyber-attack stages. In addition, various proposed data mining techniques for expected solution to cybersecurity threats is presented. Conclusion and recommendation are however presented at the end of the paper.

1.1 Outline of Cybersecurity, Cyberspace And Cybercrimes

Cybersecurity is the act of protecting ICT systems and their content from both internal and external attacks (Fischer, 2016). In another perspective, cyberspace is an interactive field comprising of digital networks that are used to store, modify and communicate information. It also includes the internet and other information systems that support human daily businesses, infrastructure and services (Lobban, 2012). Hence, cybersecurity is thus concerned with ensuring cyberspace is safe from threats viz a viz cyber threats (Olayemi, 2014). In addition, cybersecurity can also be termed as the act of securing systems processes, data or information thereby hindering their exploitation (James, 2016).

Decades ago, IT experts and policy makers have expressed the increased concerns about the act of cybersecurity from cybercrimes processes which are deliberate attempts by unauthorized persons to access ICT systems usually with the aim of inflicting destruction, damage, disruption or other ungoverned actions (Schaeffer et al., 2009). Vulnerabilities increases at an alarming rate and breaches cause substantial impairment to individual and businesses alike. Healthcare clinical data and information are bond to face more threats in Nigeria as they become more complex and also as the attackers' pay offs increases. Hence, research, policy and analysis practices all have a paramount role to play

in protecting these data against these looming threats as each stages faces challenges that are distinct to cybersecurity (Abomhara & Køien, 2015).

Cybersecurity is fundamentally multidisciplinary, which points to the fact that it takes account of both technical and mathematical intuitions deeply and also of the social and behavioural sciences. The understanding of the real-world scenarios of digital systems and human systems behaviour depends solely on the wide range of disciplines. Therefore, effective cybersecurity measures will need to integrate insights from all area. Cybersecurity challenges, threats and opportunities are global, with diverse networks, services and attacks rarely confined to a single authority. Data are easily transmitted and transferred around the world which can be rapidly replicated and are sometimes extremely long-lived. This tends to make it harder to respond to attacks, identify the attackers and secure the data (Royal Society, 2016).

Cybersecurity domain is inherently a dynamically changing one, hence newer attacks such as multi-stage exploits and zero-day attacks can be significantly more diverse that old attacks in terms of technical implementation as well as the underlying protective measures themselves in the unending knowledge race between attackers and protectors (Tianfield, 2017). As cyber-attacks have evolved and grown in sophistication, cybercrimes detection techniques have also become much more sophisticated by monitoring an ever increasing amount of diverse heterogeneous security event sources. Cybersecurity basically is about the capability to defence the information infrastructure from cyber-attacks (Tianfield, 2017). Looking at the trend cybercrimes get increasingly persistent, advanced, and stealthy, cyber defence has to rely upon systematic and intelligence oriented methodologies. Steven Noel *et.al.* (2002) in (Barbara & Jajodia, 2004) presents an overview upon various techniques under different detection models, from misuse detection to anomaly detection respectively ad introduce degree of susceptibility to attack as a way of characterizing intrusion detection activities. In overall, getting a grip of the data view is very important. Therefore, across different cyber control domains and over a practical period of time, there are actually voluminous and diverse sources of security information dat. Hence, the ability to exploit and comprehend cybersecurity data enables or otherwise restricts the capability of cyber defence (Schultz, Eskin, & Stolfo, 2002; Varun, *et.al.*, 2006)

Furthermore, in order to deal with increasing information security threat in large scale data networks such as healthcare clinical data, countless kinds of security devices have be used in the past and these devices produce lots of security events. It can be very difficult to correlate events over such large amounts of data where they are heterogeneous in nature. The heterogeneity within a myriad of security techniques and systems which do not integrate well would cause difficulties for correlating security events. Hence, in order to mitigate or prevent attacks, awareness of attack is essential to be able to react and defend against attackers. Therefore, cybersecurity defenses can further improved by utilizing security analytics to look for hidden attack patterns and trends in healthcare

clinical data through the involvement of data mining techniques (Barbara & Jajodia, 2004; Lawrence, Kudyba, & Klimberg, 2008; Thuraisingham, *et.al.*, 2008)

1.2 Healthcare Cybersecurity Objectives

The following are the important objectives of healthcare cyber-security (Frank & Odunayo, 2013).

- reduce the vulnerability of patients' PHI, HER Information and Communication Technology (ICT) systems and networks.
- develop and nurture a culture of cyber security for both healthcare users and authority
- to work collaboratively with public, private and international entities to secure healthcare cyberspace.
- to help healthcare organizations understand the current trends in IT/cybercrime, and develop effective solutions.
- Availability of security measures.
- Integrity, which may include authenticity and non-repudiation.
- Confidentiality of healthcare data and information.

2. CLASSES OF CYBER-CRIMES

Cybercrimes are the major threats that every organization experienced when a loop hole is discovered by the attackers. There are diverse classes of cyber-crimes with respect to various organizations including the healthcare sector. The following are some of the classes of cybercrimes according to Ford & Siraj, (2015; Frank & Odunayo, (2013); James, (2016); and Schaeffer et al., (2009)

(i.) Spamming– involves mass amounts of email or SMS being sent in order to promote and advertise products and websites. Email spam is becoming a serious issue amongst businesses, due to the cost overhead it causes not only in regards to bandwidth consumption but also to the amount of time spent downloading/eliminating spam mail.

(ii.) Viruses and worms: This is a major threat to everyday users and organizations. Viruses are computer programs that are designed to damage computers. It is named virus because it spreads from one computer to another like a biological virus. A virus must be attached to some other program or documents through which it enters the computer. A worm usually exploits loop holes in software or operating system. Trojan horse is dicey. It appears to do one thing but does something else.

(iii.) Cyber-Theft: Cyber-Theft is the use of computers and communication systems to steal information in electronic format. Hackers crack into the systems of banks and transfer money into their own bank accounts. This is a major concern, as larger amounts of money can be stolen and illegally transferred. Cyber-theft is the most common and the most reported of all cyber-crimes. Cyber-theft is a

popular cyber-crime because it can quickly bring experienced cyber-criminal large cash resulting from very little effort

(iv.) Financial Fraud- This is also known as "Phishing' scams, and involve a level of social engineering as they require the perpetrators to pose as a trustworthy representative of an organization, commonly the victim's bank.

(v.) Hacking: Hackers use the weaknesses and loop holes in organizations operating systems to destroy data and steal important information from victim's computer. It is normally done through the use of a backdoor program installed. A lot of hackers also try to gain access to resources through the use of password hacking software. Hackers can also monitor what u do on your computer and can also import files on your computer. A hacker could install several programs on to your system without your knowledge. Such programs could also be used to steal personal. Important data of a company can also be hacked to get the secret information of the future plans of the organization.

(vi.) Identity Theft, Credit Card Theft, Fraudulent Electronic Mails (Phishing): Phishing is an act of sending an e-mail to a user falsely claiming to be an established legitimate enterprise in order to scam the user into surrendering private information that will be used for identity theft.

(vii.) Cyber harassment- is electronically and intentionally carrying out threatening acts against individuals. Such acts include cyber-stalking.

(viii.)Cyber laundering- is an electronic transfer of illegally-obtained monies with the goal of hiding its source and possibly its destination.

(ix.) Website Cloning: One recent trend in cyber-crime is the emergence of fake 'copy-cat' web sites that take advantage of consumers what are unfamiliar with the Internet or who do not know the exact web address of the legitimate company that they wish to visit. The consumer, believing that they are entering financial details in order to purchase goods from the intended company, is instead unwittingly entering details into a fraudster's personal database. The fraudster is then able to make use of this information at a later stage, either for his own purposes or to sell on to others interested in perpetrating credit card fraud.

3. CYBER ATTACKS STAGES

Regardless of whether an attack is performed internally (within) or externally (from hackers), targeted or untargeted or the attackers is using commodity or personalized tools, cyberattacks have a numbers of stages in common. Some of the attacks may meet their intended goals while others may be blocked by the measures in placed by the recipient.

An attack may consist of recurrent stages if it is carried out by a persistent enemy. The attacker is effectively probing target defenses for weaknesses such that if exploitable

will take them closer to their ultimate objective. Understanding the stages will help the targeted organization to prepare better in defending themselves. Quite a number of attack model describe the stages of cyber-attacks(NCSC, 2016). A sample of the stages of attacks is demonstrated in a simplified model below



Figure 1: Stages in a Cyber-attack (NCSC, 2016)

- Survey - investigating and analyzing available information about the target in order to identify potential vulnerabilities
- Delivery - getting to the point in a system where a vulnerability can be exploited
- Breach - exploiting the vulnerability/vulnerabilities to gain some form of unauthorized access
- Affect - carrying out activities within a system that achieve the attacker's goal

3.1 Characteristics of Healthcare Data Breaches

Healthcare organization data breaches of patient health information (PHI) that affected 500 or more individuals according to surveys (ESET, 2016; Serianu & Paladion, 2016)were characterized by:

1. type of breach and
2. location or mode of breached information.

However, data breach types can be categorized according to the following six (6) categories:

- hacking/IT incident,
- improper disposal,
- loss,
- unauthorized access/disclosure,
- theft, and
- other/unknown

In the same vein, data breaches are also categorized to the following locations or modes. The locations or modes includes seven (7) categories namely:

- desktop computer,
- Electronic Health Records (HER),
- email, laptop computer,
- network server,
- paper/films, and
- other location.

3.2 Types of Data Mining Techniques For Cybersecurity

There are several major data mining techniques that have been developed and used in data mining projects recently. Different data mining techniques including association, classification, clustering, prediction, and decision tree are used for detecting cyber-attacks either run on system audit data or network data like healthcare clinical data. We will briefly examine those data mining techniques in the following sections.

3.2.1 Association Rule Mining

Association is one of the best-known data mining technique. In association, a pattern is discovered based on a relationship between items in the same transaction. It looks for correlation that exists between different attributes in a dataset. It also discovers patterns based on a relationship of a particular item when such item are in transaction. That's is the reason why association technique is also known as relation technique. It captures implications between attributes values using the association rule mining algorithm. The concept of association rule mining is to find all co-occurrence relationships called associations. It finds frequent sets of items (e.g. combinations of items that are purchased together in at least N transactions in the database), and from the frequent items sets such as {X,Y}, generates association rules of the form: X → Y and/or Y→X (Barbara & Jajodia, 2004; Tianfield, 2017). In general, association rule mining is considered as an unsupervised techniques.

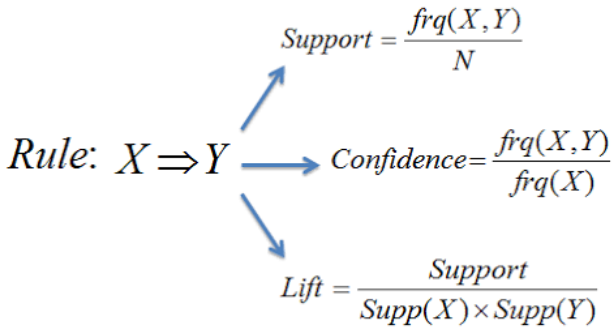


Figure 2: Association Rule Mining (Barbara & Jajodia, 2004)

The aim of association rule mining is to discover previously unknown association rules from the data. The technique would be a useful tool for cybersecurity in healthcare clinical data

3.2.2 Classification

Classification is a classic data mining technique based on machine learning. Basically, classification is used to classify each item in a set of data into one of a predefined set of classes or groups. Classification is the task of assigning database records to one out of a pre-defined set of target classes. The difficulty is that the target classes are not explicitly given in the database records but must be derived from the available attribute values

(Barbara & Jajodia, 2004). According to Tianfield (2017), Classification is the process of assigning data items to pre-defined classes. The result of these process will be a classifier based on association rules or decision trees. Classification method makes use of mathematical techniques such as decision trees, linear programming, neural network, and statistics. In classification, software models are developed that can learn how to classify the data items into groups.

There are two steps in classification : training and prediction stages (Tianfield, 2017). In the first step, classifier is trained by analyzing a training set made up of data instances and their associated class labels. Due to the class label of each training instance is provided, this is known as supervised learning. In the second step, the trained classifier is used to predict the class for unlabeled data instance.

3.2.3 *K*-Nearest Neighbour

The –Nearest Neighbour (*k*-NN) algorithm is a simple classification algorithm (Aggarwal & Chaturvedi, 2013; Barbara & Jajodia, 2004). Here all available cases (training data) are stored and new cases (test data) are classified based on a similarly measures (e.g. Euclidean distance) in the feature space. In the training data, the feature vectors are associated with respective class labels. For a new observed data, *k*-NN computes the distance between the new case an unlabeled vector) and all existing cases (labelled vectors) and then the test data is allotted to the class most common amongst its k nearest neighbours. It can be understood that the new observed data is categorized by the majority vote of its neighbours. If *k=1*, then the new data, without any doubt, is assigned to the class of its nearest neighbour. Large prediction time is needed if the value of *k* is large (Tianfield, 2017; Varun, *et.al.*, 2006)

3.2.4 Clustering

Clustering is a data mining technique that makes a meaningful or useful cluster of objects which have similar characteristics using the automatic technique. Clustering seeks to group database records so that the records within a given group/cluster are similar, whereas the records of different groups/clusters are dissimilar (Barbara & Jajodia, 2004). Evidently, the notion of similarity is key to this definition. According to Tianfield (2017); and Varun et al., (2006), classification is the process of seeking to describe the available datasets by grouping them into common clusters or categories.

Clustering could be utilized to detect anomaly. Unlike misuse detection which requires labelled data set and supervised algorithms, anomaly detections works on unlabeled dataset and uses unsupervised administrators. The clustering technique defines the classes and puts objects in each class, while in the classification techniques, objects are assigned into predefined classes. To make the concept clearer, we can take book management in the library as an example. In a library, there is a wide range of books on various topics available. The challenge is how to keep those books in a way that readers can take several books on a particular topic without hassle. By using the clustering

technique, we can keep books that have some kinds of similarities in one cluster or one shelf and label it with a meaningful name. If readers want to grab books in that topic, they would only have to go to that shelf instead of looking for the entire library. The classification scenario is also very applicable to cybersecurity in healthcare clinical data. Examples of clustering models are *k*-means algorithm, *k*-medoids clustering algorithm, expectation maximization clustering (EMC), etc.

3.2.5 Prediction – Support Vector Machine (SVM)

The prediction, as its name implied, is one of a data mining techniques that discovers the relationship between independent variables and relationship between dependent and independent variables. Support Vector Machine (SVM) is supervised learning for classification and prediction methods. SVM is a classifier based on finding a separating hyperplane in the feature space between two classes in such a way that the distance between the hyperplane and the closest data points of each class is maximized (Tianfield, 2017). SVM separates data points into two classes +1 and -1 using hyperplane. Class +1 represents normal data and class -1 for suspicious data. SVM maps the input vector into a higher dimensional feature space and obtains the optimal separating hyperplane in the higher dimensional feature space. In the event when the two classes are not separable, slack variables are added and a cost parameter is assigned for the overlapping data points (Thuraisingham, *et.al.*, 2008). SVMs are well known for their generalized tendency and are particularly useful when the number of features, *m*, is high and the number of data points, *n*, is low (i.e. $m>>n$

3.2.6 Decision Trees

The decision tree is one of the most commonly used data mining techniques because its model is easy to understand for users. Decision tree is a recursive and tree-like structures for expressing classification rules (Tianfield, 2017). It uses divide and conquer method for splitting of the data according to attribute values. The splitting process repeats for every child node till al elected attributes are considered. In decision tree technique, the root of the decision tree is a simple question or condition that has multiple answers. Each answer then leads to a set of questions or conditions that help us determine the data so that we can make the final decision based on it. Decision tree converts the given dataset in to a tree structure. The nodes of the tree represent the features and the edges represent the association between the features by value or features. Each leaf node i.e. the lowest level of the node represents the child label (Tianfield, 2017), decision tree is supervised learning and it takes a set of classified data as input, executes the algorithm o that and provides a tree as output where each leaf can be expressed as a decision and each intermediate node epitomizes a test. To classify a data item, it proceeds from root node to leaf node. The name of the class at the leaf node is the class of an unknown data item.

4. REVIEW OF RELATED LITERATURE

Several studies have been proposed by using diverse techniques in data mining to carry out data analysis and prediction of cyber-attacks detection. First on the list of cyber-attacks detection is the data analysis. The massive data collected by acquisition layer is for centralized storage and analysis in analysis tier, so as to extract the major information concerned. These studies includes:

CGI (2015) focused on the importance of cyberprivacy and cybersecurity for health data. They tried to make a clear explanation between cyberprivacy and cybersecurity to solve numerous misconceptions about the two elements with respect to health data. They develop a framework in a five stage element and demonstrate how they are aligned. The five key elements are for privacy (minimized data, limited use, data quality and assurance, security, audit and accountability) while for security (identification, protection, detection, respond and recovery)

Antony, Singh, & Leavline (2013) focused on using data mining techniques based on supervised learning based intrusion detection system to tackle cybersecurity in network systems. They analyzed the various changes of threats and attacks in network in recent times, various network sniffing, snooping tools for capturing network data and log data for analysis and learning. They make use of Naïve Bayes IB1 (nearest neighbour principles), C4.5 supervised learning algorithms and simulated it by the use of data training tool Weka with standard benchmark training and testing datasets.

Thuraisingham et al., (2008) applied different data mining techniques for cybersecurity. They work were applied to applications not limited to malicious code detection by mining binary executables, network intrusion detection by mining network traffic anomaly detection, and data stream mining. They developed different tools for data mining such as link analysis and association rule mining for detecting abnormal patterns. One of their future projects is exploring researching active defense. They also implement data mining techniques for Botnet detection.

Varun et al., (2006) predicted a model they tagged MINDS for cybersecurity. They focused on the use of clustering algorithm with emphasis on Anomaly detection approach. Their own work is a batch-mode implementation procedure that analyzes data in windows of 20 minutes. For each 20 minute observation period, the transform the Netflow data into a summary data set. With their focus on incoming scans, each new summary record correspond to a potential scanner i.e. pair of external source IP and destination port (SIDP)

Kalus Julisch (2002) in Barbara & Jajodia (2004) proposed data mining techniques for intrusion detection using a stand-alone technique of data mining. The use of data mining in isolation has adversely affect the quality of their results obtained. They discovered that the use of data mining isolation application is a dangerous activity, easily leading to the discovery of meaningless or even misleading patterns.

5 METHODOLOGY

Cyber security must be addressed seriously as it is affecting the image of the country in the outside world. The projected methodology would be tailored to meet the imminent trends of threats and vulnerabilities looming the healthcare sector in Nigeria. The following are the various projected methodology for cybersecurity breaches in healthcare sector in Nigeria.

(i.) Access Control and Identity Management: The username/password combination has been a fundamental of computer access control since the early 1960s.
(ii.) Authentication: Documents need to be authenticated as having originated from a trusted source and that they have not been subsequently altered.
(iii.) Malware scanners: Software that regularly scans files and messages for malicious code.
(iv.) Firewalls: A firewall program will monitor traffic both into and out of a computer and alert the user to apparent unauthorized usage.
(v.) Cryptography: It is used in two main ways in information security. The better known is to provide confidentiality by encrypting stored data and data in transit

6. EXPECTED SOLUTION TO CYBERSECURITY BREACHES IN NIGERIA HEALTHCARE SECTOR

The results of a breach involved in the healthcare sector be it hospitals, clinics, researchers and patients can range from annoying to catastrophic. Patients could be harmed or even die. Several people both patients and healthcare workers equally could be inconvenienced by systems going down. Likewise, bad publicity could harm clinics and hospitals in areas where consumers have choices. Prevention is the best solution but it, too, poses challenges. Experts, according to CGI (2015); Cheung, *et.al.*, (2011); Reddy & Reddy, (2015); and Serianu & Paladion, (2016), offer these ideas for shoring up security to prevent or mitigate attacks within the healthcare sector:

- Education and awareness: In the past, it was much more challenging implementing cybersecurity features because people didn't consider it a must having the notion of never been hacked, nobody stole any of my information, so I'm fine. But nowadays, the awareness is global. Continued education will help ensure that the people who need to use the secure systems are on board.
- Simplicity. The more complex a system is, the harder it can be to keep updated to guard against cyberattacks. Keep it simple idea is better. Organizations are advised not to have too many disparate things where updates are required as it breaks everything else. Hence, the hotter, new devices that a healthcare organization have, the more openings hey should have.

- Backup systems: When cybersecurity systems fail to prevent an attack, good backups can make it easier to recover.
- Emergency planning: Cybersecurity may be an emerging challenge, but emergency managers can tackle it by using strategies similar to those they use for other situations.
- Constant vigilance: Both manufacturers and owners of devices bear some responsibility for preventing attacks. Users and operators devices should be prepared to follow best practices for installing and testing the updates. This is done by starting with the fundamentals of evaluating bugs and vulnerabilities as well as information sharing.
- Realistic regulations: Cybersecurity plans need to keep in mind the mission and culture of the health-care industry. It is common in Nigeria for government agencies that regulate the healthcare systems to be slow with their approval. The regulatory space is not equipped today to handle the evolving nature of threats and the speed with which technological development is happening.
- Healthy attitude toward risk: It's easy to blame doctors for being reluctant to learn a new electronic medical record system, for example, update for their computer systems. Researchers need to be able to share information and produce new drugs. Healthcare providers need to be able to exchange patient information. The key is to consider cybersecurity through the lens of risk management.
- Cooperation: So many of the players in the healthcare sector are connected to each other and thus an attack on one entity with weaker security could threaten others. Hence, hospitals need to notify each other of attempted attacks so other hospitals can prevent them. In addition, a long-term solution would be for device developers to "develop products and services that are hard to compromise.

7. CONCLUSION AND RECOMMENDATIONS

Data mining techniques for cybersecurity in healthcare clinical data is a very active research area. Different data mining techniques has been itemized in this paper with their relevance to clinical data which can be used to detect abnormal patterns or intrusions in healthcare database system. Due to the involvement of these techniques, developers and users can now make all kinds of correlations which also raises privacy concerns. There's no doubt that cyber-attacks detection is big data processing and analytics problem. Data driven framework makes a systematic approach to addressing cyber-attacks detection issues. As an domain in itself, data mining for cybersecurity has a fairly established set of models ad techniques, however, facing advanced cyber-attacks problems, one of the practical challenges lying ahead is how the models of supervised and unsupervised learning, the models of cyber-attacks detection and the offline and online system models should be interwoven all together into an organic robust cyber-attack detection system to curb the looming menace in Nigeria healthcare sector There is no single answer for success, but by working across both public and private healthcare sector through

partnerships and by advancing security measures particularly with regard to mission critical systems, processes and applications that are connected into cyberspace, healthcare systems will be able to work towards a future environment that is both open and secure and prosperous.

REFERENCES

Abomhara, M., & Køien, G. M. (2015). Cyber Security and the Internet of Things : Vulnerabilities , Threats , Intruders. *Journal of Cyber Security*, *4*, 65–88. http://doi.org/10.13052/jcsm2245-1439.414

Aggarwal, P., & Chaturvedi, M. M. (2013). Application of Data Mining Techniques for Information Security in a Cloud : A Survey. *Int'l J. of Computer Applications*, *80*(13), 11–17.

Antony, D. A., Singh, G., & Leavline, E. J. (2013). Data Mining in Network Security - Techniques & Tools: A Research Perspective. *Journal of Theoretical and Applied Information Technology*, *57*(2), 269–278.

Barbara, D., & Jajodia, S. (2004). Applications of Data Mining in Computer Security. *Kluwer Academic Publishers*, 1–273.

Brookson, C. (2016). Tackling the Challenges of Cyber Security. *ETSI Whitepaper*, (18), 1–11.

Cameron F., K., & Gallagher, P. (2012). Cybersecurity, Innovation and the Internet Economy. *The Department of Commerce Internet Policy Task Force*, (June).

CGI. (2015). Cyberprivacy and Cybersecurity for Health Data. *CGI Group Inc*, 1–8.

Cheung, R. S., Cohen, J. P., Lo, H. Z., & Elia, F. (2011). Challenge Based Learning in Cybersecurity Education. *University of Massachusetts Journal*, 1–6.

ESET. (2016). The State of Cybersecurity in Healthcare Organizations in 2016. *Ponemon Institute Research*, 1–32.

Fischer, E. A. (2016). Cybersecurity Issues and Challenges: In Brief. *Congressional Research Service*, 1–9.

Ford, V., & Siraj, A. (2015). Applications of Machine Learning in Cyber Security. *ResearchGate*, (December), 1–7.

Frank, I., & Odunayo, E. (2013). Approach to Cyber Security Issues in Nigeria: Challenges and Solution. *Int'l Journal of Cognitive Research in Science, Engineering and Education*, *1*(1), 1–11.

James, C. (2016). Cybersecurity: Threats, Challenges, Opportunities. *ACS*, (November).

Lawrence, K. D., Kudyba, S., & Klimberg, R. K. (2008). *Data Mining Methods and Applications*. *Taylor & Francis Group, LLC*.

Lobban, I. (2012). 10 Steps to Cyber Security. *Centre for the Protection of National Infrastructure*, 1–20.

NCSC. (2016). Common cyber attacks : reducing the impact. *National Cyber Security Ceter*, (January), 1–16.

Olayemi, O. J. (2014). A socio-technological analysis of cybercrime and cyber security in Nigeria. *Int'l Journal of Sociology Ad ANthropology*, *6*(3), 116–125. http://doi.org/10.5897/IJSA2013.0510

Reddy, G. N., & Reddy, G. J. U. (2015). A study of Cyber Security Challenges and its emerging trends in latest technologies. *Int'l Journal of Scientific & Engineering Research*, 1–6.

Royal Society, T. (2016). *Progress & Research in cybersecurity - Supporting a resilient and trustworthy system for the UK*. *Science Policy Centre*.

Schaeffer, B. S., Chan, H., Chan, H., Ogulnick, S., Schaeffer, B. S., Chan, H., … Ogulnick, S. (2009). Cyber Crime and Cyber Security : *Whitepaper for Franchisors, Licensors and Others*, 1–17.

Schultz, M. G., Eskin, E., & Stolfo, S. J. (2002). Data Mining Methods for Detection of New Malicious Executables. *Columbia Uiv. Journal*, 1–12.

Serianu, & Paladion. (2016). Nigeria Cyber security report 2016. *United States International University - Africa*, 1–60.

Thuraisingham, B., Khan, L., Masud, M. M., & Hamlen, K. W. (2008). Data Mining for Security Applications. *IEEE/IFIP Int'l Conference on Embedded and Ubiquitous Computing*, (June), 1–6. http://doi.org/10.1109/EUC.2008.62

Tianfield, H. (2017). Data Mining Based Cyber-Attack Detection. *System Simulation Technology*, *13*(2), 90–104.

Varun, C., Eric, E., Levent, E., Gyotgy, S., & Vipin, K. (2006). Data Mining for Cyber Security. *Springer*, 1–20.

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A CLASSIFIED MEDIA ACCESS CONTROL ALGORITHM FOR TRAFFIC MANAGEMENT IN IEEE 802.11AH NETWORKS

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ABSTRACT

With increasing traffic demands associated with heterogeneous traffic profiles in the networks supported by IEEE 802.11ah, uncontrollable packet delay still remains an open issue. Previous works have mainly focused on reduction of network collision, and classification of stations based on major services they subscribe to. However, dynamic nature of the traffic heterogeneity associated with stations in IEEE 802.11ah were not considered. This work presents a classified media access control algorithm that takes the dynamic schedule of traffic into consideration. Preliminary results show that the scheme is able to reduce end-to-end packet delays for real-time services.

Keywords—*IEEE 802.11ah; CLZ-MAC; Delay; EDCA*

1. INTRODUCTION

The interactions of the sensor/actuator devices with the environment in the world today have brought about the emergence of new services and applications such as smart cities and smart grids. These developments have enabled a better quality of service to wireless networks (B. Bellata, L. Bononi, R. Bruno, A. Kassler, 2016). The rise in demands for delay-minimized wireless sensor networks as well as applications that involve Internet of Things (IoT) and Machine-to-Machine communications (M2M) has caused for deployment of enhanced IEEE 802.11ah Wi-Fi network (R. Akeela, Y. Elziq, 2017), (S. Tneeru, P.C. Jain, 2016). Internet of Things has enabled the interactions of smart devices to communicate and operate in a heterogeneous network and also to autonomously and

intelligently react to the environment as it leverages the virtual resources and physical resources that are cloud based (B. Afzal, S. Alvi, G.Shah, W. Mahmood, 2017). The IoT infrastructure consists of the embedded devices, sensors and other kinds of circuitry. However, challenges arrive from heterogeneity of both devices and traffic that is shared among them. There has always been a need to solve the problem of how to respond to traffic demands as well as how to enable a better scheduling of stations to ensure quality of services. IEEE 802.11ah which is expected to support M2M (Leon, 2015), involves the interactions of devices without the intervention of man. Applications in M2M includes industrial automations, smart cities, emergency services, intelligent utilities as well as agriculture and environmental monitoring. The unique features of M2M can be seen as scalability of numerous devices and infrequent transmission of small data. In order to enable better performance of this M2M technology, IEEE 802.11ah was proposed to take cognizance of traffic management to reserve energy and ensure delay is minimized. IEEE 802.11ah extends the range of transmission and enables Wi-Fi to accommodate about 8191 stations managed by only one Access Point (AP) (Leon, 2015). However, with increasing demands for heterogeneous networks by several stations of distinct traffic profiles and priorities, uncontrollable packet delay still remains an issue because stations are not effectively managed by the AP. This calls for the need to improve in managing the traffic in order to reduce the end-to-end delay for improved quality of service. Thus, this paper carried out a design of an algorithm to classify the numerous stations into four traffic profiles based on level of battery, real-time and non-real-time and the positions of stations to the AP. The paper also covers the channel access in the transmission queue and then evaluate the traffic delay performance. The technique, regroups all stations based on their service demands and gives priority in real-time. This strategy was proven to be effective in reducing the end-to-end delay experienced by real-time packets.

The other part of the paper is expressed as follows; Section II describes the background of the Wi-Fi network and relevant amendments made on its MAC layer. Section III gives the analysis of the proposed algorithm. Section IV explains the result for implementing the algorithm while section V shows the conclusion of the paper.

2. SYSTEM DESCRIPTION

In this section, the technical background of the Wi-Fi standard, the IEEE 802.11ah and other amendments were discussed. Further details of the 802.1ah scheme in the MAC layer and the specific requirements were discussed.

A. WLAN Network

Wireless Local Area Network (WLAN) also known as Wi-Fi or IEEE 802.11 is a network in wireless communication where stations (wireless sensor nodes) are connected with Access Point. Ethernet technology was first used to support the early wired LAN

which brought about the introduction of the Wireless LAN version in 1997 (B. Bellata, L. Bononi, R. Bruno, A. Kassler, 2016). The unique features of the WLAN include the ease of use, its flexibility and its interoperability. Since the emergence of Wi-Fi networks, there have been more emerging technologies, functionalities and several amendments. Among the amendments include: IEEE 802.11aa (2.4, 5GHz in 2012 established for robust streaming of Audio/Video), IEEE 802.11af (470-790 MHz band in 2014 for WLAN in TV White Space) and IEEE802.11ah in 2016 for WLAN in sub 1Ghz license exempt band.

B. IEEE 802.11ah Network

IEEE 802.11ah is an IEEE 802.11 standard which operates at sub 1GHz band of Industrial, Scientific and Medical (ISM) Band. The standard operates in the license exempt bands (W. Sun, M. Choi and Sunghyu, 2013). The IEEE 802.11ah was introduced to minimize power consumption and support a numerous stations (about 8191) coordinated by a single Access Point. IEEE 802.11ah sensors are deployed across basements, garages and market places. Table I shows the summary of IEEE 802.11ah respective features:

IEEE 802.11 set up a task group in 2010 to establish IEEE 802.11ah on the sub 1GHz standardization for improved performance in IoT and long range applications. Among the specific requirements for novel amendment include low data rates, small and infrequent data messages and non-critical delay of stations (T. Adame, A. Bel, B. Bellalta, J. Barcelo, M. Oliver, 2014).

Table 1: Summary of IEEE 802.11 Standard Amendment

Parameters	**Values**
Number of Stations	8191
Transmission mode	OFDM
Range	1000m outdoor
Network mode	Single hop
Packet Length	Up to 100 byte
Channel Bandwidth	1, 2, 4,8,16 MHz
Data Rate	150-4000

	kbps(for 1MHz BW), 65-7800KBPS (for 2MHz BW)

In order to increase the number of nodes that can be supported by the AP while the energy consumed is reduced, amendment was made on the MAC layer of the IEEE 802.11ah and stations are classified as TIM (Traffic Indication Map), Non TIM and unscheduled stations (T. Adame, A. Bel, B. Bellalta, J. Barcelo, J. Gonzalez, M. Oliver, 2013).

3. REVIEW OF RELATED LITERATURE

Several techniques have been employed to ensure a better performance on IEEE 802.11ah network to minimize end-to-end delay.

In IEEE 802.11ah TIM stations, the Distributed Channel Function (DCF), a default channel mechanism in Wi-Fi networks is combined with the allocated system for AP-Centralized period (Qutab-ud-din, 2015). DCF employs Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA) for best effort data transmission. The goal of DCF is to reduce network collision among stations that contend for channel access. However, there is no service differentiation in DCF scheme for prioritized scheduling since all stations have equal chance of channel access.

A service differentiation medium access mechanism known as Enhanced Distributed Channel Access (EDCA) is an amendment for DCF scheme of the IEEE 802.11 standard with the inclusion of Arbitration Interframe Space (AIFS), virtual collision policy and distinct Access Categories (ACs) for several classes of stations. EDCA is employed for group of stations in IEEE 802.11 networks which was first established in IEEE 802.11e standard. It has a better performance over DCF enabled stations with respect to delay (Z. Kong, Danny Tsang, B. Bensaou, D. Gao, 2004). In (T. Jun, X. Xing, C. Zhi-lan, Y. Zhi-wei Zhang zhi, 2009), the technique used the Carrier Sense Multiple Access Collision Avoidance (CSMA/CA) together with backoff mechanisms and AIFS. The effectiveness of this scheme in IEEE 802.11ah has not yet been established because of the unique requirements associated in terms of supporting multiple services and technologies.

In Grouped Synchronized DCF (GS-DCF), Restricted Access Window (RAW) and RAW slots were utilized to enable access to the groups of stations in IEEE 802.11ah (L. Zheng, M. Ni, L. Cai, J. Pan, C. Ghosh, K. Doppler, 2014). In (L. Tian, J. Famaey and S. Latre, 2016) also, RAW mechanism was used to share access to the groups but only

allowed specific groups to gain channel access simultaneously without prioritized scheduling. In another scheme, a random AIFS Number (AIFSN) technique complies with the CSMA/CA protocols (K. Ogawa, M. Morikura, K. Yamamoto, T. Sugihara, 2013). The parameters of $AIFSN_{max}$ which was randomly selected by stations are distributed to each station by the AP through a data frame to avoid traffic congestion. There was significant delay reduction compared to the DCF considering 6000 stations. It nevertheless considered the AIFS Parameters only leaving other important parameters with respect to prioritized grouping.

In (P. Sthapit, J.Y. Pyun, 2017), to minimize the association delay of IEEE 802.11ah, a technique known as authentication control was employed to classify nodes into groups and then identify the best group for prioritized scheduling in a beacon interval. The result showed that the best group had a minimum access delay. In Traffic Adaptive Raw Algorithm (TAROA) (L. Tian, E. Khorov, S. Latré and J. Famaey, 2017), real-time stations were grouped in dynamic traffic IoT networks of IEEE 802.11ah. Latency was reduced using the optimal RAW grouping as RAW slots were assigned to stations according to their transmission frequency.

Based on the above researches, there has not been a significant reduction in delay with respect to prioritized scheduling algorithm as the proposed CL-MAC Algorithm. Thus, the scheme will be compared with the EDCA based on the summary shown Table II

4. PROPOSED CL-MAC ALGORITHM

This algorithm serves to ensure better traffic management for prioritized scheduling of stations in IEEE 802.11ah and also to deliver a reduced end-to-end delay.

A. Group Classification

This algorithm serves to ensure better traffic management for prioritized scheduling of stations in IEEE 802.11ah and also to deliver a reduced end-to-end delay. The classification of stations into prioritized access to channel was made into Traffic Profiles. Factors for classification include position of nodes to the AP, types (real time or non-real time), and battery level of each station. The respective TPs can have some common features but with the algorithm , the stations with the real time packets, higher battery level and closeness to the AP can easily get access to channel as TP1 where TP1>TP2>TP3>TP4 in terms of priority.

B. Cl-Mac Algorithm Operation

As a modification to the Queue-MAC (S. Zhuo, Y.Q. Song, Z. Wang and Z. Wang, 2012), the Access Point informs the stations periodically using beacon frames on repeating superframe (of split time) with both active and inactive periods. The active period is the period for activities and communication which contains the variable TDMA

and the CSMA while the inactive period is when the stations are in sleep mode on the condition that such stations have no packets to send. In the packet structure of AP MAC as shown in Fig 1, the Group Association Packet is used in lieu of the Queue Indicator of the Queue-MAC scheme. The Group Association Packet gives the load information of stations.

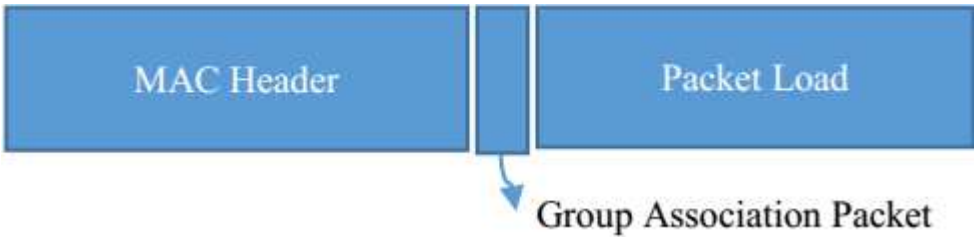
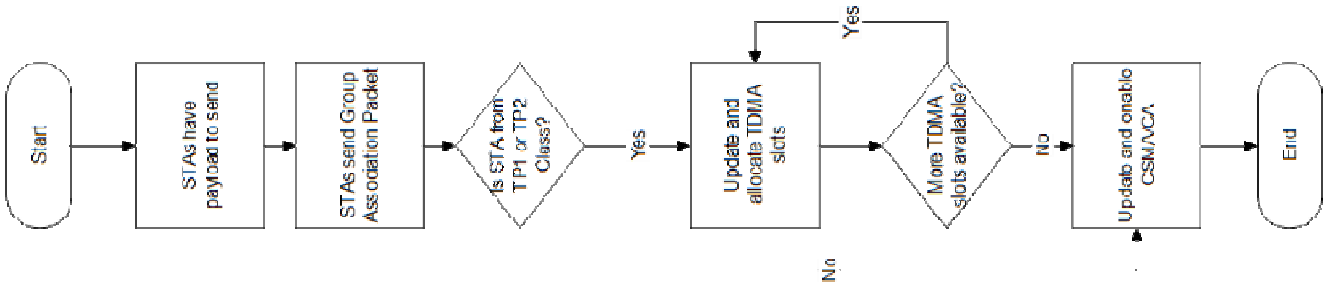


Fig. 1. MAC Packet Structure

The algorithm (as shown in Fig 2) shows the flowchart to be implemented on the AP. There are four different buffers in hierarchy (K_1 through K_4) where packets of sending nodes are forwarded in the AP and then processed to the receiver. As the first buffer K_1 is filled, the next available buffer for the stations in the K_2 and the process goes on simultaneously.

In the super frame of the AP MAC, the slots of the TDMA are assigned according to the load information form the Group Association Packet and the traffic priority. All classes contend with the default DCF for Wi-Fi networks using the RTS/CTS (Request



To Send and Clear To Send) technique to ensure that the effect of long frame collision is mitigated.

Fig. 2. CL-MAC Algorithm Flowchart

In the flow chat diagram of the algorithm, access for channels begins as soon as the AP gets load information from the Group Association Packet sent by each node. There are TDMA slots for all classes of stations except that priority is granted to stations with

real time applications. CSMA/CA protocol is then employed to cater for those stations without access to the available TDMA slots.

5. PERFORMANCE EVALUATION

A network simulator that is implemented for IEEE 802.11ah network known as NS3 (L. Tian, S. Deronne, S. Latré, J. Famaey, 2016) was employed for the simulation. To enable simplicity in the evaluation of the proposed algorithm, considered are simple applications for use cases with distinct classes of traffic requirements such as real time scenarios. For periodical transmission, a TDMA module was added in the NS3. A hybrid of TDMA and CSMA/CA was then enabled to implement our algorithm. With the physical data rate of the Wi-Fi mode, included was an input of the TDMA slots value for TDMA users, the varied value of the TDMA cycle. Adequate packets for TDMA transmission was ensured. With increasing number of 32 to 1032, the delay of each class was measured. Fig 3 shows the result at the end of the implementation considering the parameters required. Evaluations on each scheme, EDCA and CL-MAC were carried out. There was a better performance of the CL-MAC over the EDCA as the end-to-end delay was more reduced in the CL-MAC when compared with the EDCA.



Fig. 3. Evaluation of CL-MAC and EDCA on Delay

6. CONCLUSION

The rise in application of M2M and IoT on IEEE 802.11ah entails the demands for traffic management of the applications with respect to heterogeneous nature of networks. On this note, an algorithm known as Classified Media Access Control CL-MAC is used to reduce the delay in IEEE 802.11ah to support nodes in a single hop network. The

proposed scheme considers the traffic delay mitigation requirements and prioritizes a high-class station over the lower ones for scheduling after mapping up the stations into distinct classes. The algorithm is compared with the EDCA scheme. Simulations were carried out on network simulator 3 (ns-3). The result shows a great improvement in the performance of the network in the traffic delay. There was also a better service quality of end users based on the prioritized scheduling. This implies that more nodes with real time packets can communicate timely with the receiving stations with minimum delay and thus can be useful for subsequent researches. However, much work is expected in future to design a scheme that will enable more channel access to nodes with real time packets and further reduce the latency.

REFERENCE

B. Afzal, S. Alvi, G.Shah, W. Mahmood. (2017). Energy efficient context aware traffic scheduling for IoT applications. *Ad Hoc Networks*, 101-115.

B. Bellata, L. Bononi, R. Bruno, A. Kassler. (2016). Next generation IEEE 802.11 Wireless Local Area Networks: Current status, directions and open challenges. *Computer Communications, 75*, 1-25.

K. Ogawa, M. Morikura, K. Yamamoto, T. Sugihara. (2013). IEEE 802.11ah based M2M networks Employing virtual Grouping and Power saving Methods. *IEICE TRANS. COMMUN, E96-B*(12), 2976-2985.

L. Tian, E. Khorov, S. Latré and J. Famaey. (2017). Real-Time Station Grouping under Dynamic Traffic for IEEE 802.11ah. *Sensor article, 1559*, 24.

L. Tian, J. Famaey and S. Latre. (2016). *Evaluation of the IEEE 802.11ah Restricted Access Window Mechanism for dense IoT networks.* University of Antwerp: Research Gate Publication.

L. Tian, S. Deronne, S. Latré, J. Famaey. (2016). Implementation and Validation of an IEEE 802.11ah Module for ns-3. *Proceedings of the Workshop on Ns-3 (WNS3)*, (p. 5). Seattle, WA,USA.

L. Zheng, M. Ni, L. Cai, J. Pan, C. Ghosh, K. Doppler. (2014). Performance Analysis of Group-Synchronized DCF for Dense IEEE 802.11 Networks. *IEEE Transactions on Wireless Communications, 13*(11), 27.

Leon, J. (2015). *Evaluation of IEEE 802.11ah Technology for Wireless Sensor Networks Applications.* Tampere: The Faculty Council of the Faculty of Computing and Electrical Engineering, Tampere University of Technology.

P. Sthapit, J.Y. Pyun. (2017). Station Grouping Strategy for Minimizing Association Delay in IEEE 802.11AH. *IEICE TRANS. COMMUN, E100-B*(8), 1419-1427.

Qutab-ud-din, M. (2015). *Enhancements And Challenges In IEEE 802.11ah -A SubGigahertz Wi-Fi For Iot Applications.* Tampere: Tampere University of Technology.

R. Akeela, Y. Elziq. (2017). Design and Verification of IEEE 802.11ah for IoT and M2M Applications. *017 IEEE International Conference.* Kona, HI, USA: Pervasive Computing and Communications Workshops (PerCom Workshops) .

S. Tneeru, P.C. Jain. (2016). Performance Evaluation of IEEE 802.11ah Protocol in wireless Local Area Network. *2016 International Conference on Micro Electronics and Telecommunication Engineering.* India.

S. Zhuo, Y.Q. Song, Z. Wang and Z. Wang. (2012). Queue-MAC: A queue-length aware hybrid CSMA/TDMA MAC protocol for providing dynamic adaptation to traffic and duty-cycle variation in wireless sensor networks. *2012 9th IEEE Internnational Workshop on Factory Communication System*, (p. 10). Lemgo, Germany.

T. Adame, A. Bel, B. Bellalta, J. Barcelo, J. Gonzalez, M. Oliver. (2013). *Capacity Analysis of IEEE 802.11ah WLANs for M2M Communications.* Barcelona: NeTS Research Group.

T. Adame, A. Bel, B. Bellalta, J. Barcelo, M. Oliver. (2014). IEEE 802.11 AH: the WiFi approach for M2M communications. *IEEE Journal on Wireless Communications, 21*(6), 18.

T. Jun, X. Xing, C. Zhi-lan, Y. Zhi-wei Zhang zhi. (2009). *Improving Throughput for Heterogeneous Traffic in IEEE802.11e EDCA.* School of Computer Science and Technology.

W. Sun, M. Choi and Sunghyu. (2013). IEEE 802.11ah: A Long Range 802.11 WLAN at Sub 1 GHz. *Journal of ICT Standardization, 1*, 83-108.

Z. Kong, Danny Tsang, B. Bensaou, D. Gao. (2004). Perofrmance Analysis of IEEE 802.11e Contention –Based Channel Access. *IEEE Journal on Selected Areas in Communication, 22*(10), 12.

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A BAT-INSPIRED ALGORITHM FOR THE DETECTION OF HIDDEN NODES IN IEEE802.11AH NETWORKS

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ABSTRACT

The unique attribute of extended communication range of IEEE802.11ah, has also increased the occurrence of the hidden node problem by 41% as compared to previous versions of IEEE802.11 standards. As a result, the IEEE802.11ah network is prone to experience high collision and low throughput. Previous efforts to addressing this issue has mainly not addressed the issue of location potential hidden nodes in the network. As a result, the hidden node problem in IEEE802.11ah still remains an open issue. This paper proposes a bat-inspired algorithm for detecting hidden nodes in IEEE802.11ah networks. Our preliminary results have shown the effectiveness of the proposed algorithm in detecting hidden nodes. This algorithm can be used to properly manage communication in IEEE802.11ah.

Keywords: *Access window, collision, hidden node, IEEE802.11ah, NS-3, packet loss.*

1. INTRODUCTION

There is a continuous demand for internet of things. Hence, the importance of Wireless Local Area Network (WLAN) to connect devices so that they can function automatically has caused for attention. This has led to the development of different IEEE 802.11 standards that actually have different setbacks. Despite these setbacks, there is still a growing demand for WLANs to enable applications in different domains such as smart cities, smart houses, healthcare monitoring, industrial automation, agricultural monitoring and smart metering (Aust, 2014). In other to get a lasting solution to this, a sub 1 GHz standardization IEEE 802.ah with the advantage of low cost, large coverage area and energy efficient (Aust, 2014) and (Weiping Sun, Munhwan Choi and Sunghyun Choi, 2013) which is on-going emerged among others.

The PHY layer of IEEE802.11ah implements the characteristics of IEEE802.11ac in its sub1GHz frequency. It operates at a low band width which ranges from 1 to 16MHz allows a transmission range of up to 1km (Le Tian, Jeroen Famaey and Steven Latre,

2016) . It utilizes some sets of modulation and coding scheme (MCS) which includes: low density parity check (LDPC) which is optional and binary conventional coding (BCC) which is mandatory. The standard is supported by BPSK, QSPK and QAM modulation schemes. Apart from MCS, it also uses Number of Spatial Streams (NSS) and duration of Guard Interval. The MAC layer of IEEE802.11ah inherited the characteristics of IEEE 802.11ac but introduces channel access mechanisms that attempts to help in addressing the density of the network and energy of the stations. These mechanisms include; hierarchical organization, short MAC header, Traffic indication map (TIM) segmentation, Target Wake Time (TWT), Restricted Access Window (RAW) Tian et al (2016). The mechanism that deals majorly with hidden node is RAW.

RAW

Considering ratio of about 8000 nodes to one access point that exist as a result of their large coverage area, IEEE802.ah adopted a group based contention as a selection process where a group is allocated to a node in order to minimize packet collision causing network performance degradation that are likely to occur as a result of the hidden node pairs. Restricted Access Window (RAW) which refers to access interval with several time slots where a station competes for time slot during a medium access tried to solve the problem but the hidden node problem was not considered during the allocation of the time slot of RAW (Mengxi Dong ; Zhanji Wu ; Xiang Gao and Huan Zhao, 2016), this still resulted into station collision as stations that belonged to the same time slot may detect one another. This paper therefore looks into the detection of hidden nodes for easy consideration during the time allocation of RAW slots.

The section 1.0 of this paper is the introductory part, 2.0 discusses the related work, 3.0 is the proposed method,4.0 discusses the preliminary result while 5.0 is the concluding part of the paper.

2. REVIEW OF RELATED LITERATURE

There has been a general problem called the hidden node problem that cuts across all these standards. This usually occurs when an access point can communicate with node(s) which is not within the communication range of other nodes there by resulting in collision and loss of packets when they send packets at the same time.

IEEE 802.11ah suffers from hidden node problem (frequent packet collision) more than networks (IEEE 802.11a/b/n/ac) because of their wide coverage, high number of devices they can support (about 8000 nodes to one access point) and frequent simultaneous sleeping and sending of the nodes (power saving mode) (Jeong-O Seo, Changwon Nam, Sung-Guk Yoon, and Saewoong Bahk, 2013), (Tung-Chung Chang, Chi-Han Lin, Kate Ching-Ju Lin and Wen-Tsuen Chen, 2015) , (Pranesh Sthapit and Jae-Young Pyun, 2017) and Tian et al (2016). In solving the hidden node problem, most

authors like Tian et al (2016) who proposed traffic adaptive RAW optimization algorithm (TAROA) did not consider the detection of hidden nodes. The authors used the RAW parameters obtained through the estimation of packet transmission intervals of each station to obtain slots that were assigned stations using the frequency were estimated. After their simulation, it was discovered that through put performance in a dense traffic was improved upon using this TAROA more than when RAW was used although this was not very efficient because of its latency performance.

The authors in (Mengxi Dong ; Zhanji Wu ; Xiang Gao and Huan Zhao, 2016), then proposed a spatial group RAW media access control (MAC) scheme which they based on the location of station. This actually reduce the hidden node problem by reducing collision probability but the hidden node problem could not totally be solved as there are still existing hidden nodes. As a result of this, it still remains an open issue that needs to be addressed. This research therefore will look into how to detect the hidden nodes.

Researches in (Sung-Guk Yoon, Jeong-O Seo and Saewoong Bahk, 2016) proposed a regrouping algorithm using node transmission time to detect a hidden node. However, two nodes can be out of each other's detection range and this will result in collision if they transmit data at the same time, therefore the is a need for a better hidden node detection method.

3. PROPOSED METHOD

BAT ALGORITHM: Bat algorithm is a biologically inspired algorithm that is based on the echolocation characteristics of micro bats. (Yang, 2010). It has three idealized rules out of which two inspired this detection algorithm, these includes:

1. Bats flying randomly to search for prey with velocity v_i at position x_i. , with fixed frequency f_{min} which can automatically be adjusted. Similarly, for the purpose of this research, STAs are deployed randomly just like the bat.

2. Bats generally use echolocation to sense distance. They have the ability to differentiate between food/prey and background. Similarly, our algorithm will calculate distance between two node pairs asymmetrically. This helps us to determine the hidden nodes.

The detection algorithm will be based on bat algorithm where t_i is used to represent the data rate at which a station is sending its data, X_i as the position of the node with respect to the AP, f_{min} as the frequency at which they are operating and the varying wavelength as the perceived signal strength of the AP signal by the station. The formula for received signal strength indicator (RSSI) is the obtained as $\mathbf{RSSI\,(dBm) = -10log(d) + A}$ where A is the signal strength in dBm and d is the

distance. With the algorithm, it can detect the hidden pairs maximally. The method is as described using the pseudo code below:

1. Create IEEE802.11ah network scenario with "M" stations (STAs).
2. Group M nodes into G groups and associate them with one AP
3. For a particular group, define objective function $f(x), x = (x_1, x_2 \ldots x_N)$
4. Initialize the number of STAs in the group N and define the other simulation Parameters [frequency range f_{min} to f_{max} , NRaw slot count = SL, Payload size = PL, Beacon Interval = T, Data rate = t, Udp interval = u, Rho = rho]
5. Let K= (N-1) + (N-2) + (N-3) +…(N-N) // where N is the total number of STAs in a group
6. Define two solution sets where solution set 1= Not Hidden and solution set 2 = Hidden
7. Allow multiple nodes within a page or RAW group to send packets to an AP while checking their position or coordinates
8. WHILE i = 1,2,3,...K// where K is the maximum number of node pair
9. Calculate the distance D between two node pairs
10. If D ≤ rho
11. Select solution set 1 as the best solution
12. Else
13. Select solution set 2 as the best solution
14. End if
15. End WHILE
16. Report the number of hidden nodes as processed result
17. End.

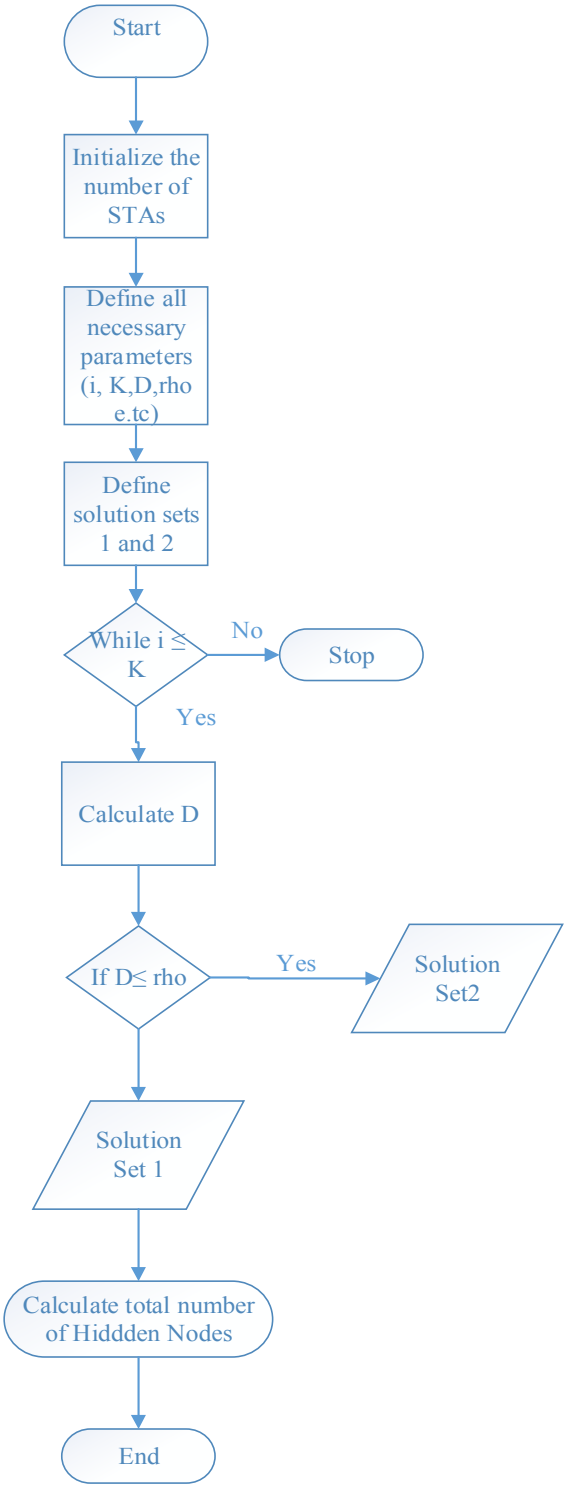
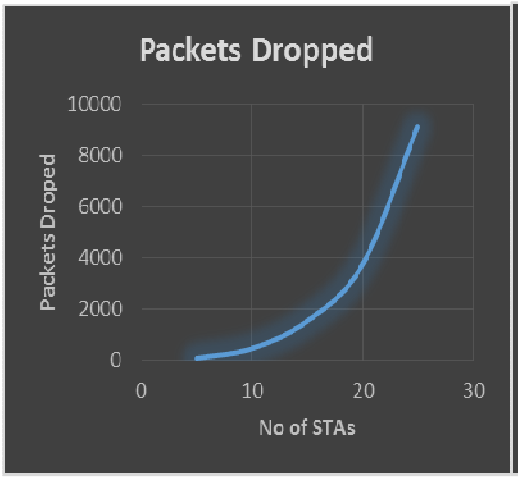


Figure 3.1: Flowchart of the Algorithm

4. PRELIMINARY RESULT

Hidden node problem is a major problem that causes heavy packet drop and degradation of throughput. The authors conducted a research on RAW using these parameters (packets dropped, hidden node pairs, throughput and packets delivered). It was discovered that as good as the RAW scheme is, it can only be efficient if there is an effective hidden node detection algorithm which is the first step to solving the hidden node problem. As illustrated by figure 1 to figure 4, the graph shows a very great increase in packet drop as the number of STAs increases. This implies that the higher the number of STAs the higher the packet drops and also the higher the hidden nodes which leads to heavy packet drops and the throughput is very small compared to other parameters, hence the effect of the hidden nodes are obvious.



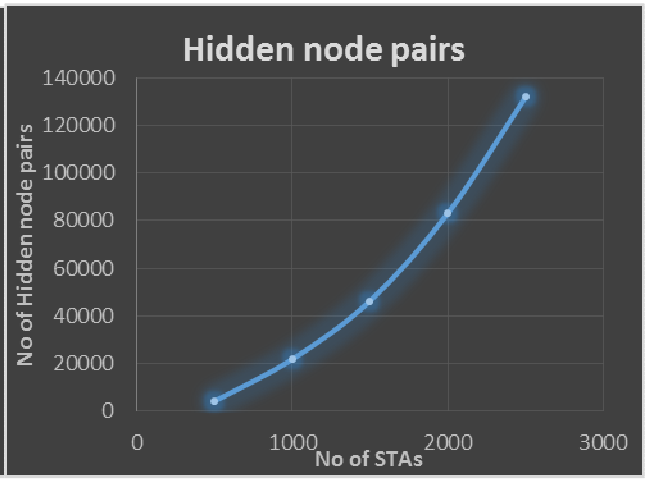
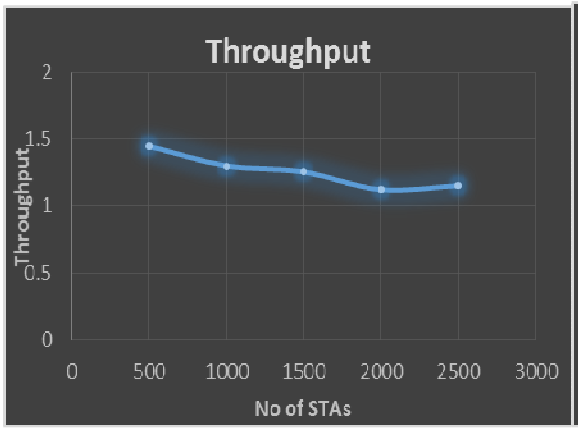


Figure1: Effect of Hidden node problem Figure 2: Detected Hidden node pairs



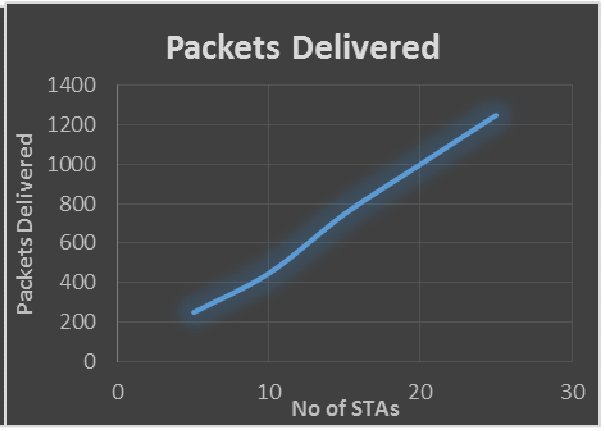


Figure3: Effect of Hidden node on throughput Figure 4: Graph of STAs versus packets delivered

5. PERFORMANCE EVALUATION

The performance of this detection algorithm will be based on the percentage of available hidden nodes before and after using it for RAW slot allocation. As this will help to determine the effectiveness of the algorith6m.

6. CONCLUSION

Hidden node problem (frequent packets collision) which leads to loss of packets affects wireless networks and most especially IEEE802.11ah. To mitigate this problem, it is important to develop an efficient hidden node detection algorithm as hidden node problem is not the only factor responsible for packet loss because if each factor that leads to packet loss is treated individually, then the problem of packet loss can be totally solved. The implementation of this detection algorithm will contribute greatly to solving the hidden node problem and the problem of packet loss at large because it will help in the RAW slot allocation. Other related topics for future research includes but not limited to: (1) Provision of appropriate regrouping algorithm based on this detection algorithm, (2) Detection of hidden nodes in a dynamic Network.

REFERENCES

Aust, S. H. (2014). *Advanced Wireless Local Area Networks in the Unlicensed Sub-1GHz ISM-bands.* Duitsland: Ipskamp Drukkers. Retrieved August 10, 2017

Jeong-O Seo, Changwon Nam, Sung-Guk Yoon, and Saewoong Bahk. (2013). *Group-based Contention in IEEE 802.11ah Networks.*

Le Tian, Jeroren Famaey and Steven Latre. (2016). Evaluation of IEEE 802.11ah restricted Access Window for dense IoT networks. *Seventh International Symposium on world of wireless, Mobile and Multimedia networks*, 1-9.

Le Tian, Jeroen Famaey and Steven Latr´ e. (2016). Evaluation of the IEEE 802.11ah Restricted Access Window Mechanism for dense IoT networks. *Seventeenth International Symposium on a World of Wireless, Mobile and Multimedia Networks* (pp. 1-9). Institutional repository IRUA.

LEON, J. C. (2015). *Evaluation of IEEE 802.11ah Technology for Wireless Sensor Network Applications.* Tampere University of Technology. Tampere, Finland: Tampere University of Technology.

Mengxi Dong ; Zhanji Wu ; Xiang Gao and Huan Zhao. (2016). An efficient spatial group restricted access window scheme for IEEE 802.11ah networks. *Information*

Science and Technology (ICIST), 2016 Sixth International Conference on. Dalian, China: IEEE.

Orod Raesi, Juho Pirkanen, Ali Hazmi, Toni Levanen, and Mikko Valkama. (2014). Performance Evaluation ofIEEE 802.11ah and its Restricted Acess Window Mechanism. *ICC'14-W7: Workshop on M2M Communication for Next Generation IoT* (pp. 460-466). IEEE.

Pranesh Sthapit and Jae-Young Pyun. (2017). Station Grouping Strategy for Minimizing Association Delay in IEEE 802.11ah. *IEICE Transaction communicaton*, 1419-1427.

Sung-Guk Yoon, Jeong-O Seo and Saewoong Bahk. (2016, May). Regrouping Algorithm to Alleviate the Hidden Node Problem in 802.11ah Networks.

Tung-Chung Chang, Chi-Han Lin, Kate Ching-Ju Lin and Wen-Tsuen Chen. (2015). Load-Balanced Sensor Grouping for IEEE 802.11ah Networks. *Global Communication Conference (GLOBECOM).* Taiwan: IEEE.

Weiping Sun, Munhwan Choi and Sunghyun Choi. (2013). IEEE802. 11ah: A long Range 802.22 WLAN at sub1GHz. *Journal of ICT standardization, 1*(1).

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INFORMATION LITERACY FOR SUSTAINABLE DEVELOPMENT: A REVIEW

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ABSTRACT

Information literacy is the ability to recognize when information is needed, locate and evaluate the appropriate information and use it effectively and responsibly. Information literacy involve knowing when and why information is essential, where to find it, and how to efficiently evaluate, use and communicate it in an ethical manner. This review examined the concept of information literacy in digital inclusion for sustainable development, which reveals that libraries at different levels have critical roles to play in surmounting the challenges of digital inclusion in the country. Information and communication technology (ICT) has affected every area of human life, this work evaluates four key application areas of information literacy (Learning and Education, Health and Human Services, Business and Economic Development, and Governance and Citizenship) as well as examined the needs for the growth and sustainable development of these sectors. The study revealed that information literacy skills are applicable and adaptable to everyday situations in life and will determine the quality of an individual life and usefulness in academic environment, health, economy, governance and the society at large. The work also discussed the merits and demerit of information literacy as it affect some specific areas, recommendations were made to the concern authorities on how information literacy can be used.

Keywords: *Information, Literacy, ICT, digital inclusion, libraries*

1. INTRODUCTION

Information literacy is the ability to recognize when information is needed, then locate and evaluate the appropriate information and use it effectively and responsibly. Information literacy is also concerned with how to know when and why information is essential, where to find it, and how to efficiently evaluate, use and communicate it in an ethical manner (Chartered Institute of Library and Information Professionals. CILIP, 2012). The skills that are required to be an information literate person call for an understanding of: a need for information, the resources available, how to find information,

the need to evaluate results, how to work or exploit results, how to communicate or share your findings and how to manage your findings.

Information literate people are those who have learned how to use information positively in a literate approach. They know the skills required to learn and obtain information because they know how information is organized, how it is found, and how to use information in such a way that others can learn from them. They are people prepared for lifelong learning because they always find the information needed for any task or decision at hand (Lowe & Spitzer, 2004).

An intellectual framework for identifying, understanding, evaluating and using information includes determining the nature and extent of the needed information, accessing information effectively and efficiently, evaluating critically information and its sources, incorporating selected information in the learner's knowledge base and value system, using information effectively to accomplish a specific purpose, understanding the economic, legal and social issues surrounding the use of information, and information technology, and observing laws, regulations and institutional policies related to the access and use of information.

Thus, the ability to access, evaluate and use information is a prerequisite for lifelong learning and a basic requirement for the information society. It is a holistic, interactive learning process. This paper adopts the definition given by the U.S. Association of College and Research Libraries (ACRL, 2000) in its Information Literacy Standard for Higher Education. According to ACRL, Information Literacy is a set of abilities requiring individuals to recognize when information is needed and have ability to locate, evaluate and use effectively the needed information.

Information literacy forms the basis for lifelong learning. It is common to all disciplines, to all learning environments, and to all levels of education. Therefore, the concept of information literacy presupposes that an individual recognizes the need for information, and knows how to find, evaluate and subsequently communicate information effectively to solve particular problems or to make decisions. More importantly, whether information comes from the internet, or the World Wide Web, Online databases, books or documents, as well as other possible sources, inherent in the concept of information literacy is the ability to understand and critically evaluate and make use of information to solve specific problems or tasks at hand.

2. REVIEW OF RELATED LITERATURE

Amusan, and Ogunmodede (2012) examined the influence of library and information services on attainment of millennium development goals (MDGs) on Education in Oyo State, Nigeria. The studied population comprised 50 personnel from Oyo State Ministry of Education, 5 public library managers, 11 primary school libraries and resource center librarians, and 50 secondary school librarians who were randomly selected using

stratified random sampling. The instruments used to collect data for the study were 2 sets of questionnaires. First set of the questionnaire was for the senior staff of the Ministry of Education. The second set of questionnaire was for the public library managers and school librarians which requested for information on the influence of library and information services on attainment of MDGs education in Oyo State. Data were analyzed using descriptive research method. Library and information services are relevant to the attainment of MDGs on education. Result shows that information repacking; awareness campaign, human resources development, mobile library and outreach services, and capacity building are some of the strategies that libraries can adopt to ensure the attainment of MDGs on education.

Goodluck & Oyeronke (2016) examined the concept of digital inclusion and its role in sustainable development. An assessment of the situation in Nigeria reveals that libraries at different levels have critical roles to play in surmounting the challenges of digital inclusion in the country. Undoubtedly, information and communication technology (ICT) has affected every area of human life. Consequently, the level of deployment of ICT in a country can determine its level of development and placement among the committee of nations. An assessment of the situation in Nigeria reveals that libraries at different levels have critical roles to play in surmounting the challenges of digital inclusion in the country. The paper concludes with a way forward for libraries and key actors in the Nigerian policy.

Leslie (2008) contributed to sustainable development by advancing policy recommendations on international trade and investment, economic policy, climate change, measurement and assessment, and natural resources management. Through the Internet, report on international negotiations are shared, knowledge is gained through collaborative projects with global partners, resulting in more rigorous research, capacity building in developing countries and better dialogue between North and South. However, when looking specifically for research on the use of ICTs for Education for Sustainable Development, including educational policies, pedagogical approaches and classroom uses of ICTs for ESD, there is not much available to date.

Shaffer (2008) composed a research piece on what Computer "literacy" in university education really means, compiling articles and resources from findings of several educators at all levels of education who hold that "literacy/fluency with respect to information and information technology should be included in the university curriculum, and should be treated with a depth of concept appropriate for a university education."

Geoff (2006) discussed current landscape of the information systems research. Developing countries were used for the survey by examining a range of research articles published from 2000 onward. These are discussed in terms of the key challenges addressed, including the role of technology, and the methodological and theoretical approaches used. With respect to labeling their methodological approach, the majority of the studies, if they address this explicitly, claim to be interpretive. Very few studies in our survey adopted a positivist approach with stated hypotheses, instruments for data

collection, statistical inference, etc. It is beyond the scope of this paper to analyze the precise reasons for this, but it is certainly true that many of the research questions and challenges tackled by IS researchers in our survey would not have lent themselves naturally to a positivist methodology. Our goal in this article is to provide a critical appraisal of the landscape of current research on IS in developing countries, and to present a forward-looking assessment of where we feel valuable future research could be directed. This latter material is aimed at stimulating debate in the field, and we believe that our views expressed here could be used as a basis for discussions in forums such as PhD workshops and working conferences.

Jagtar & Alton (2015). This conceptual article attempts to provide some new perspectives on integrating media and information literacy in the communication curriculum through a new model – the Explore, Engage, and Empower Model. Media and information literacy is a set of competencies that empowers citizens to access, retrieve, understand, evaluate, use, create as well as share information. Media content in all formats, uses various tools, in a critical, ethical, and effective way, in order to participate and engage in personal, professional, and societal activities". This model encapsulates all the relevant competencies that students in the digital age must be able to acquire in a more concise and straightforward fashion. Likewise, this highlights empowerment as the ultimate level of practicing media information literacy skillfully and applying it in our everyday lives, especially in the exercise of our universal rights and fundamental freedoms. This set of competencies must be reflected in national education policies to guide curriculum development and promote it as a framework in crafting institutional and program outcomes among educational institutions and media content using different tools and techniques.

The influence of information literacy services of millennium development goals (MDG) on education in Nigeria were examined and experimented based on stratified random sampling by researchers, on a request for information and how it influenced the growth in the society information literacy is to be adopted in different sectors of the country such as human resources development, mobile library and outreach services. Including capacity building if and only if we desired a sustainable development.

However the concept of digital inclusion and its role in sustainable development cannot be over emphasized, as it reveals that information libraries at different levels have critical roles to play in our day to day activities. Consequently, the development of ICT has influenced every area of Human life. Figuratively the level of information literacy acknowledged or equipped of a country determined its level of development and placement among the committee of a country.

Computer "literacy" in university education really means compiling articles and resources from findings of several educators at all levels of education which holds that "information literacy/ influence" with respect to information technology should be treated with a depth of concept appropriate for a sustainable academic growth.

The concept of integrating media and information literacy in the communication curriculum through a new model is to explore, engage and empower. As a result" media and information literacy (MIL) is a set of competencies that empower citizens to access, retrieve, understand, evaluate, use ,create as well as share information and media contents in all formats using various tools. A critical, ethical, and effective ways in other to participate and engage in personal, professional and societal activities. This is the model that encapsulates all the relevant/ competencies that students in the digital age must be able to acquire in a more concise and straightforward manner.

Application Areas of Information Literacy and it's Contribution to Knowledge

The relevance and applicability of Information Literacy and Lifelong Learning initiatives can be most meaningfully illuminated and understood by focusing on what is called "four keys sector domains" Learning and Education, Health and Human Services, Business and Economic Development, and Governance and Citizenship.

Learning and Education

Information Literacy is a cross-cutting consideration that affects the entire curriculum, syllabus, and permeates all subjects and courses. When ministries of education, national educational systems, school policies and curriculums, and school boards come to that realization in both formal and non-formal educational settings, then they will be able to effectively introduce the concept of Information Literacy into the educational process.

Health and Human Services

In the context of a universal commitment to enhanced quality of life, all citizens have a right to good health and to healthcare based on informed consent. In support of this right, all citizens are entitled to access information that is relevant to their health and the health of their families and communities. It is particularly important to underscore the necessary protections of the mother and the child as embodied in the Universal Declaration on Human Rights, and to the rights of children to have access to information about health as enshrined in the United Nations' Convention on the Rights of the Child23 (Article 26), and to the rights of all people to have sufficient information and understanding to give informed consent to treatment.

Business and Economy

Under current globalization trends, economic development is becoming increasingly dependent upon the use of information and the learning skills of the workforce. Governments should lead Information Literacy efforts through strategic alliances with the major stakeholders, including the business community in key economic sectors, and consumers. The target groups or institutions that are key stakeholders include government, business entities, educational institutions, information producers and providers, trade and business organizations, chambers of commerce, industrial associations and NGOs. The key target communities are businesses (SMEs and large

companies), public administration, and specific target communities such as unemployed, women, start-ups, minorities, immigrants and consumers.

Government and Citizens

The objective of introducing Information Literacy and Lifelong Learning strategies, missions and vision statements is to empower people to actively participate in governance and citizenry to better manage and control their own lives, but at the same time respecting cultural diversity in both oral and digital societies as a public good. The special target audiences consist of political and civil society leaders, NGOs, community groups, government agencies (national and international), international and regional foundations, libraries, labor unions, educational institutions, business and industry, and the media.(Forest, 2007).

3. MERIT AND DEMERITS OF INFORMATION

Merits of information are as follows:

(i) **Increases Production and Saves Time:** Businesses today, more than ever, use technology to automate tasks. A good example is a bakery which uses electronic temperature sensors to detect a drop or increase in room or oven temperature in a bakery. These sensors send information directly to the operator, reporting any temperature change. This temperature system saves the bakery time, and it also results in consistent higher quality products.

(ii) Improves Communication: With the help of communication technology, tools like phones, video conferencing, electronic mail and instant messenger, just to mention a few, have been developed. Thus, movement of information within an organization or business has become instantaneous. Employees can easily move data across departments without having any interruptions. Tools like electronic mail, e-fax, mobile phones and text messaging enhance the movement of information data among employees, customers, and business partners or suppliers. This allows for greater interconnectivity throughout internal and external structures.

(iii) **Improves Data Storage, File Management, and Data Reporting/ Analysis:** Businesses use cloud hosting services to store and backup business data, makes transfer and access to data possible remotely. With services like Dropbox.com, business owners can access their data anytime anywhere. Additionally, databases today allow for greater correlation of information, analysis of this data relationship can encourage better and more informed decision making, resulting in potential growth.

(iv) Improves Financial Management: Accounting software like Quick Books, Bookkeeper, Sage 50, and Account Edge perform various accounting tasks in a business. Business owners can easily balance their books with less experience in accounting because this software is well equipped with every tool needed in accounting. It allows for

faster processing and calculation of financial information and the recording or storing of financial data that may need to be referenced in the future.

(v) Improves Business to Consumer Relationship: Businesses have embraced the social technology to interact with their consumers and fans, creating a strong business to consumer relationship, and it results in business growth via customer loyalty and expansion. Information technology can be used to improve customer service in so many ways. For example, businesses can use their website or email to inform their customers about great deals and discounts. Making the customer aware of these offers can drive their desire to buy. Good customer service can be used as an excellent tool for any small business to gain the competitive advantage.

Demerits of information are as follows:

(i) Implementation Expenses: Small businesses sometimes struggle to afford and maintain expensive core technology, so they end up losing their clients to a company which has the capital and resources necessary to compete in the industry.

(ii) Job Elimination: Technology has replaced many positions humans used to occupy. Software is now doing complete accounting, so trained accountants have fewer opportunities; robots can cut the lawn or clean the pools, no need for a handyman.

(iii) Security Breaches: Since businesses store their data on remote cloud servers which can be accessed online with a username and password, they risk potentially losing that data to hackers or viruses.

(iv) Internet Security Issues: For the merchant to process an order online, a consumer has to provide their financial details. Experienced hackers can use this loophole to channel this information and use it for their own needs.

(v) Faulty Products and Duplication: In some cases, auction websites have products that are not original. So a user can bid on a shoe thinking it is original, upon delivery, they discover that the shoe is fake and it does not meet their expectation.

(vi) Privacy: E-commerce websites collect personal data using cookies to know more about us and suggest products based on that information. Initially, data was collected without any notice, now most websites declare they intend to collect your information.

In summary, this paper reveals that the concept of information literacy in digital inclusion for sustainable development with an assessment of the situation in Nigeria reveals that libraries at different levels have critical roles to play in surmounting the challenges of digital inclusion in the country. Undoubtedly, information and communication technology (ICT) has affected every area of human life. However, most appropriately, information literacy skills are used for academic purposes, such as research papers and group presentations in the university. It is also applicable to various sectors of the country such as health, economy, education and government. Therefore, the students

skills to find, evaluate, identify, use and share information is a vital skill that enhance students to effectively and efficiently utilize the resources of the library. Significantly, it enhances and beautifies the way we communicate with one another in our daily endeavors.

Based on the findings of this study and subsequent conclusions of the study, the following recommendations are made:

(i) The students' literacy skills should include ability to recognize when information is needed and have the ability to locate and should effectively use the information for the required purposes.
(ii) The government should create educational environments that nourish Information Literacy including appropriate infrastructure, knowledgeable leadership, supportive policies, productive partnerships and a learning culture, including multilingualism and cultural diversity.
(iii) Information literacy skills should be included either as course or part of a course to be taken by students preferably in the early part of their university education. Such courses should also be taught by professionals.
(iv) Professional organizations should identify and cultivate champions in government, business and economic development organizations in order to adopt and propagate Information Literacy and Lifelong Learning.
(v) National Health Authorities, in conjunction with relevant professional associations, should take steps to ensure that policy-makers and administrators are equipped with appropriate skills of Information Literacy to allow them to make high quality, evidence based decisions and to fulfill their responsibilities skillfully with regard to the human dignity of clinicians, patients and the public at large.

4. CONCLUSION

The study revealed that information literacy skills are applicable and adaptable to everyday situations in life and will determine the quality of an individual's life and usefulness in academic environment and society at large. However, most appropriately, information literacy skills are used for academic purposes, such as research papers and group presentations in the university. It is also applicable to various sectors of the country such as health, economy, education and government. Therefore, the students' skills to find, evaluate, identify, use and share information is a vital skill that enhance students to effectively and efficiently utilize the resources of the library.

REFERENCES

Association of College and Research Libraries (2003). Characteristics of Programs of Information Literacy that Illustrate Best Practices: A Guideline from *http/www.alce.orgaba/acristandards/characteristic.html*. Retrieved August 29, 2010.

Association of College and Research Libraries: Standards and Guidelines (2005). Information Literacy Competency Standards for Higher Education, from http/www.alace.orgala/acr/standards/information. Retrieved July 27, 2009

Amusan, O. O. (2012) Influence of Library and Information Services on Attainment of Millennium Development Goals on Education: A Case Study of Oyo State, Nigeria. *American International Journal of Contemporary Research Vol. 2* No. 8; August 2012

Bruce, C. S. (1997). Information Literacy, a Framework for Higher Education. *Australian Library Journal, 44*(3): 158.

CILIP (2012). information literacy: definitions and model. www.informationliteracy.org.uk/information literacydefinitions/ Retrieved on 20th August, 2014.

Crawford, S. (1993). Information Needs and Uses. *Annual Review of information Science and Technology*, (13): 1-30.

Dalrymple, P. W. (2001). Bibliographic Control, Organization of Information, and Search Strategies. In: R. H. Bopp and L. C. Smith (Eds.), *Reference and Information Services: An Introduction* . (pp 69-96),Eaglewood, Colorado: Libraries Unlimited Inc.

Devadason, F. 3. (2009). A Methodology for the Identification of Information Needs of Users. *Http://archive. ifia. org* Retrieved April 22, 2009..

Eisenberg, M. B; Lowe, A. C., & Spitzer, K. L. (2004). *Information Literacy Essential Skills for the Information Age*. (2 ed.). London: West Port Libraries Unlimited. p.34.

Etim, F. E. & Nssien, F. U. (2007). Information Literacy for Library Search, Uyo: Abaam Publishing Company.

Forest, W.H.Jr. (2007) *Understanding Information Literacy. United Nations Educational Scientific and Cultural Organization. (UNESCO)* United Nations Educational, Scientific and Cultural Organization 7, place de Fontenoy, 75352 Paris 07 SP, Paris, France.

Geoff Walsham. (2006) *Research on Information Systems in Developing Countries: Current Landscape and Future Prospects*. Judge Institute of Management, University of Cambridge, Cambridge CB2 1AG, UK. E-mail: g.walsham@jims.cam.ac.uk.

Goodluck , I. O. (2016). Digital Inclusion and Sustainable Development in Nigeria: The Role of Libraries. Centre for Learning Resources Covenant University,Ota, Nigeria. 3rd International Conference on AfricanDevelopment Issues (CU-ICADI 2016) ISSN:2449-075X

James, C. (2009) Primary, Secondary & Tertiary Sources of Information literacy Source: Copyright © 1995 to 2009, James Cook University, http://cms.jcu.edu.au/libcomp/assist/guides/finding/JCUPRD_030412.

Leslie, P.(2008) How Information and Communications Technologies Can Support Education for Sustainable Development. International Institute for Sustainable Development (IISD). http:www.iisd.org

Uhegbu, A. N. (2001). *The information User: issues and Theories.* Enugu: John Jacobs Classic Publishing Limited,. pp. 95-98.

Usman, N. (2005). Information Literacy: The instrument for political and Economic Empowerment in Nigeria. Nigeria international Journal of Research in Education, 2 (192): 189

HIERARCHY EXTRACTION FOR COVERT NETWORK DESTABILIZATION AND COUNTERTERRORISM MECHANISM

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ABSTRACT

Reduction of incessant crimes is the utmost priority of security agencies. Use of intelligence has potential to bring crime rate under minimal control but, organizational structure imbibes by criminal groups has been keeping and protecting covert members. However, extraction of covert members from flat organization structure has some challenges especially in identifying and analyzing high ranking criminals. Therefore, this paper proposed the used of eigenvector centrality for extraction of high rank members that social network analysis considered passive. Furthermore, this approach could offer a robust platform to detect clandestine nodes that attempt to escape detection.

Keywords*: counterterrorism, hierarchy, network destabilization, and network builder,*

1. INTRODUCTION

Generally, Metadata from communication and social media networks are new trends of procuring comprehensive information about relationships of mobile phone users. Phone calls, Short Messages Services (SMS), social media data can be collected and rendered into graph of relationships or connections for particular set of mobile phone users, or other social activities (Butt, Qamar, & Khan, 2014; Karthika & Bose, 2011). The graph of relationships is called social network structure (SNS) or network graph. From a SNS, all members are given equal representation or status; this gives description of SNS and that of criminal network structure (CNS) as a flat organizational structure, because members cannot be distinguished from one another. Criminal groups akin to flat structure in order to protect high profile members from cheap detection (Eiseit & Bhadury, 2015; Husslage, Lindelauf, & Hamers, 2012; Minor, 2012).

Minor (2012) classified members of a criminal group into expendable and non-expendable. Expendable are overt members who execute agenda of the non-expendable ones. It is learnt that high profile members always keep away from activities of the organization which can cheaply roll them up with overt members, and they can also play their roles through intermediaries (Butt et al., 2014). Collection of data from telecommunication servers and social media networks can only provide information on relationships within the reach of surveillance. Such information can accord law enforcement agent opportunity to know if there is a valid relationship between ordinary floor members who are actual perpetrators and high-profile members who are non-expendable members. Unfortunately, there are no means to distinguish expendable members from non-expendable ones within a criminal/covert social network (CSN).

Criminal networks flourish on the flat organizational structure, because roles and real life status of members cannot be represented in the network graph or SNS. Roles and responsibilities are not confined on any member; criminal members are responsible to any task at his/her disposal. Therefore, they are bound to act like leader and take any decision based on their discretion/wisdom (Manning, 2010; Roberts & Everton, 2011). This describes the leaderless principle in CSN and lack of pragmatic orders and hierarchies within the CSN (Minor, 2012).

The sort of relationships among members of criminal organization and lack of hierarchies offer opportunities to criminal organizations to wax stronger and sustain securities attacks despite the fact that some members can be eliminated. Detective techniques are designed to identify main leader(s) or key player(s), whose roles are pertinent to the existence of the criminal organizations within the social network. This compels researchers, network analysts and security agencies to search for leader(s) of a criminal group in order to destabilize criminal organizational structure (Carley, Reminga, Kamneva, & Carley, 1998; Catanese, Ferrara, & Fiumara, 2013; Ferrara, De Meo, Catanese, & Fiumara, 2014; Fortunato, 2010; Galar, Fern, Barrenechea, & Bustince, 2012; Karthika & Bose, 2011; Martonosi et al., 2011; Molinero, Riquelme, & Serna, 2014).

Obviously, all detective techniques require features upon which covert nodes can be extracted from SNS or CNS. Such features for detecting covert members should be graph-based features because external features may be inaccessible or difficult to build with SNS. Graph-based features are adopted in the absence of personal node attribute or feature PNA or PNF(Costa, Rodrigues, & Travieso, 2008; Gregory, 2007; Mahyar, 2015; Zhang, Levina, & Zhu, 2015). Structural or graph-based features are substituted for PNA or PNF for identification of determinant node i.e. the intended node that might be of interest to analysts. Structural features are accomplished through Social network analysis (SNA) (Ahajjam, Badir, & Haddad, 2015; Ahsan, Singh, & Kumari, 2015; Butt et al.,

2014; Carter, Idika, Streilein, & Member, 2014; Catanese et al., 2013; Clauset & Woodard, 2013; Ferrara et al., 2014; Karthika & Bose, 2011).

Literatures acknowledged various techniques for detecting covert members in a SNS or CSN. However, they are ineffective in counterterrorism, because elimination of few detected members do not destabilize criminal organizations network (Eiseit & Bhadury, 2015). Failure on counterterrorism is as a result of flat organizational structure and leaderless principle of criminal. A node identified as leader could be an errant or ordinary floor member while non-expendable member(s) in the organization remain undetected i.e. continue cloaking and remain clandestine in the network by manipulating relationship to evade detection.

Rhode opined that members of criminal network do swap their roles i.e. through relationships or communications networks, a leader may have floor/ordinary member attributed value, while an ordinary member may be found as a leading member (Eiseit & Bhadury, 2015; Rhodes & Keefe, 2007). Another factor gathered is that there is discrepancy between the two concepts: actual/real life leader and accrued/ascribed leader through connections. Destabilization of criminal networks cannot be actualized when wrong node(s) is mistakenly taking for real leader. And no method has been found to establish connection between the duo, that is, the real leader and ascribed leader through accrue connections(Butt et al., 2014; Eiseit & Bhadury, 2015). Though this is a false alarm, but its implication is that wrong information will be used in decision making (Butt et al., 2014; Carley et al., 1998; Minor, 2012).

The remainder of this paper is presented as follows. Section 2 presents related works on counterterrorism and network destabilization. Section 3 discuses, hierarchical structural towards network destabilization and counterterrorism and Section 4 presents three cadres/categories of members in the covert network with flat organizational structure and Section 5 concludes this paper.

2. REVIEW OF RELATED LITERATURE

This section presents some of the works that identified the problem under discussion.

Sageman (2008 & 2005) describes terrorist groups like Al-Qaeda as leaderless organizations (Husslage et al., 2012; Sageman, 2005). Husslage et al., (2012) corroborated Sageman's assertion on leaderless principle and flat organizational structure using mathematical correlation analysis. Husslage et al., (2012), presented structures that denote flat organizational structure, in which leading nodes within the structure cannot be identified visually or through graph-based tools: SNA.

Husslage et al., (2012) proved that secrecy and efficiency on criminal relationships and transactions are relatively to trade off performance μ and variance $\sigma^2$of members'

centrality values. Correlation analysis results show that low variance indicates that no significant individual(s) or key player(s) can be identified /detected within the structure; since low variance indicates low differences between individual members' centrality values; thus all members could have equal status. Ranking them again may also give insignificant traits values (Husslage et al., 2012). This does not nullify presence of key players, but it attests that high profile members cannot be distinguished and will remain undetected.

It was inferred from Husslage's correlation analysis that mathematical correlations of member's links contain clue if high-profile member(s) or key player can be detected within the network structure. Husslage opined that optimal covert networks do have very low variance σ^2on members' centrality values, an indicator that high-profile member(s) may not be detected because of very low variance. Network graphs of any social media can also exhibit low variance provided that network participators have equal number of connections; when they are well embedded. Finally, flat organizational structure is not limited to CSN, it cut across all social networking and communication networks where key player and high profile individual cannot be identified based on links/ relationships in the network.

Butt et al.,(2014) proposed technique for identifying key player(s) in a multiple-layer of transactions. The authors affirm that key players in CSN always evade detection by hiding behind intermediary node(s) or hidden mediator(s). The method showed that exploration of more than one network platforms can make covert members to become more vulnerable to detection. Butt et al., (2014) deployed degree centrality on each transaction/ social record to identify tendency of culpable nodes found of hiding i.e. key players. The SNS of suspicious individuals used was not presented for observation and assessment, to ascertain location of detected nodes if it agrees on centrality-driven concept: if detected nodes are close to or located at centre of the network graph. The authors' approached identified different leaders according to degree centrality from financial transactions record, SMS, email and phone calls log data, and no hierarchical structure was presented or implemented.

Karthika and Bose (2011) presented SNA tools for detecting covert members in a CSN. The work compared results of SNA tools for covert or hidden node extraction. The study did not limit covert nodes to only actors in the network but all elements which involved in relationships or interactions are included. To show that covert node(s) are not distinguishable provided that such node is located at the centre of the network. Comparison was made on the detected nodes using degree centrality, betweenness centrality and closeness. The graph of relationships between hijackers, conspirators and various locations in 9/11attack was presented as sources where the various statistical measure were obtained. Khalid Al-Midhar (KAM) was detected and presented as covert node in the 9/11 graph using betweenness and degree centrality. Rayed and Bandar are

two locations acknowledged with the highest closeness centrality values, i.e. detected as the most closed locations or interacted with but not centrally located from network graph.

Ahajjam, Badir and Haddad (2015), Ahsan, Singh and Kumari(2015), Molinero, RiquelmeandSerna, (2014) reformed the SNA tools towards network extraction and community detection. The SNA was viewed as a factor which could have aided community evolution better than non-established paradigm. Community's evolution was conceived around set of nodes that have influence i.e. influential nodes; nodes that have better relationships with other nodes. It is quite understood that new groups can form or break away from main graph if there is a node that can pull them (other nodes). Community's detection based on influential nodes set new rule towards network partitioning (NP) by identifying influential nodes within the network along which the main graph can be divided.

Influential approach for community evolution has contrary phenomenon to existing paradigm for NP; where a network graph is divided haphazardly or arbitrarily using sort of algorithms which can divide network graph base on specified number of researchers' order or on ground truth basis. This was also used in Maeno's work (Maeno & Ohsawa, 2007). Thereafter, modularity (Q) is always employed to validate the communities structures authenticity i.e. if evolving communities/ portioned graphs are well connected internally than outside (Chen, Zaïane, & Goebel, 2010; Choudhury & Paul, 2013; Duch & Arenas, 2005; Pujol, Bejar, & Delgado, 2006; Salehi, Rabiee, & Rajabi, 2012; Smith, Senne, Philips, Kao, & Bernstein, 2013; Zhang et al., 2015).

According to Eiseit and Bhadury(2015), hidden node is easier to find through centrality than nodes that occupy peripheral position in the network. It draws clue that hidden nodes are well embedded because all relationships, communications, interaction revolve around well embedded or central node(s). However, lesser attention is given to nodes that occupy peripheral positions. Therefore mining for covert nodes stop immediately after the general covert nodes; network leader emerges.

Further probing of member(s) next in rank/hierarchy to the leading node has been overlooked or underestimated as irrelevant. Exploring nodes which are next in centrality values to the overall leading nodes could be potential future leaders to criminal groups. They could be nodes that occupy peripheral locations in the network. Next in rank nodes may be special tasks managers in which clandestine of their actual roles prevent analysts from acknowledge that they are worthy to be eliminated along with network leader. Finally, next in raking nodes could be strategic operators which are nearly classified among passive nodes but potential network builders immediate after elimination of incumbent network leader (Eiseit & Bhadury, 2015).

Catanese et al., (2013) and Ferrara et al., (2014)developed SNA-based techniques for extracting hierarchies using visualization concept from phone communications of

criminal members. Each study presents different route to accomplish their paradigms. Baseline to duo: forensic analysis of phone call networks and detecting criminal organizations in mobile phone networks employed SNA tools. The results of visualization reveal elements/members contributing to the main leader, though other technicalities were incorporated making it not to be purely SNA-based concept.

3. METHODOLOGY

There are three different members of criminal organization whose roles are pertinent to continuity of criminal groups: network leader, network builder and sleeper partner. Bhadury and Eiseit (2105) referred to covert members who are very important but occupy peripheral positions in the criminal network. The peripheral positions include special task like coupling of improvised explosive devises (IED), recruiting new members, and training of infantry (Eiseit & Bhadury, 2015). These set of members may not be discovered because they are not occupying central positions and only very few information may passes through them. Nevertheless, they are worthy of being removed because of the positions they hold in the network (Maeno, 2009; Maeno & Ohsawa, 2007; Rhodes & Keefe, 2007). Detective techniques fail to identify them because they occupy peripheral positions of the network. SNA techniques detect central figure; not peripheral nodes that are involved in special tasks.

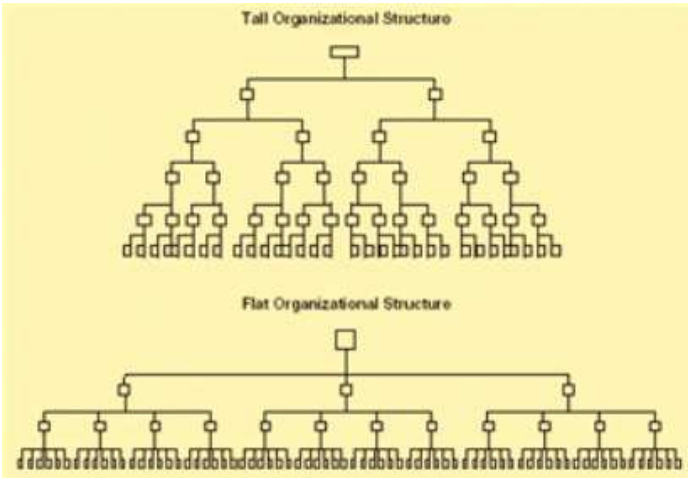


Figure 1: Tall and Flat Organizational Structures

Figure 1 presents tall/hierarchical organizational structure T/HOS and flat organizational structure FOS. The tall hierarchical structure has its top structure being narrow while flat has wider top. This implies that TOS has distinct compartment or departmental or functional sections than flat organization. The base line which is operational sections for the FOS cannot be distinguished because floor members could not be subjected under any distinct supervisor: to any superior nodes irrespective of

departments, while base line of T/HOS are distinct, because lower nodes are only beckon or answerable to their departmental or sectional superior nodes. One good analysis from the FOS is that more nodes including less expected node can succeed the current leader while T/HOS has limited number of nodes possible of succeeding current leader node; two nodes in TOS and three nodes in the FOS.

Hierarchy extractions based on SNA tools are proposed for mopping of high rank nodes and potential leaders. Mopping as being used is to identify and clear those nodes having next scoring centrality values close to a network leader as nodes occupying peripheral positions of the criminal network. The peripheral positions may be equivalent to special tasks an organization. Hierarchy is chosen to cater for some abnormal behaviour often exhibit by covert members like:

(1) Actual leader in a criminal network cannot be ascertained: detectable or not (Eiseit & Bhadury, 2015; Husslage et al., 2012).

(2) Criminal members always evade detection by swapping of their roles.

(3) SNA technique prioritizes or take cognizance of the highest scoring node(s) only, in all these cases, the leading node is the only relevant node while others are less important nodes.

Constraints to Hierarchy extraction in FOS

The chief executive officer (CEO) of T/HOS emerges from one of functional units of the organizations equivalent to special tasks in CSN (Carley et al., 1998; Eiseit& Bhadury, 2015; Kettley, 1995). The SNA tools are used to identify the general leader only. Nevertheless, the first constraint is that, FOS obtained through members' communications, relationships or social media networks cannot be further partitioned into distinct sections of work/ tasks/ department because communication network cannot include member's task features like PNA. Thus, mining hierarchies in CSN can be limited to few top members as movement towards the bottom of structures, the more it becomes difficult to separate members into sections or units due to lack features to cluster them into sections. Second constraint is that by convention, there is cord connecting upper hierarchy members to their subordinates. This might be vehemently missing because subordinates in FOS have no particular upper member(s) they are permanently and strictly taking orders from: FOS blocks identification of members from a particular unit or section. Further research can delve into how operational members can be split into sections or units.

Reliability of SNA tools for Mining Hierarchy

The SNA tools are known for data mining, specifically hidden node. The most common tools of the task are: betweenness centrality, closeness centrality, degree centrality and eigenvector centrality. Each tool attests to the fact that a hidden node could be the one closely located at centre of the network graph. Setting that aside, a central figure that emerges from eigenvector centrality is the one who takes advantage of being connected with neighbour nodes with high eigenvector values. A node will have the highest eigenvector centrality score as a result of its neighbouring nodes having high score eigenvector centrality as well. Besides, occupants of peripheral locations or special tasks in the FOS are probably the nodes with next high eigenvector values.

In addition, occupants of special tasks must be experienced, qualified personnel before it can participate in the decision making. There is no metric to quantify experience and skills of members, therefore, the next lower scores could be assumed for this qualification in the absence of none. Discretion of taking the next lower scoring nodes for nodes to occupy second cadre or hierarchy is more appealing than any others as participators in decision making. Though, individual metric values should claim the position rather than arbitrary allocated to nodes. As earlier emphasized, any of nodes in second cadre / hierarchy could be emerged as a leader after the incumbent criminal leader might have been eliminated. Finally, another opportunity in this set of nodes is that, they may require less effort to reunite falling-away nodes (operational/floor members) after elimination of the top leader. That is more reason why, they should be addressed as network builder.

Eigenvector-Mechanism

Eigenvector centrality identifies a leading node based on quantity and quality of links. The first condition which can earn a node to be a leading node or central node is that if it has the highest number of link in the network, this represents 'quantity of link' which degree centrality offers to identify leading node. It is important to admit that criminal group can structure their relationships in which ordinary errant members can have highest number of links. The Matrix in Figure 2 can be used for illustrations. Each element is a neighbour to other elements. These elements denote nodes or actors in a criminal network.

A node can emerge as highest scoring eigenvector value if majority or all other nodes have links with it. That is, node id: a_{11} will be considered as central nodes provided all other nodes communicate with a_{11}. This would earn such node to automatically appear at the central. But, this is too extreme to occur in CSN because of secrecy, security, efficiency and large area expected to. A criminal leader communicates with subordinates (members) who can get his work done and not all.

$$M = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \end{bmatrix}$$

Figure 2: Elements Constituting Flat Organizational Structure

The 'quality of links' can also determine which node will make it up to the central. It shows that for a node to have the highest eigenvector value. its neighbouring nodes too should have significant values of influence or they are locally central in their locations. For instance, a node a_{21} has other nodes as neighbours: not only$a_{11}, a_{12}, a_{31}\ and\ a_{32}$. If a node has high number of neighbour that pull crowd or nodes, such a neighbour will emerge at central irrespective of location.

Extraction of hierarchies from CSN only demands setting of threshold for eigenvectors values of nodes to be clustered in each hierarchy. First of all, hierarchical structure presented in this work adopts the highest scoring eigenvector node as the top most hierarchy which is equivalent to leading node. Second hierarchy contains nodes with equal eigenvector centrality values in which three nodes appeared. And the next lower hierarchy which is third has set of nodes that are close in eigenvector values.

4. RESULT AND DISCUSSION

The hierarchical structure presented below is from covert social network of Greece Nov 17 attacks. Names of actors in the network have been replaced with actor identity number (actor-id), for easy representation of members TOS.

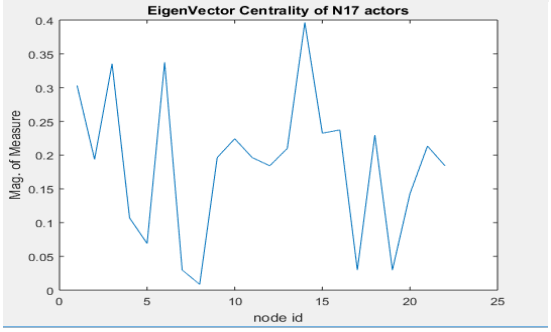


Figure 3: Eigenvector Centrality Graph

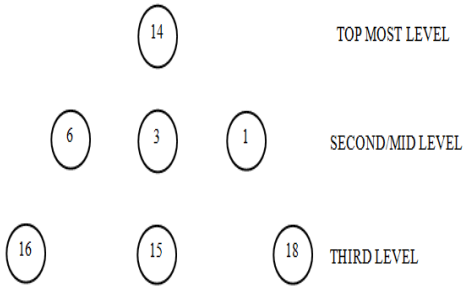


Figure 4: Eigenvector-Based Hierarchies

Figure 3 prsents eigenvector centrality graphs for actors in the N17 Greece attacks, while Figure 4 shows two more hierarchies below the leading node: node id 14. The second cadre in Figure 4 is the second hierarchy. This level is assumed to be occupied by the nodes with special tasks. The third hierarchy/cadre present set of people next in hierarch or rank to second cadre. Considering the constraints, it cannot be categoricaly

stated which node in the second cadre the node id 16 is a sub-ordinate to. Similarly, the same is appplicable to other nodes in the third cadre.

Discussion

This section presents relationship between eigenvector-based hierarchical structure and sections/factions in the N17 network. Figure 5 is the covert social network-CSN of N17 and three special tasks in the network encompasses:Generation leadership, Sardanopoulos faction and Koufontnas faction(Rhodes & Keefe, 2007). Members to each faction have relationship with members in other factions. Figure 6 is the 'gold standard' selection of members in each faction. Though, it was reported that the selection was arbitratry.

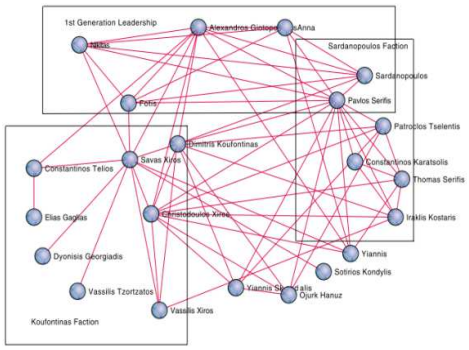


Figure 5: Covert social Network of N17

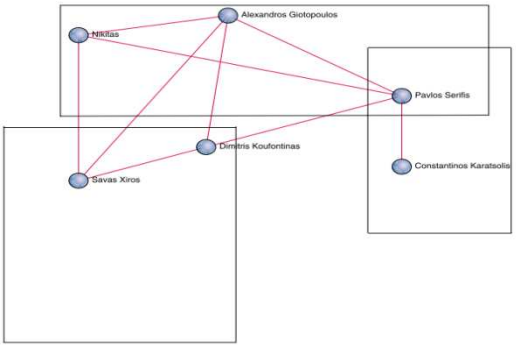


Figure 6: 'gold standard' selection (Rhodes & Keefe, 2007)

The order of nodes in Eigenvector-hierarchy are:14, 6, 3, 1, 16 , 15, and 18 are actors: Pavlos Serifis, Dimitris Koufontinas, Christodoulos Xiros, Alexandrous Giotopoulos, Savas Xiros, Sardanopoulos, and Thomas Serifis respectively. This shows that nodes id 6, 3, and 1 are prominent heads of the three factional sections in the group, but covered by FOS: so they appear in different locations i.e. not close to the actual section they control. Using the eigenvector-hierarchy, sectional heads of the CSN are nodes id 6, 3, and 1. In addition, Pavlos Serifis is the central leader according to the eigenvctor-hierarchy mechanism which is located in the faction Sardanopoulos. Then Sardanopoulos is located in the third lower hierarchy of the eigenvector based TOS. It is obvious that SNS is an illustration of flat organizational structures where section, departement individual members in an organizations belong cannot be easily categorized or classified.

5. CONCLUSION

Flat organizational structure considers all nodes to be of equal position and status in the network graph. This structure allows any node to assume any designated position in the network just to fill the gap out of exigensies. Nonetheless, current behaviours of high profile criminals in CSN necessitate the need for security agencies to utilize formidable

pragmatic concept to identify high placed covert members. Thus extraction of hierarchies using Eigenvector-based concept presents another opportunity to mop of high profile members in a CSN. Specifically, the Eigenvector-based TOS could be more robust in fixing hidden members who control the peripheral sectors of the criminal organization.

REFERENCES

Ahajjam, S., Badir, H., & Haddad, M. E. L. (2015). Towards a new approach for community detection algorithm in social networks. *International Conference on Big Data, Cloud and Applications Tetuan, Morocco, May 25 - 26, 2015 Towards*, 23–28. http://doi.org/10.1109/AICCSA.2015.7507215

Ahsan, M., Singh, T., & Kumari, M. (2015). Influential Node Detection in Social Network During Community Detection. *IEEE Cognitive Computing and Information Processing (CCIP), 2015 International Conference*.

Butt, W. H., Qamar, U., & Khan, S. A. (2014). Hidden Members and Key Players Detection in Covert Networks Using Multiple Heterogeneous Layers. *Journal of Industrial and Intelligent Information*, *2*(2), 142–146. http://doi.org/10.12720/jiii.2.2.142-146

Carley, K. M., Reminga, J., Kamneva, N., & Carley, K. M. (1998). Destabilizing Terrorist Networks. *Institute for Software Research , Carnegie Mellon University*.

Carter, K. M., Idika, N., Streilein, W. W., & Member, S. (2014). Probabilistic Threat Propagation for Network Security. *IEEE TRANSACTIONS ON INFORMATION FORENSICS AND SECURITY*, *9*(9), 1394–1405.

Catanese, S., Ferrara, E., & Fiumara, G. (2013). Forensic analysis of phone call networks. *Social Network Analysis and Mining*, *3*(1), 15–33. http://doi.org/10.1007/s13278-012-0060-1

Chen, J., Zaïane, O. R., & Goebel, R. (2010). Detecting Communities in Social Networks using Local Information. *From Sociology to Computing in Social Networks*, 197–214. http://doi.org/10.1007/978-3-7091-0294-7_11

Choudhury, D., & Paul, A. (2013). COMMUNITY DETECTION IN SOCIAL NETWORKS : AN OVERVIEW. *International Journal of Research in Engineering and Technology*, *2*(2), 83–88.

Clauset, A., & Woodard, R. (2013). Estimating the historical and future probabilities of large terrorist events. *Annals of Applied Statistics*, *7*(4). http://doi.org/10.1214/12-AOAS614

Costa, L. F., Rodrigues, F. A., & Travieso, G. (2008). Characterization of Complex Networks : A Survey of measurements.

Duch, J., & Arenas, A. (2005). Community detection in complex networks using extremal optimization. *Physical Review E - Statistical, Nonlinear, and Soft Matter Physics*, *72*(2), 1–4. http://doi.org/10.1103/PhysRevE.72.027104

Eiseit, H. A., & Bhadury, J. (2015). The Use of Structures in Communication Networks

to Track Membership in Terrorist Groups. *Journal of Terrorism Research*, *6*(1), 1–18.

Ferrara, E., De Meo, P., Catanese, S., & Fiumara, G. (2014). Detecting criminal organizations in mobile phone networks. *Expert Systems with Applications*, *41*(13), 5733–5750. http://doi.org/10.1016/j.eswa.2014.03.024

Fortunato, S. (2010). *Community detection in graphs*. Complex Networks and Systems Lagrange Laboratory, ISI Foundation, Viale S. Severo 65, 10133, Torino, I-ITALY. The.

Galar, M., Fern, A., Barrenechea, E., & Bustince, H. (2012). Hybrid-Based Approaches, *42*(4), 463–484. http://doi.org/10.1109/TSMCC.2011.2161285

Gregory, S. (2007). An algorithm to find overlapping community structure in networks, *4702 LNAI*, 91–102. Retrieved from http://www.scopus.com/inward/record.url?eid=2-s2.0-38049120277&partnerID=40&md5=086384ad72be41a9db115c1f2f428fa5

Husslage, B. G. M., Lindelauf, R., & Hamers, H. J. M. (2012). Leadeless Covert Networks: A Quantitativive Approach. *CentER Discussion Paper;2012 Tilburg: Econometrics. General*, *2012–57*, 1–15.

Karthika, S., & Bose, S. (2011). A COMPARATIVE STUDY OF SOCIAL NETWORKING. *International Journal on Web Service Computing (IJWSC)*, *2*(3), 65–78.

Kettley, P. (1995). *IS FLATTER BETTER ?: DELAYERING THE MANAGEMENT HIERARCHY*. The Institute for Employment Studies, Mental Building University of Sussex Brighton BM 1 9rF UK.

Maeno, Y. (2009). Node discovery in a networked organization. *IEEE International Conference on Systems, Man, and Cybernetics*, (October), 3522–3527.

Maeno, Y., & Ohsawa, Y. (2007). Analyzing covert social network foundation behind terrorism disaster. *International Journal of Services Sciences*, *2*(x), pp.125-141. http://doi.org/10.1504/IJSSci.2009.024936

Mahyar, H. (2015). Detection of Top-K Central Nodes in Social Networks : A Compressive Sensing Approach. *IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining*, 902–909.

Manning, J. D. (2010). Dark Networks. *U.S. Army College, Carlisle Barrack*.

Martonosi, S. E., Altner, D., Ernst, M., Ferme, E., Langsjoen, K., Lindsay, D., … Ronan, A. S. (2011). A New Framework for Network Disruption. Retrieved from http://arxiv.org/abs/1109.2954

Massa, M., & Zhang, L. (n.d.). The Role of Organizational Structure : Between Hierarchy and Specialization The Role of Organizational Structure : Between Hierarchy and Specialization, 1–39.

Minor, T. (2012). Attacking the Nodes of Terrorist Networks. *Global Security Studies*, *3*(2), 1–13.

Molinero, X., Riquelme, F., & Serna, M. (2014). Power indices of influence games and

new centrality measures for agent societies and social networks. In *Advances in Intelligent Systems and Computing*. http://doi.org/10.1007/978-3-319-07596-9_3

Pujol, J. M., Bejar, J., & Delgado, J. (2006). Clustering algorithm for determining community structure in large networks. *The American Physical Society*, (March), 1–9. http://doi.org/10.1103/PhysRevE.74.016107

Rhodes, C. J., & Keefe, E. M. J. (2007). Social network topology: a Bayesian approach. *Journal of the Operational Research Society*, *58*(12), 1605–1611. http://doi.org/10.1057/palgrave.jors.2602352

Roberts, N., & Everton, S. F. (2011). Strategies for Combating Dark Networks. *Journal of Social Structure*, *12*, 2. http://doi.org/10.1007/s10796-010-9271-z

Sageman, M. (2008). The Origins of the Jihad, (January), 1–20.

Sageman, M., & D, P. (2005). Understanding Jihadi Networks Strategic Insights , Volume IV , Issue 4 (April 2005) The Evolution of the Global Salafi Jihad Ideology The History of the Global Salafi Jihad. *Europe*, *IV*(4).

Salehi, M., Rabiee, H. R., & Rajabi, A. (2012). Sampling from complex networks with high community structures. *Chaos (Woodbury, N.Y.)*, *22*(2), 23126. http://doi.org/10.1063/1.4712602

Smith, S. T., Senne, K. D., Philips, S., Kao, E. K., & Bernstein, G. (2013). Network detection theory and performance. *arXiv:1303.5613v1 [cs.SI] 22 Mar 2013*, 1–13. Retrieved from http://arxiv.org/abs/1303.5613

Zhang, Y., Levina, E., & Zhu, J. (2015). Community Detection in Networks with Node Features. *arXiv Preprint arXiv:1509.01173*, 1–16. http://doi.org/10.1109/ICDM.2013.167

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ASSESSING URBAN TRANSPORT SUSTAINABILITY FOR PEOPLE WITH DISABILITIES IN THE DIGITAL ERA

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ABSTRACT

Urban public transportation accessibility for Persons with Disabilities facilitates participation of this demographic are important factors in reducing poverty and can facilitates the participation of Persons with Disabilities in economic, social and political processes. For the last two decades, development in transportation infrastructure is on the increase daily. The focus of the countries all over the world is shifting from infrastructure development to the best use of the infrastructure facilities available. For the optimum use of the available transportation infrastructure, Intelligent Transportation System (ITS) is being developed and used all over the world. This considered below in Nigeria compare to other world countries. This study aimed to examined the impact of ITS on the accessibility of Persons with Disabilities in Nigeria. 434 questionnaires were distributed and 422 returned. Simple random sampling was used to select sample from the population of the study and SPSS was used to analyze the study data. Results of this study indicates that, all the identified factors (Disabilities Pedestrians Safety, Internet for Disabilities, RFID, Assistive GPS and Alarm Notification) were all statistically significant with $p<0.05$. Specifically, results of this study indicates that inaccessibility has contributed negatively to the social and economic isolation of Persons with Disabilities with the lack of effective ITS in Nigeria compared to other countries. Fixing the bottleneck of Persons with Disabilities, isolation and lack of using public transport, the researchers believed that the effective use of ITS facilities and installation of technology gadgets with the new buses, maintaining and rehabilitating the old pavement and infrastructure will enhance and aid their mobility in Nigeria.

Keywords: *Transport, Intelligent Transportation System (ITS), Persons with Disabilities, Accessibility.*

1. INTRODUCTION

Traditional urban public transportation systems worldwide are generally designed for a healthy population and rarely take into account the needs of Persons with Disabilities. The United Nations estimates that between 6 to 10% of the population in developing countries and some 400 million people worldwide have a disability (Roberts and

Babinard, 2012). Besides, the number of Persons with Disabilities will increase significantly in the next decade due to the increasing number of elderly people.

Result from Roberts and Babinard,2012 shown that in order to improve the quality of life for Persons with Disabilities, both developed countries and developing countries need to improve the accessibility of the urban public transportation and to make it more attractive. Moreover the urban public transportation accessibilities for Persons with Disabilities are important factors in reducing poverty and can facilitates the participation of Persons with Disabilities in economic, social and political processes.

For the last two decades, a lot of development in the field of transportation infrastructure with various traffic problems are increase daily due to the increase in number of vehicle ownerships. Almost every country of the world whether developing or developed facing problems in the management of transportation facilities (Singh and Gupta, 2013). The focus of the countries all over the world is shifting from infrastructure development to the best use of the infrastructure facilities available (Singh et al., 2014). For the optimum use of the available transportation infrastructure, Intelligent Transportation System (ITS) is being developed and used all over the world.

ITS is an integrated system that implements a broad range of communication, control, vehicle sensing and electronics technologies, to help in monitoring and managing traffic flow, reducing congestion, providing optimum routes to travelers, enhancing productivity of the system, and saving lives, time and money. ITS provides more immediate benefits to individual by helping to make surface transportation more affordable, reliable and efficient (Yokota, 2004). It is use in improved mobility for people and freight including greater access to transportation for the elderly ones, persons with disabilities, people living in remote locations and reducing traffic related deaths and injuries. It has received much attention in the recent years in academia, industry and standardization entities due to the wide impact on people's life as the scope to provide vital applications and services to improve transportation safety, mobility and to optimize the usage of available transportation resources and time. ITS applications and services rely on advanced technologies to be deployed and distributed among the intelligent infrastructure systems and vehicles system (Tarapiah and Atalla,2015).

Access to GPS data, open data from publicly funded transit agencies and crowd-sourced data, along with a more refined understanding of how these data can be applied to transportation has led to the rapid development of transportation applications (National Mobility Management Conference, 2014). Overall, 56% of American adults now own smartphones and the number of mobile Internet users is expected to reach 788 million. 77% of 18–29 year olds with annual incomes less than $33,000 own one, although this number drops to 22% among 50–64 year olds in the same income bracket. Smartphone ownership is not limited to younger generations either 18% of Americans age of 65 years or older own a smartphone and 34% own tablets (Smith,2013). 91% of persons with a

disabilities own or use a wireless device (Wireless Rehabilitation Engineering Research Center,2013).

Despite more progress recorded by the developed countries in advancing transportation systems in developed countries, the accessibility to the urban public transportation system in developing countries failed to meet the requirements of Persons with Disabilities due to the decay infrastructure and technological facilities, obsolete cities master plans, lack of tangible legislation and corruption on the side of government officials. This considered below in Nigeria compare to other world countries.

To tackle the increasing numbers of Persons with Disabilities and isolation in Nigeria major cities, the needs to meet accessibility of urban public transportation and to improve mobility of Disabled, Wheelchair and Blind people by adopting Intelligent Transportation System (ITS) combine with advanced information & communication technologies (ICT) is required.

With a total number of 3,253,169 of Persons with Disabilities in Nigeria which represent 2.32% of Nigerian population (NPC,2006), the impact of technology and digital World on the lives of passengers with disabilities can be life-changing, providing them the feeling of certainty to visit new locality without fear of injuries, accident, expose to road externalities and using a strange transportation modes. ITS facilities tend to change and support the travel pattern of Persons with Disabilities, Older Adults, and People with limited income. This study aimed to examine the impact of ITS on the accessibility of Persons with Disabilities in Nigeria.

The main urban transport related technological solutions that cities worldwide are currently pursuing (with North American and West European cities leading the way) include alternative fuel vehicles and intelligent transportation systems (ITS). New technologies may help to tackle certain transport related problems, such as air and noise pollution, oil dependency, traffic congestion, and accidents (Chowdhury and Sadek,2003; Kulmala, 2010). Their applicability in developing cities is considered below.

2. REVIEW OF RELATED LITERATURE

Disabilities accessibility and Technological Era

The popularity of applications has grown apace with the burgeoning growth in smartphone ownerships and geographic coverage. Having limited income does not seem to deter individuals in purchasing smart phones. The brief concludes with a look at trending developments in future transportation applications (National Mobility Management Conference, 2014). Applications was developed by using these technologies to allowed the creation of data streams that revealed the exact location at any given time of the bus/train, the passengers as well as lines without operating or experiencing delays.

Thus, an application could locate a user's current position, find the closest local fixed route transit stop and show the user in real-time when the next bus or train would arrive at that stop (GTFS Data Exchange,).

Technology innovation in transportation are good news for disabilities travel, giving them access to real-time, travel pattern, eliminate previous barriers of economic and social participation by the disabilities persons using public transportation. This type of technological innovation allowed disables to free routes location, mapping, public or special vehicles schedule, trips planning, social involvement and online fare payment.

Mashiri et al, 2005 reviewed the status of public transportation services for Persons with Disabilities in the developing world. Noted that on one hand, transport is an important enabler of strategies to fight poverty through enhancing access to education, employment, and social services (Venter et al,2002) and on the other hand, it is a key issue to reduce traffic jams (air pollution) in big cities. Moreover, the urban public transportation accessibility for Persons with Disabilities are important factors in reducing poverty and can facilitate the participation of persons with disabilities in economic, social and political processes (Roberts and Babinard, 2012).

Advanced Traveler Information System (ATIS) implements a wide range of technologies, such as internet, telephones, cellular phones, television, radio, etc. To assist travelers and drivers in making informed decisions regarding trip departures, optimum routes and available modes of travel. ATIS provides the drivers both en route and pre-trip information which is advantageous in many ways. Pre-trip information availability enhances the self-belief of the drivers to use freeways and allow commuters to make better informed transit choices (Campbell et al., 2003). En route information and guidance saves travel time, helps a traveler avoid congestion and can improve traffic network performance.

Wayfinding applications assist people with physical and intellectual disabilities in navigating streets and pathways between their homes, transit stops and other destinations. Such applications are designed to provide enough information to allow an individual with a disability to travel alone, giving them unprecedented freedom. One study demonstrated, for example, that when guided by a specially designed, cognitively accessible GPS-based WayFinder application, 73% of the individuals with an intellectual disability involved in the study could travel an unfamiliar bus line and exit at the correct stop (Davies et al, 2010).

Crowdsources is an older and age-friendliness application used for different services, including sidewalks and transit services. Users rate locations on things like general accessibility, availability of seating, lighting levels, staff attitudes, and background music levels. The application uses GPS to pinpoint the user's location, and is available for iPhone, iPad, and Android devices. People can simply browse the database to see which

locations and services in a neighborhood are considered "age-friendly" and why (www.futurity.org, 2014)).

Technological advancements could help to empower Persons with Disabilities by addressing their mobility needs, but the benefits of such advancement have not yet reached this segment of the traveling public. There is a need to explore the suite of new technologies, such as global positioning systems (GPS), Signs that talk which receiver on the unit converts a transmitted infrared signal into a voice message. Pedestrian Safety Traveler-to-vehicle and traveler to infrastructure communication would enable a pedestrian with a disability to enter the dialog of what's going on at an intersection using a smart phone. On arrival at an intersection, an equipped pedestrian would send a request to cross the street, which the dedicated short range communication (DSRC) then communicates to the traffic controller (Workshop summary Report, 2011). Urban structure and transport system developments are closely connected, and it is impossible to abstract the vision of the cities of tomorrow from that of the future configuration of their transport systems. In the past century, transformations in urban form have been linked to some kind of transport revolution (Safdie, 1998). The mass diffusion of private cars made possible low density and scattered urban developments in the outskirts and countryside, but at the same time negatively affected the quality of life in cities by creating unbearable traffic congestion, scarcity of parking, and noxious emissions.

In order to improve the accessibility to the urban public transportation system for persons with disabilities, it is important to signal to the bus driver the presence of the disabled person before the next bus stop. With the Radio Frequency Identification (RFID), when the tag users arrive and wait at the bus station, their presence will be automatically detected and the bus driver will be thus informed, so that the driver will perform the bus parking carefully in order to correctly deploy the pallet. In the station park, several alarm notification measures are employed to inform the DWB passengers of the arrival of buses: the RFID module for identifying the DWB classes and the different blinking frequencies of the luminous indicator or alarms of the buzzer to inform the arrival of coming buses. The use of capabilities of Internet access (IA), so that it can provide smart urban transportation services, including transportation condition reporting, urban environment data collection, Internet access, etc (Zhou et al,2012).

Vehicular traffic represents one of the main sources of pollutants in urban areas and takes a heavy toll on human lives. In Europe, urban transport is responsible for about a quarter of CO_2 emissions from transport; 69% of road accidents occur in cities. (EC, 2011). It is commonly recognized that automated Vehicles have the potential to fundamentally alter transportation systems by reducing fatal road accidents, providing critical mobility to the elderly and disabled, increasing road capacity, saving fuel, and lowering emissions. Estimates of potential impacts on road safety. Automatic driving should enhance safety, avoiding accidents currently caused by driver distraction or bad driving behavior. All vehicles should be equipped with ADAS technology, which will

allow them to circulate safely. In some cases the basic, maybe simple, idea is that, since driver error can be considered the main contributing factor in a vast majority of road accidents, a self-driving vehicle should eliminate nearly all accidents. Hayes, 2011 suggested that motor-vehicle fatality rates (per person-km travelled) could eventually approach those seen in aviation and rail, about 1% of current rates. KPMG and CAR (2012) advocate an end goal of "crashless cars."

Other trends affecting the development of transport systems are the virtualization of life and work and the increasing importance of electronic communication and social media. These trends are establishing new lifestyles and habits. Among these trends are teleworking and e-shopping (OPTIMISM, 2013). A survey of 15 countries found that in areas where many young people use the Internet, fewer than normal have driving licenses. In another survey young interviewees declared that social media give them an access to their world that would once have been associated with cars (The Economist, 2012).

For the last decade the phrase "Intelligent Transportation Systems" and the corresponding abbreviations—ITS—became usual in strategic, political and program and target documents of the developed countries. Because the control of such systems is based on the analysis of data large amounts, and decisions must be made often in real time, it is important to provide the opportunity for professionals involved in developing strategies for the development of transport systems and operational planning processes (Makarova et al, 2016). Transport allows to reveal mechanisms of the person activity, promoting understanding of town-planning, social and other processes. However, transport takes away from the citizen an invaluable and irreplaceable resource.

Assessing the value of ITS for better functioning of the transport system, the authors of scientific developments note that ITS enhance its effectiveness (Xia and Chen, 2007) provide sustainable development of the territories (Fengqi and Jun, 2010), are used to reduce the negative impact of the transport sector on the environment and to reduce energy consumption (Gkritza and Karlaftis, 2013). At present, ITS becomes a tool of transport planning and is used for surveys (Tayyaran et al ,2003), to decrease congestion (Harb et al,2011) and planning joint travel (Gärling et al,2004).

In order to improve the accessibility of urban public transportation system for the people with disabilities different domains must be investigated such as social science (user requirements and acceptation, economic and social impacts, sustainable development …), information (real-time urban transportation traffic, traffic optimization and simulation flow, urban air quality …) and infrastructure (security, quality of service for accessibility and comfortable of waiting room at bus stops or at multimodal stations …) and vehicles (comfortable dedicated seats or spaces for disabled people (e.g., wheelchair users), low-floor buses for accessibility, etc.) (Zhou et al, 2012). Some

dedicated public transportation systems for persons with disabilities are thus implemented (Baudoin and Venard, 2010; Mashiri et al, 2005; Laskow,2012).

3. METHODOLOGY

This study was conducted in Nigeria. According to West Africa Gateway (2012), Nigeria is a Federal Republic in West Africa bordering Benin (773 km) in the west, Chad (87 km) and Cameroon (1 690 km) in the east and Niger (1 497 km) in the North. It coast in the south lies on the Gulf of Guinea in the Atlantic Ocean. It comprises of 36 States and the Federal Capital Territory Abuja, the capital city of Nigeria. It has a total area of 923,768km^2 , density of 197.2/km^2 and population of 140,431,790 (Nigeria Population Census,2006).

The population for this study was restricted to the Persons with Disabilities in Nigeria. The survey was carried out in six (6) Southwestern states comprises of Ekiti, Osun, Oyo, Ondo, Ogun, Lagos state and one (1) of North central states , Kwara State, all in Nigeria. Both institution and street based method were used to drawn the number of respondents needed for this study. The institutions comprises of Kwara State School for Special Needs, Ilorin, Federal College of Education (Special), Oyo, Centre for Empowerment of the Disabled, Lagos, The Centre for People Citizens with Disabilities, Lagos and all major streets in the selected states are purposively chosen. Simple random sampling was used to select number of respondents.

Primary data were used. Data were collected through the aid of interview and questionnaires soliciting information from various respondents. 434 questionnaires (67 questionnaires in each state) were distributed to the respondents and 422 were retrieved (that is 98.4% were found analyzable). However, Multiple regression technique was used to analyze collected data.

Model Specification

The multiple regression is expressed as;

$Y = a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + ...\beta_n X_n + e.$

Y = Disabilities accessibility using ITS.
a = Constant.
B = Coefficient of X.
X_1 = Disabilities Pedestrian Safety
X_2 = Radio Frequency Identification.
X_3 = Assistive GPS
X_4 = Parks Alarm Notification.
X_5 = Internet Access.

4. FINDINGS AND DISCUSSION

Table 4.1: Model Summary

		R Square	Adjusted R Square	Std. Error of the Estimate
	.620[a]	.385	.378	.39493

Table 4.2 ANOVA

Model	Sum of Squares	f	Mean Square		ig.
Regression	40.706	5	8.141	52.199	.000[a]
Residual	65.038	17	.156		
Total	105.745	422			

Table 4.3 Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients		ig.
	B	Std. Error	Beta		
(Constant)	.636	.088		.193	000
Disabilities Pedestrian Safety.	.126	.015	.338	.335	.000
Internet for Disabilities.	.296	.045	.284	6.563	.000
Radio Frequency Identification.	-.197	.039	-.203	-5.047	.000
Assistive GPS	.093	.019	.205	4.946	.000
Alarm Notification	.066	.020	.134	3.317	.001

.

From Table 4.1, the relationship between identified factors and disabilities accessibility as dependent variable was 62% as indicated with R=.620. This implies the

quality prediction of the dependent variable of the model. However, R^2= 38.5% which indicated the contributions of all the identified factors to disabilities accessibility using ITS in Nigeria. Therefore, about 61.5% can not be accounted for as areas of contributions. Table 4.2 shows that the independent variables statistically significant predict the dependent variable, F (5,417) = 52.199, at p<0.05. This implies that the regression model is a good fit of the data.

Table 4.3 shows that all the variables examined are statistically significant and among them, internet for disabilities with β = .296 have the highest impact on dependent variable followed by disabilities pedestrian safety with β = .126 and statistically significant at p<0.05. This implies that the increase in disabilities internet by .296 will reduces hardship of disables accessibility using ITS by -.267. Hence, the equation for the regression;

$$Y= a + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + ...\beta_n X_n + e.$$

Y (Accessibility of Disabilities using ITS)= .636 + .126(Disabilities Pedestrians Safety) + .296(Internet for Disabilities) - .197(RFID) + .093(Assistive GPS) + .066(Alarm Notification).

5. CONCLUSION AND RECOMMENDATION

Disabilities inaccessibility has contributed negatively to the economic and social isolation of people with disabilities in Nigeria especially in the area of ITS facilities using internet, radio frequency identification, alarm notification, assistive GPS and disabilities pedestrians safety to aid Persons with Disabilities a wide chance of mobility and accessibility. It has been realized from the study that all identified variables has impact on accessibility of Persons with Disabilities. Since road transport is the major means used in developing countries and majorly in the study area, to achieve sustainability development goal for all groups of people in Nigeria, there is need for the Federal Government of Nigeria to invest more on tecnologies in other to break the barrier of accessibility by the disables and further enhance the socio-economic activities and participation. Fixing socio-economic isolation of vulnerable people in Nigeria, the researchers believed that the effective use of ITS special facilities and gadgets incorporated with the new buses, maintaining and rehabilitating the old pavement and infrastructure will enhance and aid disabilities mobility in Nigeria. This study recommends further that unparalleled gap between different groups of people especially when considered accessibility of Persons with Disabilities need to be bridged to foster natural justice and conscience in the distribution of transport resources. The unequal access to ITS facilities by the Persons with Disabilities is not just only problematic but some transport facilities distributions can be considered as unfair. There is need for the

Government to considered Persons with Disabilities as part of society and part of transport decision makers.

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REFERENCES

App: a self-contained program or piece of software designed to fulfill a particular purpose; an application, especially as downloaded by a user to a mobile device (Oxford Dictionary).

Baudoin, G.; Venard, O. Information, Communication and Localization Environment for Travelers with Sensory Disabilities in Public Transports. In Proceedings of 5th International ICST Conference on Communications and Networking, Beijing, China, 25–27 August 2010.

Chowdhury, M.; Sadek, A. Fundamentals of Intelligent Transportation Systems Planning; Artech House: Norwood, MA, USA, 2003.

Campbell, J. L., Carney, C., & Kantowitz, B. H. (2003). Human Factors Design Guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operation (CVO). Federal Highway Admin., McLean, VA, Rep. FHWA-RD-98-057-2.

Davies DK, Stock SE, Holloway S, Wehmeyer ML. "Evaluating a GPS-Based Transportation Device to Support Independent Bus Travel by People With Intellectual Disability." American Journal on Intellectual and Developmental Disabilities, Vol 48, No, 6, December 2010.http://www.aaiddjournals.org/doi/pdf/10.1352/1934-9556-48.6.454 (accessed 27/12/14).

European Commission. 2011. White Paper. Roadmap to a Single European Transport Area: Towards a competitive and resource efficient transport system. COM(2011)144, Brussels

Fengqi Z, Jun S (2010) Deploying an intelligent transportation system in Chongming county. Shanghai J Urban Technol 17(3):39–51

Gärling T, Jakobsson C, Loukopoulos P (2004) Adaptation of private car use in response to travel demand management measures: potential roles of intelligent transportation systems. J Intell Transp Syst Technol Plann Oper 8(4):189–19

Gkritza K, Karlaftis MG (2013) Intelligent transportation systems applications for the environment and energy conservation (Part 1). J Intell Transp Syst Technol Plann Oper 17(1):1–2

Harb R, Radwan E, Abdel-Aty M (2011) Two simplified intelligent transportation systembased lane management strategies for short-term work zones. J Intell Transp Syst Technol Plann Oper 15(1):52–61

Hayes, B. 2011. Leave the Driving to it. American Scientist. 99: 362–366.

Http://trimet.org/apps. Noted by Kevin Chambers in his presentation during the "Harnessing Technology for Expanded Communication with Customers, Caregivers, and Health Care and Employment Providers" panel, National Mobility Management Conference, June 9–10, 2014, St. Paul, Minnesota. http://nationalcenterformobilitymanagement.org/2014mmconference/ (accessed 9/10/14)

Http://www.futurity.org/app-lets-seniors-rate-%E2%80%98age-friendly%E2%80%99-places/ (accessed 9/10/14)

Kulmala, R. Ex-Ante Assessment of the Safety Effects of Intelligent Transport Systems. Accid. Anal. Prev. 2010, 42, 1359–1369.

KPMG and CAR. 2012. Self-Driving Cars: The Next Revolution. Ann Arbor.

Laskow, S. Public Transportation Systems Are Leaving People with Disabilities Behind.Available online:http://www.good.is/post/public-transportation-systems-are-leaving-people- withdisabilities-behind/ (accessed on 10 May 2012).

Mashiri, M.; Maunder, D.; Venter, C.; Lakra, A.; Bogopane-Zulu, H.; Zukulu, R.; Buiten, D.; Boonzaier, D.Improving the Provision of Public Transport Information for Persons with Disabilities in the Developing World. In Proceedings of 24th Annual Southern African Transport Conference , Pretoria, South Africa, 11–17 June 2005; pp. 308–322.

Makarova et al (2016) Increase of City Transport System Management Efficiency with Application of Modeling Methods and Data Intellectual Analysis.

National Population Census,2006.

OPTIMISM. 2013. Deliverable 5.1: Definition of strategies for integrating and optimising transport systems. OPTIMISM (Optimising Passenger

Roberts, P.; Babinard, J. Transport Strategy to Improve Accessibility in Developing Countries. Available online: http://siteresources.worldbank.org/INTTSR/Resources/accessibility-strategy.pdf (accessed on 10 July 2012).

Safdie M., Kohn, W., (1998), The city after the automobile. An Architect's vision. Westview Press, Colorado, USA.

Smith A. "Smartphone Ownership in 2013." http://www.pewinternet.org/2013/06/05/smartphone- ownership-2013/ (accessed 8/26/14).

Singh, B. & Gupta, A. (2013). Advancements in Intelligent Transportation Systems: A Review. Proceedings of International Conference on Advanced Trends in Engineering and Technology (ICATET), Jaipur, 375-383

Singh, B., Gupta, A. & Suman, S. (2014). Framework for Development of Advanced Traveler Information System: A Case Study for Chandigarh City. Proceedings of International Conference on Transportation Planning and implementation Methodologies for Developing Countries 2014 (TPMDC-2014), Submission Id. 54.

Tarapiah and Atalla,(2015) Public Transportation Management System based on GPS/WiFi and Open Street Maps

The Economist (2012), Seeing the back of the car. In the rich world, people seem to be driving less than they used to. 22 September 2012. http://www.economist.com/node/21563280

Transport Information to Materialise Insights for Sustainable Mobility) project. Seventh Framework Programme.

Tayyaran MR, Khan AM, Anderson DA (2003) Impact of telecommuting and intelligent transportation systems on residential location choice. Transp Plann Technol 26(2):171–193

The GTFS Data Exchange maintains a listing of transit agencies providing GTFS data. Agencies that do not currently have data in GTFS format can program it to create a data exchange and then develop an app in house or purchase a program to create to create one.

Technological Innovations in Transportation for People with Disabilities.Workshop summary report • February 23, 2011

Venter, C.; Savill, T.; Rickert, T. Cornell University ILR School, DigitalCommons@ILR. Enhanced Accessibility for People with Disabilities Living in Urban Areas. Unpublished
Project Report. 2002.

Wireless Rehabilitation Engineering Research Center."Use of Wireless Devices by Adults withDisabilities."Volume2013,No.3.http://www.wirelessrerc.org/sites/default/files/public

ations/SUNspot_2013-03_Wireless_Devices_and_Adults_with Disabilities_2013-07-12%5B1%5D.pdf. (accessed 8/26/14) West Africa Gateway,2012

Xia J, Chen M (2007) Defining traffic flow phases using intelligent transportation systems

generated data. J Intell Transp Syst Technol Plann Oper 11(1):15–24

Zhou et al (2012) Intelligent Urban Public Transportation for Accessibility Dedicated to People with Disabilities.

ADOPTION OF CYBERSPACE IN SUSTAINING COMMUNITY DEVELOPMENT IN NIGERIA

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ABSTRACT

Cyberspace has been recognised globally as means to offer access to information, so as to stimulate community development in Nigeria. However, there is still limited understanding about the potential of ICT and the contribution that cyberspace can offer to both urban and rural communities. This study examines the adoption of cyberspace in sustaining the community development in Nigeria. The study employed a quantitative survey design, using a questionnaire administered on 120 respondents. The overall findings revealed that the respondents possess very impressive ICT skill levels. Most of them affirmed that cyberspace had contributed immensely to their individual educational and socio-economic improvement as well as to the general livelihoods in the community. Majority agreed that cyberspace had significantly enhanced their ICT knowledge and suggested that more cyberspace accessibility should be provided by the government, individual and corporate organisations. This will further create opportunities for a better ICT experience in the Ibadan community. The study then proposes a model of cyberspace implementation in community development in making contribution in three spheres which are information mediation, carrier development and community wellbeing. This study therefore suggests an extensive study on cyberspace at the grass-root level in Nigeria.

***Keywords**: ICT, cyberspace, community development.*

1. INTRODUCTION

Across the globe, an extraordinary importance has been given to the application of Information Communication Technology (ICT) in promoting and intensifying the course of development and in serving as means of lowering insufficiency in all nations of the

world. As a matter of fact, it is now generally believed that, any nation that fails to utilize ICTs is slowing down the speed of its development (Opara & Onyije, 2014). However, there is a wide digital divide between people living in the developed countries and in the developing nations as technological advancements are yet to reach the people in some part of Nigeria community (Christie, 2013).Whereas, ICTs can make a significant contribution to the enhancement of the standard of living of the people living in both the rural areas with reference to city community development (Hosseini *et.al*, 2009) but deficiency in access to universal Internet service still exists in some communities which is making this full adoption ICT unrealizable (Attwood, Diga, Braathen, & May, 2013).

The influence ICTs is now rapidly and successfully shaping the whole world including Nigeria; it has been recognized that ICT can serve as an essential driving force to enhance the general welfare of Nigeria people. Even, around the local government areas of Nigeria, ICTs have been noticed to be steadily performing crucial functions (Oluwatayo, 2012). Yet, one of the highest obstacles to attaining significant results in ICT programs in Nigeria is the lack of full implementation of Information and Technology (IT) policy. IT policy development was put into operation when the National Technology Development Agency (NITDA) was inaugurated in the year 2001, but it was poorly executed as a result of non-commitment of government, political inclination and commercial instability coupled with lack of coordination on the side organization of information professionals (Hassan, Siyanbola & Oyebisi, 2011).

The immense benefits of ICTs are being introduced through cyberspaces; for example, cyberspace have been acknowledged by the International Telecommunications Unit (ITU) of the United Nations as among highly encouraging models for attaining large-scale easily accessibility to ICTs (Sumbwanyambe, Nel, & Clarke, 2011; Benjamin, 2000). A standard cyberspace denotes a location that provides connectivity and access to information through diverse ICTs including Very Small Aperture (VSAT) solutions by using 3.5 GHz Fixed Wireless Access Solutions on cable technology (FWA License) (Windsor, & Royal, 2014).Cyberspace may be in form of small enterprise being run commercially but having a little non-profit characteristics or being managed by community groups as non-commercial and funded services predominantly for communal advantage (Windsor & Royal, 2014). Presently, majority of research works on cyberspace revolves around sustainability of cyberspace itself while very few works have been done to evaluate to the sustainability of socio-economic development of the community through cyberspace (Kumar & Best, 2007). Though Cyberspace have been established across Nigeria, limited information exist in the context of the ICT development and contributions in many cities such as Abuja, Kano, Kaduna in Northern region, while, Lagos, Ibadan, Oyo, Ogun, Kwara, Anambra, Enugu in South-Eastern region. This implies that there have been little efforts in the establishment of full ICT based development. Unfortunately those that are in existence are mainly located in urban cities. In spite of this, majority of people do not have access to Internet facilities. Based on the reports from oafrica.com, (2010), it clearly shows that for the past few years' limited

information that is available on Cyberspace are mostly connected and related to developments in some learning institutions located in the city. Consequently, the purpose of this study is to investigate the adoption of cyberspace in sustaining community development in Nigeria, using Ibadan locality as case study. Therefore, a critical look on how cyberspace can be adopted in meeting community needs in terms of development is examined. The objectives of this research are: (1) to identify the ICT skills among community in Nigeria, (2) to determine people's expectations from the cyberspace, (3) to propose a cyberspace implementation model to enhance the community development.

The Implication of Cyberspace in Community Development

Cyberspace is defined as a public center that provides access to internet and information technologies for the chances to produce, initiate, acquire and as well exploit information for socio-economic development (Harris, 2001). Cyberspace is public places that offer information assistance to people. It gives access to computers, internet, networks, multimedia as well as video resources with the objectives of assisting in information processing, accessing and dissemination (Aghajani, 2014). Similarly, Roman and Colle (2003) in a study describes Cyberspaces as places which give people access to computers and the internet; that is, public centers where individuals are given opportunities to numerous communication facilities with the main objective of providing information accessibility to people. Besides they specified that, cyberspace give people the chance to make use and access suitable ICTs in order to deal with their challenges and also derive assistance for their various developmental undertakings (Roman & Colle (2003). Regardless of whichever description given to cyberspaces, it is widely acknowledged that, they provide the public with opportunities to access ICTs at a common location with the main philosophy and foresight of bridging the digital divide.

World has been largely absorbed by ICTs which has spread into nearly every aspect of human endeavors at an extraordinary pace moving alongside with development. Hence, today, a widespread acknowledgement has been assigned to ICT as one of the essential bases for development and effectiveness of international economy (Goggin, (2008). As a result, ICTs have been given significant acceptance as an instrument in facilitating poverty alleviation, growing efficiency, creating commercial expansion, employment opportunities, educational promotion, skill distribution as well as worldwide communication (Union, 2007). However, several contemporary research works have been conducted regarding adoption and utilization of ICT by a target population (Dwivedi & Williams, 2008) which is impressive, but they mainly revolved around use of ICT. These do not include knowledge about the impact of Cyberspace on community development (Ashraf *et al,* 2008).

Cyberspaces have been performing numerous significant functions in every facet of human activities. There have been progressive influences of cyberspace on the political and socio-economic wellbeing of the people in both rural and urban areas. For example, the commercial activities of people have witnessed a growth in returns as cyberspace

services offer them necessary information regarding commodity value and get rid of activities of the intermediary (Abraham, 2006). Easy accessibility to ICTs has been the rationale behind the creation of cyberspace in many countries with the aims of bringing improvement to the livelihood of the community (Bailey & Ngwenyama, 2009). Developmental activities supporting this initiative are being carried out by many government bodies and a number of international organizations such as United Nation Education Science and Culture Organization (UNESCO), World Info/Mott Foundation, International Telecommunication Union (ITU), International Development Research Centre (IDRC) (Grameen Cyber Society, 2004).

Furthermore, substantial capabilities are being offered by cyberspace to spread ICTs among the underprivileged as well as bridging the digital divide (Elijah & Ogulande, 2006; Hazita *et al.*, 2007; Lennie *et al.*, 2005). The alarming gap between people who have access to ICTs and those does not have access have been used to generally describe digital divide. In order to expose digital divide as an essential obstacle, intellectuals, legislators including the generality of the people now acknowledge the enormous capability of the internet to enhance the daily activities of the marginalized individuals in order to realize larger social justice and emancipation (Figueiredo *et al.*, 2006; Mehra *et al.*, 2004).

2. METHODOLOGY

Part of the aim of this study is to investigate the adoption of cyberspace in sustaining community development in Nigeria, with a critical look at how the project is meeting community needs. Myers (2013) stated that research approach forms a plan of scrutiny that changes from the basic hypothesis to research design and collection of data. In this study, quantitative research method with a case study approach was employed in achieving the research objectives, and answers the research questions. Those answers given through the questionnaires revealed the relationship that exists between the cyberspace and the people, that is, the effect of various services being offered by the cyberspace have had on the general development of the people.

This research study involved five different phases before getting the result: identifying the problem, questionnaire design, data collection, and data analysis as well as data interpretation. The phases of the method show in the figure 1. The activities involved in the first phase include interview with cyberspace centres and comparative analysis using User Centered Design (UCD) approach. From this phase, data regarding the ICT skills among community were gathered, the first objective of the study was achieved. While, the second objective is to determine people's expectations from the cyberspace were also achieved. They are discussed in detail in the next section. The third phase is to propose the adoptions of cyberspace to enhance the community development was developed based on the data gathered in phases one and two. At this stage, this study has achieved

its third objective. Having finished the third phase, the whole objectives of this study are achieved.

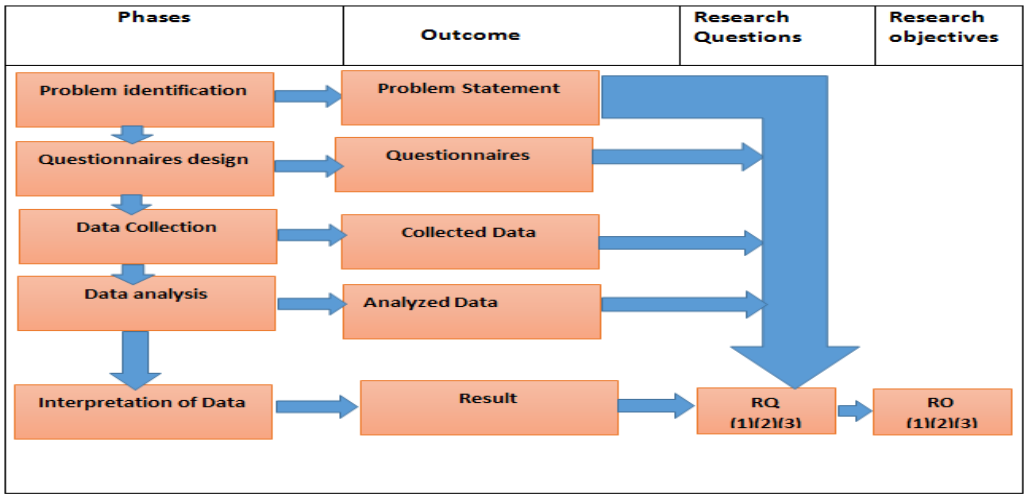


Figure 1: Phases of Research Method.

The proposed model based on cyberspace implementation divided into three major areas such as Information Mediation, Career Development and Value Added. Better implementation of cyberspace will impact positively on the Nigeria community through these three major areas. This is shown in the figure 2. Pertaining to information mediation, Most of the people in the community found it very easy to communicate and share information with people both locally and internationally in the online environment provided through the cyberspace. Also, in the aspect of carrier development nearly all the respondents strongly agreed that cyberspace activities have led to increase in job creation and business development, that is, through access to the internet provided in the cyberspace, most of the community people have developed their various business potentials as well as getting better job opportunities. As for the aspect of value added, nearly all the respondents agreed that due to cyberspace services, literacy/ knowledge of individual resident of the community have greatly increased and also there has been rapid increase in general IT skills of the community people coupled with higher improvement of human livelihood in the community. And majority also affirmed that friendship, familiarization, love and unity have increased among users through cyberspace.

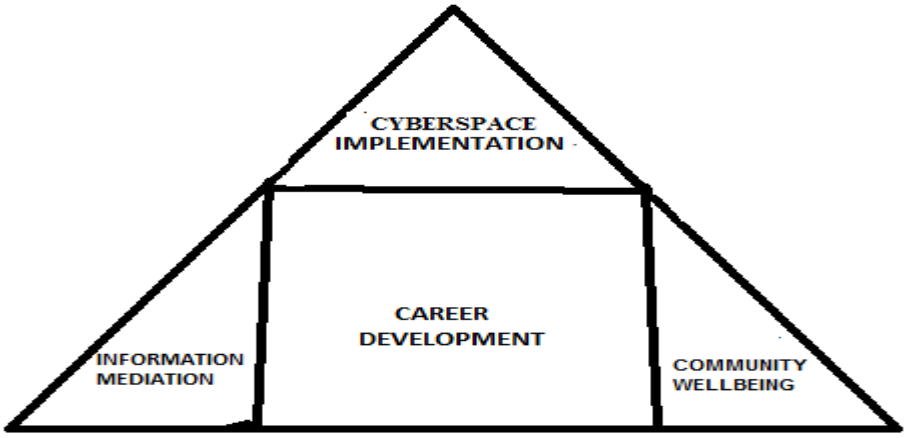


Figure 2: Cyberspace contribution model for community development.

3. EVALUATION

The explanation has been given in the analysis and results about the extent of benefits from the cyberspace to the community. The recommendation and suggestion is also given based on the results as how cyberspaces' adoption can better sustain and make better the livelihood of the generality Ibadan community area as the case study.

As shown in the Figure 1, the research phases started with the problem identification from which the statement of the problem which the research aimed to solve was derived. This was followed by questionnaire design; since the study is employing the quantitative approach, questionnaires therefore served as the instrument for data collected. The Information and Technology Unit, Universiti Utara Malaysia (ITU-UUM) questionnaire model was adapted for this study. After the completion of questionnaires with appropriates questions that can give answers to the research questions and suits the research objectives. A data collection was accomplished by distributing the questionnaire within Ibadan rural community, Nigeria. The next phase was data analysis phase where all the collected data were analyzed and then followed the last stage, the interpretation of the analyzed data and the results were derived where the result were obtained which adequately answered. Hence, all the research questions satisfied the objectives of the research.

Population and Sampling

Sampling is an important component of any piece of research because of the significant impact that it can have on the quality of results. Sampling involves the process of chosen units (sample) which can provide acceptable explanation and effective interpretations regarding the population**.** A sample refers to collection of lesser units out of the whole population which serves to give correct description of the population (Field, 2005). The users of a chosen cyberspace, Globalink Cybercafés Molete area, Ibadan, Nigeria were used as the sample population for this study from

whom one hundred participants were used as sample. This study employed, the use of a questionnaires as instrument for data collection

According to Sekaran & Bougie (2010), the use of survey questionnaire is famous, cost effective and usually efficient in the data gathering for a quantitative research method, as such it was used in this study. The respondents were given adequate orientation about the questions on the questionnaires, this was necessary so as to make sure the collected data were valid and reliable.

Data Analysis

Data analysis for this study was done using the Statistical Package for the Social Science (SPSS) software for descriptive analysis and this brought out the answers to the earlier research questions and research objectives was achieved. The last stage of the research was reporting stage which involved basically the interpretation of the results, conclusion of the research and recommendation.

After the analysis of all the collected data, it is highly encouraging to note that majority of the respondents were educated. Some are working in various offices, while others are in higher institution, and secondary school levels respectively. Also, the respondents comprises of fairly equal combination of males with females (54.3% & 45.7%) as well as student with workers (51.4 & 48.6). in addition, 52.9% which is more than half of them were within the age range of 18- 25, 21.4% are in age range 26-35 and 27.7% are in the range 35 and above. The respondents marital status were found to be fairly balanced comprising 55.7% single and 44.3% married individuals. Whereas the respondents' exceptionally high educational level is also reflected in their language proficiency status as nearly all of them (98.6%) are proficient in both English and local language.

With their higher level of education, Internet users at Globalink Cybercafés Molete are found to be highly interested and exposed to ICT as nearly all of the them have used computer before in one way or the other(97.2%) despite the fact that only 57.1% of them have computer at home while 42.9% do not have. And encouragingly majorities (76.2%) of those who do not have computer at home have planned to buy. However, the remaining 2.9% who have never experience using computer before gave only two reasons with coincidentally equal percentages. Similarly the respondents have an exceptional 92.9% internet experience which is exceedingly higher than the Nigerian 2014 Internet penetration rate of 37.59%. However, very few of the respondents (2.9%) were found not to have used the internet before and they gave two main reasons of not having the Internet connection and no knowledge to use the Internet

The respondents (users at Globalink Cybercafés Molete) were asked if cyberspace has increased employment or job creation to the individuals within Ibadan local community, interestingly, nearly all of them (95.7%) gave positive answers while neutral and negative answers were given by others (24.3%). Likewise, only 2.0% of the respondents gave

neutral answers to the business enhancement effect of cyberspace while the bulk of the rest of them (98.0%) answers affirmatively. In the same way, 95.6% of the respondents said that their literacy/knowledge level have increased through their participation in the cyberspace activities whereas just 2.9% and 1.5% gave neutral and negative answers respectively. Correspondingly, majority of the respondents (77.1%) also answers positively that cyberspace have generally lead to increase unity among various users, but 20.0% stood neutral while 2.9% gave negative answers. In addition cyberspace activity have also enhanced familiarization among users in Ibadan local community as indicated by the affirmative answers given by majority of respondents(74.3%), but 17.1% stood neutral while as small as 8.6% answers negatively. Comparably, 75.8% affirmed that friendship among individual users have increased through cyberspace while 15.7% and 8.6% gave negative and neutral answers respectively. Equally, most of the respondents (75.7%) confirmed that love among users in the community have increased through cyberspace whereas 14.3% did not support and 10.0% stood neutral. This is shown in the table 1 below;

Table 1: Cyberspace Contribution to Individuals in the Community

Cyberspace Benefits	**Positive (Percentage)**	**Neutral (Percentage)**	**Negative (Percentage)**
Business	98.0	2.0	1.4
Employment/ Job Creation	95.7	2.9	1.4
Literacy/Knowledge	95.6	2.9	1.5
Unity among users	77.1	20.0	2.9
Friendship	75.8	15.6	8.6
Love	75.7	14.3	10.0
Familiarization	74.3	17.1	8.6

Overwhelmingly, all the respondents affirmed that adoption of cyberspace have greatly increased communication within the local community. Similarly, 98.6% of the respondents also claimed that IT skills of community members have greatly increased through cyberspace while just 1.4% stood neutral. Likewise, nearly all the respondents (97.2%) confirmed that cyberspace activities had boosted general development in the community, but equal numbers of respondents (1.4% each) gave neutral and negative answers. In the same way, 97.1% also confirmed that the information sharing status among the community members have been enhanced through cyberspace while neutral and negative answers were given by the rest (1.4% each). Pertaining to improve human livelihood, almost all the respondents (91.4%) also gave positive answers while 7.1% and 1.4% gave negative and neutral answers respectively. This is depicted in the table 2.

Table 2: Cyberspace Contribution to Community

Cyberspace Benefits	Positive (Percentage)	Neutral (Percentage)	Negative (Percentage)
Communication	100.0	0.0	0.0
It increases IT skills	98.6	1.4	0.0
Community Development	97.1	1.4	1.4
Information Sharing	97.1	1.4	1.4
Improve human livelihood	91.4	7.1	1.5

4. CONCLUSION AND RECOMMENDATIONS

With the spread of cyberspace all over Nigeria including Ibadan community, this study tried to examine the adoptions of cyberspace in sustaining community development using a cyberspace in Ibadan. All respondents exhibited exceptional characteristics indicating that were able to make very good use of the cyberspace which resulted to improvement in their ICT skills and cyberspace experience. They suggest that expansion and better accessibility to cyberspace should be provided by the government, individuals and corporate organizations. Most of them then affirmed that adoption of cyberspace has contributed immensely to their individual educational and socio-economic improvement as well as to the general livelihoods in the community. The outcome of this study display effective result with similar study on ICT carried out by Adekoya, (2006) to investigate the use of ICT among the people of Oyo state. The study then proposes a model of cyberspace implementation in respect to community development in three areas covering information mediation, carrier development and community wellbeing. This study therefore suggests an extensive study on adoptions of cyberspace that will cover all geopolitical zones of Nigeria.

REFERENCES

Abraham, R, 2006. Mobile phones and Economic Development: Evidence from the Fishing industry in India. A paper presented at International Conference on Information and Communication Technology.

Adekoya, A. E. (2006). Use of ICT among rural people in Oyo State, Nigeria.*Research Journal of Applied Sciences*, *1*(1–4)), 101-105.

Aghajani, H. (2014). Perspectives of Regional IRAN Geography: ICT Case.

Ashraf, M. M., Swatman, P. A., & Hanisch, J. (2008). An Extended Framework to Investigate ICT Impact on Development at the Micro (Community) Level. In *ECIS* (pp. 1010-1021).

Attwood, H., Diga, K., Braathen, E., & May, J. (2013).Telecentre functionality in South Africa: Re-enabling the community ICT access environment. *The Journal of Community Informatics*, *9*(4).

Bailey, A. and O. Ngwenyama, 2009. Social Ties, Literacy Location and the Perception of Economic Opportunity: Factors influencing Telecentre Success in a Development Context: Proceedings of the 2nd Hawaii International Conference on System Science.

Benjamin, P. (2000). ICT projects in South Africa.

Christie, R.M. (2013). Chromic materials for technical textile applications. In *Advances in the Dyeing and Finishing of Technical Textiles* (pp. 3-36).

Dwivedi, Y. K., & Williams, M. D. (2008).Demographic influence on UK citizens'e-government adoption. *Electronic Government, an International Journal*, *5*(3), 261-274.

Elijah, O. A., & Ogulande, I. (2006).Analysis of the Uses of Information and Communcation Technology forGender Empowerment and Sustainable Poverty Alleviation in Nigeria .*International Journal of Education Development using Information and Communication Technology (IJEDICT), 2*(3), 45-69.

Field, A. (2005). Everything you ever wanted to know about statistics. *Discovering statistics using SPSS*, 2-36.

Figueiredo, M., Camara, M., &Salvin, R. (2006).Impact of the Insertion of Modern ICT in Brazilian RuralCommunities. *ieee*.

Goggin, G. (2008). The mobile turn in universal service: prosaic lessons and new ideals. *info*, *10*(5/6), 46-58.

Grameen Cyber Society. (2004).*Reflecting on the pilot telecentre operation in rural Bangladesh*. Retrieved January 27, 2011 fromhttp://siteresources.worldbank.org/EDUCATION/Resources/278200-1126210664195/1636971-1126210694253/Grameen_Final_Report.pdf

Harris, R., 2001. Cyberspaces in Rural Asia: Toward a Success Model. Conference Proceedings ofInternational Conference on Information Technology, Communication and Development (ITCD 2001), November 29-30, 2001, Kathmandu, Nepal. Retrieved from: www.itcd.net

Hassan, O. M., Siyanbola, W. O., &Oyebisi, T. O. (2011). An evaluation of the implementation mechanisms of Nigeria's information technology policy.*International Journal of Technology, Policy and Management*, *11*(1), 57-67.

Hazita, A., SitiHanim, S., Jamilah, M., Tg Nor Rizan, T. M. M., Noraza, A. Z., Kalthum, I., Norwati, M. Y., &Zaini, A. (2007). *PerananPusat e-komunititerhadap Pembangunan Kemahiran: eLiterasidiKalanganWargaBeliaLuar Bandar.* Paper presented at The E-Community Research Center Colloquium2007, Universiti Kebangsaan Malaysia, Bangi, Selangor.

Hosseini, R., Chileshe, N., Zou, J., & Baroudi, B. (2013). Approaches of implementing ICT technologies within the construction industry. In *Australasian Journal of Construction Economics and Building-Conference Series* (Vol.1, No. 2, pp. 1-12).

Kumar, R., & Best, M. L. (2007). Social impact and diffusion of cyberspace use: A study from the sustainable access in rural India project. *The journal of community informatics*, *2*(3).

Lennie, J., Hearn, G., Simpon, L., & Kimber, M. (2005).Building Community Capacities in Evaluating Rural IT Projects: Success Strategies from the LEARNERS Project. *International Journal of Education & Development using ICT [Online], 1*(1).

Mehra, B., Merkel, C., & Bishop, A. P. (2004).The Internet for Empowerment of Minority and Marginalized Users. *New Media & Society, 6*, 781-802.

Myers, M. D. (2013). *Qualitative research in business and management*. Sage

Oluwatayo, I. B. (2012). Information and Communication Technologies as Drivers of Growth: Experience from Selected Small-Scale Businesses in Rural Southwest Nigeria.

Opara, J.A., & Onyije, L.E. (2014). Information and Communication Technologies (ICT): a panacea to achieving effective goals in institutional administration. *International Letters of Social and Humanistic Sciences,* (12), 81-87.

Roman, R. and Colle, R. (2003).Notes of Cyberspace Research. In Badshah*et al* (editors) ConnectedforDevelopment – Information Kiosks and Sustainability. United Nations Information and CommunicationTechnologies Task Force (UN ICTTF) Book Series No. 4. United Nations New York: NY.

Sekaran, U., and R. Bougie. (2010). "Research methods for business: A skill building approach. Wiley.".

Sumbwanyambe, M., Nel, A., & Clarke, W. (2011, May). Challenges and proposed solutions towards telecentre sustainability: a Southern Africa case study. In *IST-Africa Conference Proceedings, 2011* (pp. 1-8). IEEE.

Union, A. (2007). Strategy to revitalize technical and vocational education and training (TVET) in Africa. In *Meeting of the Bureau of the Conference of Ministers of Education of the African Union (COMEDAF II+)* (pp. 29-31).

Windsor, S. S., & Royal, C. (2014). Different telecentre models in ICT for development and their impact on organizational sustainability. *International Journal of Technology Management & Sustainable Development*, *13*(2), 161-175.

SOCIAL MEDIA AND SEXUAL EXPRESSION AMONG ADOLESCENTS

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ABSTRACT

This study highlights the existing issues on the expression of sexuality on social media and how it affects adolescents' attitudes and behavior. Studies have concluded that indulgent in sexual practice among adolescent is high and alarming, although some of them are aware of some health implications that come with sexual practice. Issues surrounding the benefits and risk of using social media for sexuality has been discussed. It was recommended that parents need to educate adolescents on the implications of involving in any form of sexuality; there should be a guide on how the social media should be used to obtain important and impactful information that will add to the knowledge of adolescents on sexuality; regulatory agencies should deploy a means of developing an application which can screen all information, and checkmate if its fit for consumption. Such application should then be suggested to be installed on all phones especially that of the adolescents and youths.

***Keywords**: Adolescents, Sexuality, Sexual Behavior, and Social Media.*

1 INTRODUCTION

The usage of social media is becoming worrisome especially among the children and adolescents; while the medium is a platform for social changes, it has the potential for providing the ideal and right sexual orientation in a positive or negative manner (Amoo, 2013). According to Matthews (2007) it is also the means through which sexual misdemeanor are promoted worldwide. In an era when issues of sexual reproductive health and rights have become important and sometimes threatening to human existence, it is imperative to examine the abuse of these tools and their implications on the state of health, considering the fact that "health is the wealth of every nation".

The social media could represent a 'gap-filler' and dependable source of the much desired information among the adolescents in traditional African and Nigerian setting to be precise, which place restrictions on sexual information (Collins, Martino & Shaw, 2011). This is made easy because the media (internet, iphones, facebook, videos and the likes) are increasingly more explicit in sexual content (Shelia, 2001). It is reported that

more than half (56%) of all television shows contain sexual content and they could include scenes that can possibly fuel risks of sexual activity (Collins et'al, 2004).

According to the International Telecommunication Union (ITU), (2016) the access and usage of internet has increased tremendously in Nigeria like other developing nations. It number rose from about 100,000 internet users in 1999 to 11 million in 2008, to 46 million in 2011 and almost up to 95million users in 2016. Also, the proportion of individuals using internet increased from 0.06% to 3.6% between 2000 and 2005 and thereafter increased from 24% to 32.9 percent between 2010 and 2012. As at 2016, the proportion of individuals using internet is 52%. Also, mobile cellular users increased from 30,000 in 2000 to 112.8million in 2012 to 207million in 2016.

Social media has considerable potential for its uses in conveying messages about responsible sexual behavior (Jan & Kristopher, 2011). Considering the audience to this technology, knowledge relating to abstinence, effects of abortion, girl-child marriage, infant mortality, pregnancy prevention, and the like, can be effectively disseminated to the right audience through the medium (Tang, Gu & Whinston, 2012). Meanwhile, Amoo (2013) noted that, several forms of abuses are noted to be offspring of social media. Social media images of sex and sexuality are socially negative influences on adolescents' sexual decision making. He noted further that part of abuses could be 'cyber-bullying', online harassment, facebook depression, sexting (i.e. sending and receiving sexually explicit messages), pornography, sexual experimentation, internet addiction and sleep deprivation, to mention but few. Other negative effects of new media include addictions to games, incursion into others' confidential information and exposure to crimes (Blumenfeld & Cooper, 2010; Amoo 2013; Amoo 2013). Cell phone has become a vital instrument of trade for sex workers and very potent and indispensable in most illicit businesses around the world today (Downs, 2007).

The evolving abuses of these technologies by adolescents could be products of limited or lack of control over their uses (Lenhart, Purcell, Smith & Zickuhr, 2010). In addition, the susceptibility of children and adolescents to peer pressure, inadequate formal and informal sexuality education and lapses on the part of the governments could be hindering forces to sexual benevolent use of social media (Amoo, 2013). Few studies examine whether adolescents themselves find the media influential in determining their sexual attitudes, values, and behaviors (Malamuth & Impett, 2001 add) although (Amoo, 2013; Odekunmi, 2013) have examined in a quantitative study the behavior of adolescents after being exposed to sexual acts on the media and draw up conclusions that adolescent are mostly vulnerable to their exposure to sexualities on the media.

This study therefore explored the use of social media by adolescents for the expression of sexuality and further elucidate the key motivations for using social media for the expression of sexuality. It revealed whether the attitudes and behaviors' of adolescents are affected positively or negatively after using social media for the expression of sexuality.

2. REVIEW OF RELATED LITERATURE

Adolescents and Social Media

Amoo (2013) defined social media as the use of websites for social interaction including social networking sites such as face-booking, twitting, videoing, YouTube, gaming and virtual worlds like Club Penguin, Second Life and the Sims. He continued by saying that, adoption of social media has become a blended global social fabric among the teaming population of adolescents and children. Today's world could be described as a social media world where considerable hours and money are invested on new media sources. Facebook, YouTube, Twitter, LinkedIn Whats App are successful examples. Recent surveys have revealed that a growing number of today's youth often referred to as "Net Generation" (those born between 1980 and 1989) consumed approximately 9 hours of social media every day, with most of them using social networking sites with blogging and micro blogging tools (Schill, 2011). Those born between 1990 and 1999 consume even more time on social media particularly on chatting platforms such as Facebook chat, 2go chat and Google chat than they do with their friends face to face. In their study, Jan & Kristopher (2011) noted that one out of every five minutes globally is expended on network services.

According to Schill (2011), the social media sites encourage negative behaviors for teen students such as procrastination (catching up with friends), and they are more likely to drink and drug. In Latin America alone, up to 8 hours a day is spend on social network services. More than 22 percent of teenagers log on to one form of social media or the order over 10 times a day (Gwenn & Kathleen, 2011). According to a common sense media poll in 2010, over 75 percent of teenagers now own cell phones, iPhones is becoming appallingly high, about 25 percent use such phones for social media, 54% use them for texting and 24% use them for instance messaging while one out of every five teens have used it to send or post pornographies (American Academy of Pediatrics, 2011; Gwenn & Kathleen, 2011).

The relevance of social media in the quest for information especially among the children and adolescents cannot be overemphasized (Collins, Martino, & Shaw, 2011). Media generally are the suppliers and disseminators of information to large populations. The medium is recognized as a powerful tool that is indispensable and capable of presentation of factual and balanced information that can shape public opinions and enhance structural change in human behavior (Lenhart, Purcell, Smith & Zickuhr, 2010). Due to the increasing popularity of social media usage, personal social interaction with friends, family, academic and professional contacts have transformed itself from offline reading into an online entity (Musa, Azmi & Ismail, 2015).

However, the role of social media today is becoming more worrisome and misunderstood especially in the area of sexuality (Strasburger, Jordan, & Donnerstein 2012). There exist today raging controversies surrounding the way sexuality and coverage of sexual issues is being portrayed in the media (Tiemoko, 2006). Ironically, a

publication might be regarded as incomplete without featuring a sex figures or at least scantily clad girl (Gwenn & Kathleen, 2011). The preponderance of sexual 'attractive' scenes inform of entertainment is becoming appalling and called for concern especially in this age that the younger ones are the closest to such media (Lenhart, Purcell, Smith & Zickuhr, 2010).

As a system, it brought immense changes to life especially among children and adolescents round the globe. It offers opportunity for people to contact with their loved ones easily notwithstanding the distance, watch television without television, buy and sell products without physical touching (American Academy of Pediatrics, 2011; Gwenn & Kathleen, 2011). As a medium, it helps children and adolescents, especially the school going, to learn and accomplish many vital tasks/assignments (Lenhart, Purcell, Smith & Zickuhr, 2010). The ensuing connection propels connection with friends and family, sharing pictures, exchanging ideas, community engagement (e.g. volunteering services). It also has the potential to facilitate the building of individual and collective creativity through development and sharing of artistic and musical endeavors and other novel ideas. Health-wise, new media has succeeded in breaking the jinx of traditional silence on myriads reproductive taboos and behaviors. Excellent health resources are increasingly available to youth on a variety of topics of interest such as sexually transmitted infections (STIs), contraceptives, mediation adherence, meeting appointing with health official (Strasburger, Jordan, & Donnerstein 2012).

Adolescent and Sexuality

According to (Amoo 2013) adolescence is the onset of physical/sexual maturation and reproductive capacity. In the same vein, adolescent as conceptualized (in this context) are teenagers, developing from a child to an adult who falls within the age group of 13 to 17. Adolescents in Nigeria constitute over 42 percent of the total population out of which 48 percent are girls and the remaining 52 percent are boys (Nigeria Demographic Profile, NDP, 2018). While they could be adjudged as having potential to become fathers and mothers, it is unequivocal that they are not matured enough to become responsible father or mother of responsible children, which makes it exigency that sexuality education is popularized among them (Adepoju, 2005).

These populations have numerous needs and their rights to know about their bodies, to be educated and informed about their sexual health must be protected. As expected, they face myriads of social, emotional, psychological and cultural challenges (Strasburger, 2010) especially in receiving and gaining access to the right information about sexuality. Biology has long been considered a key factor in explaining adolescent sexual behavior. Several researchers have described the role of biological `unfoldment', including physical forces such as pubertal development and hormones, in adolescent sexual behavior, suggesting that the timing of sexual activity may be as much a biological issue as a social or behavioral one (Miller & Fox, 1987; Miller *et'al*, 2001; Kotchick *et'al,* 2001). Miller *et al* (2001) point out that recent research has found links between genes, hormone levels,

and the developmental point at which adolescents begin to engage in sexual intercourse. In a research by Udry (1988) evidence that levels of androgen hormones longitudinally influenced the debut of sexual intercourse of males, as well to the level of sexual motivation, though not the sexual act itself, in adolescent females.

Ikpe (2004) postulated that "Sexuality defines the very essence of one's humanity including one's self–image, being male or female, physical looks and reproductive capacity; that is sexuality is a natural part of life. It is about the way we are made, how we feel about ourselves, what roles we play in the society and how we procreate".

According to Adepoju (2005) traditionally, sex is not a subject of open discussion in Nigeria like several African nations. Besides, he declared further that in this part of the world, girls are limited or untrained in making decision regarding sexuality, due to the fact that most girls are not empowered socially or economically to refuse sex especially from the older male. But parent-child communication in sexual matters may be hindered by parental inhibitions or by various intergenerational tensions, and studies have shown that children rarely receive their first information on sexual matters from their parents (UNAIDS, 2016).

In the same vein, Amoo (2013) noted that sexual health in concept and conception is amalgam of health physically and socially and it is regarded as an essential part of good overall health and well-being. According to Guttmacher Institute (2010) sexuality is thus intertwined with life and human development. Good sexual health connotes not only the absence of disease but the ability to understand and weigh the risks, responsibilities, outcomes, and impacts of sexual actions. It means to be knowledgeable in securing the comfort of one's body and that of others free of exploitation and coercion. However, since sexual information through social media are mostly uncensored, it is no doubt therefore that ill-informed adolescents especially in the areas of procreativity could be inimical to sustaining development and post millennium development goals (Amoo 2013).

The battle has always been between sex education and abstinence-only. Some experts argue that abstinence education is the only way to prevent teenagers from having sex, while others insist that teenagers will have sex no matter what, and it is better for them to be equipped with solid educational information about sex. Such will enable them to limit HIV infections and prevent many unplanned teen pregnancies (Guttmacher Institute, 2010).

However, since sex education found its way into the Nigerian school system the emphasis has been impacting moral lesson and social value to secondary school students, although

some have voiced out that sex education increases sexual activity and sex education has not yielded much success in Nigeria since its introduction in the secondary school curriculum as more adolescents get pregnant and drop out of school (Odekunmi, 2013).

According to Vandenbosch, Van Oosten & Peter, (2015), social media are highly popular among adolescents, with adolescents checking news feeds and post updates daily. Recently, research has shown that adolescents also use social media to distribute sexually suggestive images of themselves. Although, these populations have numerous needs and their rights to know about their bodies, to be educated and informed about their sexual health must be protected. As expected, they face myriads of social, emotional, psychological and cultural challenges (Strasburger, 2010) especially in receiving and gaining access to the right information about sexuality. Biology has long been considered a key factor in explaining adolescent sexual behavior. Several researchers have described the role of biological `unfoldment', including physical forces such as pubertal development and hormones, in adolescent sexual behavior, suggesting that the timing of sexual activity may be as much a biological issue as a social or behavioral one (Miller & Fox, 1987; Miller *et'al*, 2001; Kotchick *et'al,* 2001; Udry, 1988). Miller *et al* (2001) point out that research has found links between genes, hormone levels, and the developmental point at which adolescents begin to engage in sexual intercourse. In a research by Udry (1988) evidence that levels of androgen hormones longitudinally influenced the debut of sexual intercourse of males, as well to the level of sexual motivation, though not the sexual act itself, in adolescent females.

In a research carried out by Ragsdale et'al (2015) they noted that inadequate access to comprehensive sex education has been linked to adolescent childbearing in the U.S., which has the highest teen birth rate among comparable developed nations as well as disproportionately high rates of sexually transmitted infections (STIs) among youth and young adults. Resource-limited states such as Mississippi experience high rates of adolescent childbearing and STIs. For example, at 42.6 births per 1,000 teen girls, Mississippi has the third highest adolescent birth rate in the nation. Although 58% of Mississippi high school students are sexually active, the delivery of comprehensive sex education in public schools faces a number of issues in Mississippi (e.g., a ban on condom use demonstrations).

The prevalence of the motives for the use of social media for sexuality by adolescences has been studied to a much lesser extent. I located several studies on the influences of social media on adolescents' sexuality. In a study of 400 profiles on a popular, English-language teen chat site, Kapidzic & Herring (2015) found that teen girls were more likely to post pictures in which they were wearing revealing dress or were partially undressed (49%) than were boys (26%). In another small-scale study of approximately 100 Facebook profiles of Dutch adolescents (ages 11–18), Doornwaard,

Moreno, van den Eijnden, Vanwesenbeeck, & Ter Bogt (2014) found that a minority of participants displayed sexual (24%; such as comments about sexual experiences or behaviors) and romantic (26%; such as dating or being in love) references on their social media profiles. No revealing personal images (defined as images including full or partial nudity beyond what one might see at a public beach) were found.

In a longitudinal study carried out by Vandenbosch, Van Oosten & Peter (2015) to investigate whether exposure to sexual reality television content and Internet pornography (IP) is related to sexual self-presentation on social media among 1,765 adolescents aged 13–17 years, they found out that watching sexual reality television content stimulated adolescents to produce and distribute sexual images of themselves on social media. In turn, sexual self-presentation on social media led adolescents to watch sexual reality television content more frequently. These relationships were similar among boys and girls. No reciprocal relationship between exposure to IP and boys' and girls' sexual self-presentation on social media was found. Their results suggested that sexual content in mainstream mass media may predict adolescents' sexually oriented behavior on social media and vice versa. Moreover, adolescents seem to differentiate between types of sexual content (i.e., mainstream versus more explicit sexual content) when incorporating sexual media content in their sexual behavior online.

Amoo (2013) examined the effects of adolescents' exposure to sexual contents through social media in Nigeria. Data was gathered using quantitative structured face-to-face interviews among 305 literate adolescents. They were distributed using Nigerian age-sex ratio of 15 and 19 between male and female respectively. One adolescent per house/building was purposively interviewed within randomly chosen streets in the locations of study. The study locations consist of densely populated urban areas in Lagos metropolis, Nigeria. Common social media identified among the respondents includes Facebook, Twitter, YouTube, Flickr, Instagram and LinkedIn. The result revealed that users of social media in age group 10-14 years are 4.614 times more likely to be exposed to sexual activity. Also those adolescent users of social media with primary education are 26.953 times more likely to be involved in sexual activity. Those who use social media like Twitter, Facebook, YouTube and Instagram are 6.932, 4.630, 3.566 and 2.682 times (respectively) more likely to be exposed to sexual activity compared to their counterparts that use other forms of media. The research posits that it is inimical not to monitor adolescents' exposure to sexual contents and censor the scenes available on social media gadgets. The study recommends that sexuality education must be popularized in order to stem the risk of HIV/AIDS among the group studied.

In another research carried out by Amoo (2013) which examined the effect of the silent posture of Christian religion towards the preponderance of scanty dressing, pornography (and the like) on 114 adolescents' in the age group 12-24 years sexual

behavior, it was revealed that level of "parent-child-communication" within the family is below average (32%). Over 69.3% claimed sermon/discussions/preaching ever heard excluded sexuality and about 52% that do, emphasizes only the "sinful" aspect rather than its social benefits. About 67% respondents have watched pornographic materials on TV in the last 3 months while two-third has experienced sexual intercourse. It was suggested that Indulgence in adult entertainment could be curtailed by provision of adequate sex education and open programmes on sexuality rather than the current clandestine-campaigning syndrome.

In a study by Daniels (2016) which assessed college men's perceptions of a female peer who presented herself on Facebook in either a sexualized or nonsexualized manner. One hundred and seventeen college men viewed a Facebook profile with either a sexualized profile photo or a nonsexualized profile photo of a young woman and then evaluated the profile owner. They also reported on their dating attitudes. Results indicated that the sexualized profile owner was considered less physically attractive, less socially appealing, and less competent to complete tasks. Interest in dating and casual sex with the profile owner as well as general dating attitudes were largely not impacted by the type of profile photo. Findings suggest that using a sexualized profile photo on Facebook comes with some relational costs for young women. Strategies for educating young people about new media use and sexualization are discussed.

In a research carried out by Nagaddya, Kiconco, Komuhangi, Akugizibwe & Atuhairwe (2017) on assessing the influence of social networking material on adolescents' sexual behavior in Kampala, they found out that adolescents in Uganda may be at risk of indulging in risky sexual behavior if usage of social networking sites remains unrestricted. The result of their survey indicated that majority (68.9%) of the respondents thought that messages, photos, videos with sexual content shared/posted on social networking sites, changed their sexual behavior. They concluded that Parents may need to restrict access and use sexual content especially pictures and videos available on social networking site among the adolescents.

3. IMPACT OF SOCIAL MEDIA ON ADOLESCENT SEXUAL BEHAVIOUR

Both children and adults have been reported to believe the media is a central source of information on sex and sexuality for young people (Malamuth & Impett, 2001) considering few programs (from the daily news, to "reality-based" programs, to talk shows, to family-centered programming) appear immune to stories of a sexual nature. Content analysis has been performed on print media, television and movies, music, and computerized media to determine the types of messages delivered through these sources with results showing adolescents being exposed to both implicit and explicit sexual content (Flowers-Coulson, Kushner, & Bankowski, 2000; Kehily, 1999).

Families are an incredibly important influence on the behavior of any child in many ways. For instance, low family socio economic status has been repeatedly linked to risky adolescent sexual behavior (Ramirez-Valles *et'al*, 1998; Kotchick *et'al*, 2001). Numerous studies have also demonstrated that living with both biological parents is related to increased age of sexual debut (Taris & Semin, 1997; Ramirez-Valles *et'al*., 1998; Upchurch *et'al*, 1999). Parental control and monitoring have been repeatedly linked to lower levels of risky adolescent sexual behavior, usually, it is thought, by reducing the amount of opportunity available to engage in premarital sexual behavior (Luster & Small, 1994; Small & Luster, 1994; Hovell *et'al*., 1994). Parental warmth or support has also been found to relate to adolescent sexual behavior (Miller *et'al*, 2001).

Also, in a study of Luster & Small (1994) found that highly supportive parents had adolescents at much lower risk for having more than one sexual partner and inconsistently using contraception. Fisher (1989) found that more communication with parents teens perceive as liberal was related to females engaging in more sexual behavior, and communication between conservative parents and sons led to sons being more conservative themselves. Similarly, according to Moore *et'al* (1986), higher levels of communication with liberally perceived parents was related to sons engaging in more sexual behavior, while communication between conservative parents and daughters was related to less risky sexual behavior.

Another contextual factor which has been shown to influence adolescent sexual behavior is the media. L'Engle, Brown & Kenneavey (2006) found that more exposure to sexually related media and media that conveys an approval of adolescent sexual behavior was related to higher levels of intention to engage in sexual behavior and a greater amount of sexual behavior in general. This effect persisted even after controlling for other contextual factors including parents, peers, school, and religious influences. Close friends and peers have been found to be quite important to the socio sexual development of adolescents (Smith, Udry & Morris, 1985; Christopher, Johnson & Roosa, 1993). Association with deviant peers was related to an increased risk of adolescents engaging in a number of problematic behaviours, including risky sexual behaviour (Ary *et al*, 1999; Metzler *et al*,1994).

To counter the above submissions, correlation studies indicate that exposure to sexually suggestive materials is associated with premarital sex, although whether sexually active teens seek out sexual content or whether sexual content increases sexual activity remains uncertain (Odekunmi, 2013; Amazigo , 2003; Donnerstein & Smith, 2001; Shelia, 2001; Malamuth & Impett, 2001; Amoo, 2013). Other researchers have found sexual content in the media to have a minimal, if any, impact on sexual activity of adolescents (Collins, Martino, & Shaw, 2011; Brown, 2008).

The Nigerian Association for the Promotion of Adolescent Health and Development, (NAPAHD) has also alerted that, a hospital based research has shown that, 80 per cent of patients with abortion complications are adolescents. This assertion was based on the fact that, over 16 per cent of teenage females reported first sexual intercourse by age 15 while

8.3 per cent of boys of age 15 have also had their first encounters. This adolescents' health dilemma has been attributed to their great lack of information and knowledge about the implications of their population behavior on their sexual health and the general welfare of the nation (Odekunmi, 2013).

Odekunmi made it clear that, the rational was to acquaint the youth with factual and accurate sexual information about the dimensions of sexual knowledge that will enable them understand and clarify their personal values, improve their sexual knowledge and sexual decision–making and promote their knowledge about how all these interact with socio-cultural and religious factors to affect personal well-being.

Larson (1995) suggested that since the media usage has changed (often becoming more individualistic) adolescents begin to develop their sense of self. The experiences of adolescents as they develop may impact how media is selected and how influential the messages are. Fine, Mortimer, & Roberts (1990) had suggest that the medium adolescents select is different during this life stage in an attempt to gain independence from parents. Depending on their rate of development, some adolescents may succumb to media influences, while others may not. Based on an extensive literature review regarding the influences of sexual content in the media, Malamuth & Impett (2001) state that individual personality factors may also be important, as research suggests that the type of media people select and find gratifying is predictably related to their personalities and other individual differences.

Amoo (2011) noted that along with developmental differences, learning styles may also contribute to the way media are used and interpreted by adolescents. Lenhart, Purcell, Smith & Zickuhr (2010) examined various learning styles in order to determine which contributed most to the knowledge of birth control in a study of 100 adolescents aged 13 to 17. Styles of communication and learning were assessed in terms of who the adolescent communicated with (peers, family, professionals, multiple sources, or no one). The relationship between the interactant communication styles (home, peer, professional, and multi-source) and noninteractant (media influence without communication with others) was significant; adolescents who had interactant communication styles had greater birth control knowledge than those with a noninteractant learning style.

4. CONCULSION

Going with the fact that not all information that goes on social media get censored, it make it easy for adolescents to get information on sexuality almost for free on social media. They mostly use the social media for the expression of sexuality in a relaxation, companionship and entertainment. Although, even before using social media, adolescents have been expose to sexual information through other media (television and films). This is in line with Amoo (2013) recommendation where he posits that it is inimical not to monitor adolescents' exposure to sexual contents and censor the scenes available on social media gadgets.

The study recommends that sexuality education must be popularized in order to stem the risk attached to the early exposure to sexual information such as HIV/AIDS, cyberbullying, sexual harassments, depression to mention few among adolescents.

In addition, parents need to convince and educate adolescents on the implications of involving in any form of sexuality, there should be a guide on how the social media should be used to obtain important and impactful information that will add to the knowledge of adolescents on sexuality. Also, adolescents should be made to understand that not all information they found on social media is true.

Meanwhile, regulatory agencies should deploy means of developing application which can screen all information and checkmate if such information on social media is fit for consumption. Suggestion should be made that such application should be installed on all phones especially that of the adolescents and youths.

REFERENCES

Adepoju, A. (2005). Sexuality Education in Nigeria: Evolution, Challenges and Prospects. *Africa Regional Sexuality Resource Centre.*

Ahn, J. (2011). The effect of social network sites on adolescents' social and academic development: Current theories and controversies. Journal of the American Society for Information Science and Technology, 62(8), 1435-1445.

Ajewole, O. O, & Fasola, O. S. (2012). Social Network Addiction among Youths in Nigeria. *Journal of Social Science and Policy Review*, 4.

Ajike, A. K. & Nwakoby, N. P. (2016). The Impact of Social Networking Sites on Teenagers In Nigeria. *International Journal of Public Policy and Administrative Studies, 11(1):35-64.*

American Academy of Pediatrics (2011). *Impact of Social Media on Children, Adolescents and Families*. Retrieved from https://pediatrics.aappublications.org/content/127/4/800.

Amazigo U., Silva, N., Kaufman, J. & Obikeze, D. S. (2003). *Sexual Activity and Contraceptive Knowledge and Use among in-school Adolescents in Nigeria*. Nigeria: Lagos.

Amoo, E. O. (2013). Effects of Adolescents Exposure to Sexual Contents on Social Media in Nigeria. *Creating global competitive economies: 2020 vision planning &implementation*, pp 2053-2062.

Amoo, E. O. (2013). Social Media and Adolescent Sexuality: Implications HIV/AIDS Incidence in Nigeria. *Journal of Social Sciences*, 6(6).

Ary, D. V., Duncan, T. E., Biglan, A., Metzler, C. W., Noell, J. W. & Smolkowski, K. (1999). Development of Adolescent Problem Behavior. *Journal of abnormal child psychology, 27,*141-150.

Blumenfeld, W. J. & Cooper, R. M. (2010). LGBT and Allied Youth Responses to Cyberbulling: Policy Implications. *The International Journal of Critical Pedagogy*, 3(1), 114-133.

Boyd, D. M., & Ellison, N. B. (2007). Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication*. 13, 210-230. doi:10.1111/j.10836101.2007.00393.

Brown, J. (2008). *Managing the media monster: the influence of media (from television to text Messages) on teen sexual behavior and attitudes*. Washington, DC: National Campaign to Prevent Teen and Unplanned Pregnancy.

Brown, J. D., & Steele, J. R (1995*). Sex and the Mass Media*. Menlo Park, CA: Henry J. Kaiser family foundation.

Brown, J. (2008). *Managing the media monster: the influence of media (from television to text Messages) on teen sexual behavior and attitudes*. Washington, DC: National Campaign to Prevent Teen and Unplanned Pregnancy.

Bryant, J., & Oliver, M. B. (2008).*Media Effects: Advances in Theory and Research*: Taylor & Francis.

Collins, R. I., Martino, S. C. & Shaw, R. (2011). *Influence of New Media on Adolescent Sexual Health: Evidence and Opportunities*. Working paper, Department of Health and Human Services, Washington, DC. p72.

Collins, R. I., Marc, N. E., Sandra, H. B., David, E., Kanouse, D. K., Sarah, B. H., & Angela, M. (2004). "Watching Sex on Television Predicts Adolescent Initiation of Sexual Behavior. *Pediatrics*, 114(3).

Cha, J. (2010). *Factors affecting the frequency and amount of social networking site use: Motivations, perceptions, and privacy concerns*. First Monday, 15(12), Retrieved from: http://firstmonday.org/ojs/index.php/fm/article/view/2889/2685

Christopher, F. S., Johnson, D. C. & Roosa, M. W. (1993). Family, Individual, and Social Correlates of Early Hispanic Adolescent Sexual Expression. *Journal of sex research, 30,* 54-61.

Daniels, E. A. (2016). Sexiness on Social Media: The Social Costs of Using a Sexy Profile Photo. Sexualization, Media, & Society, p. 1-10, DOI: 10.1177/2374623816683522

Downs, D. A. (2007). "*Pornography*". Redmond, WA: Microsoft Corporation.

Doornwaard, S. M., Moreno, M. A., van den Eijnden, R. M., Vanwesenbeeck, I., & Ter Bogt, T. M. (2014). Young adolescents' sexual and romantic reference displays on Facebook. Journal of Adolescent Health, 55, 535–541.

Fine, G. A., Mortimer, J. T., & Roberts, D. E. (1990). Leisure, work and the Mass media. In s. S. Feldman & Elliot, G. R. (eds.), *the Threshold: the Developing adolescent* (pp. 225-252). Cambridge, MA: Harvard University Press.

Fisher, T. D. (1989). Family Sexual Communication and Adolescent Sexual Behavior. *Journal of marriage and the family, 51,* 637-639.

Flowers-Coulson, P. A., Kushner, M. A., & Bankowski, S. (2000). The information is out there, but is anyone getting it? Adolescent misconceptions about sexuality education and reproductive health and the use of the Internet to get answers. *Journal of sex education and therapy, 25(2/*3), 178-188.

Gallion, A. J. (2014). *Applying the uses and gratifications theory to social networking sites: a review of related literature*.Academia. Retrieved from: http://www.academia.edu/1077670/Applying_the_Uses_and_Gratifications_Theory_to_Social_Networking_Sites_A_Review_of_Related_Literature (2014).

Gülnar, B., Balcı, Ş. &Çakır, V. (2010). Motivations of Facebook, You Tube and similar web sites users. *Bilig*. 54, 161-184.

Guttmacher Institute (2010). *U.s. Teenage pregnancies, births and abortions: national and*

State trends and trends by race and ethnicity. New York: Guttmacher Institute.

Gween, S. O. & Kathleen, C. (2011). Impact of Social Media on Children, Adolescents and Families. *Pediatrics*, 27(4).

International Telecommunication Union, ITU. (2016). *Nigeria Latest Profile*. Retrived from http://www.itu.int/net4/itu-d/icteye/CountryProfileReport.aspx?countryID=167.

Ikpe, E. B. (2004) "Human Sexuality in Nigeria: A Historical Perspective" in AFSRC, *human sexuality in Nigeria: understanding human sexuality seminar Series no. 1*, Lagos: African Regional Sexuality Resource Centre.

Jan, K. H., Kristopher, H. (2011). Social media? Get serious! Understanding the functional Building blocks of social media. *Business horizons,*54, 241–251.

Hovell, M., Sipan, C., Blumberg, E., Atkins, C., Hofstetter, C. R., & Kreitner, S. (1994). Family Influences on Latino and Anglo Adolescents' Sexual Behavior. *Journal of marriage and the family,* 56, 973-986.

Kapidzic, S. & Herring, S. C. (2015). Teens, Gender, and Self-Presentation in Social Media.

Katz, E., Blumler, J. G., & Gurevitch, M. (1974).Uses and gratifications research. Public Opinion Quarerly, 37 (4), 509-524.

Kehily, M. J. (1999). More Sugar? Teenager magazines, gender displays and sexual learning. *European journal of cultural studies, 2,* 65-89.

Kotchick, B. A., Shaffer, A., Miller, K. S. & Forehand, R. (2001). Adolescent sexual risk behavior: a multi-system perspective. *Clinical psychology review, 21,* 493-519.59.

Lau, W. W. F. (2016). Individual differences in motivations for using social media among university students.*Adelaide*.

Larson, R. (1995). Secrets in the bedroom: adolescents' private use of media. *Journal of youth and adolescence, 24(5),* 535-550.

L'engle, K. I., Brown, J. D., & Kenneavy, K. (2006). The mass media are an important context for Adolescents' sexual behavior. *Journal of adolescent health*, 38(3),186-192.

Lenhart, A., Purcell, K., Smith, A. & Zickuhr, K. (2010). *Social media & mobile internet use among teens and young adults*. Retrieved from http://pewinternet.org/reports/2010/social-media-and-young-adults.aspx

Lusk, B. (2010). Digital natives and social media behaviors: An overview. *Prevention Researcher.*173-6.

Luster, T. & Small, S. A. (1994). Factors associated with sexual risk-taking behaviors among adolescents. *Journal of marriage and the family,* 56, 622-632.

Malamuth, N., & Impett, E. (2001). Research on sex in the media: what do we know about effects on children and adolescents? In d. Singer & J. Singer (eds.), *Handbook of children and the media* (pp. 289-307). Thousand Oaks, CA: Sage Publications.

Matthews, A. O. (2007). *Religion and Sexuality: Individuality, Choice and Sexual Rights in Nigerian Christianit: Humanity Sexuality in Africa beyond Reproduction*. Action Health Incorporated: Fanele Jacana Media (Pty) Ltd.

Metzler, C. W., Noell, J., Biglan, A., Ary, D, & Smolkowski, K. (1994). The social context for risky sexual behavior among adolescents. *Journal of behavioral medicine,* 17(4), 419- 438.

Miller, B. C., & Fox, G. l. (1987). Theories of adolescent heterosexual behavior. *Journal of adolescent research, 2,* 269-282.

Miller, B. C., Benson, B., & Galbraith, K. A. (2001). Family relationships and adolescent pregnancy risk: a research synthesis. *Developmental review, 21,* 1-38.

Moore, K. A., Peterson, J. l. & Furstenberg, F. F. (1986). Parental Attitudes and the Occurrence of Early Sexual Activity. *Journal of marriage and the family, 48,* 777-782.

Nigeria Demographic Profile, NDP. (2018). Retrived from https://www.indexmundi.com/nigeria/demographics_profile.html

Oberst, L. (2010). *The 6S Social Network*. Retrieved from: http://sixsentences.ning.com/profile/LindsayOberst

Odekunmi, F. B. (2013). The Effect of Sex Education on Teenage Pregnancy among Secondary School Students in Ibadan Metropolis. *Journal of humanities and social science,* 17(4), 59-64.

Okoro, N. & Adide, N. K. (2013). Social media and political participation in Nigeria during the 2011 General Elections: The lapses and the lessons. *Global Journal of Arts Humanities and Social Science,* 1(3), 29-46.

Papacharissi, Z., & Rubin, A. M. (2000). Predictors of internet use.*Journal of Broadcasting & Electronic Media*. 44(2), 175-196.

Park, N., Kee, K. F., & Valenzuela, S. (2009). Being immersed in social networking environment: Facebook groups, uses and gratifications, and social outcomes.*CyberPsychology& Behavior*. 12, 729-733.

Phua, J., & Jin, S. A. A. (2011). Finding a home away from home: The use of social networking sites by Asia-Pacific students in the United States for bridging and bonding social capital. *Asian Journal of Communication*. 21, 504-519.

Phua, J. & Kim, J. (2016). Gratifications of Using Facebook, Twitter, Instagram, or Snapchat to Follow Brands: The Moderating Effect of Social Comparison, Trust, Tie Strength, and Network Homophily on Brand Identification, Brand Engagement, Brand Commitment, and Membership Intention. *Telematics and Informatics*. doi: http://dx.doi.org/10.1016/j.tele.2016.06.004

Ragsdale, K., Harper, S. K., Kathuria, S., Bardwell, J. H., Penick, C. B. & Breazeale, M. (2015). Social Media to Enhance Sexual Health Education for Youth: FactNotFiction's (Re)Design and Launch. *Strategic Communication*, 4.

Ramirez-Valles, J., Zimmerman, M. A., & Newcomb, M. D. (1998). Sexual risk behavior among youth: modeling the influence of prosocial activities and socioeconomic factors .*journal of health and social behavior, 39,* 237-253.

Ruggiero, T. E. (2000). Uses and Gratifications theory in the 21st century.*Mass Communication and Society*. 3(1), 3-37.

Schill, R. (2011). *Social Networking Teens More Likely to Drink, Use Drugs*. Retrieved from: http://jjie.org/teens-on-facebook-more-likely-drink-oruse-drugs-study-finds/

Shelia, C. (2001). Parents, peers, and pressures: identifying the influences on responsible sexual Decision-making. Practice update from the national association of social workers. *Adolescent health*, 2(2). Retrieved from Www.naswdc.org/practice/adolescent_health/ah0202.asp

Smith, E. A., Udry, J. R. & Morris, N. M. (1985). Pubertal development and friends: a biosocial explanation of adolescent sexual behavior. *Journal of health and social behavior, 26,*183-192.

Strasburger, V. C. (2010). Sexuality, Contraception and the Media (policy Statement). *Pediatrics*, 126, 576-582.

Strasburger, V. C., Jordan, A. B., & Donnerstein, E. (2012). Children, adolescents, and the media: health effects. *Journal of Pediatric Clinic of North America*, 59(3).

Steele, J. R. (1999). Teeange sexuality and media practice: factoring in the Influences of family, friends, and school. *Journal of sex research,* 36(4), 331-341.

Tang, Q, Gu, B. & Whinston, A. B. (2012). Content contribution for revenue sharing and Reputation in social media: a dynamic structural model. *Journal of management information Systems,* 29,41–75.

Taris, T. W. & Semin, G. R. (1997). Parent-child interaction during adolescence, and the adolescent's sexual experience: control, closeness, and conflict. *Journa l of youth and adolescence, 26,* 373-398.

Tiemoko, R. & Oku-egbas, A. (2006). *Monitoring media coverage of sexuality: An Introduction. Sexuality in media, emerging issues*.In Africa Regional Sexuality Resource Centre, ARSRC p6-10.

Udry, J. R. (1988). Biosocial predispositions and social control in adolescent sexual behavior. *American Sociological Review, 53,* 709-722.

Upchurch, D. M., Aneschensel, C. S., Sucoff, C. A. & Levy-storms, l. (1999). Neighborhood and family contexts of adolescent sexual activity. *Journal of marriage and the family, 61,* 920-933.

Urista, M. A., Dong, Q., & Day, K. (2009). Explaining why young adults use Myspace and Facebook through uses and gratifications theory. *Human Communication*.12(2), 215-229.

Vandenbosch, L., Van-Oosten, J. M. F., & Peter, J. (2015). The Relationship Between Sexual Content on Mass Media and Social Media: A Longitudinal Study. *Cyberpsychology,Behavior, and Social Networking*, 18(12).

Yang, K. C.C. and Kang, Y. (2006).*Exploring factors influencing internet users' adoption of internet television in Taiwan First Monday, 11(3).* Retrieved from http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/1319/1239 Zhao

ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS) IN CURBING CORRUPTION AMONG PUBLIC SERVANTS IN KWARA STATE INLAND REVENUE SERVICE (KWIRS)

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ABSTRACT

This study examined the role of Information and Communication Technologies (ICTs) in curbing corruption among public servants in Kwara State Inland Revenue Service. Thus, this study specifically analyzed the relationship between ICTs and governance; E-governance and corruption and ICTs and Integrated Tax Administration System in Nigeria (ITAS). It was discovered that even though successes have been recorded in the use of ICTs to fight corruption in some countries, there is a need to integrate the ICT initiatives with institutional support and commitment from stakeholders to make its fight against corruption very effective in Nigeria.

Keywords: *E-governance, Corruption, KWIRS, ITAS, Public servants*

1. INTRODUCTION

Corruption is a global phenomenon and one of the greatest challenges of contemporary world (Zhao and Xu, 2015) making it a major governance concern in most nations especially because it negatively affects development (Zheng, 2016). It is a systemic plague that threatens improvements in human and economic development by distorting the rule of law and weakening the institutional foundation on which economic growth depends (Duasa, 2008). This has attracted the attention of scholars to this phenomenon for many years. Yet, it is still an unresolved global problem (Zheng, 2016). Corruption affects societies socially, morally and most especially economically. It has impeded growth and development especially in developing countries like Nigeria. Accordingly, Transparency International's Corruption Perception Index (CPI) ranking in 2017 shows Nigeria falls among the countries in the bottom half of the index (Transparency International, 2017). This puts it among the most corrupt countries in the world, and like other countries in this group, is in great need of backing in fighting corruption. Evidently, an effective strategy to curb corruption in the country is urgent. One of such proposed strategies is the utilization of Information and Communication Technologies (ICTs) through E-governance initiatives. Consequently, the E-governance initiative for revenue generation in Nigeria is the Integrated Tax Administration System (ITAS) introduced by the Federal Inland Revenue Service (FIRS) in 2013 and which has been adopted at the Kwara State Inland Revenue Service (KWiRS).

Foundational to this, development in ICT has impacted on government activities globally in the past two decades. Thus, improving transparency and responsibility has been put forward as solutions to corruption in which ICT plays a great role (Zheng, 2016). Specifically, the use of ICT in the public sector increases transparency of government (Zhao and Xu, 2015) thereby curbing corruption through E-governance. Basically, E-governance reduces corruption in two ways. First, is by making a system more transparent and in so doing reducing discretion and providing less opportunity for arbitrary actions (Carr & Jago, 2014). And second, is that ICT makes it possible for citizens to monitor government employees such that they can detect and report corrupt behavior easily (Shim & Eom, 2008). A specific case in study is the Integrated Tax Administration System (ITAS) which aims to make the taxation process in the country transparent as studies have shown transparency is an important remedy against corruption. Especially as transparency in electronic taxation works as a successful solution to corruption related problems in many countries (Nam, 2018).

Hence, to combat corruption, it is necessary to focus on corrupt system and not on corrupt individuals (Pathak, Naz, Rahman, Smith & Agawal, 2009). This is especially important as E-governance is a critical factor in reducing corruption. Yet, there is little study on the relationship between corruption and E-governance (Zhao and Xu, 2015)

especially as it relates to KWiRS. While previous works have focused on the varying prospects and challenges of E-governance implementation in Nigeria (Abasilim & Edet, 2015; Budhiraja, 2003; Ojo, 2014) and its influence on the level of corruption in other climes (Lupu & Lazar, 2015), not much has been done on its role in reducing corruption among public servants in KWiRS. Although, some case studies (Akingabde, Naverra, Georgiadou, Zevenbergen, 2012; Zhao & Xu, 2015) proved compelling evidence that E-governance brings greater transparency which is related to lower levels of perceived corruption, there is still need for a review of the phenomenon in relation to specific government agencies in Nigeria. Additionally, in as much as previous studies have proved that E-governance plays an important role in reducing corruption, each government project is unique, and hence it is unsure if the same scenario will play out in a Nigerian system especially with regards to ITAS in KWiRS. Furthermore, given Nigeria's position among emerging economics in ICT, it would be worthwhile to review how it is used to curb corruption.

Therefore, this paper expounds the impact of ITAS in reducing corruption among public servants in KWiRS. Specifically, it explains how E-governance application in KWiRS is used to curb corruption and increase efficiency, responsiveness, transparency and accountability.

2. INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS) AND GOVERNANCE

The use of ICT has been acknowledged in virtually all spheres of human endeavor, including governance. The adoption of ICTs to governance represents the government attempt at developing more sophisticated ways in digitizing its routines and practices so that it can offer public access to government services in a more effective and efficient way (Gant, 2008). In a bid to ensure that governments comply with citizens' demand for quality information, ICTs are the tools adopted by the government to minimize the cost of managing information and maximize the usefulness of the information. In other words, ICTs are the most cost effective means for capturing data from the internal operation of government organizations and for serving citizens (Gant, 2012).

ICT leads to enhancement in communication which makes it possible for citizens to play more role in their governance, especially in the area of policy-making, thereby reinforcing the creation of a culture of trust and mutual interest (Pathak, Naz, Rahman, Smith & Agawal, 2009). Thus, information about government operations is a basic requirement in fostering transparency in governance. The use of Information and communication technologies could help the government as well as the civil society to inform the people of their rights and their privileges. It can also help people, especially those living in remote places to access data and actively participate in the democratic system. Information constitutes a valuable national resource, because it provides the public with knowledge of the government, society and economy and is also a tool used to

ensure the accountability of government and manage government operations in order to ensure the healthy performance of the economy. This free flow of information between the government and the public is essential to a democratic society (Gant, 2012). Similarly, Sheryazdanova and Butterfield (2017) posits that the strategy of increasing access to information as a corruption fighting tool is a novel development which expectedly coincides with the increased use of ICT in society. ICT has the potential to ensure transparency and efficiency. Thus, its use in fighting corruption falls within the scope of ICT for development because it can help manage citizen-state relationships and transactions like E-governance.

Furthermore, benefits of using ICT to fight corruption is that, it can streamline and speedup information management and transactions especially in providing services to the public, by so doing it makes room for the provision of better and effective public service to citizens. Additionally, it makes information services more transparent to use and cut unaccountable discretion of service providers which ultimately brings hope of fighting corruption (Pathak, Naz, Rahman, Smith & Agawal, 2009). For example, Pathak, Naz, Rahman, Smith and Agawal (2009) found ICT initiatives like E-governance contributes to reducing corruption in the public sector in Fiji.

Thus, it could be surmised that the major reasons for greater use of ICT in service delivery are: improving information base, decision making, improving communication between political and administrative processes, improving internal communication flows, developing integrated information systems, better record keeping and archiving, freedom of information data, inter-departmental coordination and cooperation, improving efficiency, increasing public service flexibility and increasing public safety and cost saving. (Pathak, Naz, Rahman, Smith & Agawal, 2009).

3. E-GOVERNANCE AND CORRUPTION

Transparency international defines corruption as the abuse of entrusted power by political leaders or bureaucracy for personal gain or specific group interest (Shim & Eom, 2008). It is simply the abuse of power for private benefit (Pathak, Naz, Rahman, Smith & Agawal, 2009; Zhao & Xu, 2015) and an illegal act which involves exploiting public authorities for private gain (Sheryazdanova & Butterfield, 2017). Generally, the level of corruption in nation is influenced by economic, political, demographic and cultural factors (Zhao and Xu, 2015). However, more specifically, some determinants of corruption are level of development, growth rate, government size, political system, political stability, government effectiveness, regulatory quality, rule of law, level of urbanization, female leader ratio, population, education and religion (Shim & Eom, 2008). Additionally, corruption can be caused by factors such as lack of accountability among public servants, inequality in the distribution of resources, promotion of ethnicity, and lack of nationalism and weakness of governmental enforcement agencies (Duasa,

2008). Additionally, cases of corruption includes abuse of public funds or office, kickback, palm greasing, rank pulling etc. (Pathak, Naz, Rahman, Smith & Agawal, 2009).

An application of these explications of corruption would reveal that corruption has become an integral part of the Nigerian system and has become pervasive in every sphere of the national existence. Chukwuemeka, Ugwuanyi and Ewuim (2012) espoused that the indicators of corruption such as embezzlement, bribery, misappropriation, conversion of public funds to personal purse, manipulation of procurement processes, falsification of official financial records, award of contracts by public office holders to cronies and personally held companies and rigging of elections are all easily observable in virtually all public offices and public affairs in Nigeria.

E-governance on the other hand is a distinguished concept that pertains to the utilization of ICTs for political purpose and the organization of political activity in a country (Gant, 2008). It is an electronic delivery of government services to citizens in a reliable, timely and transparent manner. It is the act of utilizing the internet and World Wide Web for delivering government information and services to citizens (Zhao & Xu, 2015). E-governance improves government activities by reducing cost of governance, increasing transparency, anticorruption and accountability and improving the decision making process by increasing government capacity (Shim & Eom, 2008). Its implementation in a country goes beyond making more investments in ICTs but rather engendering the willingness of citizens to adopt and use online services and the development of managerial and technical capabilities to implement E-governance initiatives (Prattipati, 2003). It deals with the use of ICTs by various government agencies to enhance accountability, create awareness, and ensure transparency in the management of government businesses. It is a political strategy through which the activities of the government are made public through the adoption of modern communication (Sunday, 2014). Apparently, E-governance can be used to reduce corruption in the society by promoting good governance, strengthening relations between government employees and citizens, tracking, monitoring and controlling behavior of government employees by the citizens, enhancing the effectiveness of internal control and management of corrupt behaviour by promoting government transparency and accountability (Odia & Odia, 2016). Thus, E-governance initiatives promotes greater pellucidity with the goal of curbing corruptible tendencies among service providers (Pathak, Naz, Rahman, Smith & Agawal, 2009). It makes the system more transparent making it difficult to carry out corruption practices and easy to track and catch corrupt acts (Zhao and Xu, 2015). It is a viable corruption curbing tool to reinvent the public sector by transforming internal government work processes and external relationships with citizens (Carr& Jago, 2014).Accordingly, an important aspect of E-governance is the participatory approach of which ICT is an integral part. ICT is seen here as the most important tools for ensuring a more participatory democracy and enhancing trust in government. Posting important government information online makes government seem

more transparent and citizens more knowledgeable about politics (Zhao and Xu, 2015). This is important because Pathak, Naz, Rahman, Smith and Agawal (2009) found that major influencers of corruption are monopoly of access to information by officials and high degree of discretion by officials and also lack of transparency and accountability.

Consequently, because E-governance initiatives requires ICTs, it allows government to work more effectively, share information and deliver better services to the public, it prevents corruption by increasing enforcement and access to information which ultimately improves government capacity to provide better services. To this end, case studies in a number of countries provides evidence of effectiveness (Sheryazdanova & Butterfield, 2017). Also, Pathak, Naz, Rahman, Smith and Agawal (2009) reported 65% of their respondents suggest E-governance can reduce corruption. No wonder, there are increasing number of countries using E-governance initiatives to fight corruption (Nam, 2018) making it an effective corruption fighting tool (Shim & Eom, 2008). Furthermore, in a longitudinal study of 80 countries from 2003 to 2010, Zhao and Xu (2015) reported that E-governance reduces corruption and enhances transparency. Explicitly, results of their panel data analysis shows a positively significant relationship between E-governance and perception of corruption. The higher the level of e-government readiness, the less corrupt the government in a country. Thus, they concluded that E-governance promotes democratization, increases transparency, accountability, access to government, increased trust in government (Zhao and Xu, 2015). In the same vain, Sheryazdanova and Butterfield (2017) reported positive effects of E-governance use on perceived transparency of and trust in government. Thus, it can control corruption through transparency since both concepts are negatively correlated. These arguments show E-governance has positive influence on corruption. Hence, there is generally a positively and statistically significant relationship between E-governance and corruption.

However, against the above arguments, Pathak, Naz, Rahman, Smith and Agawal (2009) reported the view of some scholars that E-governance is not the ultimate solution to the problem of corruption, rather, tackling corruption requires planning, sustained resource dedication and political will, institutional support and commitment from stakeholders. Thus, for E-governance to succeed, people, process and technology should play equal roles. Technology itself is an instrument for E-governance success. Unfortunately, in as much as ICT has the potential to make services efficient and transparent, the people part of E-governance makes it ineffective (Carr & Jago, 2014). To this end, Pathak, Naz, Rahman, Smith and Agawal (2009) suggest the best way to cut corruption is to ensure that service providers work together with the public to implement E-governance systems. Thus, the higher the level of e-government readiness, the higher the level of cleanliness and transparency in a country. Thus, promotion of E-governance through policy initiation can be effective in reducing corruption. (Zhao and Xu, 2015).

4. E-GOVERNANCE AND INTEGRATED TAX ADMINISTRATION SYSTEM (ITAS) IN NIGERIA

The advent of E-governance in Nigeria can be traced to the formulation of the Nigerian National Information Technology (NNIT) policy in the year 2000 (Abasilim & Edet, 2015). The concept was introduced in Nigeria partly due to its perceived potential of exposing corrupt practices in the government sector. Seemingly, it is reckoned that E-governance has helped to heighten transparency in the conduct of government businesses (Danfulani, 2013). The scope of it revolves around e-registration, e-participation, e-taxation, e-mobilization, e-education, e-service delivery, e-feedback, e-policing, e-debate and the analysis of public financial statements. Thus, overtime, its effective implementation has been attributed to the blockage of multiple fraudulent avenues of siphoning public resources by public servants in all tiers of the Nigerian government (Danfulani, 2013).

However, a great challenge for the global society is the ability to figure out how to harness the power of ICTs to raise the ability for government in developing countries to govern, serve its citizenry, and ultimately improve the human development conditions for its people (Gant, 2008). In other words, the perceived success of E-governance is beset with myriad of challenges, which given the developing status of Nigeria may make its full implementation a lofty ideal. Some of the problems identified include epileptic power supply, lack of trained and qualified personnel and the resistance to change attitude of most public servants (Abasilim & Edet, 2015).

Notwithstanding, some aspects of E-governance initiatives that have been recorded in recent times in Nigeria include the registration of teachers, police diary (a public radio phone in programme where citizens can interact with police laying complaints or reporting on rights abuse or crime), e-passport and visa application, voters registration, tax payment, land registration and e-payment, online registration of Joint Admission Matriculation Board (JAMB) by candidates and the organization of computer based examinations for candidates (Odia & Odia, 2016).

The E-governance arm of interest to this paper is e-taxation. Taxation is important for sustainable economic development, as such online tax systems have received global attention through the development of ICT which affects tax administration (https//iproject.com.ng). E-taxation is the E-governance initiative related to the revenue generation and it manifests in areas such as biometric and online processing of documents such as tax payer registration, and payment of taxes which curbs corruption as it reduces human contact and speed up services (Carr & Jago 2014). Electronic revenue collection is important especially in developing countries where government face great challenges in tax revenue collection. E-tax system is an integral part of revenue collection reform in Nigeria. The specific initiative used in Nigerian is Integrated Tax Administration System (ITAS) introduced by the Federal Inland Revenue Service (FIRS) in 2013. ITAS was introduced to improve tax administration in Nigeria and transform tax compliance process form a manual to an electronic system. It is the only system where

Nigerians are able to carry out various registration, filling and application activities in relation to taxation.

Accordingly, KWiRS was established in 2015, when the state government signed the Kwara state revenue administration law, 2015 (Law No 6 of 2015). It was created to diversify the revenue base of the state for financial freedom and better efficiency in government. This makes it the sole entity responsible for the effective and efficient administration of tax and related matters on behalf of the state government. The services of KWiRS include motor licensing, building permit rates, and tertiary educating tax, value added tax and other tax types as approved by the law. These tax collection cuts across the three tiers of government (federal, state and local level) (Kwara State Inland Revenue Service, 2018). The ITAS aims to make the taxation process in the country transparent as studies have shown transparency is an important remedy against corruption. Especially as transparency in electronic taxation works as a successful solution to corruption related problems in many countries (Nam, 2018). Moreso, Olatunji and Ayodele (2017) found that ICT enhances tax collectivity and administration.

5. THEORETICAL FRAMEWORK

Modernization theory proposed by Max Weber explains the influence on social change, development and progress. It focuses on political enlightenment, economic growth and technological progress. Evolution in economy and the technological innovations require concomitant institutions comprising society. Generally, modern economic institutions are characterized by the differentiation and specialization social roles. Because self-sustaining growth requires market economies which, in turn, require democracy, the modernization theory has also included in it mode of differentiating the emergence of politically specialized democratic institutions (Anaeto, Onabajo & Osifeso, 2012). Relating to this study, reduction in corruption in society is the social change and development, while political, economic and E-governance initiatives like e-taxation is the technological advancement.

However, given that the Technology Acceptance Model (TAM) has gained popularity for understanding the relationship between humans and technology through Perceived Usefulness (PU) and Perceived Ease of Use (PEU), this model will also be applied to understand the role of Information and Communication Technologies (ICTs) in curbing corruption among public servants at KWiRS.

The Technology Acceptance Model describes factors that determine technology acceptance and information technology usage behavior. According to Ducey (2013), Technology Acceptance Model includes Perceived Ease of Use and Perceived Usefulness which are the important determinants of technology acceptance and user behavior. In furtherance to this, Teo (2013) identified various factors that promote the use and acceptance of technology as individual differences, social influences, beliefs, attitudes and situational influences. Additionally, an individual's behavior is influenced by the

intention to perform the behavior, thus the real behavior is heralded by a person's behavioral intention to engage in the activity (Teo, 2013).

An application of this model to this study invariably suggests that the adoption of ICTs to curb corruption among public servants in KWiRS is determined by the acceptance of e- governance initiatives such as the ITAS (Integrated Tax Administration System) and the user behavior of public servants towards such initiatives.

6. CONCLUSION

This study set out to examine the role of Information and Communication Technologies (ICTs) in curbing corruption among public servants in the Kwara State Inland Revenue Service (KWiRS). Thus, the relationship between the concepts of corruption and E-governance; ICTs and Integrated Tax Administration System (ITAS) were explored. It was discovered that the utilization of ICTs alone to fight corruption might not be as effective as combining it with proper institutional support and commitment from stakeholders. Thus, the study further reveals that the effective adoption of e- governance initiatives such as the ITAS to curb corruption among public servants in KWiRS would be largely determined by their acceptance of ICTs and the their behavior towards its adoption.

REFERENCE

Abasilim, U. & Edet, L. (2015). E-governance and its implementation challenges in the Nigerian public service. *ACTA UNIVERSITATIS DANIBUS*, 7(1), 30-42.

Adamu, Y. M, Mohammed, H., & Dandogo, K.L (2006). Readings in the Social Sciences. K.I Adamu (ed) Joji publishers

Akingabde, A.O., Naverra, D.D., Georgiadou, Y., Zevenbergen J.A. (2012). A case study of geo- ICT for e-government in Nigeria: does computerization reduce corruption in the provision of land administration services? Survey Review 44(327), 290-300. Doi:10.1179/1752270611y.0000000023

Anaeto, S., Onabajo, O. & Osifeso, J. (2012). *Models and theories of communication*. Lagos, Nigeria: African Renaissance Books Incorporated.

Bashir, Y. (2016). Effects of treasury single account on public finance management in Nigeria. *Research Journal of Finance and Accounting*, 7(6), 164-170.

Budhiraja, R. (2003). *Electronic governance- A key issue in the 21st century*. Retrieved from http://www.mit.gov.in/eg/article2.htm

Carr, I & Jago, R (2014) Petty Corruption, development and IT as an antidote. The Commonwealth Journal of International Affairs. 103(5), 465-482. Doi:10.1080/0035853320.4.966495

Chukwuemeka, E., Ugwuanyi, B. & Ewuim, N. (2012). Curbing corruption in Nigeria: The imperatives of good leadership. *African Research Review*, 6(3), 338-358.

Creswell, J. W. (2012). *Educational research. Planning, conducting and evaluating quantitative and qualitative research*. (4th Ed.). Boston, MA. United States of America: Pearson Education, Inc.

Danfulani, J. (2013). *E-governance: A weapon for the fight against corruption in Nigeria*. Retrieved from http://saharareporters.com/2013/08/10/E-governance-weapon-fight- against-corruption-nigeria- john-danfulani-phd

Duasa, J. (2008). *Tendency of corruption and its determinants among public servants: A study on Malaysia*. Retrieved from https://mpra.ub.unimuenchen.de/11562/1/MPRA_paper_11562.pdf

Ducey, A. (2013). *Predicting tablet computer use: An extended technology acceptance model*. Retrieved from http://scholarcommons.usf.edu/etd/4471

Durodolu, O. (2016). *Technology acceptance model as a predictor of using information system to acquire information literacy skills*. Retrieved from http://digitalcommons.unl.edu/libphilprac/1450.

Junaidu, B. & Aminu, M. (2015). Public service in Nigeria- An overview of functions and code of conduct. *Global Journal of Politics and Law Research*, 3(1), 61-69.

Kaur, J. & Rathor, V. (2012). Importance of ICT and E-governance security in Punjab. *Global Journal of Computer Science and Technology*, 12(2), 63-69.

Kwara State Inland Revenue Service (2018) irs.kw.gov.ng retrieved on 15/2/18

Lupu, D. & Lazar, C. (2015). Influence of e-government on the level of corruption in some EU and non-EU states. *Procedia Economics and Finance*, 20, 365-371.

Nam, T. (2018). Examining the anti-corruption effect of E-government and the moderating effect of national culture: A cross-country study. *Government Information Quarterly*. Doi: org/10:1016/j.g.iq.2018.01.005

Odia, J. & Odia, A. (2016). E-government and corruption in Nigeria: The case of Treasury Single Account (TSA). *Afro Asian Journal of Social Sciences*, 7(4), 1-25.

Olatunji, O.C & Ayodele, K. B. (2017) Impact Of Information Technology On Tax Administration In Southwest Nigeria, *Global Journal Of Management And Business Research : D Accounting and Auditing*, 17(2). Global Journal Inc. USA ISSN: 2249

Ojo, S. (2014). E-governance: An imperative for sustainable grassroots development in Nigeria. *Journal of Public Administration and Policy Research,* 6(2), 77-89.

Pathak, R.D., Naz, R., Rahman, M. H., Smith, F. I. & Agawal, K. N. (2009). E-governance to Cut Corruption in Public Service Delivery: A Case Study of Fiji. *International Journal of Public Administration*, 32(5). 415-437 doi: 10.1080/01900690902799482

Prattipati, S. (2003). Adoption of E-governance: Differences between countries in the use of online government services. *Journal of American Academy of Business*, 3(1), 386-391.

Sheryazdanova, G. & Butterfield, J. (2017) E-Government as an Anti-Corruption Strategy In Kazakhstan. Journal of Information Technology and Politics 14(1), 83-94. doi: 10.1080/19331681.2016.1275998

Shim, D.C. Eom, T.H. (2008) E- Government and Anti-Corruption: Empirical Analysis of International Data. International Journal of Public Administration. 31. 298-314 doi: 10.1080/01900690701590553

Sunday, O. (2014). E-governance: An imperative for sustainable grass root development in Nigeria. *Journal of Public Administration and Policy Research*, 6(4), 77-89.

Teo, T. (2013). A comparison of non-tested models in explaining teacher's intention to use technology. *British Journal of Educational Technology*, 44(3), 81-84.

Transparency International (2017). Corruption Perception Index 2017 retrieved March 3, 2018

Zhao, X & Xu, H.D. (2015). E-government and Corruption: A Longitudinal Analysis of Countries. International Journal of Public Administration, 38(6) 410-421. Doi: 10.1080/01900692.2014.942736

Zheng, Y (2016). The Impact of E-Participation on Corruption: A Cross-Country Analysis. International Review of Public Administration. 21(2) 91-103 doi: 10.1080/12294659.2016.1186457.

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STOCK MARKET PREDICTION USING COMBINATION OF FIVE (5) DATA MINING TECHNIQUES

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ABSTRACT

The evolution of information and communication technology and increase in economic globalization has given birth to faster generation of financial data at an unprecedented rate and as a result of this, there has been a critical need for automated approaches to effectively and efficiently utilize the massive amount of financial data to support companies and individuals in planning and investment decision making. The study is aimed at developing a web-based stock market prediction portal using a combination of some data mining techniques. Five data mining techniques which are Typical Price (TP), Stochastic Momentum Index, Relative Strength Index (RSI), Chaikin Money Flow Indicator (CMI) and Moving Average (MA) were combined and used to predict stock trade signals and recommend to investor the appropriate time to buy or sell their stock. VB.NET and Microsoft SQL Server 2010 were used to implement the proposed system and the system shows a very high accuracy when advising an investor on when to buy or sell their stock. Future study can include more methods of analyzing stocks to better predict stock trade.

Keyword: *Stock market, Prediction, Forecast, Data mining, Stochastic momentum index*

1. INTRODUCTION

One of the most challenging problems in modern finance and researches in stock market prediction is finding efficient ways to summarize and visualize the stock market data to give individuals or institutions useful information about the market behaviour for investment decisions. Researches in data mining has gained a high attraction due to the importance of its applications, and benefits accruing from direct money making from stock market investments. The capital market provides economic growth and consist of mechanisms that encourage investment saving and provides accessibility to those that have interest in investing in the market. This capital market which is made up of stock exchanges is quite efficient to capture savings and channel it to the most productive activities (Lima et al., 2016).

The non-linearity and non-parametric of the stock market environment make it is extremely hard to model with any reasonable accuracy (Wang, 2003). Several attempts have been made by investors to predict stock prices and to find the right stocks and right timing to buy or sell their stock and in order to achieve these laudable objectives, several researches used the techniques of fundamental analysis where trading rules are developed based on the information associated with macroeconomics, industry, and company (Al-Radaideh, Assaf, and Alnagi, 2013). In using fundamental analysis, it is assume that the price of a stock depends on its intrinsic value and expected return on investment. Analyzing the company's operations and the market in which the company is operating can do this and hence the stock price can be predicted reasonably well (Tsang et al., 2007). Most people believe that fundamental analysis is a good method only on a long-term basis. However, for short- and medium term speculations, fundamental analysis is generally not suitable (Ritchie, 1996). Some researchers have attempted to predict stock prices by applying statistical and charting approaches but unfortunately, these methods has proved inefficient as result of human biased decisions on stock market based on day to day mind set of human behavior (Prasanna and Ezhilmaran, 2013). Application of data mining in a suitable way will uncover hidden patterns which was not possible by traditional approaches. Also, by applying business intelligence future price prediction with increased accuracy levels are possible with data mining techniques. The huge amount of data generated by stock markets and challenges of stock market can be effectively addressed by mining techniques.

Over the past decade, researchers have made several attempts to predict stock market directions using statistical models. However, these methods suffer serious drawback due to difficulties in understanding results and inaccurate predictions. Data mining techniques are able to uncover hidden patterns, predict future trends and behaviors in financial markets. The proposed systems uses combination of five (5) data mining techniques to predict the direction and it is expected that the results will outperformed the use of statistical methods, charting and fundamental analysis.

This study developed a Web based Stock Market Prediction Portal using combination of five (5) data mining techniques to predict the directions of stock and to assist investors

in making trading decisions as to when to buy or sell their stock. Specific objectives of this research are:

(i) To carried out a detailed literature review on existing methods for predicting stock directions.

(ii) To carried a literature of several technical analysis indicators and select the most appropriate ones that can be combined to predict stock direction.

(iii) To implement the algorithms for five (5) Technical indicators selected based on the literature reviewed using a workable and runnable computer codes.

2. METHODOLOGY

The Proposed system uses combination of Five (5) data mining techniques to predict stock directions and advices an investor the best time to buy or sell his/her stock. The system is a web-based stock market prediction portal that uses a combination of some data mining techniques. Five data mining techniques which are Typical Price (TP), Stochastic Momentum Index, Relative Strength Index (RSI), Chaikin Money Flow Indicator (CMI) and Moving Average (MA) were combined and used to predict stock trade signals and recommend to investor the appropriate time to buy or sell their stock. VB.NET and Microsoft SQL Server 2010 will be used to implement the proposed system. The data mining techniques are technical indicators selected after a rigorous literature review of over twenty (20) technical indicators. Also, several books, journal and other electronic materials were consulted during the course of this research work.

3. OVERVIEW OF THE PROPOSED SYSTEMS

The Proposed System is a a web-based stock market prediction portal that uses a combination of some data mining techniques to provide advices to investor in a friendly and easy to understand war. The Proposed System contain a User Interface whereby existing user can login and the new user can create his/her self-profile by inputting his user Id and Password. After successful login, the User can perform the Followings options:

- ✓ View Stock Price
- ✓ Get Prediction and Trade signals which represent an advice on whether to buy or sell his/her Stock.

The Proposed System will use Combination five (5) Data Mining tools namely:

(a) 20 days Moving Average
(b) 20 days Typical Price Moving Average
(c) Stochastic momentum index

(d) Relative Strength Index (RSI)
(e) Chaikin Money Flow Indicator (CMI)

The five Data Mining techniques are jointly referred to as Technical Indicators.

Technical analysis indicators are indicators used in predicting the appropriate time to buy or sell a stock and the idea behind Technical analysis is that the share prices move in trends dedicated by the constantly changing attributes of investor using technical data such as price, volume, highest and lowest prices per trading period (Dewangan et al. 2016). Technical analyst shares the opinion that share prices are determined by the demand and supply forces operating in the market. These demand and supply forces in turn are influenced by a number of fundamental forces as well as certain psychological or emotional factors. Many of these factors cannot be quantified. The combined impact of all these factors is reflected in the share price movement. A technical analyst therefore concentrates on the movement of share prices and claims that by examining past share price movements, future share prices can be accurately predicted. The basic premise of technical analysis is that prices move in trends or waves which may be upward or downward. It is believed that the present trends are influenced by the past trends and that the projection of future trends is possible by an analysis of past price trends. A technical analyst therefore uses the price and volume movements of individual securities as well as market index. The technical analyst uses charts to predict future stock movement .Price charts are used to detect the trends or daily movement of market. These trends and movements are assumed to be based on supply and demand issues which often have cyclical or noticeable patterns.

The five (5) technical indicators and their algorithms are described below.

3.1.1 Typical Price Moving Average (TPMA)

The Typical Price Moving Average indicator is calculated using the high, low, and closing prices of stock as shown in the formula below:

$$Typical\ \text{Pr}ice\ Moving\ Average = \frac{High + Low + Close}{3}$$

The result is the Average, or Typical Price.

The Algorithm is as follows:

(i) Read High (H), Low(L) , Close(C) values of the daily share
(ii) Take an output array and add the values of H,L,C
(iii) Divide the total by 3 (i.e (H + L + C)/3

(iv) Compute Typical Price Average for Yesterday as an Average of Typical Price for the last N days starting from Yesterday

(v) Compute Typical Price for Today as an Average of Typical Price for the last N days.

(vi) if(Today Typical Average > Yesterday Typical Average) then
Buy the Stock

(vii) Else if (Today Typical Average > Yesterday Typical Average) then
Sell the Stock)

(viii) Else
Hold the Stock

3.1.2 Relative Strength Index (RSI)

Relative Strength Index (RSI) is a technical indicator that compares the magnitude of a stock's recent gains to the magnitude of its recent losses and turns that information into a number that ranges from 0 to 100. It takes a single parameter, the number of time periods to use in the calculation. A popular method of analyzing the RSI is to look for a divergence in which the security is making a new high, but the RSI is failing to surpass its previous high. This divergence is an indication of an impending reversal. When the Relative Strength Index turns down and falls below its most recent trough, it is said to have completed a "failure swing". The failure swing is considered a confirmation of the impending reversal.

The Prediction Algorithm using the Relative Strength Index (RSI) are:-

(i). Initialize Tc = today's closing price, yc = yesterday's closing price
(ii) Set peak parameters : Upclose = Downclose = 0
(iii) If (tc > yc) then
set : upclose = upclose + tc
Else if (tc < yc)
set : downclose = downclose + tc
(iv) Repeat step 3 for 'x' consecutive days
(v) RSI = 100 – 100 / (1 + upclose / downclose)
(vi) If (RSI < 50), then
predict increase in impending closing price and Buy the Stock
Else if (RSI < 50) then
predict decrease in impending closing price and Sell the Stock
Else
Hold
Endif

3.1.3 Moving Averages

The Moving Averages method uses the average of the most recent k data values in the time series as the forecast for the next period. Moving averages are generally used to measure momentum and define areas of possible support and resistance. They are used to emphasize the direction of a trend and to smooth out price and volume fluctuations, or "noise", that can confuse interpretation. Typically, upward momentum is confirmed when a short-term average (e.g.15 day) crosses above a longer-term average (e.g. 50-day) while Downward momentum is confirmed when a short-term average crosses below a long-term average. The most common way for interpreting the price moving average is to compare its dynamics to the price action. When the stock price rises above its moving average, a buy signal appears, if the price falls below its moving average, what we have is a sell signal. This trading system, which is based on the moving average, is not designed to provide entrance into the market right in its lowest point, and its exit right on the peak. It allows the Moving Average to act according to the following trend: to buy soon after the prices reach the bottom, and to sell soon after the prices have reached their peak.

The Moving Average Prediction algorithm**:**

(i) Initalize tma = today's moving average, yma = yesterday's moving average to 0
(ii) Find tma as average of closing prices of last N days.
(iii) Find yma as average of closing prices of last N days starting from yesterday.
(iv) If (tma > yma) then
predict increase in impending closing price
(v) Else if (tma < yma) then
predict decrease in impending closing price

3.1.4 Chaikin Money Flow Indicator (CMI)

Chaikin's money flow is based on Chaikin's accumulation/distribution while . accumulation/distribution is based on the premise that if the stock closes above its mid-point (i.e. [(high + low)/2] for the day, then there was accumulation that day, and if it closes below its mid-point, then there was distribution that day. Chaikin's money flow is calculated by summing the values of accumulation/distribution for thirteen (13) periods and then dividing by the 13-period sum of the volume. It uses the assumption that a bullish stock will have a relatively high close price within its daily range and have increasing volume. However, if a stock consistently closed with a relatively low close price within its daily range with high volume, this would be indicative of a weak security. There is pressure to buy when a stock closes in the upper half of a period's range and there is selling pressure when a stock closes in the lower half of the period's trading range. The formulas for calculating the Chaikin Money Flow Indicator (CMI) are**:-**

$$CMI = \left[\frac{Sum(AD,n)}{Sum(Vol,n)}\right] \quad ; \quad AD = VOL\left[\frac{(Close - Open)}{(High - Low)}\right]$$

Where AD = Accumulation Distribution, n=Period; Close = today's close price; Open = today's open price; High = High Value and Low = Low value.

3.1.5 Stochastic Momentum Index

The Stochastic Momentum Index is a type of momentum indicator introduced by George Lane in the 1950s and it compares the closing price of a commodity to its price range over a given time span. Prices tend to close near their past highs in bull markets, and near their lows in bear markets and transaction signals can be spotted when the stochastic oscillator crosses its moving average. Two stochastic oscillator indicators are typically calculated to assess future variations in prices, a fast **(%K_{fast})** and slow **(%D_{slow})**. **%K_{fast}** calculates the ratio of two closing price statistics: the difference between the latest closing price and the lowest closing price in the last N days over the difference between the highest and lowest closing prices in the last N days. %D_{slow} is not used in this algorithm.

3.2.1 Prediction Algorithms

The Prediction algorithms are**:**

(i) Initialize **tc** = Today's closing price
(ii) Find **hn** = Highest price with past N days
(iii) Find **ln** = Lowest price within past N days
(iv) Calculate **K_{fast} = (tc – ln) / (hn – ln)**
(v) Calculate **% K_{fast} = K_{fast} * 100**
(vi) If (**%K_{fast} > 80)** then
Predict increase in impending closing price and Buy
Else if (**%K_{fast} > 80)** then
Predict decrease in impending closing price and Sell
Else
Hold
End if

3.2.2 TRADING ALGORITHMS

The Trading Algorithm for combining The Technical Indicators are:

(i) Collect all index value as data sets

(ii) Compute all technical indicators and store Buy or Sell Signal

(iii) If all the five(5) Technical Indicators indicate ***Buy*** then

Tell the investor to Buy

(iv) Else if all the five (5) Technical Indicators indicate ***Sell*** then

Tell the investor to Sell

(v) Else

Tell Investor to Hold Stock

End if

3.3 Proposed System Model

The Proposed system model for the Web based Stock Market Prediction consists of the followings:

(a) Login Page

The login page contains the following menu descriptions:

- ✓ **Sign up as New User:-** This menu allows new user who is visiting the Web portal for the first time to register.
- ✓ **Forgot Password** :- This menu allows users to reset their password after verification

(b) Home Page

The home page contains three menu descriptions which are:

- ✓ **Get Stock Price:–** This menu allows user to get the Price of a Particular Stock on a particular day.
- ✓ **Get Stock Prediction:-** This menu allows users to select a particular stock and get trade signals on it (i.e. to determine whether to Buy or Sell the Stock).
- ✓ **Log out: -** This menu allows user to log out and close session.

3.3.1 Functional Model of The System

The functional model of the systems is depicted using the Use Case Modeling diagram as shown in the Figure 1. The actors are the System administrator and Investors.

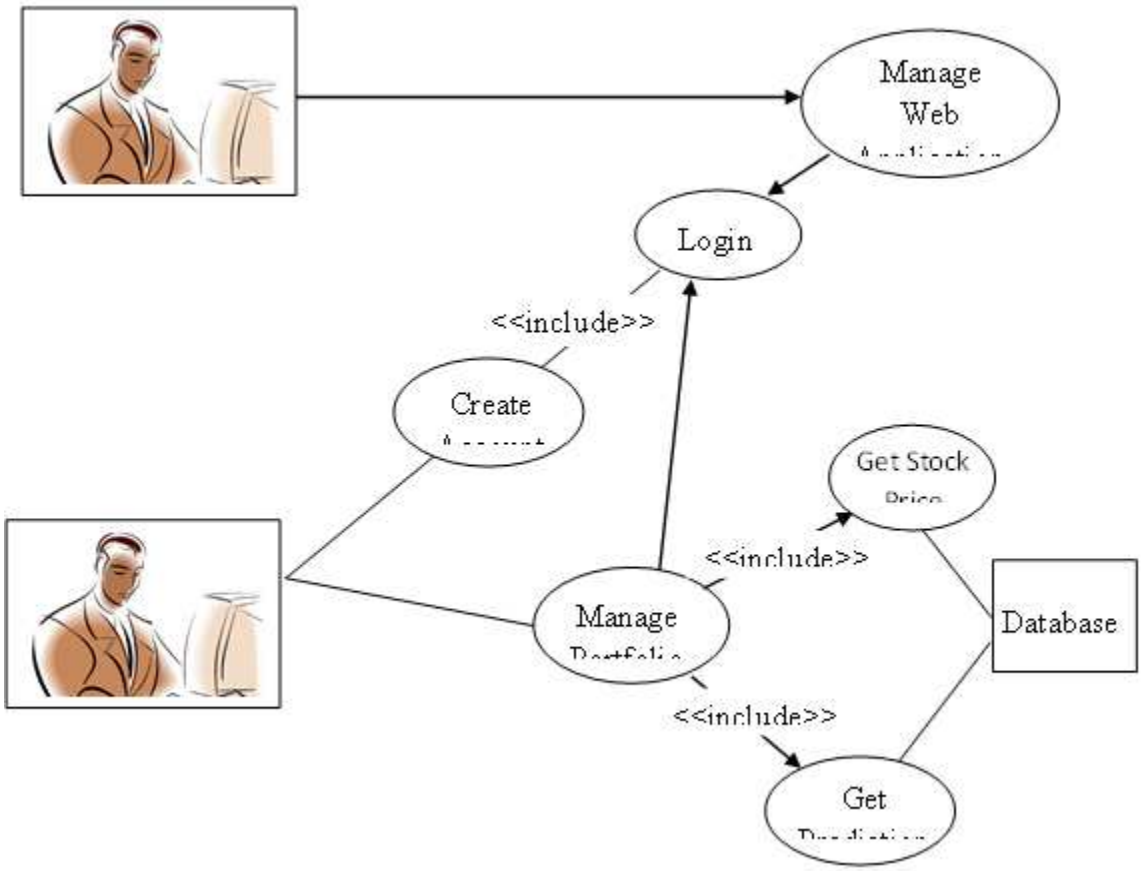


Figure 1: Use Case Modeling Diagram for Stock Market Prediction

3.3.2 Activity Flow Diagram

The Activity diagram describes the behavior of the proposed system in terms of activities. Activities are modeling elements that represent the execution of a set of operations. The execution of an activity can be triggered by the completion of other activities, by the availability of objects, or by external events. The activity flow diagram is used to depict the Algorithm for the System and is shown in the figure 2**.**

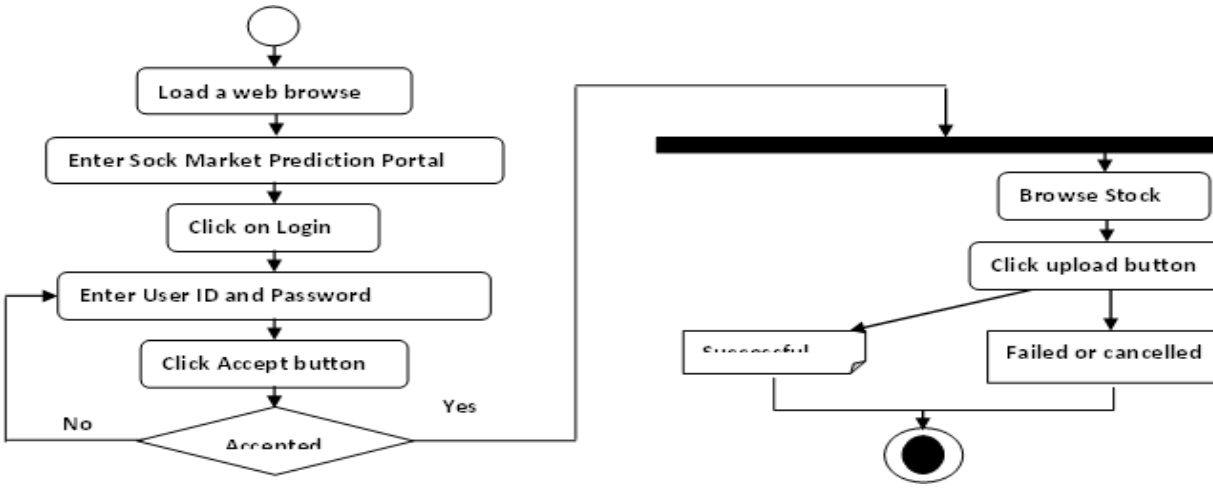


Figure 2: Activity Flow Diagram for Stock Market Prediction

4. RESULTS AND DISCUSSION

The proposed system is a Web based Stock Market Prediction Portal implemented by combining Five (5) data mining techniques for prediction. The Web based Prediction System was implemented using Microsoft Visual Basic. Net 2015. The Prediction System was tested using the historical data obtained from the daily prices of the Nigeria Stock exchange for a period of three (3) months. Desirable results were achieved and some of them are shown below:

4.1.1 Login Interface

The Login Interface is used by both the Administrator and Investors

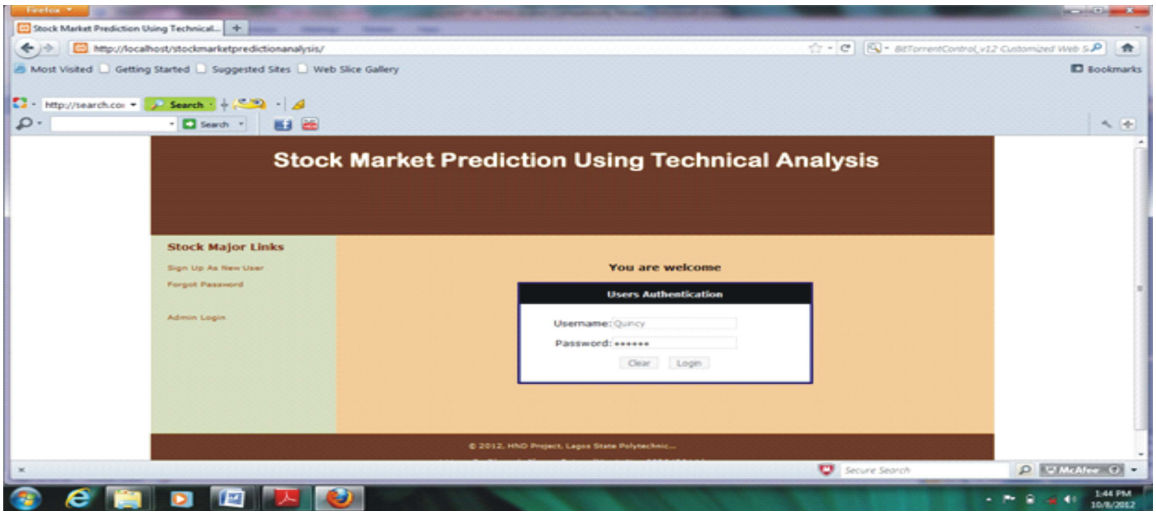


Figure 3: Login Interface

4.1.2 Forgot Password Interface

This interface is used by the Investors (Users) to reset their Password.

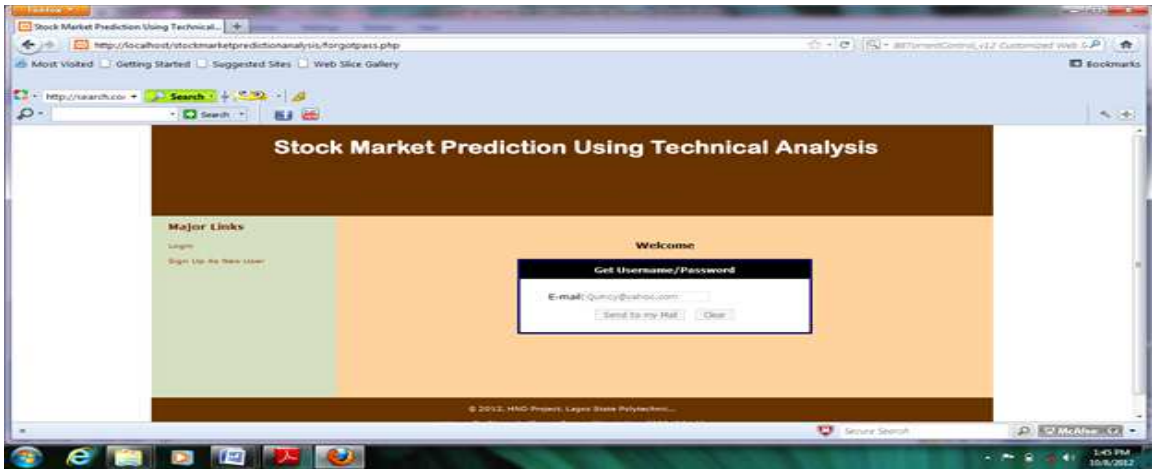


Figure 4: Forgot Password Interface

4.1.3 Administrator Login Interface

This is the Login Interface only for the Administrator.

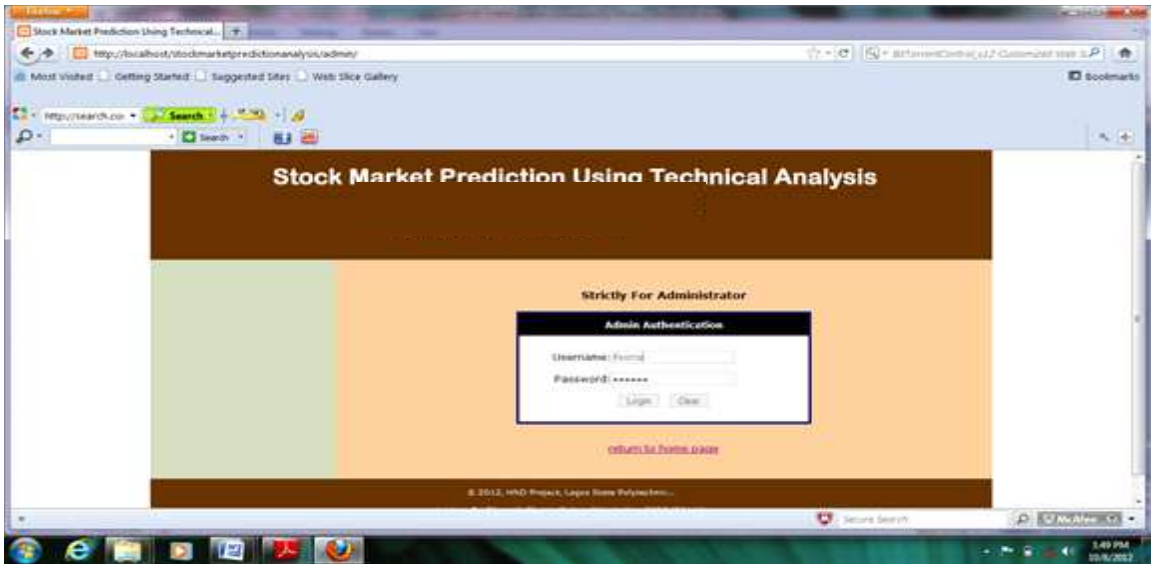


Figure 5: Administrator Login Interface

4.1.4 Administrator Add View Data Page

This Interface is used to add a new Stock that has just arrived in the Stock Market.

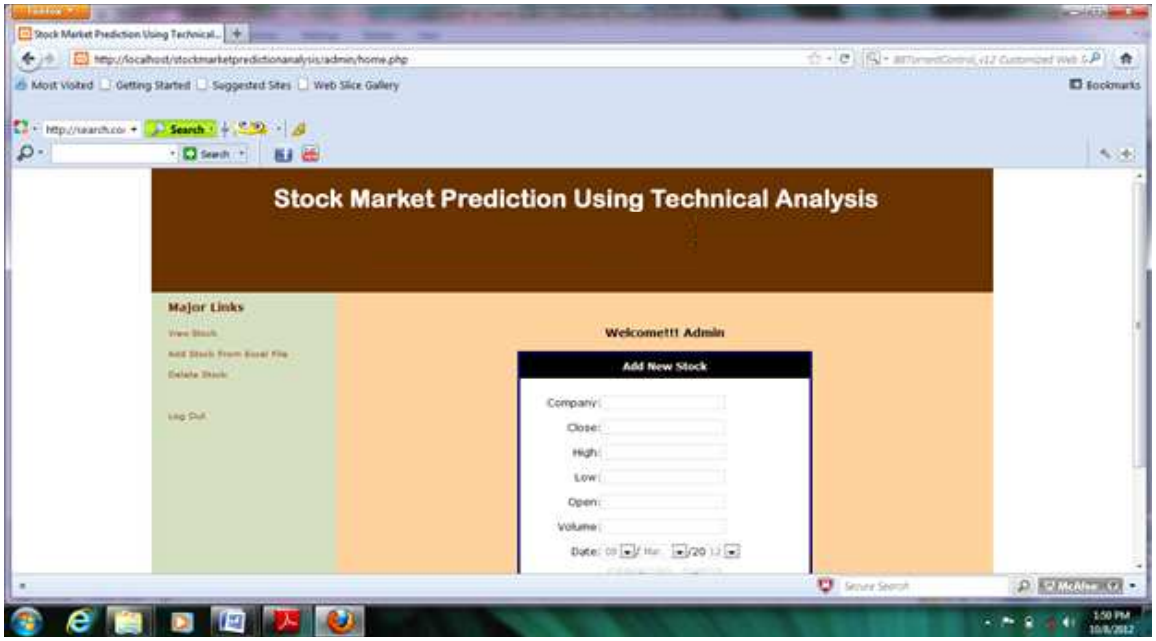


Figure 6: Add New Data Interface

4.1.5 New User Creation Interface

This Interface is used by the new Investor to create an account.

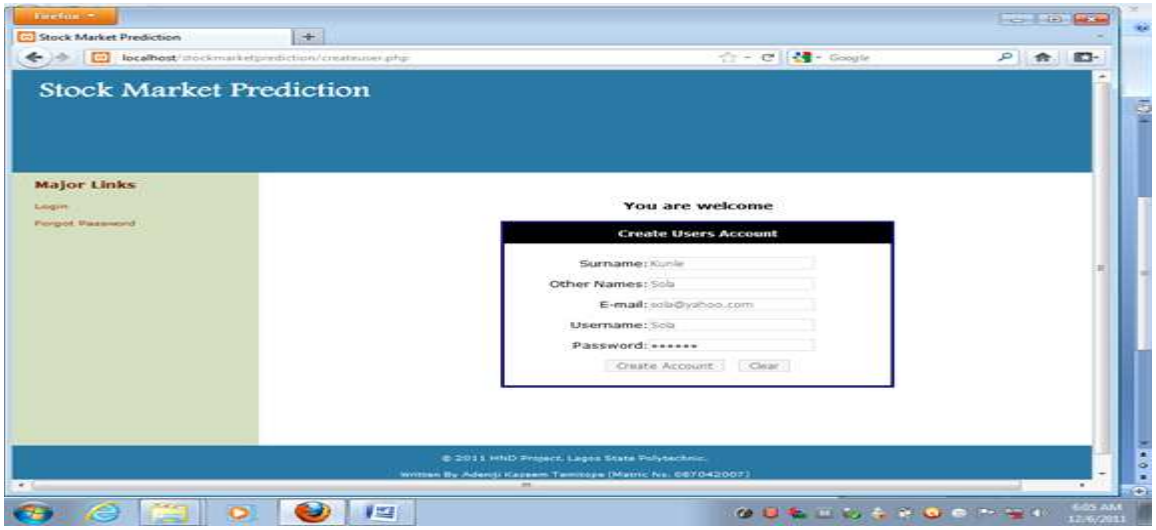


Figure 7: New User Creation Interface

4.1.6 Upload Stock Data

This Interface is used by Administrator to upload Daily stock prices obtain from the Nigerian Stock Exchange in Microsoft Excel format.

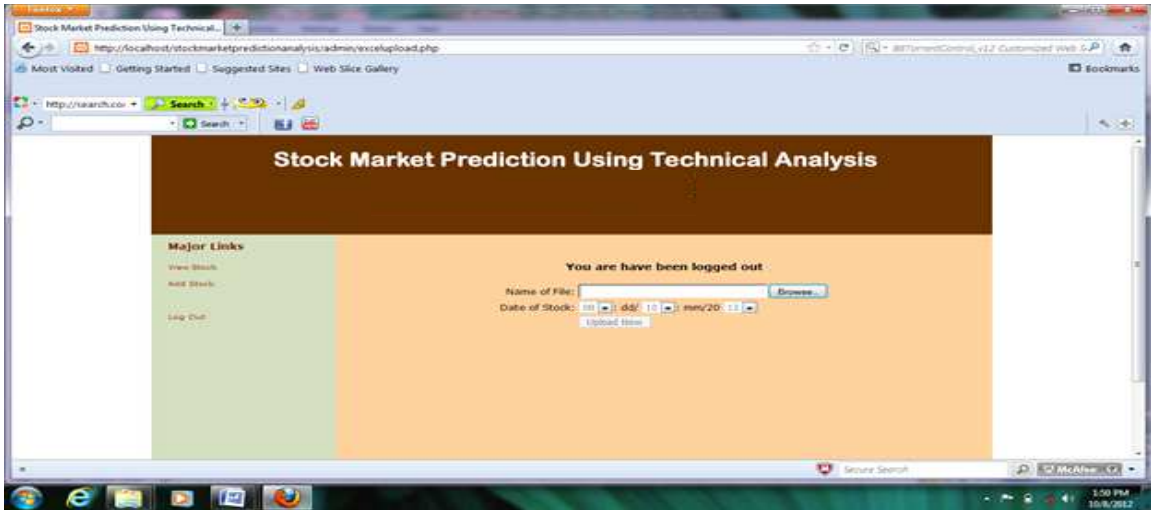


Figure 8: Upload Stock Data Interface

4.1.7 Home Page

The Home contains command buttons for View Stock, Predict Stock and Log out.

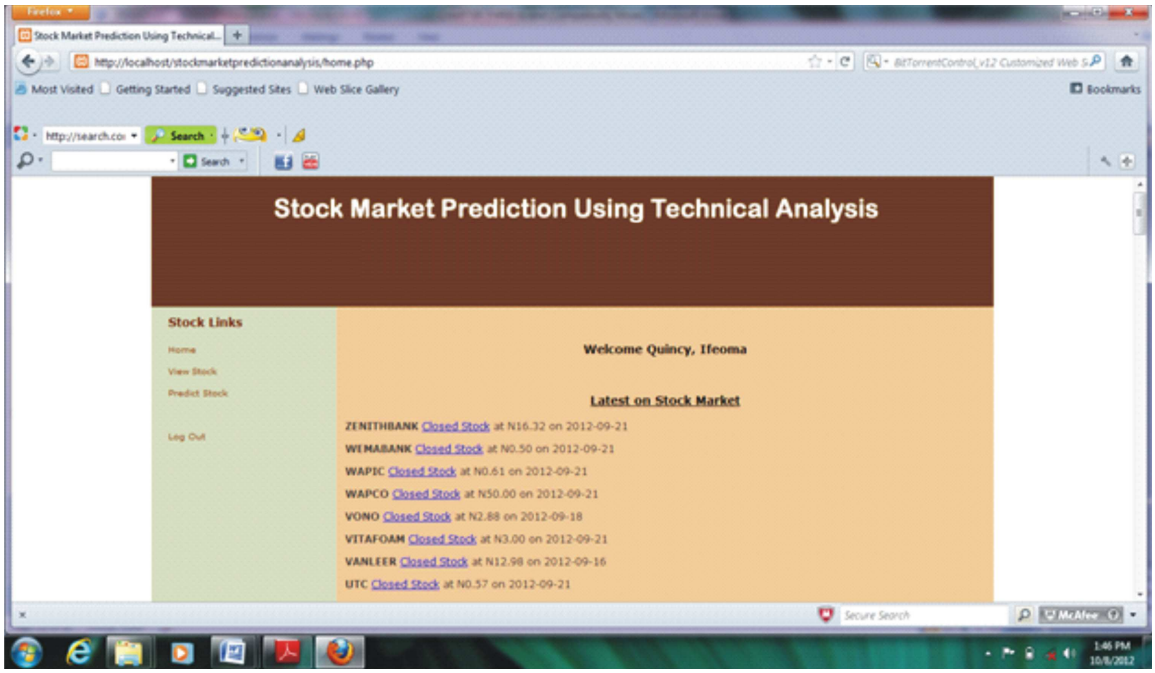


Figure 9: Home Page

4.1.8 View Daily Price Stock

This Interface enables Investors to view daily price of stocks.

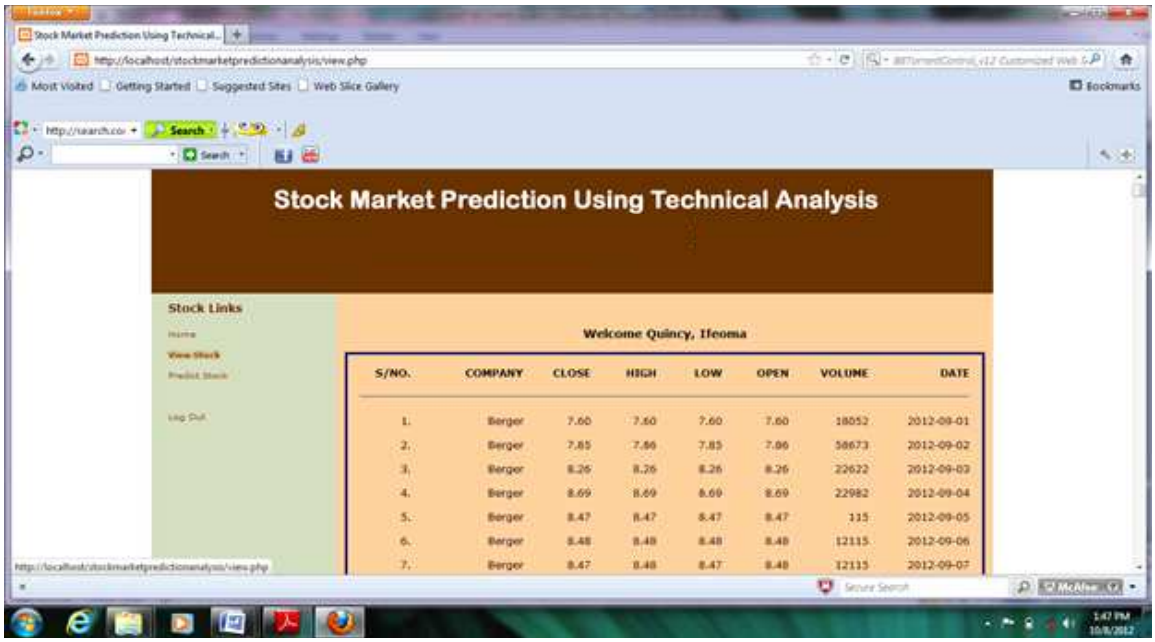


Figure 10: View Daily Price Stock Interface

4.1.9 Predict Stock

This Interface is the display screen that shows the Investors the Trading decision as to whether to Buy or Sell their Stock.

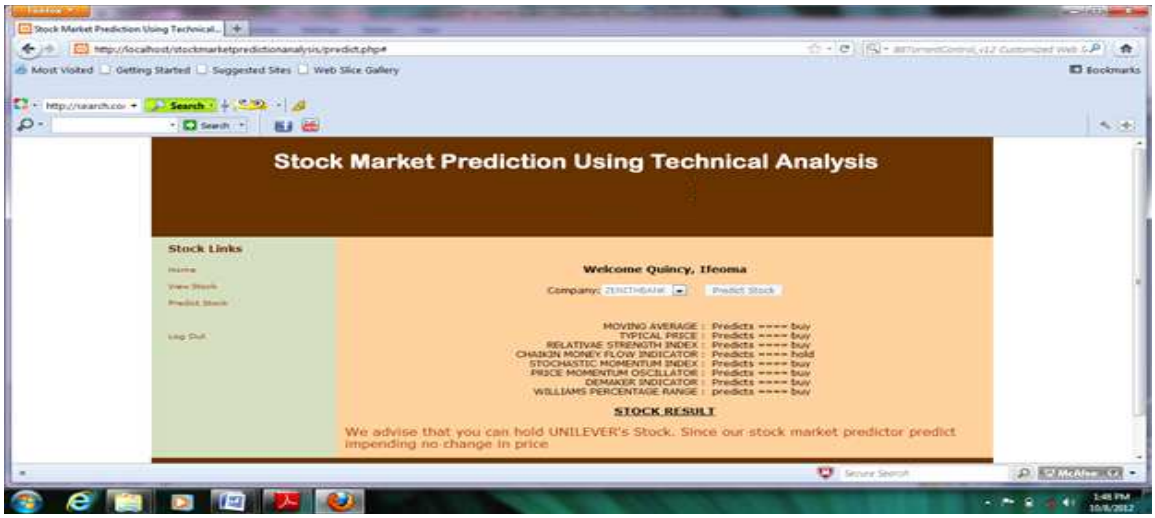


Figure 11: Predict Stock Interface

5.0 CONCLUSION

The researchers present paper that develops a prediction system that uses five (5) technical indicators as a data mining techniques for predicting stock directions. A

prediction system has been built that uses data mining techniques to produce forecasts about stock market trade signals. The techniques complement proven numeric forecasting method using data mining analysis with technology taking as input the financial information obtained from the daily activity summary (equities) published by Nigerian Stock Exchange. In this paper, the authors were able to use technical indicators as a data mining techniques to describe the trends of stock market prices and predict the future stock market trade signals using the companies listed on the Nigerian Stock exchange as a case study. The system demonstrate a better way of predicting stock market prices and predict the future stock trade signals by recommend on when to buy or sell in the stock market with an prediction accuracy of 93.4%.

The paper have been able to develop an Web based Stock Market Prediction portal that uses a combination of five (5) Data Mining techniques to predict trade signals to investors on when to buy or sell their stock. The proposed system provides an accurate and secure method of securing investment portfolio in the stock market; it is secure and has the speed required to minimize user's frustration during access.

REFERENCES

[1]Fama, E. F. (1965). The behavior of stock-market prices. *The journal of Business*, *38*(1), 34-105.

[2]Ritchie, J.C., (1996). Fundamental Analysis: a Backto- the-Basics Investment Guide to Selecting Quality Stocks. Irwin Professional Publishing.

[3]Wang, Y.F., (2003). "Mining stock price using fuzzy rough set system", Expert Systems with Applications, 24, pp. 13-23.

[4]Tsang, P.M., Kwok, P., Choy, S.O., Kwan, R., Ng, S.C., Mak, J., Tsang, J., Koong, K., and Wong, T.L. (2007). "Design and implementation of NN5 for Hong Kong stock price forecasting", Engineering Applications of Artificial Intelligence, 20, pp. 453-461.

[5]Qian, B., and Rasheed, K. (2007). Stock market prediction with multiple classifiers. *Applied Intelligence*, *26*(1), 25-33.

[6]Al-Radaideh, Q. A., Assaf, A. A., and Alnagi, E. (2013). Predicting stock prices using data mining techniques. In *The International Arab Conference on Information Technology (ACIT'2013)*.

[7]Prasanna, S., and Ezhilmaran, D. (2013). An analysis on stock market prediction using data mining techniques. *International Journal of Computer Science and Engineering Technology (IJCSET)*, *4*(3), 49-51.

[8]Lima, M. L., Nascimento, T. P., Labidi, S., Timbó, N. S., Batista, M. V., Neto, G. N., and Sousa, S. R. S. (2016). Using sentiment analysis for stock exchange prediction. *International Journal of Artificial Intelligence and Applications*, *7*(1), 59-67.

[9]Dewangan, S., Tandan, S, R., Farzana, S. and Miri, R (2016). Prediction of Stock Market Using Financial News Analysis and Supervised Data Mining Technique. International Journal for Research in Applied Science and Engineering Technology (IJRASET), *4(6),541-547.*

[10]Pagolu, V. S., Reddy, K. N., Panda, G., and Majhi, B. (2016, October). Sentiment analysis of Twitter data for predicting stock market movements. In *Signal Processing, Communication, Power and Embedded System (SCOPES), 2016 International Conference on* (pp. 1345-1350). IEEE.

[11]Khedr, A. E., and Yaseen, N. (2017). Predicting Stock Market Behavior using Data Mining Technique and News Sentiment Analysis. *International Journal of Intelligent Systems and Applications*, *9*(7), 22.

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IMPROVING PERFORMANCE OF PRINCIPAL COMPONENT ANALYSIS BASED FACE RECOGNITION USING ILLUMINATION NORMALIZATION TECHNIQUES: PROPOSED STUDY

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ABSTRACT

Face recognition is an authentication system that is being used for limited number of applications due to its unreliability under uncontrolled environment. Among the reasons that makes it unreliable is illumination variation problem. Face recognition under varying illumination is one of the challenging problems in real-time applications. Illumination can be considered a complex problem in both indoor and outdoor pattern matching. Principle Component Analysis (PCA) is an appearance-based classical feature extraction and data representation technique widely used in pattern recognition. But this technique suffers from illumination conditions, thus the challenge of knowing which illumination control methods to be used in facial recognition system based on PCA algorithm is very important. This study will apply three illumination control techniques; Discrete Cosine Transform, Adaptive Histogram Equalization and Contrast Limited Adaptive Histogram Equalization on Principal Component Analysis algorithm to conduct analysis on which of the illumination control techniques perform better.

Keywords: *Face recognition, Illumination normalization, Principal Component Analysis, Discrete Cosine Transform, Contrast Limited Adaptive Histogram Equalization, Adaptive Histogram Equalization*.

1. INTRODUCTION

Biometric technologies include identification based on face, iris, hand geometry, fingerprint, palm print, keystroke, gait, hand vein, retina, voice and signature. Among so many other methods of biometric recognition system, facial recognition is considered a user friendly and confidentially respectful biometric recognition technique with high accuracy and low intrusiveness (Kashem, Akhter, Ahmed & Alam, 2011). Face recognition is a biometric technique for verifying and identifying a person from digital image or video using dataset of face images (Joshi & Deshpande, 2015). The recognition of a face image is achieved by comparing selected facial features from database of stored face images in order to identify the input image (Barbu, 2010). This biometric technology is one of the most successful representative applications in computer vision that has received a great interest in commercial and law enforcement domains such as human-computer interaction, access control, digital libraries, telecommunication and security systems (Shen & Bai, 2006; Jin & Ruan, 2009; Haider, Bashir, Sharif, Sharif & Wahab, 2014).

The performance of face recognition systems depends on some key factors like illumination variations, pose changes, facial exposure, age variations and occlusion (Reza & Qi, 2016). Among these factors, illumination variations such as shadows, underexposure (too dark) and overexposure (too bright) attracted much attention in the last decade (Abate, Nappi, Riccio& Sabatino, 2007). Illumination is one of the most significant factors affecting the appearance of an image. It often leads to diminished structures or inhomogeneous intensities of the image due to different texture of the object surface and the shadows cast from different light source directions. Illumination normalization is an important task in the field of computer vision and pattern recognition. In real world, one of the most important problems of illumination normalization is face recognition under varying illumination. Face recognition has many applications, such as public security, identity authentication and access control area.

Different illumination preprocessing techniques have been employed in face recognition, but many of them have been reported to perform effectively on some feature extraction techniques or databases (Han, Shan, Chen & Gao, 2013). Principal Component Analysis (PCA) is global approach to face recognition algorithm that relies on encoding of whole face image region for recognition (Sufyanu, Mohamad, Yusuf & Mustafa, 2016). In PCA, a digital image is represented in form of vector. This technique is sensitive to lighting variations (Kaymak, Sarici & Aysegul, 2015).

Due to the problem of illumination variability in face recognition system using PCA method, the same image can appear out rightly different even when it is captured in fixed pose. The challenge of knowing which illumination control methods to be used in facial recognition system based on PCA algorithm is very important. This study will apply the most three commonly used methods of illumination control techniques; Discrete Cosine Transform, Adaptive Histogram Equalization and Contrast Limited Adaptive Histogram

Equalization on Principal Component Analysis algorithm to conduct analysis on which of the illumination control techniques perform better.

2. REVIEW OF RELATED LITERATURE

Salkar et al., (2017**)** presented a system in which face recognition was carried out using local feature description under different illumination changes. Local directional number pattern (LDN) were applied to extract the features from face image. Six-bit binary code was generated to give LDN image. The face image was divided into several regions and for each region LDN was calculated and histogram for each region taken. The system was evaluated on three face image datasets; PIE, YALE and ORL. Experimental results showed 70 % of recognition accuracy.

Reza and Qi (2016) proposed a method which produces illumination-invariant features for images irrespective of their level of illumination. The work combined adaptive homomorphic filtering, simplified logarithmic fractal dimension and complete eight local directional patterns to produce the illumination invariant features. They determined from their experiments that their proposed method outperforms nine (9) state of the art methods and thus results in a better face recognition accuracy.

Dan-ali (2014) came up with a study by conducting experimentation and analysis on five illumination normalization techniques. The study compared and analyzed the system using different distance metrics. The performance and execution times of the various techniques were recorded and measured for accuracy and efficiency. The illumination normalized techniques were Gamma Intensity Correction (GIC), Discrete Cosine Transform (DCT), Histogram Remapping using Normal Distribution (HRN), Histogram Remapping using Normal Distribution (HRL) and Anisotropic Smoothing Technique (AS). Results showed that improved recognition rate was obtained when the right preprocessing method was applied to the appropriate database using the right classifier.

Kalaiselvi and Nithya (2013) presented a simple and efficient preprocessing chain that eliminates most of the effects of changing illumination while still preserving the essential details needed for recognition. They combined the strengths of local texture based face representations, robust illumination normalization, distance transform based matching and kernel based feature extraction and multiple feature fusion. Their work was simulated using MATLAB and their experiments showed that their method outperforms several other preprocessing techniques catering for illumination.

Anila & Devarajan (2012) developed a system to solve illumination conditions. The study employed different illumination normalization techniques; Gamma correction, Different of Gaussian and Contrast Equalization (DOG) and Contrast Equalization. The technique was applied on YALE-B, FRGC Version 2 and a real-time created dataset.

Raghu (2012) proposed a gradient face approach for face recognition under varying illumination. The proposed method is claimed to have the ability to extract illumination

insensitive measure, which is then used for face recognition. The merit of this method is that neither does it require any lighting assumption nor does it need any training images. Gradient face method reaches very high recognition rate of 98.96% in the test on Yale B face database. Furthermore, the experimental results on Yale database validate that gradient faces is also insensitive to image noise and object artifacts such as facial expression.

Chande and Shah (2012) presented illumination invariant face recognition system using Discrete Cosine Transform (DCT) and Principal Component Analysis (PCA). A discrete cosine transform was used to compensate for illumination variations in the logarithm domain. PCA was further applied to recognition of face images. The Cropped Yale Face B Database with 65 illumination variations was used to evaluate the performance of this approach.

Goel, Nehra and Vishwakarma (2011) came up with a Comparative analysis of various illumination normalization techniques for face recognition. The study considered various states of art illumination normalization techniques to explained and compare. The classification of the image recognition was done using artificial neural networks (ANN). Four illumination normalization methods which are (1) discrete cosine transform (DCT) with rescaling of low frequency coefficients (2) discrete cosine transform (DCT) with discarding of low frequency coefficients (3) homomorphic filtering (HF) (4) gamma intensity correction (GIC) were compared. These methods were further evaluated and compared on Yale and Yale B Faces databases.

Sharif, Mohsin, Muhammad and Mudassar (2010) described an illumination normalization technique which works at the pre-processing stage where the face image is first divided into equal sub-regions. Each sub region is then processed separately for illumination normalization. Then the segments are joined back followed by further processing like noise removal and contrast enhancement. The proposed technique was tested on Yale dataset and compared with some previous illumination normalization methods using PCA as a face recognition technique, experimental results showed that the proposed technique performed better.

Beveridge et al.(2010) came up with how lighting and focus affects the performance of face recognition systems. The study explained edge density effect in terms of illumination, showing that lightning affects the face image quality while focus which had been initially suggested as a factor addicting the edge density effect is not so significant. Lighting direction can be viewed as an important quality measure that predicts face recognition performance.

Vishwakarma (2009) proposed Illumination Invariant Accurate Face Recognition with Down Scaling of DCT Coefficients. It employed the fact that Discrete Cosine Transform low-frequency coefficients correspond to illumination variations in a digital image. Under different illuminations, face images captured may have low contrast; initially Histogram Equalization was applied to the faces for contrast stretching. Then the low-frequency DCT coefficients were scaled down to compensate the illumination variations.

The classification was done using k-nearest neighbor classification and nearest mean classification on the images obtained by inverse DCT on the processed coefficients. The correlation coefficient and Euclidean distance obtained using Principal Component Analysis were used as distance metrics in classification.

Xie and Lam (2006) presented a method on efficient normalization method for face recognition, since theoretical analysis shows that the effects of varying lighting on a human face image can be modeled by a sequence of multiplicative and additive noises, but this is extremely difficult in real life applications, they used a local normalization technique to eliminate uneven illuminations while also ensuring that the local statistical properties of the processed image have similar values with that of the same image under normal lightning conditions.

3. METHODOLOGY OF THE PROPOSED SYSTEM

The proposed system will consider the performance analysis of three selected illumination normalization approaches; Contrast Limited Adaptive Histogram Equalization, Discrete Cosine Transform and Adaptive Histogram Equalization. The first phase of this study used two publicly available face image datasets; ORL Database (AT&T Database) and FERET Database. The second phase handled the image normalization, which is the major focus of the proposed system which involved the illumination normalization techniques. Three illumination normalization techniques aforementioned were applied to preprocess the face images from two databases. Principal Component Analysis (PCA) was applied for extraction of facial features from face images. The extracted feature subspace was passed into euclidean distance measure for classification of face into matched or mismatched. Finally, comparative analysis conducted to show the effect of illumination normalization methods on the PCA extracted facial feature. The block diagram of the proposed system is shown in Figure 1.

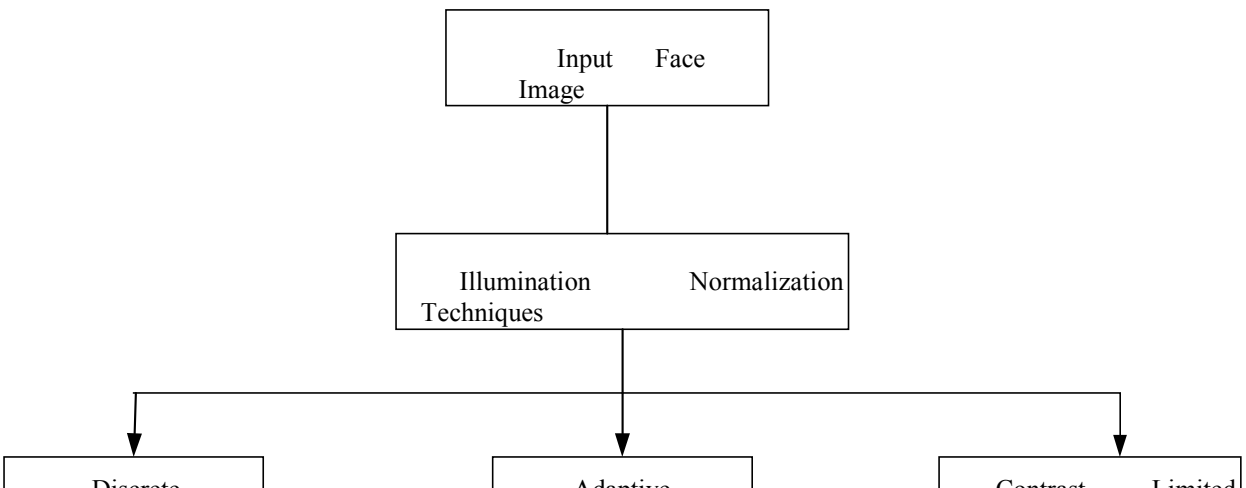


Figure 1: Block Diagram of Proposed System

3. DISCUSSION AND SUMMARY

Illumination is an important element for image quality, changes of the source of light cannot only affect the brightness of the image, but also tend to distortion (Ambade, Soni & Wagadre, 2015). Illumination variations on faces degrade not only on face matching performance, but also on face detection accuracy (Han, Shan, Chen & Gao, 2013). The robustness of any face recognition system has been identified to be adversely affected by changes in facial appearance caused by variations in lighting (illumination) and pose (Salkar et al., 2017). Researchers have attempted to improve face recognition under uncontrolled lighting conditions through the choice of various techniques for illumination compensation and preprocessing enhancement. Among these illumination normalization methods Discrete Cosine Transform, Adaptive Histogram Equalization (AHE) and Contrast Limited Adapted Histogram Equalization (CLAHE) are commonly used approaches. Discrete Cosine Transform is an efficient technique for image coding and has been successfully used for face recognition (Fathima, Vasuhi, Babu, Vaidehi & Treesa, 2014), since the most high frequency coefficient of DCT are almost zero, such coefficient can be ignored with degrading the quality of image (uses low frequency coefficients correspond to illumination variations in a digital image) (Vishwakarma,

2009). Also different coefficients can be quantized based on visual sensitivity with different accuracy. This property is responsible for the choice of DCT as one of the robust illumination normalization methods. The Contrast Limited Adaptive Histogram Equalization (CLAHE) is also a powerful illumination preprocessing technique where contrast of an image is enhanced by applying Contrast Limited Histogram Equalization (CLHE) on small data regions called tiles rather than the entire image (Sasi & Jayasree, 2013). Adaptive Histogram Equalization is an extension of convectional histogram equalization used for contrast enhancement in which the information in an image entropy remains the same (Zhu & Cheng, 2012). The proposed study on performance analysis of Illumination normalization techniques is aimed at normalizing illumination variations in facial recognition using three different techniques, which in turn will help to deduce the method that will perform best based on training time during feature extraction using Principal Component Analysis.

4. CONCLUSION

Illumination normalization is a technique that is generally used for the elimination of lighting variations in face recognition system. The representative illumination normalization approaches of three methods; Adaptive Histogram Equalization (AHE), Discrete Cosine Transform (DCT), Contrast Limited Adaptive Histogram Equalization (CLAHE) will be used to conduct comparative performance analysis of illumination normalization techniques. The presentation of overall performance of each illumination normalization technique as preprocessing method before feature extraction stage will in future give adequate information to researchers in the field of image processing the influence of illumination normalization methods in the development of facial recognition model.

REFERENCES

Aarthy, M. & Sumathy, P. (2014). Comparison of Histogram Equalization Method and Histogram Expansion. *International Journal of Computer Science and Mobile Application*, *2*(3), 25–34.

Abate, A. F., Nappi, M., Riccio, D., & Sabatino, G. (2007). 2D and 3D face recognition: A

survey. *Pattern Recognition Letters*, *28*(14), 1885–1906.

http://doi.org/10.1016/j.patrec.2006.12.018

Ambade, S., Soni, H. K., & Wagadre, G. (2015). Improving Illumination Normalization in Multiple remote sensing images using Laplacian and Gaussian Pyramids. *International Journal of Engineering Research and General Science*, *3*(3), 379–387.

Barbu, T. (2010). Gabor filter-based face recognition technique. *Proceedings of the Romanian Academy Series A - Mathematics Physics Technical Sciences Information Science*, *11*(3), 277–283.

Chen, W., Er, M. J., & Wu, S. (2006). Illumination Compensation and Normalization for Robust Face Recognition Using Discrete Cosine Transform in Logarithm Domain. *iEEE Transactions on Man and Cybernetics*, *36*(2), 458–466.

Chen, Z., Liu, C., Changs, F., Han, X., & Wang, K. (2014). Illumination Processing in Face Recognition. *International Journal of Pattern Recognition and Artificial Intelligence*, *28*(5), 187–214. http://doi.org/10.1142/S0218001414560114

Fathima, A. A., Vasuhi, S., Babu, N. T. N., Vaidehi, V., & Treesa, T. M. (2014). Fusion framework for multimodal biometric person authentication system. *IAENG International Journal of Computer Science*, *41*(1), 18–31.

Gupta, E. S., & Kaur, E. Y. (2014). Review of Different Histogram Equalization Based Contrast Enhancement Techniques. *InternationalJournal of Advanced Research in Computer and Communication Engineering*, *3*(7), 7585–7589.

Han, H., Shan, S., Chen, X., & Gao, W. (2013). A comparative study on illumination preprocessing in face recognition. *Pattern Recognition*, *46*(6), 1691–1699. http://doi.org/10.1016/j.patcog.2012.11.022

Joshi, A. G. & Deshpande, A. S. (2015). Review of Face Recognition Techniques. *International Journal of Advanced Research in Computer Science and Software Engineeering*, *5*(1), 71–75.

Kashem, M. A., Akhter, N., Ahmed, S., & Alam, M. (2011). Face Recognition System Based on Principal Component Analysis (PCA) with Back Propagation Neural Networks (BPNN). *International Journal of Scientific & Engineering Research*, *2*(6), 1–10.

Kaymak. C., Sarici, R. & Aysegul, U. (2015). *Illumination Invariant Face Recognition Using Principal Component Analysis – An Overview*. (P. B. John Billingsley, Ed.). Machine Vision and Mechatronics in Practice. http://doi.org/10.1007/978-3-662-45514-2

Krishna, A. S., Rao, G. S., & Sravya, M. (2013). Constrast Enhancement Technique Using Histogram Equalization Methods on Colour Images with Poor Ligthening. *International Journal of Computer, Engineering and Applications*, *3*(4), 2013.

Patil, S. N., & Bharat, M. S. (2017). High Performance Algorithm for Enhancement of Echocardiography Images using Adaptive Histogram Equalization, *7*(3), 4721–4725.

Reza, M., & Qi, X. (2016). Face recognition under varying illuminations using logarithmic fractal dimension-based complete eight local directional patterns. *Neurocomputing*, *199*, 16–30. http://doi.org/10.1016/j.neucom.2016.01.094

Salkar, S. R., Patankar, N. S., Chintamani, R. D., & Deshmu, Y. S. (2017). Illumination Invariant Face Recognition using Local Directional Number Pattern (LDN). *International Journal of Engineering Development and Research*, *5*(2), 303–308.

Sasi, N. M., & Jayasree, V. K. (2013). Contrast Limited Adaptive Histogram Equalization for Qualitative Enhancement of Myocardial Perfusion Images, *2013*(October), 326–331.

Shen, L., & Bai, L. (2006). A review on Gabor wavelets for face recognition. *Pattern Analysis and Applications*, *9*(2–3), 273–292. http://doi.org/10.1007/s10044-006-0033-y

Sufyanu, Z., Mohamad, F. S., Yusuf, A. A., & Mustafa, B. (2016). Enhanced Face Recognition Using Discrete Cosine Transform. *Engineering Letters*, *24*(1), 1–10.

Vishwakarma, V. P. (2009). An Illumination Invariant Accurate Face Recognition with Down Scaling of DCT Coefficients. *Journal of Computing and Information Technology*, *18*(1), 53–67. http://doi.org/10.2498/cit.1001427

Zhu, Y., &, & Cheng, H. (2012). An Adaptive Histogram Equalization Algorithm on the Image. *Physics Procedia*, *25*, 601–608. http://doi.org/10.1016/j.phpro.2012.03.132

ADOPTION OF VIRTUAL REALITY FOR LEARNING AMONG STUDENTS

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ABSTRACT

This study examines student view on the use of Virtual Reality (VR) in a learning environment as part of their university experience with the goal to enhance their learning, and in particular the extent to which it could replace real method of teaching/learning (Traditional teaching/learning method). The study employed a qualitative survey study and 5 participants were interviewed. In all, based on the student experience with and visualization of VR applications the findings revealed that students would love to experience and view their course content through the means of VR. Students were extremely positive about the potential of Virtual Reality in a learning environment to provide valuable learning experiences. Most of the informant affirmed that the use of VR for learning will be creative, interactive and full of immersion. The study, therefore, suggests that more studies should be carried out and implementation done on the use of Virtual Reality for both teaching and learning in Nigeria Universities.

Keywords: *Virtual Reality (VR), visualize, experience, adoption*

1. INTRODUCTION

The Information and Communication Technology (ICT) era has broadened the dissemination and spread of Information and knowledge in developed and developing countries, such as; United States of America, Malaysia, Japan, Australia, South Korea, Kenya and of course Nigeria. ICT has given rise to the positive innovation and revolution in these countries and has helped to enhance and boost their educational, social, political, cultural and economic sector (de Almeida Belo & Ye, 2015).

The advent of technology has exceptionally refined the educational system. The application of teaching and learning technological aids has enhanced and augmented the quality of knowledge across all disciplines. Educational technologies have been able to

provide an operative learning system in enabling students to learn at their own pace and convenience (de Almeida Belo & Ye, 2015).

In recent times, the use of computer-based systems in the process of teaching and learning have greatly helped to monitor the dissemination, improvement and progress of information to students in several ways as they progress in their study (Beatty, 2013). Modern computing tools in Nigeria are capable of handling graphics-related application tools. These graphical tools can play a tremendous role in providing an interactive 3Dimensional (3D) Virtual Reality world, to essentially transform students learning in the classroom (Merchant, Goetz, Cifuentes, Keeney-Kennicutt & Davis, 2014). Three Dimension (3D) technologies is a powerful tool which provides an interactive, immersive and imaginative arena for students in order to augment their understanding and learning; most especially in difficult, time-consuming and practical–based courses (Merchant et al; 2014).

Despite the unprecedented usage of VR in education, with regards to past research, few studies have been reported on the adoption of VR in learning among higher institution students in Nigeria. Hence, this study aims to look into the adoption of VR for learning among undergraduate students in University of Ilorin, Ilorin, Nigeria.

2. REVIEW OF RELATED LITERATURE

Virtual Reality offers lots of advantageous benefits in various fields. In education, VR offers many benefits to both students and educators as a tool to stimulate, enhance, and motivate users. The creation of interactive environment and hands-on experience makes the VR environment more interesting and attractive for users.

In medical and engineering field, VR can be used to simulate real-life situations and perform experience that seems risky and difficult to be performed in the real life. It can be used to test, retest and see the effectiveness of a prototype before coming up with real design by engineers. VR as well offers opportunity in medical profession especially to the surgeons in enabling them performs surgery on patient to determine their level of competence before actually performing the real operation on them and to train new surgeons (Vaughan, Dubey, Wainwright & Middleton, 2016).

Various educational technologies have contributed to an improved scholarship with the aid of webinar, e-learning, and virtual learning. Virtual learning, in particular, employs the use of Virtual Reality (VR) which is one of the current and widely used multimedia elements; it is also an important application tool which can provide significant support for education (Janßen, Tummel, Richert & Isenhardt, 2016).

Virtual Reality (VR) is an educational tool that improves student learning and provides a simulated, experiential, imaginative, intuitive, interactive and enhances learning environment (Haroon & Abdulrauf, 2015). VR is made up of many features including; hands-on experience and visualization to students, which makes it a unique and interactive environment (Laver, George, Thomas, Deutsch & Crotty, 2012). It creates

a 3D experience that looks like a real life situation, making it useful to practice procedures which seem to be difficult, technical, expensive, multifaceted and time consuming (Yasin, Darleena & Issa, 2012).

These features and elements are specific elements which result in the introduction of Virtual Reality (VR) in a learning environment for institutions of higher education. The traditional teaching practice, such as Blackboard, using the chalk-talk method of instruction is structured into many e-learning techniques, such as VR. The introduction of VR to university(s) will help teachers and students understand the techniques involved in moving around the virtual space. Moreover, technologies such as VR are more than just a whiteboard; they bring about immersiveness, imagination, and interactivity (Crouch, 2014). Many of VR applications have been implemented and designed to aid education. The future of higher education institutions practice all over the world is that instructors or teachers popularly teach in a vicious circle; that is, by engaging in the traditional teacher-students teaching practice based on class discussion and lectures that are no more in vogue.

However, with regards to the technological advancement and improvement, teaching of students, especially undergraduates in the higher institutions can be made more interactive, imaginative and interesting with the involvement of the 3D Virtual Reality world.

The use of VR has taken place in several educational fields in the higher institutions, most especially in engineering design, corrective surgery and industrial sciences (Gardiner & Ritchie, 1999). Also, is the development of a web-based multi-user virtual world known as second life, which was developed in the USA and has since been used by a lot of higher institutions in the USA due to its potential in providing students with hands-on experience and an interactive platform (Onyesolu, 2009). VR is used to teach physics and through that researchers were able to develop "Newton and Maxwell world." These two developments provide an immersive environment for learning among students and enable them to explore the electrostatic forces, the dynamics of motion and other physical concepts. In addition to that, researchers developed a VR application to teach students some biological concepts like the function and structure of cells; which enables students to understand more and construct cells on their own (Riva & Galimberti, 2001).

3. METHODOLOGY

This study makes use of the qualitative research method. The study focused on students of Faculty of Communication and Information Sciences, University of Ilorin, Kwara State, Nigeria in February 2018. An unstructured personal interview was conducted for 5 students. The Sampling of the students was based on convenience sample. The information on research interview was passed across to the students through one of the student familiar with Virtual Reality and they were asked to report to either of the researcher if they were willing to participate. In total, 5 participants were used for the

interview session. Before each interview was conducted, the researcher ensured each of the informant were given opportunity to go through the interview questions to be asked, the purpose of the interview was also explained to the student by the researcher, and the students were given the opportunity to turn down the offer of being interviewed if they so wish.

The students were personally contacted by the researcher, who explained the objectives of the study to them. The In-depth interview method was used for the data collection. According to Guion, Diehl, and McDonald (2001) in-depth interview method is a form of qualitative data collection method used for several purposes; thereby, an in-depth interview is an appropriate tool in cases where the researcher plans to use open-ended questions to obtain in depth information from less people. Interviews were conducted, recorded and transcribed to get the response which was used for the study.

4. FINDINGS AND DISCUSSIONS

All students interviewed had admitted that they experience Virtual Reality in one way or the other. Analysis of the transcripts revealed three main themes which were checked by the reviewers of the transcripts. The three themes are: Visualize, Experience and Adoption

4.1 Visualize

The informants explained their different views and imaginations about VR application, with statements such as:

> "Hmmn lets say most times when am there am always like though logically I know it's no way so most times I just try to play along. The game is just the normal VR game with a goggle"

Some of the informants explained further the way they visualize and imagined the Virtual Reality with the presence of graphical designs that made them actually realize they are in a VR world.

> "There is this shooting game whereby people moving around and you actually an agent and you have to look for criminals and arrest them, if you have to shoot you shoot, and if you have to fight you fight. So when there is anything hitting the person there the gun will vibrate and you feel as if you are in the world"

The informants were also enquired about if they will like to view or complement their course content in a VR world

> "Well that will be great because, yea, it will be great, awesome"

> "Sure yea! I guess with that it will aid more understanding and at least you will know what you are doing instead of the theory theory theeoy thing"

> "It will be immerse and its gonna be positive"

> "Yes I would actually prefer that the reason I would prefer that is anytime a student has an issue concerning a particular course or concerning a particular thing they can always login and make request and probably there will be an hologram or at teacher that will anytime a student is online the teacher is always there with programmed information to always reply to every requests that the students has"

VR has offered several advantages in various fields. It's been used to complement learning and makes student interact with learning materials and improve their understanding. In 2016, Ray & Deb developed a VR application to teach arduino boards and micro-controllers with Google cardboard headsets (Ray & Deb, 2016). More recently, in 2017, a University in Brazil modeled a complete charcoal mini-blast furnace with all of its subsystems. Their application included additional information, 360-degree photos, and videos, from real blast furnaces and it was used to teach engineering students how the process works and how the various subsystems interact using Virtual Reality (Vieira, Seshadri, Oliveira, Reinhardt, Calazans & Vieira Filho, 2017).

4.2 Experience

The informants acknowledged that they have experienced VR in a certain way. This revealed their experience and how they felt about it in the statements below:

> "Wow! For the first time I was so surprised like wow something like this, looks real because when am going in the game and I probably bump into somebody by mistake, the gun will vibrate and haa wow. Is like real as if I am actually in the game"

> "Okay emm like currently I'm working on my project using unity 3D software working on like the emm the 3D navigation of the University of Ilorin, so is a VR application also"

> "Yes, it was a game, a piloting game you sit in the pod and then it moves so as you control it you are seeing them form the cockpit then there are controls in the pod control"

> "Hmmn yea I will say yes because have played a game on VR before"

> "Yea, its cool, it's fun and I believe it's a technology that has a future you know it can play lot of roles in many many ways, it has a role to play in many aspects of our lives"

Other informant expressed that:

> "Yes just normal thought like you just wish this thing is happening"

> "It was interesting but it was also dangerous because you can't just use VR anywhere you have to be in a safe environment, because you realize most times you have to move around and if you put like a VR goggle on now and you are moving in the place it may be straight but meanwhile there is a wall right inform of you"

Some VR users shared their experience of using VR for storytelling, it was said that VR is great and effective tool for interactive storytelling using computer generated images, audio and videos to tell story that will ensure users interaction, imagination, immersion and simulation of the VR world (Shin, 2018). Furthermore, VR is an effective tool in learning foreign languages it has been of great help by allowing students has interactions with native speakers through 3D virtual worlds via the Desktop VR. This bridges the gap of distance, thereby allowing foreign language students to communicate with native speakers from any part of the world (Jauregi, de Graaff & Canto, 2011; Ibáñez, Rueda, Galán, Maroto, Morillo & Kloos, 2011; Blasing, 2010).

4.3 Adoption

Testing the informants' adoption of VR usage to the traditional learning method, and how they think VR adoption will affect their studies. Several different points were given by the informants such as:

> "Yes I will, I want to"

> "It will help because I feel emm what you see actually helps you remember more than actually what you read at times"

> "It would help because it will help you bring out some facilities you can't actually get in real life you will be able to have contact with them"

> "Obviously, anything automation would always come first before the traditional. Though it make some students get lazy through that method. It is more preferable, the VR is more preferable"

> "Well yes it will be a nice concept because it will allow students to be able to plug in themselves whenever they feel they have a bit of commission which they will like to get, so it gives them real time like it makes it all happen and make sure its gonna be VR, you can always plug in at your convenience time, so it will be a great technology to implement"

> "Well it will affect positive and negative, because there are some students whereby if VR learning centre we could have it here that's the end of some student coming down to school, you can always, so far you are connected anytime anywhere you can always be in class or anywhere. But positively now, anytime a student is having issues you can always go back there and okay refer to a particular emm a particular class that he's having issues with and even during the VR while the teacher is speaking in class there will be recordings so that okay probably I miss this part of the note or I miss this part of the class I can always go back to it unlike in the real world"

Despite the preference rate of VR method, some suggestions were highlighted by the informant on the view regarding the adoption of VR for teaching and learning

> "To assist traditional yes, but as a form of teaching on its own NO"

> "Hmmn okay I will just say a test like a pre-test should be done when it's actually implemented, so to check the study pattern of people who are making use of it then see if any positive

> and negative behavior, like if there's behavioral change or if its impact on their leaning experience"
>
> "Well well emm not really but I think the case of hologram will be implemented if something like this is put in place. Would the case of hologram be implemented like teachers been in class like recorded in class but not in class actually, so it actually gives everybody the confidence that okay when teacher is not in class. So hologram can be implemented."

Virtual Reality has been adopted in so many areas such as science, engineering, and foreign languages learning to name a few. In science education VR usage can be traced back to 1998, when two researchers Bell & Fogler used VR in visualizing chemical reactions (Bell and Fogler, 1998). An earlier use of VR that supersedes that of Bell & Fogler was in 1996 where VR was used to learn about and assemble molecule (Byrne, 1996). Recently in 2015, an astronomy application using a Head-Mounted Display was used to explore the solar system so as to make students have a grasp of how the solar system is, this was however possible because of Virtual Reality (Hussein & Nätterdal, 2015).

5. CONCLUSION

Virtual Reality with its advancement is a technology has been able to create a direct intuitive imagination, interaction and immersiveness between human and computer. The theme of this study was to explore the different experience of the students with Virtual Reality, the student visualization of VR based on their different opinions and views, and the adoption of VR for learning to the normal traditional method as well as how they feel it will affect their studies if adopted for learning. The findings of this study proved that to a large extent the students will prefer to visualize and adopt the VR method and as such to complement the normal traditional means of learning. It was gotten from the findings that most of the students experienced the use of VR through the VR game and based on their experience with that, they would love to experience and visualize it in their studies as they believe it will be more educative, create fun out of learning and enable them explore their learning material.

It is thereby recommended that more studies should be carried out and implemented in the adoption of Virtual Reality for learning among students as it will be beneficial to both lecturers and students.

REFERENCES

Beatty, K. (2013). *Teaching & researching: Computer-assisted language learning*. Routledge.

Bell, J. T., & Fogler, H. S. (1998). Virtual reality in chemical engineering education. In *Proceedings of the 1995 Illinois/Indiana ASEE Sectional Conference* (pp. 16-18).

Blasing, M. T. (2010). Second language in Second Life: Exploring interaction, identity and pedagogical practice in a virtual world. *The Slavic and East European Journal*, 96-117.

Bricken, M. (1991). Virtual Reality Learning Environments: potentials and challenges. *ACM SIGGRAPH Computer Graphics*, *25*(3), 178-184.

Crouch, I. D. (2014). On the Effect of Virtual Reality on Student Understanding of and Interest in Physics.

Almeida Belo, F., & Ye, Y. (2015). A Study of ICT Facility Readiness and Teachers' Use of ICT Facilities in The Escola Técnica Professional Becora Dili and The Técnica Professional Dom Bosco Fatumaca Baucau, Dili Timor-Leste. *Scholar*, *7*(2).

Elzinga, C. B., & Parry, K. (2000). "Technology Assisted Learning". *U.S. Patent No. 6,077,085*. Washington, DC: U.S. Patent and Trademark Office.

Gardiner P.D., & Ritchie, J. M. (1999). Project Planning in a Virtual World: information management metamorphosis or technology going too far?.*International Journal of Information Management*, *19*(6), 485-494.

Guion, L. A., Diehl, D. C., & McDonald, D. (2001). Conducting an In-depth Interview1.

Häfner, P., Häfner, V., & Ovtcharova, J. (2013). Teaching Methodology for Virtual Reality Practical Course in Engineering Education. *Procedia Computer Science, 25*, 251-260

Haroon, S. O., & Abdulrauf, T. (2015). A virtual reality prototype for learning maize planting. *Commun. Appl. Electron*, *2*(1).

Hussein, M., & Nätterdal, C. (2015). The Benefits of Virtual Reality in Education-A comparision Study.

Ibáñez, M. B., Rueda, J. J. G., Galán, S., Maroto, D., Morillo, D., & Kloos, C. D. (2011). Design and implementation of a 3D multi-user virtual world for language learning. *Educational Technology & Society*, *14*(4), 2-10.

Janßen, D., Tummel, C., Richert, A., & Isenhardt, I. (2016, June). Towards Measuring User Experience, Activation and Task Performance in Immersive Virtual Learning Environments for Students. In *International Conference on Immersive Learning* (pp. 45-58). Springer International Publishing.

Jauregi, K., de Graaff, R., & Canto, S. (2011). Integrating Cross-Cultural Interaction through Video-Communication and Virtual Worlds in Foreign Language Teaching Programs: Burden or Added Value?. *European Association for Computer-Assisted Language Learning (EUROCALL)*.

Laver, K., George, S., Thomas, S., Deutsch, J. E., & Crotty, M. (2012). Virtual reality for stroke rehabilitation. *Stroke*, *43*(2), e20-e21.

Lockwood, D. (2004). Evaluation of virtual reality in Africa: an educational perspective. *United Nations Educational, Scientific and Cultural Organization.* Paris

Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., & Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*, *70*, 29-40.

Onyesolu, M. (2009). Virtual reality laboratories: An ideal solution to the problems facing laboratory setup and management. In *Proc. of the World Congress on Engineering and computer science*.

Ray, A. B., & Deb, S. (2016, December). Smartphone Based Virtual Reality Systems in Classroom Teaching—A Study on the Effects of Learning Outcome. In *Technology for Education (T4E), 2016 IEEE Eighth International Conference on* (pp. 68-71). IEEE.

Riva, G., & Galimberti, C. (2001). *Towards Cyberpsychology: Mind, cognition, and society in the internet age* (Vol. 2). IOS Press.

Sherman, W. R., & Craig, A. B. (2002). Understanding Virtual Reality: Interface, application, and design. Elsevier.

Shin, D. (2018). Empathy and embodied experience in virtual environment: To what extent can virtual reality stimulate empathy and embodied experience?. *Computers in Human Behavior*, *78*, 64-73.

Siemens, G. (2014). Connectivism. *A Learning Theory for the Digital Age.* International Journal of Instructional Technology and Distance Learning (ITDL) (pp. 1-8).

Spicer, J. I., & Stratford, J. (2001). Student perceptions of a virtual field trip to replace a real field trip. *Journal of Computer Assisted Learning*, *17*(4), 345-354.)

Varagunam, T. (1971). Student awareness of behavioral objectives: the effect on learning. *Medical Education*, *5*(3), 213-216.

Vaughan, N., Dubey, V.N., Wainwright, T.W., & Middleton, R.G. (2016). A review of virtual reality based training simulators for orthopaedic surgery. *Medical Engineering and Physics, 38(2),* 59-71.

Vieira, C. B., Seshadri, V., Oliveira, R. A. R., Reinhardt, P., Calazans, P. M. P., & Vieira Filho, J. B. (2017). Applying virtual reality model to green ironmaking industry and education:'a case study of charcoal mini-blast furnace plant'. *Mineral Processing and Extractive Metallurgy*, *126*(1-2), 116-123.

Yasin, A. M., Darleena, Z., & Isa, M. A. M. (2012). Avatar Implementation in Virtual Reality Environment using Situated Learning for "Tawaf". *Procedia-Social and Behavioral Sciences, 67*, 73-80.

STRATEGIES FOR KNOWLEDGE SHARING IN NIGERIAN AGRICULTURAL RESEARCH INSTITUTES

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ABSTRACT

The study investigates the strategies for knowledge dissemination in Nigerian agricultural research institutes. The study adopted quantitative approach through questionnaire to collect data randomly from the sample of two hundred and fourteen (214) research scientists. The findings of the study revealed that knowledge sharing was a norm in the institutes through regular staff meetings, cropping scheme meetings, review meetings, community of practice, while knowledge transmission to stakeholders such as farmers, Agricultural Development Partners (ADPs) and other governmental and non-governmental organisations was largely manual via newsletters and bulletins, followed by personal/face-to-face contact with research scientists and extension agents. The implication of the study is that it would inform the establishment of a coordinated programme for the development of a National-wide Information Infrastructure using emerging technologies, such as satellites, including VSAT, fibre optic networks, high-speed gateways and broad-band/multimedia technologies to facilitate information and knowledge transfer among the research institutes and stakeholders/end-users.

***Keywords**: Knowledge, Knowledge management, Agricultural research institutes, Knowledge dissemination, Knowledge sharing, Nigeria,*

1. INTRODUCTION

Sharing of knowledge is vital for the survival of an organisation in a dynamic economy, as shared knowledge keeps the organisation alive and is used as a reference for future use by employees of the organisation. Shared knowledge allows learning and re-examination of the knowledge that was created, which is necessary for the organisation to have a competitive advantage (Munyua, 2011). Employees thus become innovative and there is quick responsiveness by the organization to new situations. Knowledge-sharing amongst employees contributes to the creation of new knowledge in the organisation, which is a critical activity that contributes to the success of the organisation as new knowledge

becomes available for everyone in the organisation to take advantage of. This may lead to innovative initiatives within the organization, giving the company an advantage in the competitive world (Nonaka, 1991). As knowledge is shared, people are no longer mere receivers of the new knowledge; instead, they become innovative actors with the new knowledge which makes it more context-specific to different situations.

Farmers use conventional (older) ICTs (print media, radio, television, video, fax) and modern ICTs (WorldSpace radio, computers, internet, web-based applications, cellular phones, CD-ROM) concurrently to allow different community target groups to select the communication tools that suit their needs (Colle and Roman, 2003; Wild, 2006, cited in Munyua, 2011) and the type of information needed. For instance, in Nigeria today government and farmers share and disseminate information via mobile telephones; government informs farmers about the availability of farm implements, fertilizer, seeds and seedlings, while farmers seek clarification on many issues about farming and farming techniques, and farmers draw the attention of extension workers to any threat to the development of the agricultural system in their locality. At global level, Farmers' Friend is an innovation of Google in collaboration with the Grameen Village Program. WorldSpace radio is also being used to deliver agricultural information and knowledge to disadvantaged rural communities (Mchombu *et al.,* 2001; Munyua, 2007; CABI, 2014). However, Nigeria as a country is experiencing a decline in the agricultural productivity since late 1970s and early 1980s largely due to over-dependence on oil, and the declining agricultural production arising from total dependence on crude oil exports as a means of growing the economy has relegated the role played by the agricultural research institutes in innovation development and knowledge sharing, which is now characterised by a myriad of problems such as poor knowledge sharing infrastructure, capacity building (i.e. requisite skills and expertise), declining research culture, poor staff motivation, inadequate government support and a perennially declining research budget. This is evident in the nation's agricultural sector contribution to the GDP, which was down to 30.9% in the year 2013. In this regard, the main objective of the present study was to investigate the knowledge sharing practices and its impact on the overall activities of the institutes. The specific objectives are;

- To identify the activities that lead to knowledge sharing in the institutes
- To investigates the sources of acquiring knowledge in the institutes

2. METHODOLOGY

The main methodologies or research approaches in social research include the quantitative, the qualitative (Sheppard, 2004; Durrheim and Painter, 2006) and mixed methods research (Creswell and Plano, 2007; Greene, 2008; Teddlie and Tashakkori, 2009). In the present study, quantitative method was adopted using survey design.

Survey was adopted in order to allow for the collection of data from the sample drawn in the five research institutes, using questionnaires. Survey describe trends in the data rather than

offering rigorous explanations (Creswell, 2008). Survey design has been used in similar studies by Dawoe, Quashie-Sam, Isaac, and Oppong (2012), Munyua and Stilwell (2013). Collected data was analyse statistically to describe the strategies of knowledge sharing in the institutes.

Out of the 17 agricultural research institutes in Nigeria, five were purposively chosen from five geo-political zones with major agro-based research institute. Each of the five zones has one major agro-based research institute (A.R.C.N., 2008). The five institutes covered serve as zonal agricultural research coordinating institutes for all the states within the zones. The research institutes include (A.R.C.N., 2008):

1. National Root Crops Research Institute (NRCRI), Umudike, Abia State (South-East), covering Abia, Akwa Ibom, Anambra, Bayelsa, Cross-Rivers, Ebonyi, Enugu, Imo and Rivers States.
2. Institute for Agricultural Research and Training (IAR&T), Ibadan, Oyo State (South-West) covering Ogun, Oyo, Osun, Ondo, Ekiti, Edo and Delta States.
3. National Cereals Research Institute, Badeggi, Niger State (North-Central), covering Niger, Abuja FCT, Kwara, Kogi and Benue States.
4. Institute for Agricultural Research (IAR), Zaria, Kaduna State (North-West), covering Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara States.
5. Lake Chad Research Institute (LCRI), Maiduguri, Borno State (North-East), covering Gombe, Bauchi, Adamawa, Taraba, Yobe and Borno States.

The population of this study is 1 363. According to Israel (2012), if the population is 1 363 and ±5% is taken for precision, the sample should be 214 at the 95% confidence level. Finally, the data collected from the survey (questionnaire) was sorted, scrutinised, edited and analysed using the Statistical Package for Social Sciences (SPSS) version 20.0 for Windows 7, to generate descriptive statistics via percentages, frequencies and Pie charts to complement the descriptive statistics and results that were obtained.

3. RESULTS AND DISCUSSION

This section presents the analysis of data collected on the strategies for dissemination of knowledge in the five research institutes for increased productivity and diffusion of know-how.

3.1 Profile of Respondents

Table 1 presents the response rate *vis-à-vis* the total number of questionnaires administered to the population of researchers in the five research institutes, as depicted in Table 1.

Table 1 Response rate from the five research institutes (N=214)

Institutes	Questionnaire Administered	Questionnaire Returned	% of Actual Respondents
I.A.R. Zaria	56	47	83.10
I.A.R.&T. Ibadan	59	42	71.18
N.R.C.R.I. Umudike	54	44	81.48
N.C.R.I. Badeggi	53	41	77.35
L.C.R.I. Maiduguri	54	40	74.07
Total	**276**	**214**	**77.6**

The results in Table 1 show that 214(77.6%) copies of questionnaires were completed and returned out of the total 276 that were administered. In this regard, 47(83.10%) were returned from I.A.R Zaria, 42(71.18%) from I.A.R. &T. Ibadan, 44(81.48%) from N.R.C.R.I. Umudike, 41(77.35%) from N.C.R.I. Badeggi, 40(74.07%) from L.C.R.I. Maiduguri. From these results, it is evident the highest returns were recorded at I.A.R. Zaria, with 83.10%, followed by N.R.C.R.I. Umudike, with 81.48%.

Demographic analysis was conducted to determine the department/unit/programme, educational status, gender, age, years of working experience and position/rank of the respondents in the research institutes.

The study revealed that the majority of the respondents were males 151(70.6%), while females stood at 57(26.6%) and 2.8% as missing values, working in various departments/units/programmes of the institutes, as follows: 18(8.4%) were working in the Agric Econs and Extension Programme, 29(13.6%) in the farming system, while 26(12.1%) were working in the Biotechnology Department. The findings further revealed that 38(17.8%) of the respondents were working in the product development programme and 24(11.2%) were in the research outreach departments of the institutes, while the majority 79(36.9%) of the respondents were working in other departments/programmes, which include the cassava programme, yam programme, sweet potato, cocoyam, ginger, post-harvest, technology, maize, banana, kenaf and jute, cereals, trypanotolerant livestock, grain legumes, land and water resource management, cowpea, groundnut, cotton, confectioneries, castor and tomato programmes.

4.2 Knowledge-Sharing Activities in The Research Institutes

Respondents were asked to rate the statements that describe the adoption of knowledge culture in the research institutes. The responses are as follows: the manner things are done makes the sharing of experience and knowledge with others difficult 60(28.0%) strongly disagreed, 39(18.2%) disagreed, 37(17.3%) neither agreed nor disagreed, 58(27.1%) agreed, while 20(9.3%) respondents strongly disagreed; the sharing of experience and knowledge with others is enhanced by the way things are done in the institutes 5(2.3%) disagreed, 20(9.3%) neither agreed nor disagreed, 116(54.2%) agreed, 73(34.1%) strongly agreed, while there was no response for strongly disagree; communication in the institutes only comes from the top management down to the subordinates 23(10.7%) strongly disagreed, 41(19.2%) disagreed, 46(21.5%) neither agreed nor disagreed, 66(30.8%) agreed, and 38(17.8%) strongly agreed; knowledge creation, codification and transfer is made part of the institutes' culture 5(2.3%) disagreed, 30(14.0%) neither agreed nor disagreed, 113(52.8%) agreed, 66(30.8%) strongly agreed, while there was no response for strongly disagree; research results are accessed easily by the stakeholders 3(1.4%) strongly disagreed, 4(1.9%) disagreed, 44(20.6%) neither agreed nor disagreed, 102(47.7%) agreed, and 61(28.5%) strongly agreed; new staff are taught about the job by older/experience staff in the course of performing their duties (mentoring) 6(2.8%) strongly disagreed, 14(6.5%) disagreed, 31(14.5%), 88(41.1%) agreed, and 75(35.0%) strongly agreed; induction courses are organised for the new staff in the institutes 6(2.8%) strongly disagreed, 4(1.9%) disagreed, 48(22.4%) neither agreed nor disagreed, 86(40.2%) agreed, while 70(32.7%) strongly agreed.

4.3 Availability and Accessibility to Sources of Knowledge

The respondents were asked to identify which of the following source(s) of knowledge was available and accessible in their institutes. The responses indicated that: experiences (tacit knowledge) of staff who have retired from service 24(11.2%) were not available, while 83(38.8%) said they were available but not accessible, 107(50.0%) of the respondents claimed knowledge was available and accessible; the experience (tacit knowledge) of staff who are transferred to your dept./unit 20(9.3%) respondents was not available, 60(28.0%) claimed was available but not accessible, while 134(62.6%) said it was available and accessible; experience (tacit knowledge) of staff who are transferred from your dept/unit 1(0.5%) believed was not available, 33(15.4%) responded was available but not accessible, 180(84.1) said it was available and accessible; minutes of meetings (explicit knowledge) 11(5.1%) of respondents were of the opinion that they were not available, 45(21.0%) said they were available but not accessible, while 131(61.2%) responded was available and accessible in the institutes; research findings/results (explicit knowledge) 1(0.5%) respondents said they were not available, 45(21.0%) responded they were available but not accessible, while 168(78.5%) agreed

they were available and accessible; internal/external memos (explicit knowledge) 27(12.6%) said were not available, 79(36.9%) claimed they were available but not accessible, while 108(50.5%) believed they were available and accessible; official letters/files (explicit knowledge) 24(11.2%) of the respondents believed they were not available, 91(42.5%) said they were available but not accessible, while 99(46.3) claimed they were available and accessible. These results reveal that all the sources of knowledge were available and accessible in the institutes. This would, in no small measure, facilitate knowledge production, communication, access and sharing.

4.4 Condition for Accessing and Utilising Knowledge in The Institutes

The respondents were asked to state whether or not there were condition(s) for accessing and utilising knowledge by stakeholders. The results are shown in Figure 2.

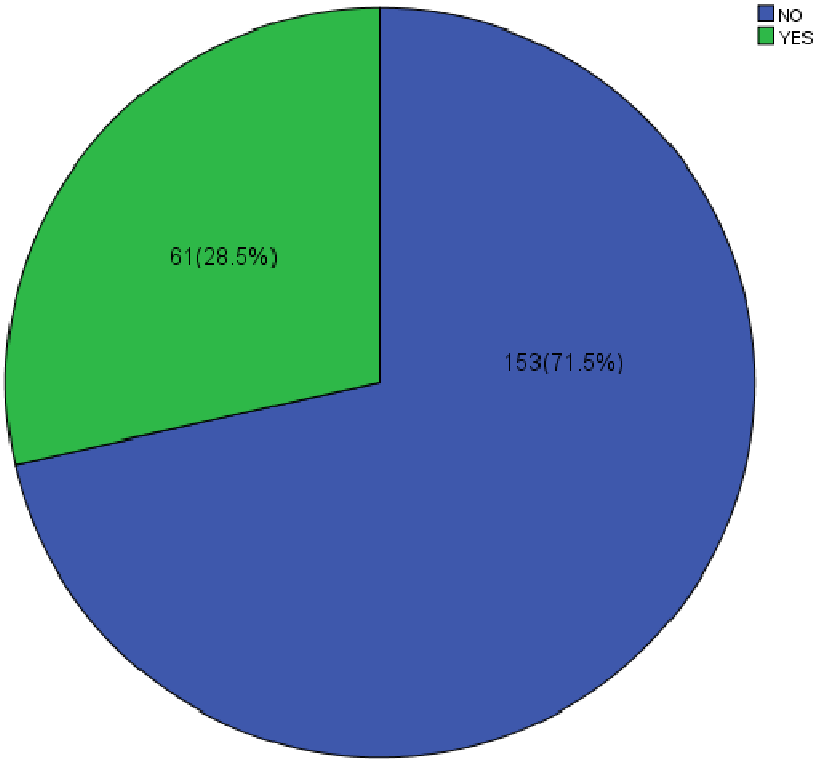


Figure 2 Condition(s) for accessing and utilising knowledge in the institutes (N=214)

Figure 2 depicts the conditions for accessing and utilising knowledge in the five research institutes. The results show that 61(28.5%) of the respondents claimed that there were conditions attached, while 153(71.5%) said there were not conditions for access and utilisation of available knowledge by the stakeholders of the institutes.

Furthermore, an option was given to the respondents regarding whether or not conditions are attached to the access and utilization of knowledge in the institutes. Accordingly, some the respondents had claimed that there were conditions, which include the following:

- Memorandum of Understanding (MoU)
- You must register before access
- State clearly reason(s) for access and utilization
- Secure management approval
- State how the knowledge/information will be utilized

5. CONCLUSION AND RECOMMENDATIONS

It is evident from the findings of the study that the research scientists in the five agricultural research institutes appeared to share knowledge freely with their colleagues, or through research reports and newsletters, cropping scheme meetings, review meetings, regular and formal staff meetings, community of practice, knowledge networks and interactions. The extensive use of personal exchange of information, conferences and workshops suggest extensive sharing of explicit and tacit knowledge in the research institutes. Based on the findings, the study recommends that an enabling environment should be created through appropriate policies to facilitate access to knowledge generated in the research institutes. National agricultural research database/databank should be established to enhance awareness, documentation, access and utilisation of agricultural information and knowledge for overall national development. The present study also recommends the establishment of a co-ordinated programme for the development of a National Information Infrastructure (NII), State Information Infrastructure (SII) and Local Information Infrastructure (LII), by using emerging technologies, such as satellites, including VSAT, fibre optic networks, high-speed gateways and broad-band/multimedia technologies to facilitate information and knowledge transfer among the research institutes and stakeholders/end-users.

REFERENCES

Agricultural Research Council of Nigeria. (June, 2008). Agricultural research council of Nigeria. Available at: http://www.arcn.org.ng (accessed 12/2/2014).

Centre for Agriculture and Biosciences International. (2014). Centre for Agriculture and Biosciences International". Available at: www.cabi.org/ (accessed 19/8/2014).

Creswell, J.W. and Plano, C.V. (2007). *Designing and conducting mixed method approaches*. Thousand Oaks: Sage Publishing.

Creswell, J. W. (2008). *Educational research: planning, conducting quantitative and qualitative research*. New Jersey: Pearson Merril Prentice Hall.

Durrheim, K. and Painter, D. (2006). Collecting qualitative data: sampling and measuring. In M. T. Blanche, K. Durrheim, & D. Painter, (Eds), *Research in practice: applied methods for the social sciences*. Cape Town: University of Cape Town.

Greene, J. C. (2008). Is mixed methods social inquiry a distinctive methodology? *Journal of Mixed Methods Research*, 2(1), 7-22.

Israel, G. D. (2012). *Determining sample size. Program evaluation and organizational development*. University of Florida: IFAS, POED-6. Available at: http://edis.ifas.ufl.edu (accessed 19/3/2011).

Munyua, H.T. (2011). *Agricultural knowledge and information systems (AKISs) among small scale farmers in Kirinyaga district, Kenya* (Ph.D. thesis). University of KwaZulu-Natal: Pietermaritzburg.

Munyua, H. T. (2007). *ICTs and small-scale agriculture in Africa. A scoping study*. IDRC: Nairobi. Available at: <http://www.idrc.ca/uploads/userS/12212542261Final_Report_HMunya.pdf> (accessed 15/03/2014).

Mchombu, K. J., Genesse, R., Tadesse, E. & Mariam, M. H. (2001). Information and development symposium. A symposium on information and development held in Addis Ababa in May 2001. *Information Development,* 17(3), 184-188.

Nonaka, I. (1991). The knowledge-Creating Company. *Harvard Business Review*, 69(6), 96-104.

Sheppard, M. (2004). *Appraising and using social research in the human services: an introduction for social work and health professionals*. London: Jessica Kingsley Publishers.

Teddlie, C. and Tashakkori, A. (2006). General typology of research designs featuring mixed methods. *Research in the Schools*, 13(1), 12-28.

USAGE OF SOCIAL MEDIA AMONG STUDENT ENTREPRENEURS IN NIGERIA UNIVERSITY

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ABSTRACT

In recent times, there has been an increasing global concern over the continuously expanded rates of unemployment around the world, particularly among students. Recently, the students have used the social media as a means to fill the gap of unemployment. The power that the social media applications possess enables them to make use of social media for marketing, advertising, and promotion. Therefore, this study sets to investigate the usage of social media by student entrepreneur, the factors that motivated student entrepreneurs to involve in business on campus and the relevance of social media to the student entrepreneurs. The study employed the qualitative research technique; the in-depth interview method was used for data collection and 38 participants were interviewed in all. The results revealed that students are involved in entrepreneurial activities because of one reason or the other. Some of the reasons advanced by the respondents are passion for fulfilling a lifelong dream and to sustain thereof financially. Most of the informants also affirmed that their reason for social media usage was due to its accessibility and affordability which has been really helpful to them and contributed to a high rate turnover of their businesses.

Keywords: *student entrepreneur, social media, motivation, relevance, usage*

1. INTRODUCTION

In recent time, there has been an increasing global concern over the continuously expanded rates of unemployment around the world, particularly in most developing countries, where the youth have been identified as the most affected groups (Akhuemonkhan, Raimi & Sofoluwe, 2013). Social media has given young entrepreneurs the capability of gaining access to resources that were otherwise not available to them. The power that the social media applications possess enables these youths to make use of

social media for marketing, advertising, and promotion through the usage of Facebook, Twitter, Instagram, You Tube, etc. (Hanna, Rohm & Crittenden, 2011).

Social media has ushered in many changes in all spheres of life of almost everyone from all walks of life (Bolton et al., 2013). They have changed the way people communicate, work, study and do business. Social media sites can be classified into several types; for instance, social media (i.e. Facebook, Twitter and MySpace), photos and videos (i.e. Flickr and YouTube), online encyclopaedia (i.e. Wikipedia), online bookmarking (i.e. Delicious), virtual social worlds (i.e. Second Life) and virtual game worlds (i.e. World of Craft) (Albarran, 2013; Edwards, 2011).

Nigeria has experienced a rapid transformation in technological advancements and Internet connectivity thereby leading to a sporadic increase in the number of people who use internet between the years 2010 and 2014 (Ezeani & Igwesi, 2012). Currently, the country has the highest number of internet users in Sub-Saharan Africa (International Telecommunication Union, 2015); no wonder the numbers of internet users in Nigeria is recorded as 97.2 million (NCC Report, 2016). The social media that is mostly used in the country is Facebook (93.72%), Twitter ranks second (5.29%), Pinterest ranks third (0.42%), Tumblr ranks fourth (0.2%) and the remaining social networks hold 0.37% using Mobile internet (NCC Report, 2016). These staggering statistics reflect the explosive growth social media has experienced over the past years, nevertheless the usage and adoption of social media among student entrepreneurs seems unclear especially in developing economies as Nigeria.

One defining characteristic of all social media is their potential to facilitate engagement—the interactive, synchronous communication and collaboration among numerous participants via technology (Bolton et al., 2013). It is a multi-way communication, at the same time but in different places, enabling people to disseminate information, ideas, experiences, and pictures typical of traditional mass media to a fully interactive information sharing dialogue. Simply put, social media have now become a common communication channel among young people particularly students in tertiary institutions (Tella & Adu, 2013).

However, the usage of social media among undergraduates goes beyond the interactive aura that it provides. Few of these students are young entrepreneurs and they use these platforms to pass across information to their various clients on the products and services that they have to offer (Shokery, Nawi,Nasir & Mamun, 2016). The networks are fantastic resources for businesses of all sizes that need to promote their brands online. These platforms are free to use, though some offers advertising options for brands that want to reach even more new audiences (Shokery, Nawi,Nasir & Mamun, 2016). They give young student entrepreneurs an opportunity to connect in an affordable, personal and meaningful way with their clientele. It also allows for quick access to customer support issues, share and praise compliments about the organisation.

Despite the unprecedented usage of social media among students entrepreneurs(Shokery, Nawi, Nasir & Mamun, 2016), most studies focus on the usage of

social networking among students (Ali & Aliyu, 2015; Boumarafi, 2015; Eke & Odoh, 2014; Ezeah,Euphemia,Asogwa & Obiorah, 2013), how higher education institutions utilize social media (Hall, 2014), the impact of social media use on academic performance among university students(Al-rahmi & Othman, 2013; Heffner, 2016; Camilia, Ibrahim, Dalhatu, 2013), social media addiction level among selected Nigerian University undergraduates (Sokoya, 2013, Ajewole, Olowu & Fashola, 2012), accessibility and usage of internet among Nigerian undergraduates (Ani,2010; Uche &Obiora, 2016); the influence of social media on rate of violence among Nigerian youths (Adaugo, Ovute & Obochi, 2015), gender usage of social networking among youths (Lin & Subrahmanyam, 2007; Bonds-Raacke & Raacke, 2008; Giles & Price,2008).

However, there is dearth of research on social media usage and adoption among tertiary institution students entrepreneurs in Nigeria, particularly undergraduate students. Therefore, this study seeks to take a different stand by exploring the usage of social media among undergraduate student's entrepreneurs in University of Ilorin, Ilorin, Nigeria. The research on social media usage of students' entrepreneurs becomes highly important because social media is one of the fastest growing segments on the web (Parra-López, Bulchand-Gidumal, Gutiérrez-Taño & Díaz-Armas, 2011). This research would also be of high significant because it will show the attributes of social media that can be beneficial to the marketing, communication, and engagement efforts of undergraduates' entrepreneurs. Therefore, the main question this study would strive to answer is to have an in-depth understanding on the relevance of social media to students' entrepreneurs. This research would also answer question on how student entrepreneurs use social media in marketing their products and services? What is the impact of social media on the rate of turnover of their business? What contributes to the acceptance of social media as a viable business platform? It is also important to understand the speed at which the social media outlets are penetrating and reforming the business terrain and offering new ways and tools for the delivery of information across the globe making the cyber-space a borderless learning sphere. It is expected that the outcomes from the paper will fill some gaps on social media usage among entrepreneurial students in Nigerian University.

2. REVIEW OF RELATED LITERATURE

In recent time, there has been an increasing global concern over the continuously expanded rates of unemployment around the world, particularly in most developing countries, where the youth have been identified as the most affected groups (Akhuemonkhan, Raimi & Sofoluwe, 2013). Particularly in Nigeria, government is leaving no stone unturned in a bid to see that all citizens irrespective of their status are economically empowered by introducing entrepreneur programmes (Akhuemonkhan, Raimi & Sofoluwe, 2013). This is due to few government jobs provided for potential graduates and the array of unemployed individuals. As a result of this, various governmental and non-governmental organizations have initiated policies through some

support agencies such as the National Directorate for Employment (NDE), National Poverty Eradication Programme (NAPEP), Small Medium Enterprises Development Agency (SMEDAN), National Office for Technology Acquisition and Promotion (NOTAP), Raw Materials & Development Council (RMRDC) among others to address the problems of unemployment among Nigerian citizens (Akhuemonkhan, Raimi & Sofoluwe, 2013; Emannuel, 2012; Olayinka 2010).

In the year 2006, Federal Government of Nigeria mandated that all tertiary institutions in the country should introduce entrepreneurship education course which started in the 2007/2008 academic session (Akhuemonkhan, Raimi & Sofoluwe, 2013). In the same vein, establishing entrepreneurial development centres in those institutions supported the theoretical based in practical. The course was being taught as part of the prerequisite for graduation in tertiary institutions. Akpan, Effiong, and Ele (2012) noted that the aim of adopting entrepreneurship education in the post-secondary institutions is to equip graduates to be self-reliance and to achieve faster economic development in the country. Being a student entrepreneur is not only by attending its classes but it involves the engagement and involvement in entrepreneurial activities in and around the university and its environs (Marchand & Sood, 2014).

Entrepreneur is widely believed to be a vehicle for self-dependence, poverty reduction and economic empowerment. Serarols-Tarrés, Padilla-Meléndez, & del Aguila-Obra (2006) explained further that entrepreneurship is a process that identifies an opportunity by understanding the resource requirements, acquiring the resources, planning, and implementation. Acs (2008) considered entrepreneurship to be an important mechanism for national economic development due to its contribution to the generation of employment and innovation. However, considerable differences exist between countries in the extent to which entrepreneurship contributes positively to national economic development (Autio & Acs, 2007; Hessels, van Gelderen & Thurik, 2008; Acs, 2008).

As a result of the contribution of youth entrepreneurship to economic development and growth in Nigeria, these youths have revolutionized the way they communicate with their various clients. The power that the social media applications possess enables these youths to make use of social media for marketing, advertising, and promotion through the usage of Facebook, Twitter, Instagram, You Tube, etc. (Hanna, Rohm & Crittenden, 2011). Social media has given businesses the capability of gaining access to resources that were otherwise not available to them. It has also helped businesses to increase their worthiness, cultivate strategic partnerships and increase their contact with customers and suppliers (Jagongo & Kinyua, 2013).

Entrepreneurs prefer to use the social media as a business platform because in social media services, users can share their experiences with their friends to create free word of mouth marketing for the business (Mikalef, Giannakos & Pateli, 2013). Moreover, social media provides an opportunity for entrepreneurs and their various clients to share and exchange their experiences, reviews and opinions about the goods and services that are purchased. As a result of this, social media became the best platform for student

entrepreneurs, not only to sell products and services, but to stay in touch with their customers (Jagongo & Kinyua, 2013).

Many businesses are now turning to social networks as a worthwhile communication tool and, if used adequately, they can significantly improve their online presence, in the form of effective promotion (Jagongo & Kinyua, 2013). To achieve success with the online marketing, the marketers need to have a presence in the environment that their customers inhabit. Mark Zukerberg, co-founder of Facebook supports this by saying that advertising is fast changing and businesses need to understand the usage of Internet technologies in order to remain relevant (Maymann, 2008).

As there are low barriers to the use of social media technologies, small businesses can make use of social media in the same ways that large corporate can, without the need for extensive resources. Fruhling and Digman (2000) set out that the adoption of the Internet can help a business increase its customer and market base and this makes a contribution towards the business' growth strategy. The internet can also facilitate a business to expand its scope and extend its main business through market penetration and development or product development. Porter & Micheal (2001) goes further to say that the relationships formed via the internet can boost sales and generate opportunities to come up with new products and services.

Mangold and Faulds (2009) recognize that social media allows an enterprise to connect with both existing and potential customers, engage with them and reinforce a sense of community around the enterprise's offering(s). Further, an information rich website can help a business to develop relationships with customers by providing more effective marketing, new communication and distribution channels, shorter time to market, customized products, 24hour online technical support and online interactive community. Social media can be an excellent way to acquire new customers and retain existing ones. The real challenge lies in the way to engage with the audience on a personal level. Social media can build online groups around various companies, where clients and prospective customers can interact with like-minded individuals. These groups provide valuable insights, plus useful feedback that help the marketers improve their products to suit the needs of their customers.

This important feedback can assist in advancing their marketing efforts, and the general brand values their company projects. The use of social media as a marketing tool allows companies to mingle with fellow professionals in the field, conduct research, connect with the community and get business opportunities (Smith & Taylor, 2004). Social media has led to the introduction of social media marketing and presented new ways of communicating to expanse audiences on various Internet platforms. Marketers can no longer rely on mass media channels alone to communicate with their consumers. They must adopt new strategies if they wish to succeed (Armstrong, Kotler, Merino, Pintado & Juan, 2011).

3. METHODOLOGY

The study was carried out among young student entrepreneurs in Faculty of Information and Communication Sciences, University of Ilorin, Ilorin, Kwara State in November, 2016. An unstructured personal interview was conducted for thirty-eight students who involve in one form of entrepreneurship or the other. Sampling of the students was based on convenience sample. The information on research interview was passed across to the students through their class governors and they were asked to report to the research assistant if they were willing to participate. In total, 17 females and 21 males participated in the interview session. Before each interview was conducted, the researcher explained in details to each informant the purpose of the interview and the students were given the opportunity to turn down the offer of being interviewed if they so wish. The students that were interviewed gave verbal consent before the commencement of the interview. The interview sessions centred on knowing the relevance of social media to student entrepreneurship, how student entrepreneurs use social media, what contributes to the adoption of social media as a communication platform. Upon completion of data collection, all data were compiled from audio tapes, recording notes, and the primary researcher's note book. Creswell recommended that in transcribing the data, attempts must be made to transcribe the discussions verbatim, outlining emphasized words, pauses, and other such vocal activities (Cresswell, 2008). After transcription, and an overall reading and surface analysis of the transcript was completed, the data were then organised by question and response set. The thematic analysis was further used to uncover the themes and trends.

4. FINDINGS

All students interviewed had admitted that have incorporated facebook, twitter, you-tube and instagram into their entrepreneurial communication strategy. Analysis of the transcripts revealed four main themes which were identified simultaneously by two independent reviewers of the transcripts. The four themes are: motivation, relevance and usage.

4.1 Motivation

The informants acknowledged that they were involved in entrepreneurial activities for many reasons which are the need to augment the stipends that they received from their parents and guardians, the need to make a difference in their community / environment or simply because they are passionate about fulfilling a lifelong dream.

> "I actually like cooking and I cook for my friends in the hostel and they tell me that my food is tasty and some of them asked me to cook for them

> for a fee. Then I was involved in a class project photo-journalism and that was where I finally discovered my skills" (Informant 1a)

Another Informant echoed what the previous informant expressed:

> "I like to be independent. So I try to make my money now instead of relying on my parent for everything and I have always like fashion and all those stuffs. More so, I always wanted a fashion line. So I decided to start now" (Informant 2)

Despite the deep motivation to involve in entrepreneurism; these students explained that entrepreneurism isn't a joke or a simple task. They explained that the task needs lots of resources such as capital, labour, technology/ technical know-how, and so much patience.

> "…it is possible for someone to tell me they want a cake tomorrow, and I have a lecture, and I don't want to push them away because of another day. So at times, I will have to skip that lecture for that person or I bake over the night then the next day I wouldn't be able to come to class"

> "Before I ventured into cinematography, I never had the idea of what it entails but some I can remember very well that I had the passion for it. Therefore, I had to go to a training school to acquire the necessary skill. It took me a long time to achieve that feat but I am happy that I did."

The results of the in-depth interviews revealed that majority of the informants were motivated to involve in entrepreneurial activities because they believe they have skills and knowledge that can use to solve some world problems.

For instance, informant 2a who is a social media influencer explained:

> "I have huge followers. So people requested that they would like me to be our publicist and that we should meet up and we met and they ask me questions, just bits of interview and from there that how I started"

However some of the informant expressed the challenges they encounter during their entrepreneurship journey which demotivated them or made them to give up on their passion.

> "I had a problem with some customers on the payment module of the goods acquired by my customers. Some of them want to pay on delivery which is very risky. I have done it in the past and it was a bad experience. While some of the customers like to waste my time. They are not interested

in buying the goods but they keep on disturbing me to provide what I don't have. "

"Entrepreneurship on social media is a jolly good ride only if customers pay. Putting goods online is not an easy task. You need to learn, relearn and unlearn many social media strategies, skills and tactics"

While another informant explained that he did not have adequate skills set for the entrepreneurial activities that they are involved in but he is positioned to involve in continuous self-training till he gets to the saturation point.

4.2 Relevance

Both in reality and from overwhelming prove of literature, it is not too hard to see why most business needs the presence of social media in their daily transactions. Regardless of size or funding or status, most businesses regularly leverage on popular social media to support their business' goals. The data in this study show that social media to a large extent has a lot of relevance and impact to student entrepreneurship drive. Social media gives the students an opportunity to connect in a very personal and meaningful way with their customers. Thereby availing them of the huge opportunity of responding quickly to customer support issues share and praise compliments about their entrepreneurship ideas as well as provide offers to people who are going out of their way to show support for their ideas.

The informants explained that social media is not only readily available but it is also easily accessible to them and their various clients.

"….recently I had someone who ordered for brochures and gown from Lafia and I have one other from Ogun State. So, the social media is really helpful in marketing of my product."

"It has really helped me a lot because now I have more customers and I do have a good relationship with them. Because when I was in SS2 or 3, I actually started the clothing line but it was a flop, because I would just tell my friends. I didn't have a large audience to tell about my clothing line. So, I just ended up selling some to my family and dashing the rest out. But now, on social media I have a large audience and I can sell it to the. Its bigger and more people know about it now."

"Social media has really helped me and I believe its helping a lot of people who are more focus on their business not someone like me who have

> to deal with school. …it is really good for students even more than the business expert."

Some informants explained how social media has allayed some of the fears they when they wanted to embark into the entrepreneurship sojourn.

> "When I wanted to start my Kampala clothe business, I was sceptical about how I will get customers to buy my wares. Then one of my friends told me about how social media has been able to boost her rate of turn-over. She explained how I can use sponsored ad to reach a lot of the target audience of my wares. I tried it and it worked for me. I have more sales than ever before. I get calls and direct messages from at least 10 customers on a daily basis. Marketing on social media is fun.it makes me feel so relevant."

Another informant also explained that social media has really improved her business strategy and communication skill other than the physical market. She said through social media I meet people from different states in the country by chatting them up, hey place order, I send goods to them and receive positive feedbacks with more referrals from them.

4.3 Usage

Testing the informants' usage of social media for entrepreneurial purpose revealed that students use and adopt a particular social medium handle based on the type of the business they involve in and the prospect that it will serve their business. Students who involve in goods that need pictures for emphasis and clarity prefers to use instagram, while instagram is the most used social media handle, then those whose goods and services need clarification and explanation prefer to use the facebook.

One of the informant explained that the rational for choosing Facebook is because of the need to meet new people, as opposed to other social media sites like LinkedIn. He explained further that Facebook does not require third-party introductions or the approval of intermediaries, thereby facilitating the fast acquisition of new acquaintances as well as an avenue to better understand the audience and their social context.

Yet another informant explained that Facebook does not enforce any policies against the informal offering, selling or promoting of products, and actually, provides many tools for the commercialization of products of services, which constitutes a basic liberty necessary for incipient social media entrepreneurs

> "The choice of a specific Facebook group allowed us to effectively accompany the different posts, interactions, frequency and participation of all users, since all the content on a Facebook group is available and visible to all members, this alleviates issues of access, authenticity and transparency."

According to a female student entrepreneur, she attributed her usage of Facebook to the interactive features of these channels which encourage engagement with key audiences especially during some specific marketing media campaigns.

Some of the informant explained instagram is their choice for social media entrepreneurial campaign because of its picture appeal.

> "I use instagram the most because is for posting pictures and videos and everyone that are there see what you are posting and perhaps I try to make use of a good camera so that my picture will come out well and I get comments more so you can relate well on instagram via people's comment asking you where are you? And the likes, so I have to put my number if they want bake and they add me through whatsapp and we chat up and then I don't really use Facebook like that although that what I noticed and most time when they come online they only just scroll down and most people I know are on instagram"

> "If you want to use instagram it's just basically posting, for instance a brand called me and said they want to promote their goods. There are two ways I can promote their good its either I post from one account or I give them sponsored ad. Sponsored ad is when I will have to pay instagram to work it out for me but then mostly they still prefer me posting because the followers are real. The people that will set it are still real and they can account for it easily than using sponsored art."

> "Most people use instagram than other social networks, facebook has most people but most teenagers and everybody use instagram because they can easily post pictures, video and tag people and other stuffs. Facebook is the owner of instagram, so whatever you post on facebook you can see it on instagram"

> "They send me a direct mail. I have like a personal or private mail for the clothing line. So, they just send me a direct mail and make enquiries about it. If they are interested, they send the money to me and deliver it to them"

> "Ok, like the clothing line, I could just use my phone to take pictures of people wearing it but I use professional photographers so that the quality of the picture could be better and smart. And I look more professional not just taking a phone and taking selfie or something"

Few of the student entrepreneur use twitter; they explained that it is usually for elite or specific oriented products or services. One of the informants explained

> "From my own perspective I work with an NGO in Lagos so he was like one of the reasons you should be using twitter is because on Instagram people post more of pornography content. So its only youth that feels like let us use instagram because youth can still use it and feel less concerned but the adult are like is not reasonable which twitter regulate very well. Sometimes, if you tweet pornographic contents, twitter will still lock your picture just to verify. So they are more conscious of pornographic"

> "we use what we have to get what we want because in this generation technology has taken over so it is how we can reach the audience more that is more important e.g when we were in 200 level in performing arts we use print media where we made our first magazine and we call it entertainment plus, we found out that we decided to do posters on it. When we try to reach out to everyone we could not get the exact response that we needed so I believe people are more interested in social media because it is easier for them to carry their phone, on their data, and just check what they want to check"

Another informant explained that she make use of YouTube for her fashion designing business, by posting some short videos on different dress and pattern making just to entice customers and encourage them to join her fashion class, and this has promoted her business by creating more customers and improve her communication skills

On many of the cases, some of the students explained that social media are used to gather important customer intelligence that can be used in driving innovation in a business, provides insights, thoughts and ideas on how to better serve customers and enables businesses to discover innovative ways to conduct business or new products and services to offer customers.

5. DISCUSSION

The purpose of this study was to assess the usage of social media among student entrepreneurs in Nigeria University, which social media they used, what prompted them to the use of social media, how they used it and the reason for using it. Majority of the

student entrepreneurs (respondents) used at least one social media platform ranging from Instagram, Facebook, Whatsapp, Blog and Twitter depending on individuals choice and the type of business they are involved in. However, most of the students' entrepreneur prefers to use Instagram. The overwhelming preference for Instagram was associated to been seen as a marketing platform; for its flexibility in posting pictures, viewing of posts likes, followers and comments. This finding is similar to the study of Hashim (2017).which shows that there is a great potential for entrepreneurship through instagram platform, because instagram ensures the visibility of unique content and features which entice the community of both young and old and as such help entrepreneurs in advertising and promoting their brand.

The study also revealed that some of the reasons for social media usage to other media like television and radio are due to its accessibility because social media applications are found on most mobile devices and it's used by majority of people including both young and old. Other reason for its adoption was that it's affordable and cheaper in price compared to other media. It was also stated that it reach out to wide range of customers, leads to high business turnover and most of all it's an effective tool to network and promote their business. Similar study on Park, Sung and Im (2017) attests to the fact that social media has created great business opportunities and have been an effective tool for student entrepreneurs by creating a wide range of customer and great business turnover.

6. RECOMMENDATIONS

Data collection could be expanded to include a larger sample by covering a wide range from more than one university. This research work has also clearly shown that Nigeria is not lagging behind among other social media users across the globe, despite the limited internet facilities in the country. In addition to that, the University of Ilorin management should provide adequate internet facility so as to help student entrepreneurs promote their business with social media usage.

7. CONCLUSION

Entrepreneurship has become a next option for undergraduates, graduates and youths generally as the rate of unemployment in the country keeps increasing. The findings and results indicated that the reason or what motivated the student entrepreneur was majorly passion, self dependent and financial challenges. In terms of relevance, the results and findings show that to a large extent social media has a lot of relevance and impact to student entrepreneurship drive. The usage of social media generally among the student entrepreneurs has increased their marketing skills and creates wide range of customers.

REFERENCE

Acs, Z. J., Desai, S., & Hessels, J. (2008). Entrepreneurship, economic development and institutions. *Small business economics*, *31*(3), 219-234.

Adu, E., & Tella, A. (2013). A comparison of social networking sites use among undergraduate students in two selected African Universities: University of Ilorin, Nigeria and BA ISAGO University College, Botswana. In *Society for Information Technology & Teacher Education International Conference* (pp. 5170-5176). Association for the Advancement of Computing in Education (AACE).

Akhuemonkhan, I. A., Raimi, L., & Sofoluwe, A. O. (2013). Entrepreneurship education and employment stimulation in Nigeria. *Journal of Studies in Social Sciences*, *3*(1).

Akpan, E. I., Effiong, S. A., & Ele, A. A. (2012). Entrepreneurship education policy: An intervention strategy for economic development in Nigeria. *Business & Entrepreneurship Journal*, *1*(1), 101-110.

Albarran, A. B. (Ed.). (2013). *The social media industries*. Routledge. Pp 4

Ali, F. A., & Aliyu, U. Y. (2015). The Use of Social Networking among Senior Secondary School Students in Abuja Municipal Area of Federal Capital Territory, Nigeria. *Journal of Education and Practice*, *6*(15), 15-22.

Al-Rahmi, W., & Othman, M. (2013). The impact of social media use on academic performance among university students: A pilot study. *Journal of information systems research and innovation*, *4*(12), 1-10.

Ani, O. E. (2010). Internet access and use: A study of undergraduate students in three Nigerian universities. *The Electronic Library*, *28*(4), 555-567.

Armstrong, G., Kotler, P., Merino, M. D. J., Pintado, T., & Juan, J. M. (2011). *Introducción al marketing*. Pearson.

Autio, E., & Acs, Z. J. (2007). Individual and country-level determinants of growth aspiration in new ventures. *Frontiers of entrepreneurship research*, *27*(19), 2.

Bolton, R. N., Parasuraman, A., Hoefnagels, A., Migchels, N., Kabadayi, S., Gruber, T., ... & Solnet, D. (2013). Understanding Generation Y and their use of social media: a review and research agenda. *Journal of Service Management*, *24*(3), 245-267.

Boumarafi, B. (2015). Linking library profession and the market place: Finding connections for the library in the digital environment. *QScience Proceedings*, (2015), 4.

Camilia, O. N., Ibrahim, S. D., & Dalhatu, B. L. (2013). The effect of social networking sites usage on the studies of Nigerian students. *The International Journal of Engineering and Science (IJES), Nigeria*, 39-46.

Edwards, S. M. (2011). A social media mindset. *Journal of Interactive Advertising*, *12*(1), 1-3.

Eke, H. N., & Odoh, N. J. (2014). The use of social networking sites among the undergraduate students of University of Nigeria, Nsukka. *Library Philosophy and Practice*, 0-1.

Ezeah, G. H., Asogwa, C. E., & Obiorah, E. I. (2013). Social media use among students of Universities in South-East Nigeria. *IOSR Journal of Humanities and Social Science (IOSR-JHSS)*, *16*(3), 23-32.

Ezeani, C. N., & Igwesi, U. (2012). Using social media for dynamic library service delivery: The Nigeria experience.

Fruhling, A. L., & Digman, L. A. (2000). The impact of electronic commerce on business-level strategies. *Journal of Electronic Commerce Research*, *1*(1), 13.

Giles, G., & Price, I. R. (2008). Adolescent computer use: Approach, avoidance, and parental control. *Australian journal of psychology*, *60*(2), 63-71.

Hall, N. (2014). The Kardashian index: a measure of discrepant social media profile for scientists. *Genome biology*, *15*(7), 424.

Hanna, R., Rohm, A., & Crittenden, V. L. (2011). We're all connected: The power of the social media ecosystem. *Business horizons*, *54*(3), 265-273.

Hashim, N. A. B. (2017). Embracing the Instagram Waves–The New Business Episode to the Potential Entrepreneurs. *Journal of Entrepreneurship and Business Innovation*, *4*(2), 13.

Heffner, T. M. (2016). *The effects of social media use in undergraduate students*. Rowan University.

Hessels, J., Van Gelderen, M., & Thurik, R. (2008). Entrepreneurial aspirations, motivations, and their drivers. *Small Business Economics*, *31*(3), 323-339.

Http://www.ncc.gov.ng/

Jagongo, A. O., & Kinyua, C. (2013). The social media and entrepreneurship growth (A new business communication paradigm among SMEs in Nairobi).

Mangold, W. G., & Faulds, D. J. (2009). Social media: The new hybrid element of the promotion mix. *Business horizons*, *52*(4), 357-365.

Marchand, J., & Sood, S. (2014). The alchemy of student entrepreneurs: towards a model of entrepreneurial maturity. *International Journal of Entrepreneurship and Innovation Management*, *18*(1), 75-92.

Maymann, J. (2008). *The social metropolis*. GoViral.

Mikalef, P., Giannakos, M., & Pateli, A. (2013). Shopping and word-of-mouth intentions on social media. *Journal of theoretical and applied electronic commerce research*, *8*(1), 17-34.

Park, J. Y., Sung, C. S., & Im, I. (2017). Does Social Media Use Influence Entrepreneurial Opportunity? A Review of its Moderating Role. *Sustainability*, *9*(9), 1593.

Parra-López, E., Bulchand-Gidumal, J., Gutiérrez-Taño, D., & Díaz-Armas, R. (2011). Intentions to use social media in organizing and taking vacation trips. *Computers in Human Behavior*, *27*(2), 640-654.

Porter, M. E., & Michael; ilustraciones Gibbs. (2001). Strategy and the Internet.

Raacke, J., & Bonds-Raacke, J. (2008). MySpace and Facebook: Applying the uses and gratifications theory to exploring friend-networking sites. *Cyberpsychology & behavior*, *11*(2), 169-174.

Serarols-Tarrés, C., Padilla-Meléndez, A., & del Aguila-Obra, A. R. (2006). The influence of entrepreneur characteristics on the success of pure dot. com firms. *International Journal of Technology Management*, *33*(4), 373-388.

Shokery, N. M. B. A. H, Nawi, N. B. C., Nasir, N. A. B. M, Mamun, A. A. (2016).Factors contributing to the acceptance of social media as a platform among student entrepreneurs: A Review. Mediterranean *Journal of Social Sciences*, *7(*2), 42-51.

Smith, P. R., & Taylor, J. (2004). *Marketing communications: an integrated approach*. Kogan Page Publishers. Pp20

Sokoya, A. A., Onifade, F. N., & Alabi, A. O. (2013). Establishing connection and Networking; The Role of Social Media in Agricultural Research in Nigeria. World Library and Information Congress.

Subrahmanyam, K., & Lin, G. (2007). Adolescents on the net: Internet use and well-being. *Adolescence*, *42*(168), 659.

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MOBILE BASED TEST (MBT) SYSTEM

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ABSTRACT

Today, dozens of admissions, placement, certification, and licensure testing programs are administered on computer, with the number growing each year. Hundreds of schools or districts employ Computer Based Tests (CBT) in a formative or diagnostic role in service of instruction. It is an efficient way for test sponsors to provide a secure, consistent environment for certification and licensure while significantly enhancing the candidate experience. The goal of this paper is to design and implement a secure Mobile Based Test (MBT) system like the CBT but portable.

1. INTRODUCTION

Assessment is a fundamental activity in the learning process because it does not only evaluate learners' knowledge, understanding, abilities and skills but also it can be used to evaluate the learning outcome itself, advancing through appropriate feedback mechanisms the learning procedure.

It is admitted today that the challenges faced with Pencil-Paper Test (PPT) or Paper based test and Computer Based Test is overwhelming. They include but not limited to exam malpractice, inaccuracy in marking, delay in marking results, limited computers, and time constraint. These challenges do not help in the growth of the education sector in Nigeria. Although, Computer Based Test are more economical and accurate, it is sometimes faced with the problem of limited resources, the primary resources being electricity, limited computer, very few man-power.

These challenges can be sub mounted by using the proposed Mobile Based Test (MBT) system Examination bodies such as the Joint Admission and Matriculation Board (JAMB) which use CBT systems extensively can adopt this Secured MBT. The aim of this research project is to design and implement a secure MBT system. Specific objectives of this research paper are to: (i) develop a secure MBT system powered by Android OS with similar features as those enjoyed by CBT system, (ii) develop a system

with enhanced security features to avoid exam malpractice, (iii) design a system with real time processing of questions and timely submission of tests.

This study covers the design and implementation of a secure mobile-based test system, using the Android OS as a platform, Java Programming Language as its development language and CBT interface from the University of Ilorin as a case study.

2. REVIEW OF RELATED LITERATURE

A large body of literature already exists on online assessment using computers and paper. For example, Hwang and Chang (2011) conducted an experimental study to compare speed and performances differences among CBTs and PPTs. In the experiment fifty-five undergraduate students enrolled in the subject of educational psychology, participated in the studies which were already familiar with CBTs. Both CBTs and PPTs contained 30 MCQs items with 35 minute of time limit. The findings observed that undergraduates completed the CBT faster than PBT with no difference in scores.

Research outcomes have thus supported the fact that when students are motivated and testing conditions are equivalent, there are no differences between the scores obtained via CBT or PPT. At the University of New South Wales, Sydney studied the effect of online formative assessment on learning. The outcomes support the contention that integrated well designed online formative assessments can have significant positive effects on learning. Web based formative assessments also support equity and inclusiveness by allowing students to attempt each assessment anonymously on multiple occasions at any time (Wu , J, and Zhang, Y. 2010.).

The interest in developing and using MBT in educational assessment in schools and educational institutions has been increased in recent years. A MBT may be a simple transfer of the paper format onto the screen of the mobile device. Furthermore, more sophisticated methods can be implemented with the use of multimedia and adaptation techniques. Many studies implement nowadays adaptive personalized approaches to mobile learning exploiting learner, location and other contextual information adaptations (Hwang and Chang 2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. However, there are not enough studies that evaluate the use of mobile devices for testing compared to CBT, WBT or PBT and inconclusive results have been reported regarding exam performance.

3. METHODOLOGY

Conventionally, a mobile based test application stores its data on the local device storage and due to the nature of the open-ness of mobile technology, this technique exposes the data to whoever knows where to look. To maintain the security enjoyed by CBT systems,

this project research proposes a new way, technically another way, a way similar to what the popular software version control system ***git*** uses.

The development of this application is done primarily with Java programming languages and other open-source libraries for maintaining maximum security. At the launch of the application, a small registration process takes place. Just a simple login to secure the application users from third-parties. On successful completion of the registration, if it doesn't exist already, a user is asked to obtain a link to the remote "repository" that will serve as a gateway to getting the information needed. The data on the other end of the link contains the guide to the questions and (or) answers, time, security level and their metadata that have to be followed by the application. Hard-coding these constraints into the application would leave no room for flexibility, genericity and composability of the system.

4. THE PROPOSED MBT SYSTEM

4.1 Architecture of The System

The proposed system is expected to be a close companion or partial replacement to the current Computer Based Test being in use. It is mainly based on the system analysis, the architecture used for the system is a 3 tier Client/Server Architecture where a client uses an Android Application to access the online questions and some other housekeeping information provided by the system within or outside the local area network of the school.

The data tier maintains the applications data such as student data, teacher data, timetable data etc. It stores these data in a relational database management system. The middle tier (web/application server) implements the business logic, controller logic and presentation logic to control the interaction between the application's user and the system. The controller logic processes client requests such as setting and obtaining question information, providing answers, viewing results and requesting user information from the database. Business rules enforced by the business logic dictate how users can and cannot access application data and how the applications process data. The system requires a web server such as FreeBSD. HTTPS is used to transfer data across an Intranet or the Internet. It is the standard secure protocol for moving data securely across the internet. The client tier is the applications user interface containing data entry forms and client side applications. It displays data to the user. Users interact directly with the application through user interface. The client tier interacts with the web/application server to make requests and to retrieve data from the database. It then displays to the user the data retrieved from the server.

Figure 3.1 depicts the architecture of the proposed MBT system. It consists of web based server system serving a desktop client used by examiners to set assessment questions and their solutions. The Desktop client system also assists units and officials to

get or view status and report on students' achievement and progress. The system automatically generate results based on the answers set during the course's setup by the examiner. The server runs on a networked environment on any Operating System. The client/server architecture of the system enables different clients to connect to the server remotely through Internet connection.

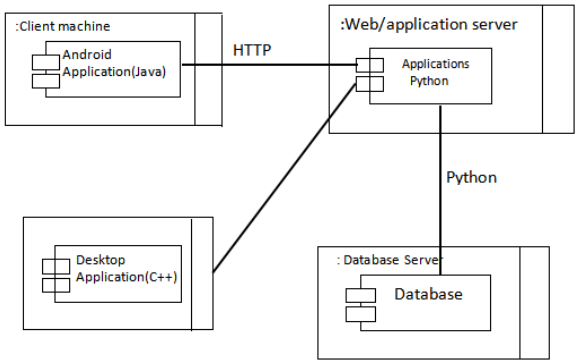


Figure 3 Deployment Diagram of the Proposed System

The system has two applications to be developed that depends solely on the same web server --a cross-platform desktop application and an android application. The server side is a Python application carefully crafted to work on a FreeBSD server, using PostgreSQL as its database engine. The administrative client is a C++ application for major popular operating systems such as Windows, Linux and Mac OS. The Android application written entirely in Java is a application that runs on Android OS for devices with version 4.0 and above.

4.2 Implementation

The front end of this application was developed using Java, while the server was deployed with Python. The interaction between these parts was achieved using the open web standard interface called JSON.

4.2.1 Administration Registration Module

One of the basic modules of this application is the administrator's registration module(for the Desktop client). This module enables prospective administrators perform registration in order to be able to add repositories, set questions and answers and perform other operations. After filling the admin registration profile form, the information supplied by the user are moved by desktop client to the server managing the database. Once the user is successfully registered, the administrator may then sign in into their account and proceed to perform any administrative operations like adding

other administrators, setting new questions/answers, update/removing existing questions/answers, checking results, adding/removing repositories etc.

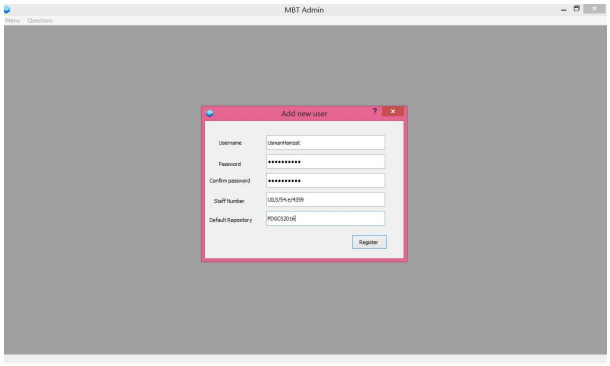


Figure 3.2: Examination Available

4.2.2 The Android Application

The Android application, the user is first presented with a list of cached(stored) repository names and their URL. The user can use any of their saved repositories to obtain the questions set by their examiners. When the URL has been selected, the user is presented with a list of examinations for the day as shown in Figure 2. The presented courses can be of two types, as specified by the examiner, it can specified to be a free test (which requires no login) and examinations (which requires unique login process). If a paper is specified to be "Login Required," then the user is presented with Sign In prompt.

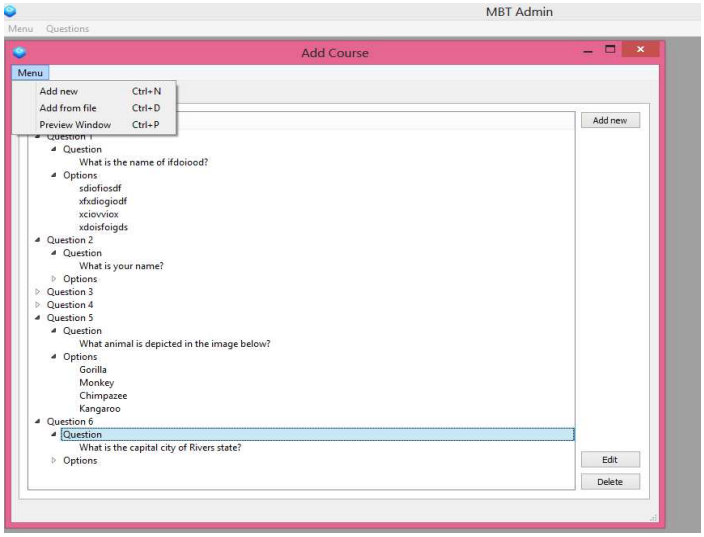


Figure 3.3: Examination Available

Thereafter, the user can start the examination, each examination has a unique timer which keeps the use in check. The user can freely navigate the questions one after the other as seen in the figure above.

5. CONCLUSION

In this study, we developed a system that may be used hand-in-hand with- or as a replacement for the popular Computer Based Test system. This system makes use of the technology behind the version control system.The Mobile Based Test System is designed for ease of usability, portability, efficiency and effectiveness.

REFERENCES

Browning, J. (1990):A Curriculum for Change. The Economist, 16 June

Bush, T., Glatter, R., Goodey, J. and Riches, C. (eds.) (1980) Approaches to School Management. London: Harper and Row

Bugbee, Jr., A. C. and Bernt, F. M. 1990. Testing by computer: Findings in six years of use 1982-1988. Journal of Research on Computing in Education, 23, 87-101

Hwang, G.J., and Chang. H., F. 2011. A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students, Computers & Education, 56, 1023–1031

Masri, A.A. 2012. Using Mobile Phone For Assessing University Students in English Literature in Jordan. Orlando International Academic Conference, Orlando, FL, USAand Muhanna, W. 2011.

Romero, C., Ventura, S., and De Bra, P. 2009. Using Mobile and Web-Based Computerized Tests to Evaluate University Students, Computer Applications in Engineering Education, 17(4), 435–447.

Segall, N., Toni, L., Doolen, J., and Porter, D. 2005. A usability comparison of PDA-based quizzes and paper-andpencil quizzes. Computers & Education, 45(4),417–432

Treadwell, 2006. The usability of personal digital assistants (PDAs) for assessment of practical performance. Medical Education, 40 (9), 855–861.

Schroeders, U. and Wilhelm, O. 2010.Testing Reasoning Ability with Handheld Computers, Notebooks, and Paper and Pencil , European Journal of Psychological Assessment, 26(4)

Wu , J., and Zhang, Y. 2010. Examining potentialities of handheld technology in students' academic attainments Educational Media International, 47(1), 57–67

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THE JOURNEY OF 5G MOBILE COMMUNICATION NETWORKS

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ABSTRACT

It is expected by 2020 5G cellular technologies will be rolled out, and it is expected to provide higher data rate, reduces end-to-end delay, ultra-low energy consumption and interconnects to other existing and emerging technology (autonomous systems). Different working groups have proposed different template that will suite 5G cellular network, but these can only be achieved by harmonizing all these standards, policies and regulations to achieve this goal. This study focused on how existing mobile cellular technologies can be fused into the proposed 5G cellular technology and highlight key challenges that will be experienced from planning phase to full deployment phase.

***Keywords**: Second generation, Third Generation, Fourth generation, Fifth Generation, Point-to-Point, Software Defined Radio*

1. INTRODUCTION

The need to explore new frontier of radio spectrum globally is a hot topic in order to cope with the exponential increase of data usage. It is expected that by year 2020 the numbers of connected devices will be 50 Billion and the volume of data traffic per year will be between (300- 420) Exabyte's amounting to (25-50) % increase (Ancans, Bobrovs, Ancans, Kalibatiene, et al., 2017)(Cisco, 2012)(Osseiran et al., 2014). The current consumer trends are shifting from voice oriented traffic to data driven traffic with the emergence of smarter phones to satisfy services like video gaming, multimedia streaming, video conferencing ,VoIP(Voice over Internet Protocol), making technology advancement to move at an extremely fast pace.

Therefore data-centric users have taking the bull-horn to push technology to provide for their needs which includes faster data rate to download or upload and gaming experiences, extremely low latency for their real time applications, reliability connection for critical services , low energy consumption devices and low cost smart devices. It is expected, that by 2021, Middle East and Africa CARG (Compound Annual Growth Rate) would have increase by 65% indicating that these regions will be the fastest growing mobile data traffic user (Cisco, 2012).

Expected growth explained in(Cisco, 2012) shows that 4G (fourth Generation) won't be able to cater for such services which triggered researchers and the industry at large to envisage on creating another generation of network called NGN(Next Generation Network) or 5G (fifth Generation) Network(Ancans, Bobrovs, Ancans, Kalibatiene, et al., 2017).

Therefore this paper will be focusing on key challenges facing deployment of 5G cellular networks, and how diverse development by researchers can be integrated to meet 5G requirements.

The rest of this paper is organized as follows. Section II discuss the background study while section III discusses the challenges facing the reliability of 5G networks and section IV discusses the challenges, proposed solutions and conclusions.

2. EVOLUTION OF MOBILE CELLULAR TECHNOLOGIES FROM 1G TO 5G

Mobile cellular communications have been in existence for over 30 years. The mobile industry started with the first wireless technology called First Generation (1G) which was first of it's kind to implement the cellular concept(Panwar, Sharma, & Kumar, 2016) (Bhalla & Bhalla, 2010). During this time there were no concrete standardization countries like USA was using AMPS (Advanced Mobile Phone System), Russia and other eastern European countries were using NMT (Nordic Mobile Telephone), United Kingdom were using TAC (Total Access Communication System) to mention a few. Issues such has handover management, interference, coverage, poor capacity, QoS (Quality of Service) and standardization did not allow this technology to spread(Panwar et al., 2016) (Bhalla & Bhalla, 2010) see Table 1.

Second Generation (2G) cellular network was developed to answer issues encountered in 1G. ETSI (European Telecommunication Standards Institute) developed what is now known as GSM (originally called Group Special Mobile but translated as Global System for Mobile Communication) which was first deployed in Finland in 1991(Panwar et al., 2016) (Bhalla & Bhalla, 2010) [6]. GSM used a combination of FDMA (Frequency Division Multiple Access) and TDMA (Time Division Multiple Access) as its multiple access technique and transmitted signal using digital signal in a circuit switched system see *Figure 1*. While the Americans were busy developing CDMA which was using spread spectrum based technology which showed a more promising advantage, there

were three lines of development of the 2G system in the United States of America. The first, introduced in 1991, was the IS-54 (North America TDMA Digital Cellular), with a new version supporting additional services (IS-136) introduced in 1996. Meanwhile, IS-95 (CDMA One) was deployed in 1993(Chen, 2003).

Later technologies like GPRS (General Packet Radio Service), EDGE (Enhanced Data rates in GSM Environment), and HSCSD (High Speed Circuit Switched Data) were developed to enhance services provided by GSM (see *Table 1* and *Figure 1*). Limitations encountered by 2G were few but includes, better mobility management that is soft handover, higher data rate, interoperability between 2G cellular networks, roaming and poor standardization.

Third Generations (3G) was developed to solve limitations in 2G and proffer better services. IMT-2000 (International Mobile Telecommunications) was created to unify all standards and work together to build 3G cellular network. ITU (International Telecommunications Union) created WCDMA (Wideband Code Division Multiple Access) while ETSI in Europe created UMTS (Universal Mobile Telecommunications Services). 3G networks was developed to provide a unified standardization, backward compatibility with GSM , multimedia services, roaming, higher data rate as compared to 2G, vehicular user experience, better network coverage, softer handover ,high speed packet data rate and larger capacity (Bhalla & Bhalla, 2010) [6] (Chen, 2003) (Prasad, R., Mohr, W., Konhauser, 2000) see *Table 1* and *Figure 1*.

Later, IMT-2000 then divided the standardization into two groups: 3GPP (3G partnership project) for WCDMA standard which will be backward compatible with GSM, GPRS systems and 3GPP2 (3G Partnership Project for CDMA 2000 standard) which will provide a backward compatibility of older CDMA technologies such as IS-95 (Prasad, R., Mohr, W., Konhauser, 2000).

With the advent of Internet Protocol (IP) standard acceptability in telecommunication industry, the need to for mobile technology to adopt this standard was pertinent, after all packet switched technology has being able to provide a significant revolutionary change in mobile internet usage. Fourth Generation (4G) was developed to meet IMT-Advanced specifications(Ancans, Bobrovs, Ancans, & Kalibatiene, 2017), which were IP based packet switched network, backward compatibility with existing cellular technologies and wireless standards, spectral efficient, seamless connectivity and global roaming, data rate up from 100Mbps to 1Gbps, higher QOS , support broadband services (Panwar et al., 2016) (Bhalla & Bhalla, 2010)(Wang et al., 2014)(Intelligence, 2014) see *Table 1* for details and *Figure 1* for system architecture. LTE-A (Long Term Evolution Advance) system is a 3GPP LTE Release 10 (Cao, Ma, Li, Zhang, & Luo, 2014)(Ergen, 2009)(Paradisi, Figueiredo, Yacoub, & Tronco, 2016) which is an IP-based network, compatible with other existing network, focusing more on reducing the network architecture for 4G cellular network as shown in *Figure 1*. LTE-A provides better security, higher date rate, better spectral efficiency, interconnectivity to HetNet (Heterogeneous Networks), support data-centric users, flexible radio planning as

compared to other existing technologies. Other features for LTE-A cellular system are Carrier Aggregation, Multiple Input Multiple Output, and Coordinated Multi Point (CoMP) operation(Cao et al., 2014)(Nakamura, 2009). 4G mobile technology had limitations which were end-to-end (E2E) delay for real-time services, handoff delay, security, poor battery life, coverage and connection cost (Ancans, Bobrovs, Ancans, Kalibatiene, et al., 2017)(Martin & Amin, n.d.) (Intelligence, 2014)(Mitra & Agrawal, 2016) .

Fifth Generation (5G) is the next generation network in focus to solve many of the limitations being encountered in 4G. 5G Mobile Technology which is expected to be rolled out by 2020 is attracting researchers, academics, industries, and government at large (Osseiran et al., 2014) (Ancans, Bobrovs, Ancans, & Kalibatiene, 2017) [(Intelligence, 2014) (Mitra & Agrawal, 2016) (Massaro, 2017)(Hossain & Hasan, 2015). It's being expected that by 2020 the total number of connected device should be over 50 billion(Ancans, Bobrovs, Ancans, Kalibatiene, et al., 2017) (Mitra & Agrawal, 2016). It can be shown from figure 2, the world data traffic growth as at 2016 was 67% (Cisco, 2012) while figure 3 indicates world internet usage as at 2017 was 66.3% ("World Internet Users Statistics and 2018 World Population Stats," n.d.). With this exponential increase of data usage different groups which will be mentioned later has been working tirelessly to meet the demand.

5G by IMT-2020 is expected to have the following characteristics(Osseiran et al., 2014) (Mitra & Agrawal, 2016) (Ericsson, 2016)(Mohammed, Huq, Mumtaz, Rodriguez, & Telecomunicaç, 2017)(Akyildiz, Nie, Lin, & Chandrasekaran, 2016) as shown in Figure 4:

- Below 1ms E2E latency
- Support other technologies such as P2P (Point-to-Point) communications, Internet of Things (IoT), SDR (Software Defined Radio)
- Larger bandwidth
- Higher data rate (1-10) Gbps
- Backward compatibility with existing mobile technologies
- Very low energy consumption
- High reliability to support critical services such as Fire Service, Police, Military, Ambulance Services
- Larger coverage area
- Better mobility management i.e. seamless handoff amongst existing wireless technologies

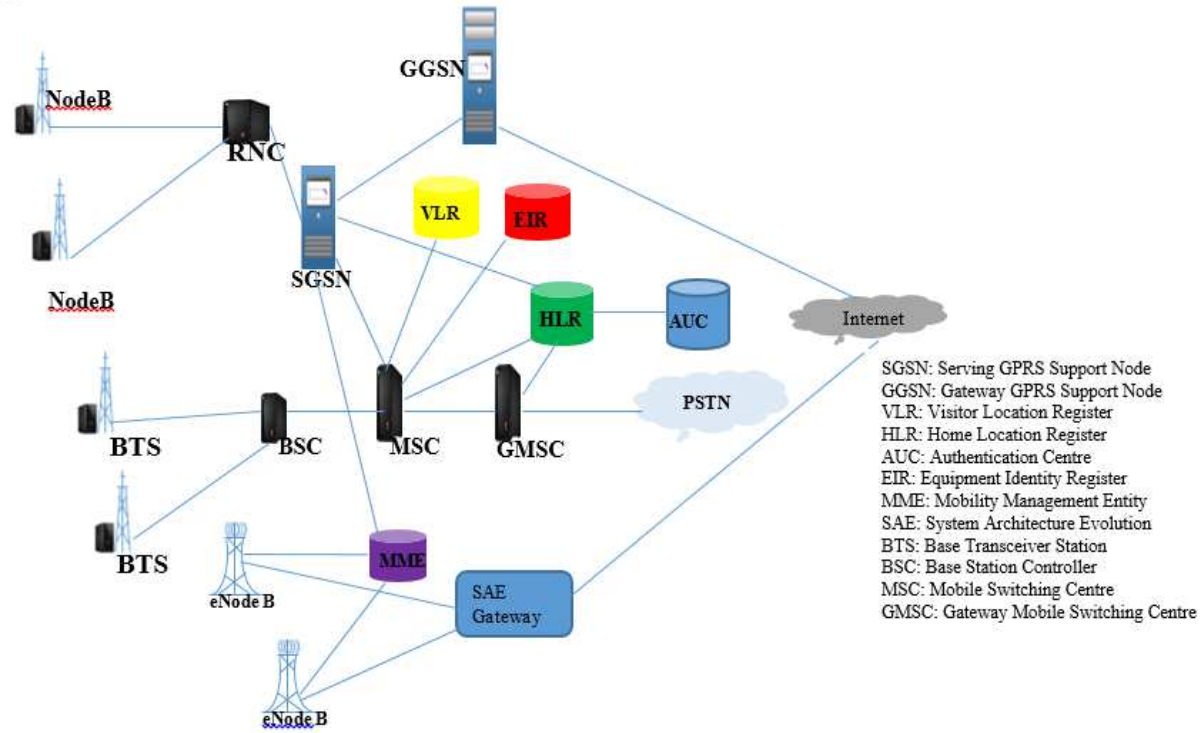


Figure 1: 2G/3G/4G Cellualar Architecture

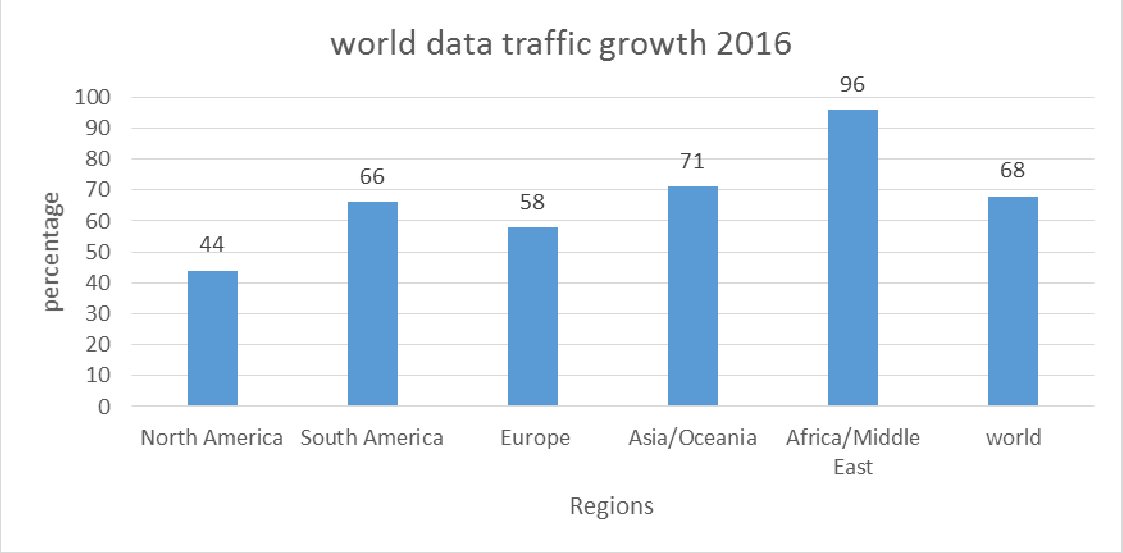


Figure 2 : 2016 world data traffic growth ("World Internet Users Statistics and 2018 World Population Stats,")

2. 5G MOBILE NETWORKS

This section will focus on current research group's activity and their achievements, system architecture, key challenges, possible solutions.

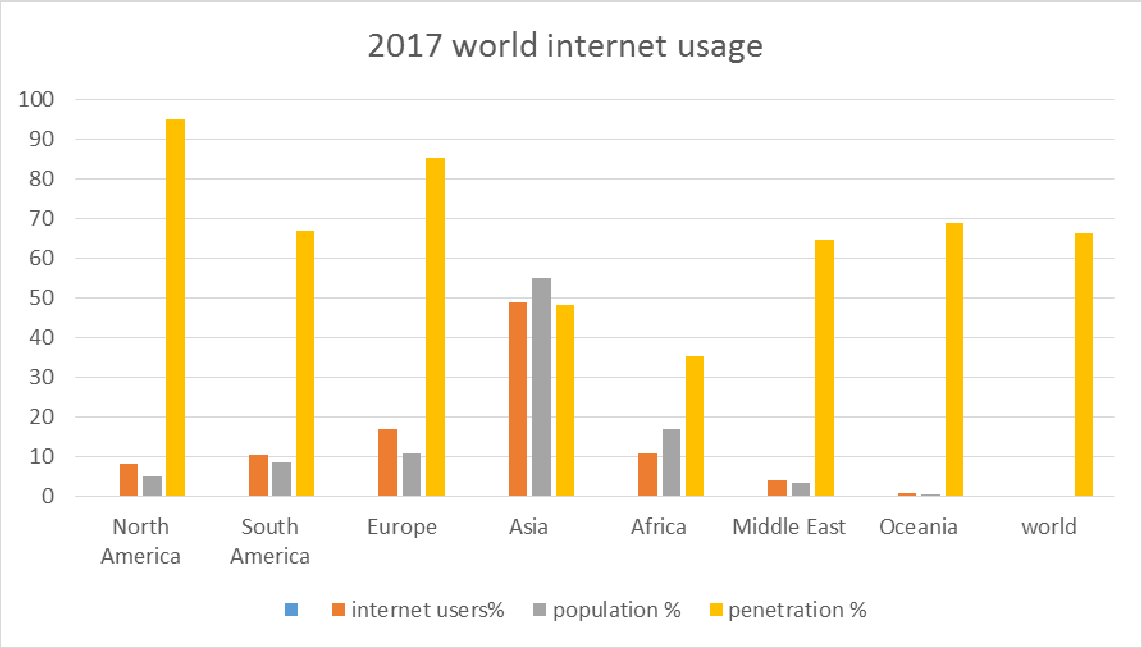


Figure 3: 2017 world internet usage as per population

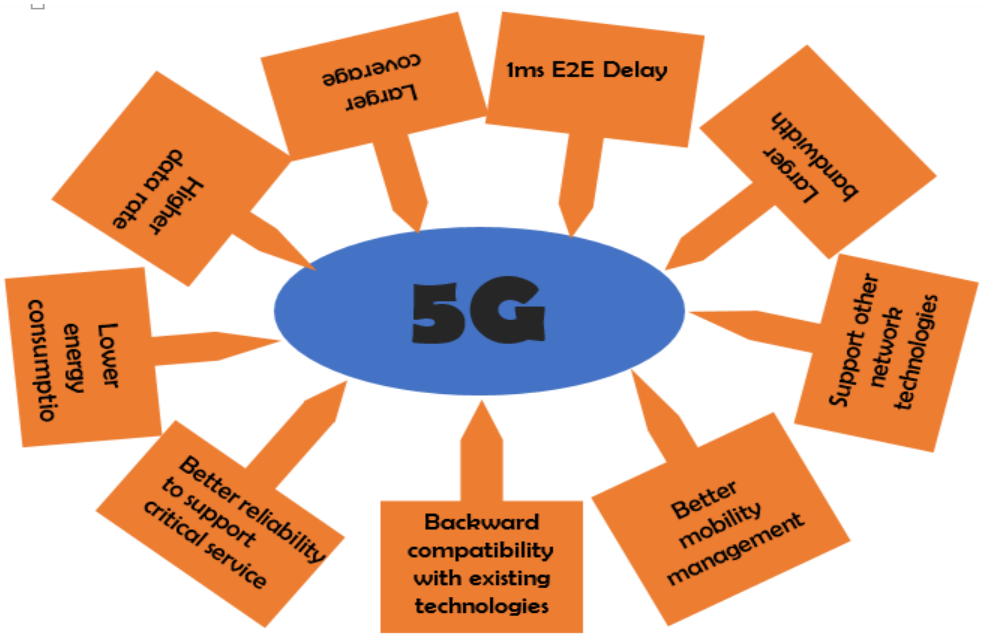


Figure 4: 5G mobile Technology characteristics

Table 1: Summarized mobile cellular generations

Generation	**1G**	**2G**			**3G**	**4G**
Year Deployed	1980's	1991			2001	2012
Data rate	2.4Kbps	9.6Kbps	115 Kbps	(80-100) Kbps	384Kbps (Outdoor) – 2Mbps (Indoor)	Up to 50Mbps
Services provided	Voice only	Voice, SMS,	Voice, SMS,MMS,WAP	Voice, SMS,MMS,WAP	Voice, data and multimedia service	Voice, data and multimedia, Mobile broadband service
Modulation technique	Binary FSK	GMSK	GMSK	QPSK	DPSK & BPSK	OFDM/MIMO
Multiple access techniques	FDMA	FDMA and TDMA	TDMA	TDMA (1S-136) CMDA	DS-CDMA	Uplink: SC-FDMA Downlink:OFDMA
Bandwidth	40MHz	25MHz	aries	aries	5MHz	20MHz or 40MHz
Transmission mode	Analog	Digital signal	Digital signal	Digital signal	Digital Signal	Digital Signal, IP Based
System Architecture Components	MTSO, Land Station	BTS,BSC, MSC,AUC, EIR,GMSC HLR,VLR	SGSN, GGSN	BTS,BSC, MSC,AUC EIR,VLR, GMSC, HLR	NodeB, RNC	eNodeB,MME, SAE gateway, SGW,PCRF,HSS
Technologies	AMPS, NTT,TAC	GSM	GPRS, EDGE, HSCSD	IS-54, IS-136). IS-95	WCDMA, UMTS, CDMA 2000 (1xRTT, EVDO), HSDPA,HS	WiMAX, LTE-A

					UPA,LTE	

3. CURRENT RESEARCH GROUPS ACTIVITIES

Various research groups such as**.** METIS (Mobile and Wireless communication enablers for the twenty-twenty Information Society), 5GNOW (5th Generation Non-Orthogonal Waveforms for Asynchronous Signalling), EM-PhAtiC (Enhanced Multicarrier Technology for Professional Ad-Hoc and Cell-Based Communications), NEWCOM (Network of Excellence in Wireless Communications), 5GPPP (5G Infrastructure Public Private Partnership), ETRI (Electronics and Telecommunications Research Institute), 5GIC (5G Innovation Center), NYU WIRELESS are currently working on different aspects of 5G cellular network (see Table 2 for further details):

Table 2: 5G research group activities

	Research Group	Research activities
	METIS	METIS published in 2015, final report, which consists of system architecture, channel models, technology component. METIS consist of telecommunication companies, such as NSN, Ericsson, T-Mobile, Docomo, and Orange, and academic institutions, such as the Royal Institute of Technology in Stockholm (KTH), Poznan University of Technology, Kaiserslautern University of Technology, Polytechnic University of Valencia, and University of Oulu, as its partners(Osseiran et al., 2014) (Mitra & Agrawal, 2016). They proposes 5G KPI's (Key Performance Indicator) such as traffic volume per subscriber, traffic volume per area, average user data rate during busy hours, and actual user data rates. There simulation achieved E2E latency under 1ms, simulated environment were carried out at outdoor, indoor, shopping mail and stadiums. Currently METIS is working on METIS II standardization, and overall 5G RAN architecture design(Osseiran et al., 2014) (Mitra & Agrawal, 2016).
	5GNOW	They are researching on achieving a frame structure, ultra-low latency and ultra-high reliability (Mitra & Agrawal, 2016). Currently they developed a signalling system called Gabor signalling which uses a combination of time and

		frequency shift of a short term Fourier Transform (STFT) (Mitra & Agrawal, 2016)
	EM-PhAtiC	EM-PhAtiC are exploring how to improve MIMO transmission, equalization, developing high flexibility filter-bank and multi-hop or relay based communication (Mitra & Agrawal, 2016). They researched on different schemes for MIMO transceiver for FBMC under Frequency selective channel (Mitra & Agrawal, 2016).
	NEWCOM	They are working on how they could form a bridge between 4G and 5G spectrum, multi-hop coding, mobile broadcasting, Cloud-RAN, localization with distributed antenna .Currently working on multi-hop coding, mobile broadcasting, signal processing for 5G, channel efficiency [12]
	5GPPP	5GPPP is a joint partnership between European Commission and European ICT (Information Communication Technology) industries (Mitra & Agrawal, 2016) (5GPPP Architecture Working Group, 2017) .Their aim is meet up with 5G criteria. They are currently working on more than 16 project air interface, system architecture, KPI's, management, RAN to mention a few(Mitra & Agrawal, 2016) (5GPPP Architecture Working Group, 2017) . June 2017, a white paper was release to end the first phase of their research which includes identifying design recommendations for 5G development and standardization (5GPPP Architecture Working Group, 2017).
	ETRI	**ETRI** is a Korean based global ICT research institute, which created a sub-group called 5G Giga Service Research Laboratory dedicated for 5G mobile communication technologies see (Mitra & Agrawal, 2016)("Introduction of Research Laboratory | 5G Giga Communication Research Laboratory | Organization | Welcome to ETRI," n.d.).Their key research interest is into mmWave (Millimeter Wave) communication and convergence technologies. They are researching on D2D communication, reliability and mobile hotspot network (MHN) protocol stack (Mitra & Agrawal, 2016)("Introduction of Research Laboratory | 5G

		Giga Communication Research Laboratory | Organization | Welcome to ETRI," n.d.)
	5GIC	Achieved 1Tbps speed for P2P communication, currently working on how to achieve the basic characteristics of 5G cellular networks
	NYU Wireless	**NYU Wireless** is an academic research group in collaboration with some technical partners in working on Next Generation Network (NGN) Technologies (Mitra & Agrawal, 2016)(Theodore S Rappaport, Sun, & Shafi, 2017)(T. S. Rappaport, 2014). They have extensively conducted experiments on mmWave propagation models and path loss at different millimetre frequency bands in New York and Austin (Mitra & Agrawal, 2016).

4. KEY CHALLENGES AND POSSIBLE SOLUTIONS

In this section, the focus will be highlighting key challenges facing 5G mobile technology deployment and possible solutions.

A. Spectrum Usage

Many literatures have highlighted that though the spectrum is scarce but truly under-utilized (Faruk et al., 2016). From resolution 238, World Radio Conference (WRC-2015) report shows that 11 mmWave frequencies bands (24.25–27.5GHz; 31.8 GHz–33.4 GHz; 37 – 40.5GHz;
42.5GHz -43.5GHz;45.5GHz – 47GHz; 47 GHz- 47.2GHz; 47.2 GHz – 50.2 GHz; 50.4GHz – 52.6GHz; 66 GHz- 76 GHz; 81 GHz– 86 GHz) were highlighted as possible spectrum to be used(Mohammed et al., 2017)(Akyildiz et al., 2016)(Ancans, Bobrovs, Ancans, & Kalibatiene, 2017) while some researchers concluded that the existing spectrum bands below 6GHz can still be used for deployment of 5G (Ancans, Bobrovs, Ancans, & Kalibatiene, 2017)(Intelligence, 2014) (Theodore S Rappaport et al., 2017). It is worthwhile to note that mmWave band spans between 24 GHz -300 GHz.

Rappaport et al and METIS to mention a few have extensively worked on mmWave band spanning from propagation model to path loss model (Mitra & Agrawal, 2016)(Panwar et al., 2016). It is expected that by 2019 a concise propagation model will be available for deployment (Ancans, Bobrovs, Ancans, & Kalibatiene, 2017).

B. Radio Access Technology and Channel Modelling

Air Interface

New air interface will be required to be developed in order to meet 5G criteria and also coexist with other existing air interface being deployed (Ancans, Bobrovs, Ancans, Kalibatiene, et al., 2017)(Osseiran et al., 2014). 5GPP group proposed that different air interface and RAT (Radio Access Technology) should be reconciled at the MAC layer putting in mind that flexibility is key (5GPPP Architecture Working Group, 2017).FANTASTIC 5G considered a frequency –time resource allocation using a multi-service air interface(Mohammed et al., 2017) .

Frame Structure and Multiple Access Techniques

Immerse research work is being conducted in this area. 5GNOW which is an EU based research group considered a unified frame structures using both NOMA (Non-Orthogonal Multiple Access) and OFDM for both uplink and downlink. 5GNOW,METIS,5GPP t are currently working a wide range of waveforms which could be jointly considered and they are Filter Bank Based Multicarrier (FBMC), Universal Filtered Multicarrier (UFMC), Zero-tail Discrete Fourier Transform spread OFDM,NOMA, Generalized Frequency Division Multiplexing (GFDM) for more details see (Mohammed et al., 2017)(5GPPP Architecture Working Group, 2017).

Designing a realistic channel modelling

METIS proposed a WINNER II/+ channel model originally designed for below 6GHz band, . It extended its work using 3-D parameters, small scale considering (AOA, AOD propagation delay and power) and large scale like r.m.s delay spread. WINNER II/+ model is a 3D model with geometric polarization. GSCM doesn't full compliments continuous motion (non-stationary). Not suitable for P2P communications(Medbo et al., 2014) . COST 2100 Model which is similar to WINNERII model, modelled for scattered scenarios, it support spherical wave modelling but does take mobility into consideration not applicable to P2P , there is no fixed model for a particular scenarios for more details see (Verdone & Zanella, 2012)(Medbo et al., 2014).

Rapaport and other researchers at NYU conducted an extensive channel measurement for different mmWave frequencies at NY and Austin details can be found in (Theodore S Rappaport et al., 2017)(T. S. Rappaport, 2014).

Effective, realistic and extensive propagation model at different mmWave frequency bands and below 6GHz band for outdoor, indoor, dense, less dense, stationary and vehicular environment needs to be harmonised. Bearing in mind, that propagation model is environment dependent, the need to model different scenarios for a longer period using different modelling techniques should be key to development of propagation models.

C. Network Architecture (RAN and Core Network) and Network Convergence

One of the key characteristics of 5G is lower ultra-low energy consumption of UE, RAN and CN. RAN technology to be used will be a combination of physical and virtual infrastructure (Huawei, 2014)(5GPPP Architecture Working Group, 2017).Cloud RAN has been proposed to be the embedded into 5G to cater for service like cloud computing, software define network (SDN), network function virtualization (NFV), HETNET (Heterogeneous Networks). Network overhead is expected to be reduced at the BS (base station) consisting of low powered radio heads and antenna, also a centralized BBU (Base Band Unit) will be required. BBU will function as an intermediary between RRH and the CN, act as a transportation system for traffic flow (Mohammed et al., 2017)(Ancans, Bobrovs, Ancans, Kalibatiene, et al., 2017).

C-RAN will be in charge of Mobility management, congestion control, handoff management, security, QoS management, Resource management and reliability management for critical services(Mohammed et al., 2017)(5GPPP Architecture Working Group, 2017) . Deployment of C-RAN is going to be one of the most challenging aspect for 5G architecture in nearest future. It is expected that other newer technologies such as D2D, V2V,V2I,,P2P,M2M communication devices and IoT will be able to connect to this network(Intelligence, 2014)(Ancans, Bobrovs, Ancans, Kalibatiene, et al., 2017) . The use of very large antenna arrays or Massive MIMO for future base stations also should be explored (Wang et al., 2014).

D. Mobility and Interference Management

A new approach is being considered consisting of UE autonomous mobility, softer handover and mobility concept for URLLC() (5GPPP Architecture Working Group, 2017). It is expected that mobility management in intra-RAT, inter-RAT and multi-connectivity to different technologies will be seamless and less complex to achieve low energy consumption, higher data rate and ultra-low E2E delay(Intelligence, 2014) (5GPPP Architecture Working Group, 2017). Handoff between different RAT will require UE to select most suitable RAT without compromising QoS.

It is expected that managing interference between mobile technologies with other network technologies will require a new dynamic approach. This approach has to sense the spectrum and compute if the SINR (Signal-to-Interference Ratio) using CR (Cognitive Radio) technique to manage interference.

E. Privacy and Security

In 3G and 4G, certain security concerns were not addressed such as softwarization, virtualization, trust models which will be the core values of 5G systems(5GPPP Architecture Working Group, 2017). Consideration of attacks such as eavesdropping, man-in the middle attack, denial of service, impersonation, malicious attack on transfer of data needs to be addressed. Applying security control on all layers at 5G model is required, embedding softwarization and virtualization to the proposed security model to mitigate known and unforeseen attack(5GPPP Architecture Working Group, 2017).

In order to achieve ultra-low latency, present authentication mechanism used is unsuitable. Therefore, there is need to develop a fast, reliable, low complexity and efficient E2E authentication mechanism to achieve below 1ms, also authentication mode should be enhance right from the UE (User Equipment) to the core network.

5. CONCLUSION

In this study, we discussed in summary existing mobile technologies evolution and their limitations, reasons why 5G is required to meet future data traffic demands and highlight key challenges facing the deployment of 5G. In spite of various group working on 5G Cellular system, before year 2020, regulation, policies and standardization would have been agreed upon.

However, it is expected that by World Radio Congress 2019 (WRC-2019), remarkable milestone would have been achieved.

REFERENCE

5GPPP Architecture Working Group. (2017). *view on 5G architecture*. *white paper*. Retrieved from https://5g-ppp.eu/wp-content/uploads/2018/01/5G-PPP-5G-Architecture-White-Paper-Jan-2018-v2.0.pdf

Akyildiz, I. F., Nie, S., Lin, S., & Chandrasekaran, M. (2016). 5G roadmap : 10 key enabling technologies. *Computer Networks*, *106*, 17–48. https://doi.org/10.1016/j.comnet.2016.06.010

Ancans, G., Bobrovs, V., Ancans, A., & Kalibatiene, D. (2017). Spectrum Considerations for 5G Mobile Communication Systems. *Procedia - Procedia Computer Science*, *104*(December 2016), 509–516. https://doi.org/10.1016/j.procs.2017.01.166

Ancans, G., Bobrovs, V., Ancans, A., Kalibatiene, D., Osseiran, A., Boccardi, F., … Guizani, M. (2017). Ten 5G Challenges for Engineers to Overcome. *Procedia - Procedia Computer Science*, *104*(August), 1–11. https://doi.org/10.1016/j.dcan.2017.09.010

Bhalla, M. R., & Bhalla, A. V. (2010). Generations of mobile wireless technology: a survey. *International Journal of Computer Applications*, *5*(4), 7. https://doi.org/10.5120/905-1282

Cao, J., Ma, M., Li, I. H., Zhang, Y., & Luo, Z. (2014). A Survey on Security Aspects for LTE and LTE-A Networks. *IEEE Communication Surveys and Tutorials*, *16*(1), 283–302.

Chen, Y. (2003). Soft Handover Issues in Radio Resource Management for 3G WCDMA

Networks. 书, (September).

Cisco. (2012). Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2011–2016 [Visual Networking Index (VNI)]. *Cisco*, 2016–2021. https://doi.org/10.1109/SURV.2008.080403

Ergen, M. (2009). *Mobile Broadband including WiMAX and LTE*. Berkeley, CA, USA: Springer Science+Business Media. https://doi.org/10.1007/978-0-387-68192-4

Ericsson. (2016). 5G Radio Access. *White Paper*, (April), 10. https://doi.org/Uen 284 23-3204 Rev C | April 2016

Faruk, N., Bello, O. W., Sowande, O. A., Onidare, S. O., Muhammad, M. Y., & Ayeni, A. A. (2016). Large scale spectrum survey in rural and urban environments within the 50 MHz-6 GHz bands. *Journal of the International Measurement Confederation,Elsevier*, *91*(May), 228–238. https://doi.org/10.1016/j.measurement.2016.05.046

Hossain, E., & Hasan, M. (2015). 5G Cellular : Key Enabling Technologies and Research Challenges. *IEEE Instrumentation & Measurement Magazine*, *18*(3), 11–21.

Huawei. (2014). 5G : A Technology Vision. *Huawei, White Paer*, 1–16.

Intelligence, G. S. M. A. (2014). Understanding 5G : Perspectives on future technological advancements in mobile. *White Paper*, (December), 1–26.

Introduction of Research Laboratory | 5G Giga Communication Research Laboratory | Organization | Welcome to ETRI. (n.d.). Retrieved March 27, 2018,

Martin, J., & Amin, R. (n.d.). Limitations of 4G Wireless Systems.

Massaro, M. (2017). Next generation of radio spectrum management : Licensed shared access for 5G. *Telecommunications Policy*, *41*(5–6), 422–433.

Medbo, J., Börner, K., Haneda, K., Hovinen, V., Imai, T., Järvelainen, J., … Kusume, K. (2014). Channel Modelling for the Fifth Generation Mobile Communications. In *Antennas and Propagation (EuCAP), 2014 8th European Conference* (pp. 219–223).

Mitra, R. N., & Agrawal, D. P. (2016). 5G mobile technology : A survey ☆. *ICT Express*, *1*(3), 132–137. https://doi.org/10.1016/j.icte.2016.01.003

Mohammed, K., Huq, S., Mumtaz, S., Rodriguez, J., & Telecomunicaç, I. De. (2017). A survey of 5G technologies : Regulatory , standardization and industrial perspectives, (August), 1–11. https://doi.org/10.1016/j.dcan.2017.09.010

Nakamura, T. (2009). Proposal for candidate radio interface technologies for IMT-advanced based on LTE Release 10 and Beyond (LTE-advanced). In *ITU-R WP 5D 3rd Workshop on IMT-Advanced* (pp. 1–63).

Osseiran, A., Boccardi, F., Braun, V., Kusume, K., Marsch, P., Maternia, M., … Uusitalo, M. A. (2014). Scenarios for 5G Mobile and Wireless Communications : The Vision of the METIS Project, (May), 26–35.

Panwar, N., Sharma, S., & Kumar, A. (2016). A survey on 5G : The next generation of mobile communication. *Physical Communication*, *18*, 64–84. https://doi.org/10.1016/j.phycom.2015.10.006

Paradisi, A., Figueiredo, F. L., Yacoub, M. D., & Tronco, T. R. (2016). *Long Term Evolution: 4G and Beyond*. (A. Paradisi, F. L. Figueiredo, M. D. Yacoub, & T. R. Tronco, Eds.). Switzerland: Springer Science+Business Media. https://doi.org/10.1007/978-3-319-23823-4

Prasad, R., Mohr, W., Konhauser, W. (2000). *Third Generation Mobile Communication Systems* (First). Boston,United State of America: Artech House.

Rappaport, T. S. (2014). Millimeter Wave Cellular Communications: Channel Models Capacity Limits Challenges and Opportunities. In *Invited Talk, IEEE Comm. Theory Workshop*.

Rappaport, T. S., Sun, S., & Shafi, M. (2017). Investigation and Comparison of 3GPP and NYUSIM Channel Models for 5G Wireless Communications. In *IEEE 86th Vehicular Technology Conference (VTC Fall)* (pp. 6–11). Toronto, Canada.

Verdone, R., & Zanella, A. (2012). *Pervasive mobile and ambient wireless communications: COST action 2100*.

Wang, C.-X., Haider, F., Gao, X., You, X.-H., Yang, Y., Yuan, D., … Hepsaydir, E. (2014). Cellular architecture and key technologies for 5G wireless communication networks. *IEEE Communications Magazine*, *52*(2), 122–130. https://doi.org/10.1109/MCOM.2014.6736752

World Internet Users Statistics and 2018 World Population Stats. (n.d.). Retrieved March 26, 2018, from https://www.internetworldstats.com/stats.htm

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QUALITY OF SERVICE (QOS) EVALUATION OF MOBILE NETWORK SERVICES: A CASE STUDY ON THE FEDERAL POLYTECHNIC BIDA, NIGERIA

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ABSTRACT

The requisite for an assurance of telecommunication services is imperative as it establishes the relationship between perceptions and expectations of service delivered by a service provider. Mobile networks need to be under continues monitoring and control in order to maintain and improve the performance of services. In this paper, we examine and evaluate the quality of service of mobile network operators within the Federal Polytechnic Bida campus. This evaluation was undertaken using some KPIs of mobile network services. These KPIs are: Call Setup Time (CST), Call Setup Failure Rate (CSFR), Call Dropped Rate (CDR) and Call Completion Rate (CCSR). For the purpose of this study Drive test was performed using the Mobile Station (MS) software package called MyMobileCoverage Pro (MMC Pro). The result of the study revealed that the QoS provided by mobile network operators for mobile users is not sufficient, unreliable and unsatisfactory. The study also indicated that network accessibility and network retainability in the area being considered is poor. The study presents recommendations on how to improve the QoS of mobile network operators in the campus.

Keywords: *Quality of service, mobile network operators, telecommunication system, key performance indicators (KPIs), drive test.*

1. INTRODUCTION

Before the liberalization of Telecommunication system in Nigeria, the Nigerian Communication Commission (NCC) disclosed that Nigeria had a very limited telephone network for many years which made communication difficult and inaccessible. Over ten (10) million subscribers applied to be connected to the Telecommunication system, (NITEL), for services. Today, the story has changed dramatically with the lunched of

global system for mobile communication (GSM) in Nigeria in 2001 [8]. During its launching in 2001, the core objectives was to provide effective telecommunication services that will support good speech quality, roaming, spectral efficiency, minimized crosstalk, maximum handoff, minimum drop call and good interconnectivity [1]. Since then, the number of Mobile subscribers continues to grow in Nigeria; it grew from 400 lines in 2001 to 231.525 million lines of subscribers with the current active lines stand at 154.12 millions represent 66.57% and inactive subscribers at 77.41 million subscribers or 33.43% [11, 9, and 15]. Currently, there are four major wireless Mobile operators in Nigeria competing for mobile subscribers for Telecom services namely; Airtel, 9mobile, Globalcom and MTN. However, the unprecedented number of subscribers witnessed by the telecommunication industries has not help the situation as the subscribers are faced with one problem or the others among which is poor quality of service been provided by the mobile service providers. Telecommunication Subscribers in Nigeria have been complaining and suffering from bad quality of service (QoS), ranging from problem of network congestion, incessant dropped calls, failed calls, poor voice clarity, and failed handover, among others [3, 2]. How can we maintain a good, secure, uninterruptible wireless mobile network for disaster responses, military control, public health, safety, and law enforcement command in the face of Call Setup Failure, dropped call and poor voice clarity? How can the failed or dropped calls be minimized for everyone to enjoy the use of mobile communication effectively? Thus the need to tackle the problem of QoS on the mobile network is important, as this will both be of advantage to the operators and users [5].

Quality of Service (QoS) is defined as the degree and direction of difference between the customer (mobile users) perceptions and expectations of service delivered by a service provider [4, 12]. In telecommunication system, Network coverage, accessibility, retain-ability and connection quality are the four major factors used in evaluating quality of service (QoS) of a Mobile Network operator. Therefore, Mobile networks needs to be under continues monitoring and control in order to maintain and improve the performance of services. In finding the lasting solution to the problem of poor QoS, the NCC, an organization responsible for the regulation of Mobile services in Nigeria, on 6th July 2007 issued out the threshold levels on the key performance indicators (KPIs) for ascertaining QoS of all the Mobile Networks in the country [10]. For the purpose of this research focus is on Network accessibility and Network retainability.

2. REVIEW OF RELATED LITERATURE

Many research works had been carried out on quality of service (QoS) measurement, evaluation and performance on various KPI parameters of mobile network operators, causes and how to improve on such QoS. However, most papers focus on statistical network data collected from Network Operating Centre (NOC), administering of questionnaires on subscribers for analysis with few researches works on Drive Test models. [13] Presented Outgoing call quality evaluation of GSM services in Epe, Lagos

State. The researchers obtained data from the Network Operating Centre (NOC) for three GSM services operators, providing mobile services in Epe town, for a period of twenty three weeks. A model of service quality and a set of dimensions for comparative evaluation, which could provide useful directions to regulators and service providers, were developed. [14] Worked on determining the Drop call Rate, Failed Call Rate and Signal Strength of Celcom Mobile Network in the Universiti Tenaga National Putrajaya Campus. The Mobile Station application called MyMobileCoverage was used for the drive test which enables the mobile user to view current network coverage with the signal strength mapping with drop and fail calls information. It was concluded from the research that the QoS in the area was poor and need an improvement and recommendations were made by the researchers. The Mobile subscribers of mobile network all over the world as well as in Nigeria continues to face series of problem and poor QoS been provided by the mobile network operators in telecommunication industry. Besiege with the problem of poor QoS been faced by the subscribers gave rise to this study. Area where mobile services are mostly needed and useful for academic, economic and businesses purposes was selected. For the purpose of this research the Federal Polytechnic Bida, was chosen. The Federal Polytechnic Bida is located along Bida- Doko Road in Bida Local Government Area of Niger State, Nigeria and covers a land area of about 2 kilometer square.

3. QUALITY OF SERVICE KEY PERFORMANCE INDICATOR (KPI)

The QoS of any mobile network is been access and measure by the KPI. This research considered the following KPI parameters for evaluation; Call Setup Time (CST), Call Setup Success Rate (CSSR), Call Setup Failure Rate (CSFR), Call Drop Rate (CDR), and Call Completion Success Rate (CCSR). The KPI parameters on each network were calculated from the data obtained from the drive test using the following KPI equations defined by NCC. These are:

i. Call Setup Time (CST)

CST can be calculated from the data obtained from drive test using equations 1 and 2

Percentage of CST ($\leq$ 6s/E) = ($\sum$ calls $\leq$ 6s/ Attempted calls) $\times$ 100 (1)

Where CST ($\leq$ 6s/E) mean call setup time completed within six (6) second, E mean easy call

Percentage of CST ($\geq$ 6s/D) = ($\sum$ calls $\geq$ 6s/ Attempted calls) $\times$ 100 (2)

CST ($\geq$ 6s/D) mean call setup time completed after six (6) second, D mean difficult call

ii. Call Setup Success Rate (CSSR)

CSSR was also calculated using equation 3.

$$CSSR = \frac{Numberofunblockedcallattempts}{totalnumberofcallattempts} \quad (3)$$

iii. CALL SETUP FAILURE RATE (CSFR)

CSFR was calculated using the expression below

$$CSFR = \frac{\text{Number of blocked call attempts}}{\text{total number of call attempts}} \times 100 \quad (4)$$

iv. Call Drop Rate (CDR)

CDR was obtained using the equation 5

$$CDR = \frac{\text{Number of dropped call}}{\text{total number of call attempts}} \times 100 \quad (5)$$

v. Call Completion Success Rate (CCSR)

Finally, CCSR was calculated using the equation below.

$$CCSR = \frac{totalNumberofcompletedcalls}{totalnumberofcallattempts} \quad (6)$$

[10, 3]

vi. The NCC Benchmarked on the KPI Parameters

The NCC, body responsible for the regulation of Mobile services in Nigeria, on 6th July 2007 issued out the threshold levels on the key performance indicators (KPIs) for ascertaining QoS of all the Mobile Networks in the country.

Table 1: KPI parameters considered by NCC.

KPI	CST	CSSR	CSFR	CDR	CCSR
NCC	≤ 6s	≥ 98%	≤ 10%	≤ 1%	≥ 97%

[6, 7]

3.1 Quality of Service in The Federal Polytechnic, Bida

The institution currently has all the four major mobile network operators operating in Nigeria. Figure 2:0 shows that there are four Base Stations (BS) installed outside the school main gate serving the polytechnic and its environs; one for each Mobile Service Provider. A Base Station from one Network provider was installed for Data efficiency used for internet facilities in the institution.

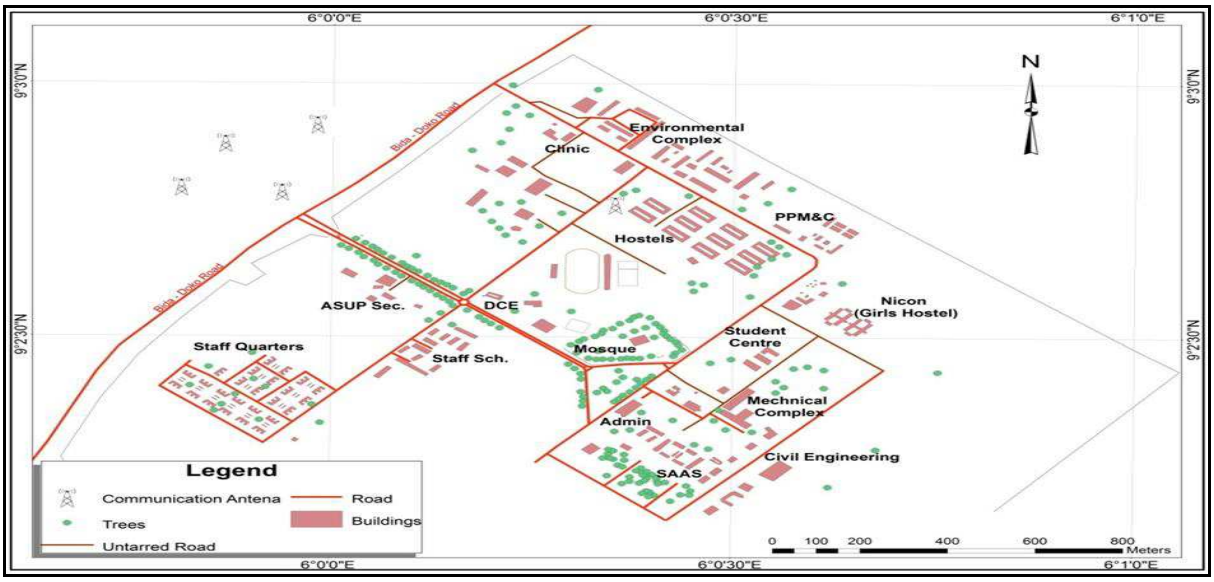


Figure 1.0: The Map of Federal Polytechnic, Bida showing Base Stations.

However, the distance of all the Base Stations with the drive test areas is within 2 km but land slope is a major factor here. Critical surveyed and analysis of the available network facilities in the Institution with over twenty five thousand estimated students showed that during the Busy Hour period the probability that over three to four thousands mobile users may compete for limited services which usually results to congestions and queuing which leads to poor quality of service.

3.2 MATERIALS AND PROCEDURE

This research measurement was conducted within a period of 4 months (August 2017 - November 2017) at the Federal polytechnic, Bida, Niger State, where all the four Mobile networks considered were operating. The Mobile networks studied are Network A, Network B, Network C and Network D. The study was conducted using a Mobile Station (cell phone) software application called MyMobileCoverage Pro (MMC PRO) to perform the drive test under the following metrics; Call Setup Time (CST), Call Setup Success Rate (CSSR), Call Setup Failure Rate (CSFR), Call Drop Rate (CDR), and Call Completion Success Rate (CCSR).The KPI parameters were compared with the NCC benchmarked to see the compliances and also to determine MNO with best quality of service. For the purpose of this Research, the following materials, tools and some definition of terms were used. These materials and tools are: Mobile Stations (MSs), Subscribers Identification Modules (SIMs) Card for all the networks under consideration (Network A, Network B, Network C and Network D), Electronic Stop Watches (4) and a Motor Vehicle.

To perform the drive test, MyMobileCoverage Pro was installed in a Mobile Station(s) (MSs) to take the measurement of the Mobile Network Operators or GSM services. Each

MobileStation has a SIM card installed it depending on the Mobile Network Operator (MNO). Calls were then made on the numbers to carry out the drive tests. The pictorial view of the MMC PRO platform is shown in figure 2.0.

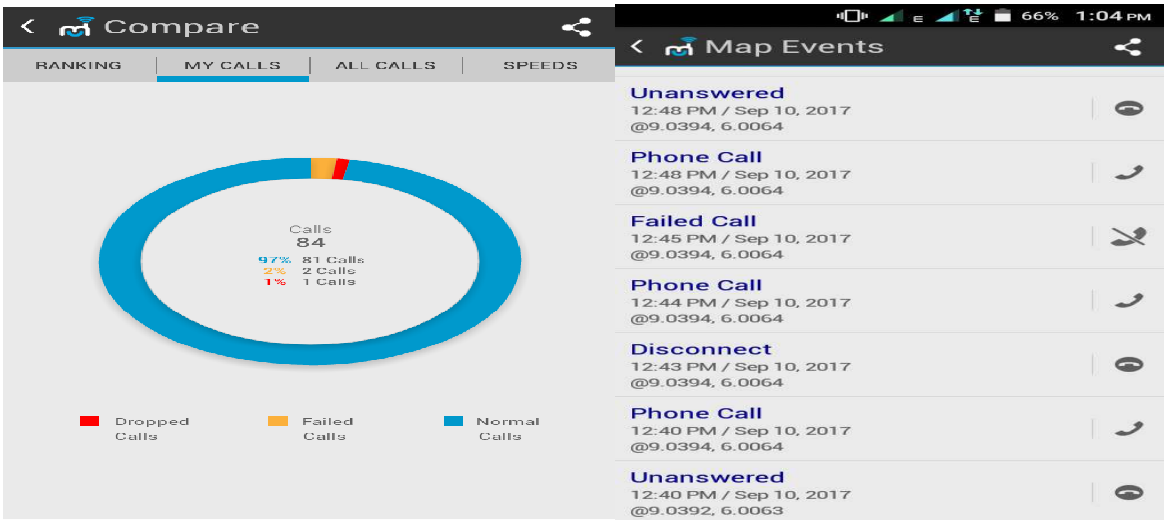


Figure 2.0: MMC PRO Platforms for KPI parameters & their factors.

4. RESULTS AND DISCUSSION

The MMC PRO was able to capture data for each of the Mobile station (MS) on different MNO parameters (either in idle mode or in dedicated mode).The drive test was performed at 8:00pm each day. 8:00pm was selected as it was observed to be the normal busy hour for students when mobile traffic is expected to be at its peak. A total of 4,000 calls were made from the networks under study that is 1000 calls to each network. The KPI values were calculated using the expression earlier defined from equations 1 to 6 on all mobile network providers and results for various KPIs is presented on figure 1 to 5.

4.1 Network Accessibility (NA)

Network accessibility is the ability of mobile station to verify, establish and maintain calls. The KPIs connected to network accessibility are: CST, CSFR and CSSR. The responses on NA from the study are shown in figures 3.0, 4.0 and 5.0.

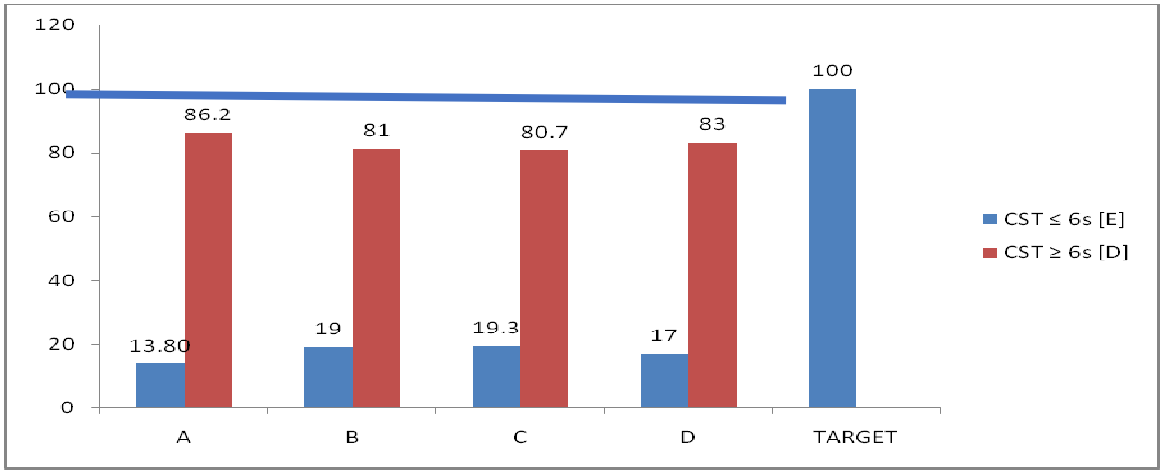


Figure 3.0: Call Setup Time

Fig 3.0 shows the call setup time or call accessibility to each of the Mobile network provider.

CST (≤ 6s/E) means easy call setup time while CST (≥ 6s/D) means difficult call setup time.

Network C has the highest easy call setup time, CST (E/≤ 6s) of 19.3% with call difficult CST (D/≥ 6s) of 80.7% while Network A has the lowest easy call setup time. This simply implies that the accessibility into Network C in terms of call setup time is the easiest. Comparing the KPIs from the graph with NCC benchmarked, all the networks performed below the minimum standard set by NCC of CST≤ 6s.

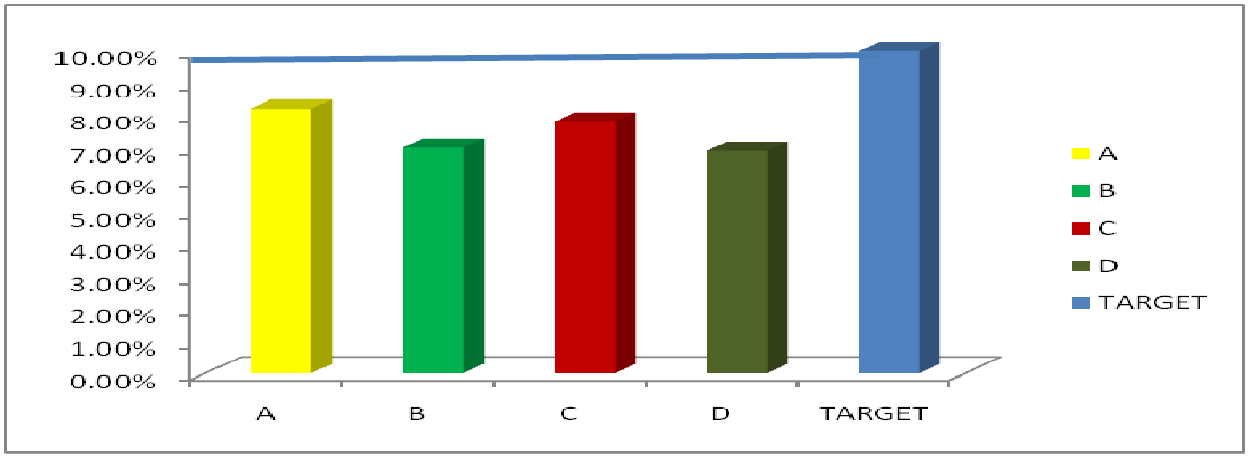


Figure 4.0: Call Setup Failure Rate

Figure 4.0 shows the rate at which call setup failed to each of the mobile networks. The figure shows that the entire mobile networks studied Network D has the best call setup failure rate of 6.9% while Network A has the highest network calls failure. This implies that for every 100 calls made to Network D, 94 calls are likely to be successful without interruption or termination with only 6 calls unsuccessful or blocked

(CSFR).Nevertheless, all the mobile networks studied performed magnificently as the minimum standard (which is Target) of (≤ 10%) benchmark set by the telecom regulatory body the NCC, was not violated.

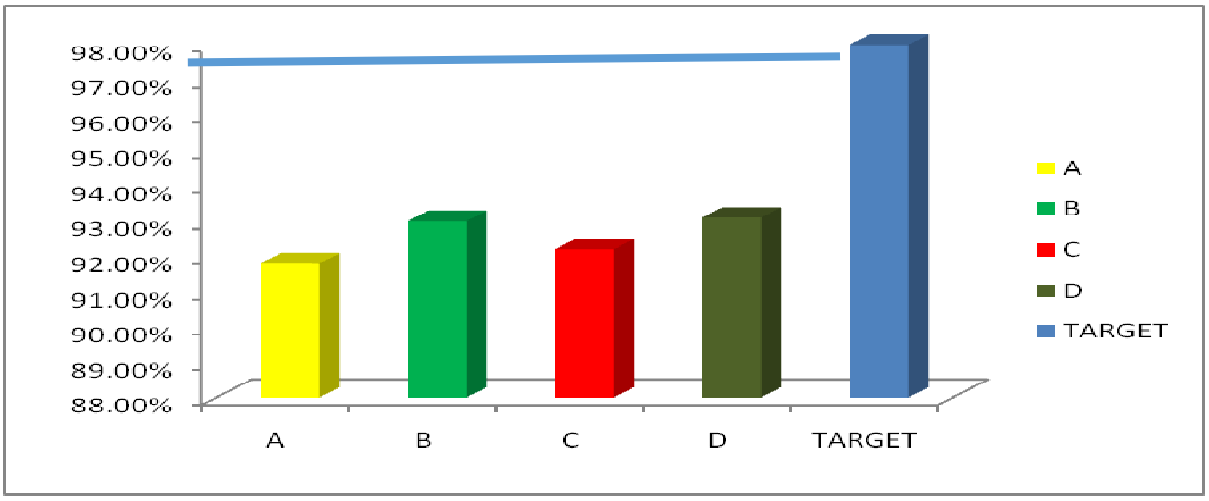


Figure 5.0: Call Setup Success Rate

The degree of accessibility into each network is better shown in figure 3, which indicates the rate at which calls setup were successful. From figure 3 Network D has the best mobile network in establishing calls of 93.1% CSSR while Network A has the poor mobile network of 91.8%. However, all the mobile networks studied slightly performed below the minimum standard (Target) of (≥ 98%) set by the telecom regulatory body the NCC.

4.2 Network Retainability (NR)

Network retainability refers to how long a mobile subscriber stays on a network after the call has been connected or established. The KPIs connected to network retainability are Call Dropped rate and Call Completion Success Rate. The responses of network retainability from the study are shown if figure 6.0 and 7.0 respectively.

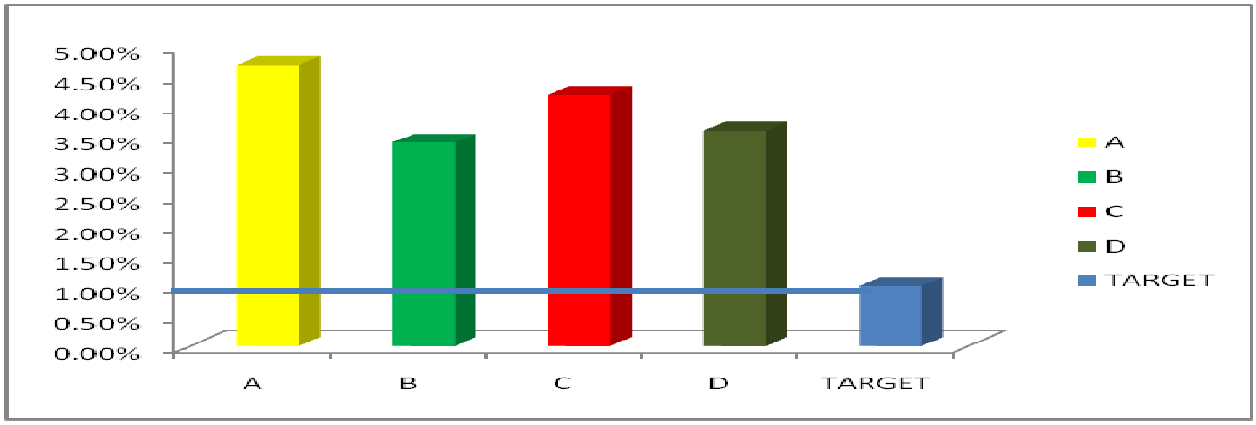


Figure 6.0: Call Dropped Rate

Call dropped rate is said to be among the worst and highest performing metric that affect QoS in Nigeria. The results from figure 6.0 shows that Network A has the highest call dropped rate (CDR) of 4.7% followed by Network C with (CDR) of 4.2%. While Network B has the lowest call drop rate (CDR) of 3.4%, and closely followed by Network D with (CDR) of 3.6%. From figure 4, it shows that majority of the mobile subscribers' experiences call dropped to all the networks while a serious conversation is still ongoing in the institution. On the other hand, all the mobile networks studied performed very poorly as the minimum standard (Target) of (≤ 1%) benchmark set by the telecom regulatory body the NCC, was grossly violated.

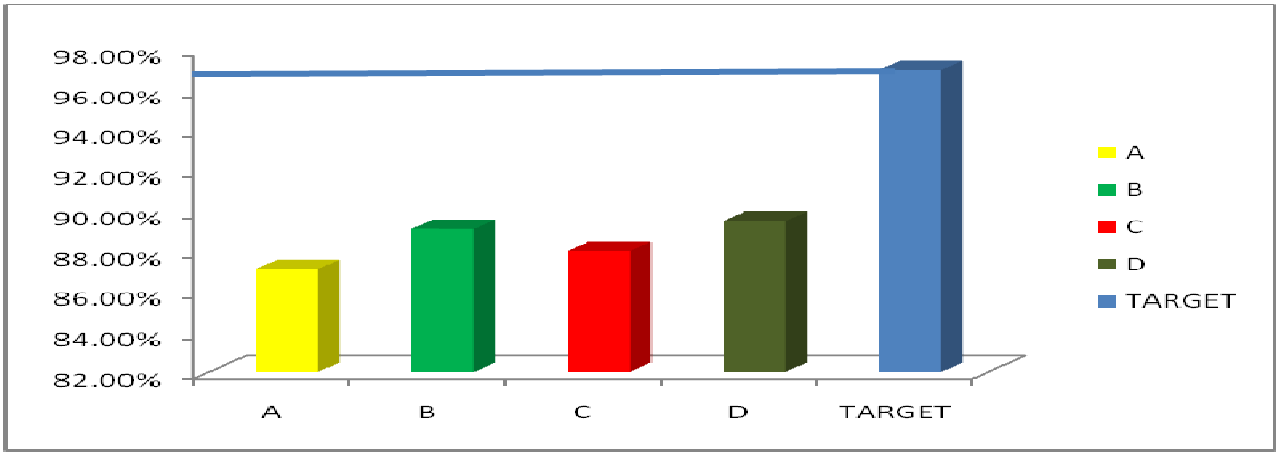


Figure 7.0: Call Completion Success Rate

Meanwhile, the call completion success rate (CCSR) and Call drop rate (CDR) are inversely related. From figure 7.0, with Network A higher in CDR of 4.7% value, it means the CCSR value of (87%) will be lowest. However, Network B that has lowest CDR will have its CCSR highest of 89.6% and follow by Network D with CCSR of 89.4%. This indicates that all mobile subscribers on Network B and Network D have higher probability of finishing their conversation before call terminate when compare with mobile users on Network A and Network C. Nevertheless, all the mobile networks studied performed very poorly and violated the minimum standard (Target) of CCSR (≥ 97%) benchmark set by the telecom regulatory body the NCC for all mobile network operators to complied with.

4.3 The Result for Performance Test and Network Quality

The performance analysis for each of the KPI parameters was done as shown from figure 1 to 5. Generally, these results reveal that poor Quality of Service (QoS) is persistent across all the mobile networks. However, these results only present a comparative study of the networks with the telecom regulatory body NCC benchmarked. Table 2.0 shows the result for performance test and network quality.

Table 2.0 Result for Performance Test and Network Quality

	KPIs	Target	Best Result	Worst Results
	BH Call Setup Time (CST)	≤ 6s	Network C; 19.3%	Network A; 13.8%
	BH Call Setup Failure Rate (CSFR)	≤ 10%	Network D; 6.9%	Network A; 8.2%
	BH Call setup Success Rate (CSSR)	≥ 98%	Network D; 93.1%	Network A; 91.8%
	BH Call Dropped Rate (CDR)	≤ 1%	Network B; 3.4%	Network A; 4.7%
	BH Call Completion Success Rate (CCSR)	≥ 97%	Network B; 89.6%	Network A; 87.1%

From table 2.0, it shows that the overall performance of the mobile network operators is far from being satisfactory. The network accessibility of network C; 19.3% (CST) was better than the rest mobile networks studied. Network D performed better with a minimum 0f 6.9% Call Setup Failure rate and a maximum of 93.1% in Call Setup Success Rate respectively. However, Network B performed wonderfully in network retainability with a minimum Call Dropped rate of 3.4% and Call Completion Success Rate of 89.6%. It further reveals that the entire mobile networks studied Network A has the worst quality of service (QoS) in both network accessibility and network retainability.

5.0 CONCLUSION

This study was undertaken to evaluate the Quality of Service (QoS) of various KPI parameters of mobile network services available at the Federal Polytechnic, Bida. From the results of the study, it is evident and clearly shows that the four mobile network operators studied and operating in Nigeria are far from providing sufficient and reliable services to the subscribers in the study area. From the study undertaken none of the Mobile network operators satisfied the minimum standard set by the telecommunication regulatory organ in Nigeria the NCC.

With these findings, it can be concluded that the QoS evaluation over all the KPIs performance of the mobile network operators in the institution campus and probably in Nigeria at large is poor, unreliable and unsatisfactory and may not be safe for disaster responses, military control, public health, safety, and law enforcement command.

6.0 RECOMMENDATIONS

Frequent call drops, low call setup success rate, high call setup time and high call setup failure rate etc, which affects the quality of service of a mobile networks are indicator of an optimization skull area. The networks need optimization. In order to correct the problem of poor QoS in the country and any other areas with similar situation, suggestions on how to improve the QoS of the Mobile network operators need to be made. It is on this base that the following recommendations are made in order to improve the observed defects:

- All the mobile network operators should ensure a robust optimization of its networks in order to ensure good service delivery to the subscribers.
- Wireless Mobile Operators should constantly carry out proper signaling traffic evaluation to know the capacities of their network equipment so as to meet the expected number of subscribers within the network.
- The mobile network providers/mobile users should install Signal booster to boost the strength of the signal in case of high cost of installing BS/BTS.
- A geographical survey of the area should be carried out before the installation of BS/BTS as presently land slope account for network coverage problem in the Institution.
- The NCC body should always access, monitor, regulate and give timely warning to the mobile operators, and where necessary sanctioned for any contravention if they were not meeting the require standard in the telecommunication industry in order to ensure good quality of service.

It is believed that if the above recommendations are strictly observe and adhered to, the QoS and the overall performance of the Mobile network operation in the area and country at large shall definitely improve.

REFERENCES

Adegoke, A.S and Babalola, I.T. (2011). Quality of service analysis of GSM telephone system in Nigeria,*American Journal of Scientific and Industrial Research.* ISSN: 2153-649X

Alenoghena, C., O and J. O Emagbetere (2012). Base station placement challenges in cellular networks: The Nigerian experience. Proceedings of 4th IEEE International Conference on Adaptive Science &Technology (ICAST) Ghana 25-27th Oct 2012. (Pages 7-11)

Celinus Kiyea (2012). Performance Analysis of Quality of Service of

GSM/CDMA Mobile Networks in Zaria,*International Journal of Science and Research (IJSR)ISSN (Online): 2319-7064Impact Factor (2012): 3.358*

Longe, F.A. 2011. Subscribers' Perception of the Quality of Service (QoS) of the Global System for Mobile Services in Ibadan, Nigeria,*Computing, Information Systems & Development Informatics Journal*

Kuboye, B.M., Alese, B.K and Fajuyigbe, O. 2009. Congestion Analysis on the Nigerian Global System for Mobile Communications (GSM) Network. *The Pacific Journal of Science and Technology* http://www.akamaiuniversity.us/PJST.htm Volume 10

Nigerian Communications Commission, Nigerian Communications Act 2003 Quality of Service Regulations 2011. Arrangement of Regulations (online Retrieved 24/11/2016)

Nigerian Communications Commission, Nigerian Communications Act (No 19 of 2003) (Online Retrieved 24/11/2016) Quality of Service Regulations, 2012

Nnochiri, I.U. 2015. Evaluation of the Quality of Service of Global System for Mobile Telecommunication (Gsm) Operators in Nigeria, *Journal of Multidisciplinary Engineering Science and Technology (JMEST) ISSN: 3159-0040*

National Bureau of Statistics (2016) (online Retrieved 24/01/2017)

Popoola, J.J., Megbowon, I.O. and Adeloye, V.S.A. 2009. Performance Evaluation and Improvement on Quality of Service of Global System for Mobile Communications in Nigeria,*Journal of Information Technology Impact*

Rex Ndubuisi Ali 2015. Handoff and Drop Call Probability: A Case Study of Nigeria's Global System forMobile Communications (GSM) Sector, *Scholars Journal of Engineering and Technology (SJET) ISSN 2321-435X (Online) ISSN 2347-9523 (Print)*

Rajesh, K. Y. and Mr Nishant Dabhade 2013. Impact of Service Quality on Customer Satisfaction of Mobile Users- A Case Study of Airtel, *International journal of Innovative Research Studies ISSN: 2319- 9725*

Shoewu, O and Edeko, F. O. 2011. Outgoing call quality evaluation of GSM network services in Epe, Lagos state, *American Journal of Scientific and Industrial Research ISSN: 2153-649X.*

Sagadevan, S. S.and Nurul, A. B. M. R. 2015. Determining the Drop Call Rate, Failed Call Rate and Signal Strength of Celcom Mobile Network in the Universiti Tenaga National Putrajaya Campus. The 3rd National Graduate Conference (NatGrad2015), Universiti Tenaga Nasional, Putrajaya Campus, 8-9 April 2015*ISBN 978-967-5770-63-0 349*

Zakariyya, A. and Omobayo, A. 2017. Telcos Connect 236m lines in 14years, retrieved from

Daily Trust Newspaper of Monday, January 30, 2017.

Proceedings of the 1st International Conference on ICT for National Development and Its Sustainability, Faculty of Communication and Information Sciences, University of Ilorin, Ilorin, Nigeria- 2018

PROVISION AND UTILIZATION OF OFFLINE ELECTRONIC RESOURCES IN NIGERIAN ACADEMIC LIBRARIES AND ITS IMPLICATION FOR SUSTAINABLE NATIONAL DEVELOPMENT

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ABSTRACT

The study is a conceptual research that examines the provision and utilization of Electronic Information Resources for teaching, learning and research activities by academic and research libraries in Nigeria and its implication for national development and its sustainability. The authors provide a highlight on the concept and significance of offline information resources and need for their utilization by students and researchers in developing countries, like Nigeria; discussed types and contents of some prominent offline information databases; the challenges in the provision and use of the offline databases and the strategies of improving the provision and use of offline information resources in academic and research communities towards quality teaching, learning and research for accelerated national development and its sustainability. These include the need to embark on door to door public awareness campaign; procurements of more computers for accessing relevant offline information resources on CD-ROM, DVD, VHS tapes; giving prizes for the outstanding users of offline databases; periodic system and content update; periodic faculty and departmental interaction and training on their use;, creating user friendly links on the library portal to relevant off line databases; and use of social media sites such as Facebook, Twitter, Blogging, YouTube, Flicker, MySpace and LinkedIn among others.

Keywords: *Provision, Utilisation, Offline Electronic Resources, Academic Libraries, National Development, Sustainability*

1. INTRODUCTION

Developments in Information and Communication Technologies (ICTs) have completely changed the processes of collection development, storage, access and dissemination of information in libraries. And, in order to meet the ever increasing demands of current and relevant information by library customers, academic and research libraries across the globe now embark in subscribing to a large number of offline and online databases to suit the interest of new technology savvy library customers. Scholarly electronic information resources in reality have become one of the most used technological innovations in modern times and also the backbone of many academic institutions. Electronic resources **(e-resources)** as invaluable research tools come in to complement print-based library materials in any traditional library and they enable access to information which otherwise would not have been available because of geographical or financial restrictions. E-resources they also make available to users current information as these are mostly updated frequently. Through various search strategies, e-resources provide a lot of links to explore additional resources. According to Khan et al. **(**2009), a number of universities and institutions nowadays are providing access to databases online for their users to facilitate learning, research, and development.

Offline information resources, as e-resources, are generally recognized as prominent electronic databases for searching the latest literature conveniently without internet connectivity. Perhaps, searching information in the offline resources content are easier, faster, less time consuming above all user friendly and relevant. Basically, of whatever form (online or offline resources) solve storage problems and the flood of information (Adegbore, 2011). Apparently, instant access speed, reuse is quite possible with e-resources within a shorted possible time frame. Kaminer (1997) observed that the use of electronic resources would enable scientist to be more productive in their research.

2. OBJECTIVES OF THE STUDY

The general objective of this study is to highlight the need for the provision and use of offline databases for access to research information and its implication for national development and its sustainability in Nigeria. The specific of objectives of the study are to**:**

1. Examine the significance of offline data bases in providing access to research information for teaching, learning and research and its implication for national development.
2. Enumerate and discuss the characteristics and the contents of some prominent offline databases that have implication for teaching, learning and research in Nigeria with a view to promoting awareness and use for national development.

3. Examine the Challenges to the Provision and Use offline Databases for academic and research purposes
4. Discuss strategies for Improving the provision and use of Offline Resources in Academic Communities

3. REVIEW OF RELATED LITERATURE

Several studies have been conducted on the use of electronic resources by users of the library in developing countries, including Nigeria much of which revealed that users of libraries in the developing world have come to appreciate the importance of information available through the international information system. However, they have not been able to take full advantage of these facilities.

Asemi and Riyaahiniya (2007) conducted a survey to investigate the awareness and use of digital resources by 250 students in the libraries of Isfahan University of medical sciences, Iran. The results were that 70% of students were aware of digital resources, but only 69% of them have used them, 62% were aware of offline databases, whereas only about 19% used them through the central library network. Similarly, Bayugo and Agbeko (2007) investigated faculty members' preferences for specific databases and full-text journals in a survey they conducted at the University of Ghana. Contrary to the above findings, Govindaraju (2010) found by his survey that the use of electronic is found to be significant among users of the Andhra University. The author lamented that some of the resources such as e-book, encyclopedias, e-dictionaries are less used. In another study on the use of electronic information services by undergraduate nursing students at the University of Namibia's Northern Campus, Ndinoshiho (2010) found that many electronic resources were considerably under-utilized. The basic obstacles in using these resources were the shortage of computers, unreliable internet connection and lack of skills.

Islam et al. (2011) discussed the usage of e-journals subscribed by the Dhaka University Library and reported low usage of the electronic journals due to major hindrances like lack of knowledge or awareness of e-journals among students and faculty members, lack of adequate fund allocation to subscriptions, lack of knowledge about the links to e-journals, lack of computer skills, lack of adequate computer lab facilities, and lack of training and orientation programs.

Tanveer (2012) in a survey on the use of databases among 250 registered postgraduate students and research scholars at GBPUAT Library, India, raised a question for unawareness about electronic databases and the findings revealed that 51.85% and 33% of the postgraduate students studied were not using electronic databases due to lack of skills and time respectively, whereas, 50% of the research scholars were not using e-databases due to lack of time and for facility respectively. In contrast, the author further raised a question on the satisfaction with e-database for their academic pursuits and majority 91.49% of the research scholars and 68.89% of the postgraduate students were satisfied with e-databases aware and use with. It is evident from the findings of this study

that the21st Century library and information customer preferred electronic databases than any other information resources.

In a study conducted by Oyedapo and Ojo (2013) on the use of electronic resources at Obafami Alowowo University, Nigeria under-utilization of electronic resources was observed. The major reason for the very poor utilization of electronic resources was poor searching skills.

Aina (2014) revealed that, the of awareness of electronic databases among the academic staff of Babcock Business School is varied. For instance, majority of respondents were aware of Academic Journal (59:69.4%), followed by JSTOR (48:56.5%) as well as dissertation and theses and EBSCOHOST with (46:54.1) and (43:50.6%) respectively. The result revealed that majority of the respondents were not aware of Bookboon, World Bank Open Knowledge Repository and National Virtual Library with (22:25.9%), (28:32.9%) and 25(29.4) respectively.

However, the main focus of a study by Ernest, Boakye (2015) was to compare awareness, accessibility and utilization of scholarly electronic journals by the academic staff of garden city university college (GCUC) and Christian Service University College (CSUC), Kumasi, Ghana. The findings revealed low awareness and accessibility levels as well as under-utilization of scholarly electronic journals in both university colleges.

In a study by Jasper, Bernard, Evans and Ezekiel (2016) a questionnaire was used to investigate on strategies to enhance access and use of databases by postgraduate students in selected University libraries in Kisii county of Kenya. When asked about the challenges that hindered the access and use of e-resources in academic libraries in Kisii County, 51% of the respondents cited internet failure, 36% cited lack of training and 13% indicated lack of willingness from the library customers to promote their utility. It is observed that the major determinant to improve utilisation of electronic resources (offline or internet in a box) is anchored around information literacy, retrieval skills and willingness of the information user on particular resources.

Also, the findings of a study by Farouk & Yusuf (2017) on the awareness, access and use of academic databases by faculty members of Bayero University, Kano, Nigeria revealed that majority of the academic staff of the University were aware of the E-databases available in the library and their level of awareness varies in respect of the databases available. They used online databases "sometimes" but "never" used the offline databases.

4. CONCEPT OF OFFLINE ELECTRONIC RESOURCES AND NATIONAL DEVELOPMENT

Today libraries of all kinds have been spending substantial amount of money to adopt or gain access to electronic resources (online/offline) from publishers and vendors. The 21st Century library services is anchored on the Provision of adequate and relevant electronic information resources to improve services in a variety of ways that tailored the needs and interest of digital native library customers for rapid national development and its

sustainability. According to BC University Library (2012) a library database is an electronic catalogue or index, often contains information about published items, and is searchable. Therefore, an offline database is conceived as a resource that is searchable without internet connectivity which is stored in a computer work station (server), CD or Flash and allows sharing of information locally or through library portal. Interestingly, it is very easy to search and retrieve information in a fraction of seconds as no network connectivity is required. Registered and authorized library customers are allows to downloading, copying and printing at his/her convenient without fear of network failure because the system is fully supported by inverters. Materials found in this kind of databases include journals articles, e-books, images, tutorials in forms of videos/audio formats and reference sources. Offline resources if properly harnessed and used accordingly in the area of teaching, learning and research processes would surely produce a well responsible and intellectual citizen who would directly or indirectly contribute to a greater national development educationally, economically, and socially. National development is a desire for gradual change from a certain situation to a better and effective way to tackle the country's challenges. In the view of Ita (2009), national development involves all attempts at alleviating poverty and enhancing the quality of life of the average citizen. The author further observed that it includes the ability of the citizen to realise their potential and live a life of dignity and fulfillment. It is important to understand that the quality of any society solely depend on the awareness, access and utilisation of relevant and current information available around them irrespective of its format. Therefore, access and use of relevant offline resources would no doubt take any information rich and conscious society to a promised land which is characterized by producing high number of intellectuals, responsible individuals, independent, crime free society, stable economic and growth and above all, creating enabling environment for investors, job creators which are the bedrock for sustainable national development and transformation.

5. TYPES OF SCHOLARLY OFFLINE DATABASES AND ITS INFORMATION CONTENTS

An electronic resource (offline) has become a sign of the modern age and is invaluable tool for teaching, learning and research (Sethi & Panda, 2011). Supporting this argument, Ibrahim **&** Usman (2013) pointed out that scholarly databases are form of bibliographic databases that are dedicated to specific academic disciplines, subjects, issues and areas. The following well-known, reputable and recognized databases worldwide will be discuss.

- **eGranary** (Internet in a Box): provides millions of digital educational resources to institutions lacking adequate internet access. You will find more than 30 million documents each of them fully indexed and searchable using powerful built search engine.

- ***TEEAL*:** The Essential Electronic Agricultural Library (TEEAL) is a full-text digital library of hundreds of essential journals in agriculture and related sciences made available at low cost to institutions in eligible low-income countries. TEEAL is an offline tool – no Internet or phone line needed. The project is administered in partnership between the international Programs and the Information Technology services (ITS) staff of Albert R.Mann LibraryThe information in TEEAL covers several subject areas:
  - Agricultural Engineering Chemistry/Biochemistry/Biophysics/ Food Science/Nutrition.
  - Agriculture Economics/Social Science/Development Human Medicine/Physiology
  - Animal Science/Veterinary Medicine Entomology/Pest Control Forestry
  - Biology Environment/Ecology/Natural Resources Plant Science/Soil Science
  - Biotechnology/Applied Microbiology Fisheries/Aquatic Science.

6. CHALLENGES IN THE PROVISION AND USE OFFLINE DATABASES FOR TEACHING, LEARNING AND RESEARCH

The poor state of telecommunication facilities, shrinking nature of library budget and allocation, high cost/ irregularities in subscription and licensing of online information resources, system failure, technical hitches, cyber insecurity, low bandwidth, lack of system analysts, technophobia and lack of effective web searching and information retrieval skills among other has compelled academic and research libraries to acquire or subscribed to offline information resources to augment the situation for the provision of current and relevant information for a robust and healthy academic transactions within and outside the intellectual community. With this therefore, access and utilisation of offline electronic content will go a long way in supporting the quality of teaching, learning and research process in line with global best practices.

7. STRATEGIES FOR IMPROVING THE PROVISION AND USE OF OFFLINE RESOURCES TO ACADEMIC COMMUNITIES

A well stocked library with update and relevance resources both in print and electronic resources (online and offline databases) that allow on campus and off-campus at any time of the day would favourably guarantee and transform the quality of teaching, learning and research process for national developments and its sustainability. With this type and nature of library the right caliber of people with right stock of knowledge that would transform the nation in all ramifications would be produced. The channels for improving offline resources usage are:

- Adoption and implementing door to door public awareness campaign.
- Deploying more computer systems meant for accessing relevant offline information resources on CD, DVD, and VHS among others.
- Periodic system and content update.
- Periodic faculty and departmental interaction on how to use available offline database.
- Information retrieval skills: optimal use of electronic resources (offline database) by library customers may depends on their information retrieval skills. Wien (2000) defined information retrieval skills as the ability to find information in such a way that non relevant data are excluded while relevant information is found. Information retrieval skills are crucial for retrieving information in this era of technology and that most of the information needed for research can be retrieved from electronic resources. Ekenna and Iyabo (2013) observed that students' effort to compliment their work with electronic resources may be limited due to lack of skills.
- Information literacy skills: IL includes having skills to not only access information, but also to ascertain it veracity, reliability, bias, timeliness and context. To retrieve information in the open web, not only formal information skills are needed but substantial information skills (Okiki & Mabawonku, 2013).
- Mobile alert service
- Using fosters pamphlets, electronic bill board, and handout.
- Encouraging researchers and students to use offline through giving them references.
- Making the resources available through local area network (LAN) and library portal.
- Creating user friendly link in the university website.
- Using social media flat form such as Facebook, Twitter, Blogging, You Tube, Flicker, MySpace and LinkedIn among others.

8. CONCLUSION

The study was targeted at enhancing the provision and use of offline electronic resources as a panacea for poor access to research information in Nigerian academic libraries. Apparently, the best options to address the poor state of access to research information in Nigerian academic libraries is to rethink and reconfigure our thinking in providing offline electronic resources for rapid national development and its sustainability. Access and utilisation of offline electronic resources would no doubt meet the yearning and aspiration of the new minds set of academic library customers and subsequently strengthen the quality of teaching, learning and research process in Nigerian tertiary institutions due to the poor state of international information network services (low internet connectivity) and this in turns promote scholarly culture and sprits which are

characterised by stable economic growth, job creations and having crime free society for accelerated national development and its sustainability.

REFERENCES

Adegbore, A. M. (2011) University Faculty Use of Electronic Resources. A review of the Recent Literature. *PNLA Quarterly,* the Official Publication of the Northwest Library. 3 (1) 1-11

Asemi, A. and Riyaahiniya, N. (2007) Awareness and Use of Digital Resources in the Libraries of Isfahan University of Medical Sciences, Iran. 23 (3), *The Electronic Library* 316-327.

Chowdhury, G.G. (2004) Introduction to Modern Information Retrieval. 2nd ed: London: Facet

Ekenna, M. and Iyabo, M. (2013) Information Retrieval Skills and Use of Library Electronic Resources by University Undergraduates in Nigeria. *Information and Knowledge Management. 3 (9): 6-14*

Govindaraju, N. (2010) Use and User Awareness of E-resources in Andhra University Library. A study, PEARL: *A Journal of Library and Information Science*. 4 (3) 183-188.

Jasper, M.M. , Omallah, G., Evans, N.M. and Ezekiel, N.M. (2016) Strategies to enhance Access and Use of Electronic Resources by Postgraduate Students in Selected University Libraries in Kisii County Kenya*. International Journal of Academic Library and Information Science. 4* (8) Available at: http://www.academicresearchjournals.org/IJALIS/Index.htm. Accessed on 23-February, 2018

Okiki, O.C. and Mabawonku, I. M. (2013) Information Literacy Skills of Academic Staff in Nigerian Federal Universities, *International Journal of Library Science.* 8 (2): 62-77

Omallah, B.G. (2013) Role of Electronic Resources in Research Management. A case of Mount Kenya University.

Sethi, B.B. and Panda, K.C. (2011) Use of Electronic Resources by Scientists: A case Study of Sambalpur University, India: Library Philosophy and Practice (e-journal) Available at: http://www.webpages.uidaho.edu/~mbolin/Sethi-Pandahtm) Accessed on 23-February, 2018.

Tanveer, H. N (2012) Use of Electronic Databases by Postgraduate Students and Research Scholarly at GBPU at Library, India. *Library Philosophy and Practice*

(e-journal). Available at: digitalcommons.unl.edu/libphil/prac/809. Accessed on 23-February, 2018.

Wien, C. (2000) Teaching Online Information Retrieval to Students of Journalism. Aslib Proceedings 52 (1): 39-47

PERCEPTIONS OF ACADEMIC LIBRARIANS ON KNOWLEDGE MANAGEMENT FOR SUSTAINABLE DEVELOPMENT IN NORTHWEST FEDERAL UNIVERSITIES IN NIGERIA

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ABSTRACT

This study explores the perception of knowledge management by Library and Information Science professionals in Federal University Libraries in Northwestern States of Nigeria, its integration into library practices and their perceived challenges. Survey research design was adopted for the study, using questionnaire as an instrument for data collection. The population of the study consists of two hundred (200) academic librarians in the seven (7) Federal University Libraries in Northwestern States of Nigeria. Total enumeration sampling technique was adopted where the entire academic librarians in the area covered were considered as sample for the study. Two hundred (200) copies of questionnaires were administered to academic librarians in the area covered by the study, in which 179 were duly completed and found usable for the study. The data collected for the study were presented and analyzed using descriptive statistics (simple percentage). The finding of the study revealed that majority of libraries covered by the study do not have formal knowledge management structure for knowledge sharing. It was also revealed that there is high level of awareness among the academic librarians covered by the study on the term KM; even though the respondents indicated high level of awareness and familiarity with KM, their awareness hinged mainly on the term as they lacked extensive knowledge on Knowledge management strategy due to nonexistent of formal KM Structure. It was also discovered that the most challenging problem experienced by the academic libraries covered by the study was lack of clearly defined guidelines on KM implementation and practice, lack of cooperation among junior and senior staff in terms of knowledge sharing among others. It is therefore, recommended that motivation to encourage open access to knowledge, continuous education courses and training, support system to alerted mind and creative people, team membership, mentoring and leadership development programs are all needed. This is one of the ways

towards ensuring sustainable library development and best practices in Federal University Libraries in Northwestern States of Nigeria.

Keywords: *Knowledge Management; Sustainable Development; Academic Librarians; Libraries; Library and Information Science Professionals; Perception; Nigeria.*

1. INTRODUCTION

Libraries should support knowledge-driven society through generating new knowledge and building capacity to access and share existing expertise, repositories of global knowledge and adapt that knowledge to local use for sustainable development; this can never be possible without proper knowledge management. In Nigeria today, it is observed that there is discrepancies among library and information science (LIS) professionals, on their understanding of Knowledge Management (KM) as a concept which to a large extent affects the level of knowledge management practices for sustainable development. Knowledge management being an emerging field of specialization in a number of professions, including Library and Information Science has remained an issue of concern. Wiig (1997) assert that effective Knowledge management will be the foundation of success of any organization in the 21st century. The growing value of information and knowledge in social systems, and the way of managing them has created unique challenges for the organizations, information institutions, managers, and workers (Roknuzzaman & Umemoto, 2009). In responding to the exciting and emerging phenomenon of KM, library practitioners must embrace KM as a means of uplifting their service, hence, this demands for an understanding of its ramifications and relevance to their work.

According to White (2004) knowledge management is the process of creating, storing, sharing and re-using organizational knowledge (know how) to enable an organization to achieve its goals and objectives. In this regard, it becomes apparent that knowledge management is concerned with the process of identifying, acquiring, distributing and maintaining knowledge that is essential to the organization. Through KM, organizations seek to acquire or create potentially useful knowledge and make it available to those who can use it at a time and place that is appropriate for them to achieve maximum usage and maximal impact on organizational performance (King, 2007). Thus, the true value is created by fostering innovation in the organization. In this respect the organization must consider knowledge management as strategic assets, and these organizations should capitalize on knowledge management tools to improve and build up an intellectual assets base, as an attempt to gain a competitive advantage (Alrawi & Alrawi, 2011).

With all the benefits of knowledge management to library and information professionals yet, not adequate attention has been given to it in most developing countries

including Nigeria. For example, Nazim and Mukherje (2011) while reporting the case of Indian Library and Information Professionals with regards to knowledge management, they stated that, Indian library and information professionals are still involved in the traditional practices of knowledge organization and information management. Malhan (2006) also reported lack of understanding of various dimensions of KM and a lack of necessary competencies among library and information professionals to develop and apply KM tools and techniques. This is not different with the situation of academic librarians in Federal Universities in Northwestern States of Nigeria

The importance of this study is to explore the available formal Knowledge Management structures used by academic Librarians, level of understanding of knowledge management as a concept and factors militating against knowledge management practices among academic librarians in Northwestern States of Nigeria. For any library or information center to ensure full exploration of its most potential asset and utilization for sustainable development, it becomes so imperative to ensure proper understanding of knowledge management in all it ramification since Knowledge management is based on applying the fullness of an organisation's knowledge to its decisions and this requires working hard to represent it, transfer it, make it accessible and encourage its use only through this we can ensure sustainable development.

2. PROBLEM STATEMENT

The dynamism in library and information science profession in the digital era begin to transform and shape the profession, making Library and Information Science (LIS) professionals and their services more demanding and more challenging. One of the most challenging areas being faced by (LIS) professionals during the last decade was the emergence of Knowledge Management (KM) and it integration into daily routine of library and Information Professionals. To attain sustainable development, the roles of library and information professionals in Knowledge management cannot be neglected.

Malhotra (1998) puts knowledge management in the context of environmental changes, which bring organizations to the need to find ways to survive and increase competence. "Knowledge management caters for the critical issues of organizational adaptation, survival, and competence in the face of increasingly discontinuous environmental change. Essentially, it embodies organizational processes that seek synergistic combination of data and information processing capacity of information technologies, and the creative and innovative capacity of human beings (Malhotra, 1998) in order to ensure sustainable development. The only way to ensure Sustainable development is through meeting the social, economic and technological needs of the present without endangering the ability of future generations to meet their own needs and this can never be realized without access existing repositories of global knowledge through best practice in knowledge management.

Knowledge management has been seen as a survival factor for libraries to overcome the challenges library professionals face in the changing and competitive environment (Sinotte, 2004; Wen, 2005). Respondents in a study by Sarrafzadeh, Martin, and Hazeri (2010) agreed by strong majority that knowledge management can contribute to an improvement in the future prospects of libraries for sustainable development. Libraries can also improve their knowledge-based services for internal and external users through creating an organizational culture of sharing knowledge and expertise within the library (Roknuzzaman & Umemoto, 2009; Teng & Hawamdeh, 2002). Sarrafzadeh, Martin, and Hazeri (2006) reported that if library professionals remain reluctant to gaining new skills they will become irrelevant to their organization and will probably lose out in competition for employment to people from other fields.

However, preliminary investigation by the researcher on academic librarians in Federal Universities in Northwestern States of Nigeria revealed that with all the numerous advantages of KM still, there is very few formal knowledge management structure used by academic librarian, as well as reluctance by the academic librarians to fully utilised the various knowledge management structure in sharing their knowledge. Similarly, there are few evidences of practical applications of knowledge management among academic librarians. Even though several studies reported that the most important knowledge management enabling factors are technology, structure and organizational culture (Gold et al, 2001) yet, literature on available knowledge management structure, its applications and use as well as Library and Information Science Professionals' on perceptions on their level of understanding of knowledge management as a concepts, and their perceived challenges have also been neglected. These to a large extent affect best practices and hinder the exploitation of repositories of organizational knowledge in most University Libraries in Northwestern State of Nigeria. This scenario has created a gap. Therefore, this study is set out to explore the available formal KM structures used by academic Librarians, level of understanding of knowledge management as a concept and factors militating against knowledge management practices among academic librarians in Northwestern States of Nigeria, in order to fill up the existing gap.

2.1 Research Questions

The study focused on the following research questions:

1-What are the available formal Knowledge Management structures used by academic librarians in Federal Universities in Northwestern States of Nigeria?

2-What is the level of understanding of KM concept among academic librarians in Federal Universities in Northwestern States of Nigeria?

3-What are the factors militating against Knowledge Management practices among academic librarians in Federal Universities in Northwestern States of Nigeria?

3. REVIEW OF RELATED LITERATURE

Sustainable development is efficient management of resources for human survival, taking into consideration both the present and future generations (Adejumo & Adejumo 2014). Therefore, to achieve sustainable development, the world summit on sustainable development suggested that countries must ensure the full participation of their citizens in development programmes and strengthen the capacities of citizens to access and utilize timely information (Goodluck, Iwu-James, & Adebayo 2016). Hence, the need for knowledge management has become so imperative. Knowledge management (KM) has been an issue of discussions and debates in the last two decades. The term has been described from different perspective by different scholars. A body of literature reported views of experts about KM and considers librarians from more positive viewpoints and call for full involvement of LIS people in KM (Abell & Oxbrow, 2001; Broadbent, 1998; Butler, 2000; Corrall, 1998; Southon & Todd, 2001) Bouthillier and Shearer (2002), reported that, there seems to be a close relationship between Library and Information Science (LIS) and KM. Hawkins (2000), explain that KM is an old concept and a new name for what librarians or information professionals have been doing for years. In line with this, librarians as an embodiment of Knowledge, information and practices serving a wide spectrum of information seekers, has a critical role to play in the facilitation of knowledge generation; hence, an exchange of ideas and access to knowledge is essential in a development process so as to allows organizations to generate value from their intellectual and knowledge-based assets (Santosus & Surmacz, 2001), and makes it possible to get the right information into the hands of the appropriate people at the time. These dreams can never be realized without proper understanding of knowledge management concept as well as KM implementation challenges. In an effort to achieve this, this resulted in the approval of the Knowledge Management Section as IFLA section in December 2003 (IFLA, 2009). The KM section is a unit in IFLA Division IV (Bibliographic Control). With this approval, the Library and Information Science professionals have continued to express the need for a deeper understanding of KM's many dimensions and its relevance to the profession. To successfully achieve this, training and retraining of library staff in form of workshop, seminars, conferences, and extensive reading of literature sources is highly important (Siddike, Kalam, & Munshi, 2012).

In highlighting the perception of librarians about KM, Southon and Todd (2001) conducted a survey where they investigated the perceptions held by experienced LIS professionals about knowledge Management in the library and information sector in Australia. The results suggest a lack of understanding of knowledge management among LIS professionals and a considerable variation in the levels of awareness of with regards to the term knowledge management. Ali and Khan (2015); Nazim and Mukherje (2011) found discrepancies in librarians knowledge and understanding of KM in India. Nazim

and Mukherje (2011) further stressed that librarians' perceptions of KM in India are shallow dealing with the management of only explicit knowledge or information management rather than sharing and using tacit knowledge embedded in employees. Another study regarding library specialists' views of knowledge management and its incorporation in to library practice was conducted by Roknuzzaman and Umemoto (2008), the results of their study showed that the ways of knowing and understanding knowledge management concepts were varied among the library specialists from different countries and that most of them focused on a limited perception of knowledge management for its incorporation in the library activity. Among the reasons for responding to knowledge management there can be mentioned increased value of knowledge in the knowledge economy, library itself is a knowledge-based organization, opportunities for improved library practices.

With all the relevance of KM to library and Information professional very few of these projects focus on managing knowledge as an asset that can add value or produce a return on investment (Gandhi, 2004). Most KM initiatives in libraries have not followed a systematic and logical approach/process to identify, organize, or share internal knowledge or best practices to improve the operational effectiveness of the library (Jantz, 2001). According to Roknuzzaman and Umemoto (2008), Reluctances and level of library practitioners response to KM is comparatively slow and they are reluctant to incorporate KM into library practice because of their traditional mind set as well as reluctant on the part of to share their knowledge and ideas with their seniors, because they feel that there is no benefit of it Some librarians do not take any initiative for positive changes in their libraries. In another related study McKnight (2007) reiterated that lack of clearly defined guidelines on KM (KM strategies) implementation, pose a challenge in most of the universities in UK. KM initiatives in libraries have a long way to go and have tremendous potential for improvement (Gandhi, 2004). It is clear that, full understanding of KM and identification of challenges affecting proper implementation of KM will no doubt ensure sustainable development. However, several steps other steps must be undertaken by libraries and information professionals to ensure successful knowledge management for sustainable development in the 21st century.

4. METHODOLOGY

This study adopted descriptive survey research design. The populations of the study consist of 200 academic librarians in the seven (7) Federal Universities in Northwestern state of Nigerian. These universities comprise Ahmadu Bello University Zaria, Bayero University Kano, Usmanu Danfodiyo University Sokoto, Federal University Dutse, Federal University Dutsinma, Federal University Birnin Kebbi and Federal University, Gusau. Questionnaire was the instrument used for data collection. A reliability test of the instrument was conducted using split-half method, where reliability coefficient of 0.87 was obtained, which indicates that the instrument is reliable as postulated by Ponterotto

and Ruckdeschel (2007) that, a reliability coefficient of 0.8 and higher is generally considered to be good. With regards to the sample for the study, total enumeration technique was employed where the entire population was considered in the study. Two hundred (200) copies of questionnaires were administered to academic librarians in the area covered by the study, in which 179 were duly completed and found usable for the study. The data collected were presented and analyzed using descriptive statistics (simple percentage). The analysis was done using Statistical Package for Social Sciences (SPSS) version 16. The choice of this software was based on its high descriptive and multivariate statistical power for quantitative data analysis (Dulle, 2010).

5. FINDINGS OF THE STUDY

This section presents the findings of the study in line with the research questions raised.

5.1 Formal Knowledge Management Structure Available in Libraries Studied

Respondents were asked about the knowledge management structure available in their libraries in table 1:

Table 1: Formal Knowledge Management Structure Available in Libraries Studied

S/N	Formal Knowledge Management Structure Available in your Library (mechanism, flat forms and tools recognized formally by Authorities of the libraries)	Frequencies	Percentages (%)
	Yes	29	16.20
	No	150	83.79
	Total	**179**	99.99

The finding in Table 1: indicates that majority of the respondents 150 (83.79%) stressed that they have no formal Knowledge Management structure available in the libraries covered by the study only 29 (16.20%) acknowledge that they have formal knowledge management structure. This shows that academic librarians lack formal KM structure for knowledge creation and sharing in the area covered by the study. This implies that despite the need to create knowledge management structure that would identify,

capture, organize, retrieve and apply knowledge to ensure sustainable development yet, little attention is given to this area.

5.2 Levels of Understanding of KM Concept among Academic Librarians in Northwestern States of Nigeria

Table 2 presents the responses depicting the level of understanding of Knowledge Management concepts among academic librarians in Northwestern States of Nigeria.

Table 2: Levels of Understanding of KM Concept among Academic Librarians in Northwestern States of Nigeria

Level of Understanding of KM **Concept**	**Ratings (number & percentage)**				
	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Sure
I believe km will fade away in favor of enhance information management	64 (35.8%)	42 (23.5%)	35 (19.6%)	28 (15.6%)	10 (5.6%)
I have heard about KM it doesn't sound like new jargon	79 (45.4%)	4 (42.5%)	6 (3.35%)	11(6.3%)	9 (5.2%)
for me I see KM as something that has always been there it is now labeled	67 (37.5%)	49 (27.4%)	28 (15.6%)	30 (16.6%)	5 (2.8%)
KM is a term with meaning	70 (40.2%)	77 (44.3%)	20 (11.5%)	7 (4.0%)	5 (2.8%)
I am familiar with Knowledge management strategy	5 (2.79%)	11 (6.3%)	82 (47.1%)	79 (45.4%)	2 (1.1%)
Knowledge management is a process of creation, assimilation, retention and utilization of knowledge	63 (33.5%)	42 (23.5%)	35 (19.6%)	28 (15.6%)	11 (6.1)

Result arising from table 2 on the examination of the level of understanding of KM shows that, majority of the respondents 153 (87.9%) strongly agree or agree that, they "have heard about KM it doesn't sound like sound like new jargon." Also, 147 (84.5%), of the respondents strongly agree or agree that, KM is a term with meaning. Similarly, 105 (57%) opined that, Knowledge management is a process of creation, assimilation, retention and utilization of knowledge. While, 116 (64.9%) indicated that, they see KM as something that has always been there it is now labeled. Worthy to mention is the fact majority of the respondent lacks extensive knowledge on Knowledge management strategy with 161 (92.5%) responses. Lastly, 106 (59.3%) of the respondents believe km will fade away in favor of enhance information management.

The finding arising from the study indicates some level of understanding of KM concept among the academic librarians in the area covered by the study, even though the respondents indicated some level of understanding and familiarity with KM, their understanding hinged mainly on KM as a concept, they lacked extensive knowledge on Knowledge management strategies. The finding of this study supported those conducted by Nazim and Mukherje (2011); (Roknuzzaman & Umemoto, 2008), who reported that majority of the respondents covered by their study, lacked extensive knowledge on KM strategy which to a large extent affects it incorporation into library activities

5.3 FACTORS MILITATING AGAINST KNOWLEDGE MANAGEMENT PRACTICES AMONG ACADEMIC LIBRARIANS IN NORTHWESTERN STATES OF NIGERIA

The respondents were asked about the factors militating against knowledge management practices in Federal University Libraries in Northwestern state of Nigeria in Table 3.

Table 3: Factors Militating against Knowledge Management Practices among Academic Librarians in Northwestern States of Nigeria

	Factors Militating against Knowledge Management Practices among Academic Librarians in Northwestern States of Nigeria	**Frequency**	**Percentage (%)**
	lack of cooperation among juniors and seniors staff	**32**	**17.9**
	Tracking the materials from departments is time consuming	**8**	**4.5**
	Inadequate staff training	**20**	11.2
	Limited expertise in KM	**10**	**5.5**
	Lack of clearly defined guidelines on KM implementation and Practice	**41**	22.9

	Lack of trust and incentives	**13**	**7.3**
	A lack of knowledge sharing culture	**27**	15.0
	Constant budget decline	**20**	11.2
	Insufficient Technology to harness the benefit of KM	**8**	**4.5**
	Total	**179**	**100**

The result in table 3 indicates that, 41 (22.9%) of the respondents stressed that, the most challenging factor experienced by the libraries covered by the study is lack of clearly defined guidelines on KM implementation and practice. Worthy to mention is the fact that 32 (17.9%) of the respondents indicated lack of cooperation among junior and senior staff as a challenge to KM practice. Similarly, inadequate staff training and constant budget decline also hindered librarians from KM practices with 20 (11.2%) responses respectively. The least problems responded to, were tracking materials from departments and insufficient technology to harness the benefit of KM with 8 (4.5%) responses respectively.

The implications of the findings arising from the study suggest that information professionals being custodian of knowledge right from their generation, processing, storage and dissemination in the 21st century have lots to do in overcoming the challenges identified.

The findings of the study is in line with those conducted by Nazim and Mukherje (2011), McKnight (2007) who reported lack of cooperation among staff and lack of clearly defined guidelines on KM implementation as hindrance to successful KM practice.

6. CONCLUSION

Academic librarians have a long history towards supporting teaching, learning, research activities and development of culture in sharing and imparting knowledge in order to maximize the impact, effectiveness as well as achieving the overall objectives of the their parent institutions through effective service delivery, best practices and sustainable development. With the advancement in ICT academic librarians in federal universities in Northwestern states of Nigeria need to deploy and exploit numerous benefit of km through various km tools. With all the advantages of km, yet anecdotal evidence indicates that potentialities of km is not fully exploited by academic librarians in most of the federal universities in Northwestern States of Nigeria as most of the libraries in the area covered by the study have no formal KM structure. This indicates that km platforms are less explored in Northwestern States of Nigeria due to the absence of the KM structures

in the libraries covered by the study. Universities libraries in Federal Universities in Northwestern States of Nigeria still have a long way to go towards ensuring better knowledge management practices. As km holds a greater promise towards ensuring full exploitation of both tacit/explicit and knowledge, academic librarians need to take advantage of the potentialities of km through the deployment of various km tools in improving their service as well as ensuring best practices, sustainable development and continuous improvement.

7. RECOMMENDATIONS

Based on the findings arising from the study, the following recommendations were made;

(1) The library management should create more knowledge management structure using social media as flat form to exploit the potentialities of organizational knowledge. The structure when put in place should be made known to the academic librarians through sensitisation/awareness campaigns in form of workshop, seminars and training.

(2) The library management should consider redesigning jobs situations, so also continuous education courses and regular training programmes like seminars, workshops to help academic librarians to extensively understand knowledge management, its strategies and application in order to manage their knowledge for sustainable development is equally.

(3) Library management needs to consider preparing appropriate policies to support the academic librarians to understand knowledge management and its potentials. So also the policy should consider motivation and incentives to encourage open access knowledge, support systems to alerted mind and creative people, team membership, mentoring and leadership development programs are all needed.

REFERENCES

Abell, A. and Oxbrow, N. (2001). Competing with Knowledge: The information professionals in the knowledge management age, Library Association Publishing, London

Adejumo, A. V. & Adejumo, O. O. (2014). "Prospects for achieving sustainable development through the millennium development goals in Nigeria". *European Journal of Sustainable Development*, 3 (1), 33-46,

Ali, P. M. N., & Khan, D. (2015). "Perception of Knowledge Management among LIS Professionals: a survey of Central Universities in North India" (2015). *Library Philosophy and Practice (e-journal).* 1320. Retrieved 7 February, from

http://digital
commons.unl.edu/libphilprac/1320

Alrawi, K., & Alrawi, W. (2011). Managers' perception of potential impact of knowledge management in the workplace: Case study. American Journal of Social and Management
Sciences 2(1), 188-195.

Bouthillier, F., & Shearer, K. (2002). Understanding knowledge management and information management: the need for an empirical perspective. *Information research,* 8(1).

Broadbent, M. (1998). The phenomenon of knowledge management: what does it mean to the information profession? *Information Outlook,* 2(5), 23-37.

Butler, Y. (2000). Knowledge management—if only you knew what you knew. *The Australian Library Journal,* 49(1), 31-43.

Corrall, S. (1998). Are we in the knowledge management business? *Ariadne,* (18). Retrieved 8
February, 2018 from http://www.ariadne.ac.uk/issue18/knowledge-mgt/

Dulle, F. W. (2010). *An analysis of open access scholarly communication in Tanzanian public universities.* (PhD Thesis), University of South Africa, Pretoria

Gandhi, S. (2004). Knowledge management and reference services. *The journal of academic librarianship,* 30(5), 368-381.

Goodluck I., Iwu-James J., & Adebayo O. (2016). Digital Inclusion and Sustainable Development
inNigeria: The Role of Libraries

Hawkins, Brian. (2000). *Libraries, Knowledge Management, and Higher Education in an Electronic Environment.*

Jantz, R. C. (2001). Knowledge management in academic libraries: special tools and processes to support information professionals. *Reference Services Review,* 29(1), 33-39.

King, W. R. (2007). Keynote paper: knowledge management: a systems perspective. *International Journal of Business and Systems Research,* 7(1), 5-28.

Malhan, I. V. (2006). Strategic planning for developing Indian university libraries into knowledge resource and service centres.

Malhotra, Y. (1998). Tooks@ work: Deciphering the knowledge management hype. *The journal for quality and participation, 21(4),* 58.

McKnight, S. (2007). A futuristic view of knowledge and information management. *Retrieved March, 12,* 2008.

Nazim, M., & Mukherje, B. (2011). Implementing knowledge management in Indian academic libraries. *Journal of Knowledge Management Practice, 12(3).*

Newman, J. C, & Feldman, R. (2011). Copyright and open access at the bedside. *New England Journal of Medicine, 365(26),* 2447-2449.

Ponterotto, J. G., & Ruckdeschel, D. E. (2007). An overview of coefficient alpha and a reliability matrix for estimating adequacy of internal consistency coefficients with psychological research measures 1. *Perceptual and Motor Skills, 105(3),* 997-1014.

oknuzzamam, M., & Umemoto, Katsuhiro. (2009). How library practitioners view knowledge management in libraries: A qualitative study. *Library Management,* 30(8/9), 643-656.

Roknuzzaman, Md, & Umemoto, Katsuhiro. (2008). Knowledge Management's Relevance to Library and Information Science: An Interdisciplinary Approach. *Journal of Information & Knowledge Management,* 07(04), 279-290. doi: 10.1142/S0219649208002147

Santosus, M., & Surmacz, J. (2001). The ABCs of knowledge management. *CIO Magazine, 23.*

Sarrafzadeh, M., Martin, B. & Hazeri, A. (2006). LIS professionals and knowledge management: some recent perspectives. *Library Management,* 27(9), 621-635.

Sarrafzadeh, M., Martin, B. & Hazeri, A. (2010). Knowledge management and its potential applicability for libraries. *Library Management, 31(3),* 198-212.

Siddike, M., Kalam, A., & Munshi, M. N. (2012). Perceptions of information professionals about knowledge management in the information institutions of Bangladesh: An exploratory study.

Sinotte, M. (2004). Exploration of the field of knowledge management for the library and information professional. *Libri, 54(3),* 190-198.

Southon, G., & Todd, R. (2001). Library and information professionals and knowledge management: conceptions, challenges and conflicts. *The Australian Library Journal,* 50(3), 259-281.

Teng, S., & Hawamdeh, S. (2002). *Knowledge management in public libraries.* Paper presented at the Aslib Proceedings.

Wen, S. (2005). Implementing knowledge management in academic libraries: a pragmatic approach. *Ann Arbor, 1001,* 48109-41205.

White, T. (2004). *Knowledge management in an academic library: based on the case study KM within OULS.* Paper presented at the World Library and Information Congress: 70th IFLA General Conference and Council.

Wiig, K. M. (1997). Knowledge management: where did it come from and where will it go? *Expert systems with applications,* 13 (1), 1-14.

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PERFORMANCE ANALYSIS OF EMPIRICAL PROPAGATION MODELS FOR FIXED WIRELESS APPLICATION

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ABSTRACT

In this study, an efficacy assessment was carried out on 5 most widely used empirical propagation models by using MATLAB simulator to compare these models for FWA in both urban and suburban environment. Simulations were carried out at two different frequencies of 2.5 GHz and 3.5 GHz with a transmitter height of 30 m and varying distance from 250 m to 10 km. Three different receiver antenna heights of 3 m, 6 m, & 10 m were considered. The results indicated that, Ericsson model has the least prediction of 145 dB to 147 dB at 10 m and 6 m receivers' antenna height respectively, operating on 2.5 GHz frequency in urban environment. Apparently, COST 231 Hata indicated the highest predicted path loss at 10 m and 6 m with predictions of 160 dB and 162 dB respectively in urban environment while the SUI model revealed the least variation of propagation loss of 136 dB to 138 dB. Similarly, the study revealed that Ericsson model has the lowest predicted path loss (150 dB to 153 dB) in an urban environment at 3.5 GHz. The study concluded that no specific model predicted the least path loss for both urban and suburban environment with the varying receiver antenna heights.

Keywords: *Path loss; fixed wireless application; empirical models; signal propagation; simulation*

1. INTRODUCTION

Communication involves the transmission of signals from a source to a destination. Wired transmission of signal can only be employed when the sources and destinations are not extremely far apart, making it almost impractical to achieve long-range communication with wired infrastructure. In the 18th century, wireless transmission of signals was introduced to bridge this gap, ever since then, the usage of this means of information transfer had experienced incessant

proliferation [1]. To conquer the great need for the mobile accessibility of internet by users, irrespective of place and time with impeccable Quality of Service (QoS) and Quality of Experience (QoE), WiMAX was trolled into the market as a Wireless Application that is fixed (FWA) by the working group of IEEE 802.16 [2]. The use of radio waves as wireless medium of propagating radio signals encounter technical challenges as it propagates through the wireless channel. Initial phase of network planning requires the feasibility study of the environment which plays a major role in successful implementation of wireless system. During the design phase of how practical implementation of the transmitting antenna communicates with the receiving antenna, important parameters such as the received signal power, the coverage area and possible interferences occurrence are carefully optimized. The prediction of the attenuation of received power signal and interference analysis lead to a sophisticated plan of a network and also construct futuristic networks that can perform better in different environment. Radio propagation models are used at the initial planning phase to predict the behavior of how the radio waves behave during propagation of signals in disparate environment [3]. The focus of this paper is to identify suitable empirical propagation path loss model in urban and suburban area with the application of appropriate transmitter and receiver antenna heights in planning, designing and implementing an effective WiMAX wireless systems. In this paper, five empirical propagation models which were proposed for radio frequency band up to 3.5GHz in urban and suburban environments in diverse transmitter and receiver antenna at 2. 5 & 3.5 GHz using WiMAX technology were compared. Section II gives an overview of previous related literature. In section III, the study briefly discussed about the simulation software used and the models for the study. Section IV is devoted to compare the result and analysis of the propagation models. Section V comprises the summaries and conclusion of this study.

In [4], efficacy assessments of propagation models were conducted in Kano City with the aim of identifying a suitable model for Kano, Nigeria. A drive test was conducted in Kano and the data obtained was used for graphical representation for the purpose of comparison. The results showed that the mean path loss values 137.7 dB and 138.7 dB for HATA and COST 231 respectively. It was concluded that COST 231 model would be more suitable for use in urban environment. The study in [5] presented the comparison between three basic propagation models for mobile communication in urban, suburban, and rural environment in Rivers State. Its aim was to investigate the effectiveness of commonly used existing models (COST 231 Hata, SUI, and ECC-33) for cellular transmission simulated on Matlab. The measurement data was obtained from the drive-test taken with a test mobile phone capturing the received signal power at 2100 MHz with a specific distance from Globacom NodeBs available in the State. The result obtained from the analysis reported by Standard Deviation (SD) and (MSE) Mean Square Error indicated COST 231 Hata model having accurate predicted values and was suggested for path loss predictions in River State. In [6], the performance of Okumura, Hata, and Lee Models were compared on a large scale prediction. The paper methods include the use of MS antenna height, T-R distance and Base Transceivers Station (BTS) antenna height with 900 MHz frequency band through MATLAB

simulation software. The result indicated that Okumura model shows better performance amongst compared large-scale propagation models.

Comparative study of different path loss models on 4th generation LTE networks was conducted in [7]. The comparative assessment was made using disparate environment e.g. rural, suburban and urban simulated on MATLAB software. The result revealed that the lowest predicted path loss in all terrain was reported by the SUI model while the highest predicted path loss reported was COST 231 HATA Model in urban environment, suburban and rural terrain reported COST Walfisch-Ikegami model as the highest predicted path loss. In [8], the performance of eight empirical path loss models and a localized model along a predefined routes in Osun States, Nigeria was presented. It was concluded that localized (ILORIN) model demonstrated the best path loss prediction with significant accuracy over the compared models. In [9], a study on how empirical models were used for prediction of path loss of TV signals for secondary use in which measurement campaign of field strength in the VHF and UHF band along six different routes that covers rural, suburban and urban environment of Kwara State was also presented. The results indicated that there is no record of a single model revealing a good fit consistently.

2. METHODOLOGY

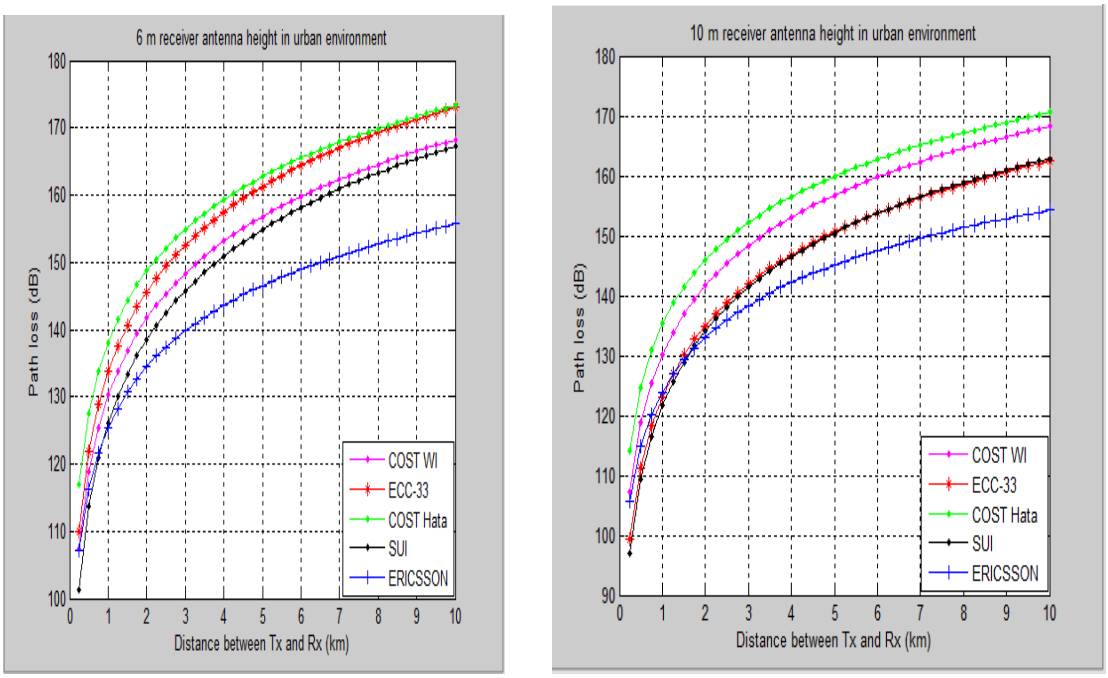
In this paper, five different empirical models were assessed for the investigation on WiMAX technology that can operate both in 2.5GHz and 3.5GHz [10-13]. The best fitted parameters were chosen suitable for Nigerian terrain in terms frequency and average heights of the building. The propagation models ECC-33 Model, SUI Model, Hata COST 231 Model, COST 231 Walfish-Ikegami and Ericsson Model were compared. MATLAB (2010a) simulator was used for the graph of comparison.

Table 1: Simulation parameters

PARAMETERS	VALUE
Tx Power of the base station	43 dBm
Mobile Tx power	30 dBm
Height of antenna Transmitter	30 m in urban and suburban
Tx-MS Distance	10 m
Operating Frequency	2.5 GHz and 3.5 GHz
Height of the receiving	3 m, 6 m and 10m

Distance of Building to Building	50 m
Height of Average Building	15 m
Width of the street	25 m
Street Orientation Angle	30^0 (urban) & 40^0 suburban)
Correction for Shadowing	8.2 dB (suburban) and 10.6 dB (urban environment)

3. SIMULATION RESULTS AND DISCUSSION



(a) (b)

Figure1: Graph of predicted losses in urban environment at 2.5GHz with (a) 6m and (b) 10m antenna receiver height.

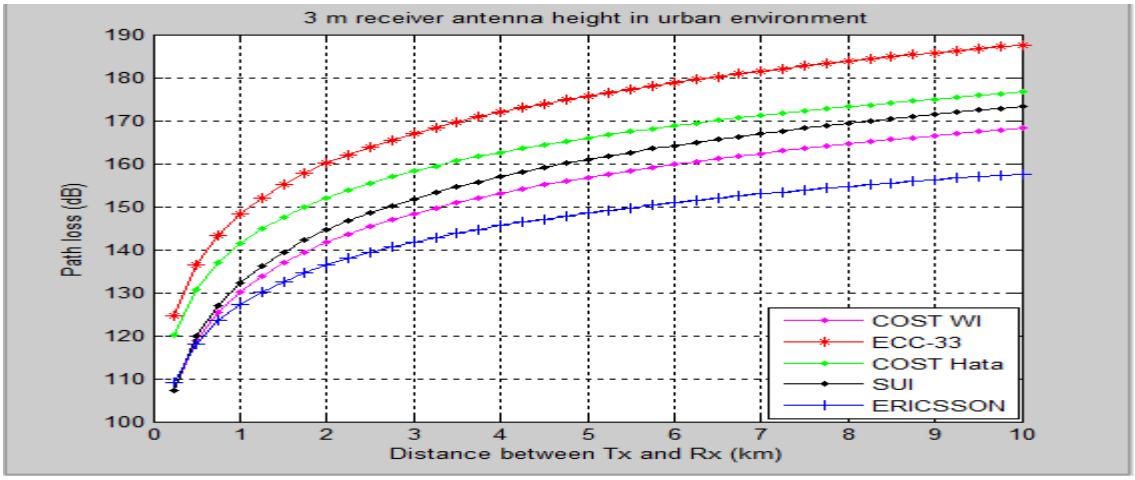
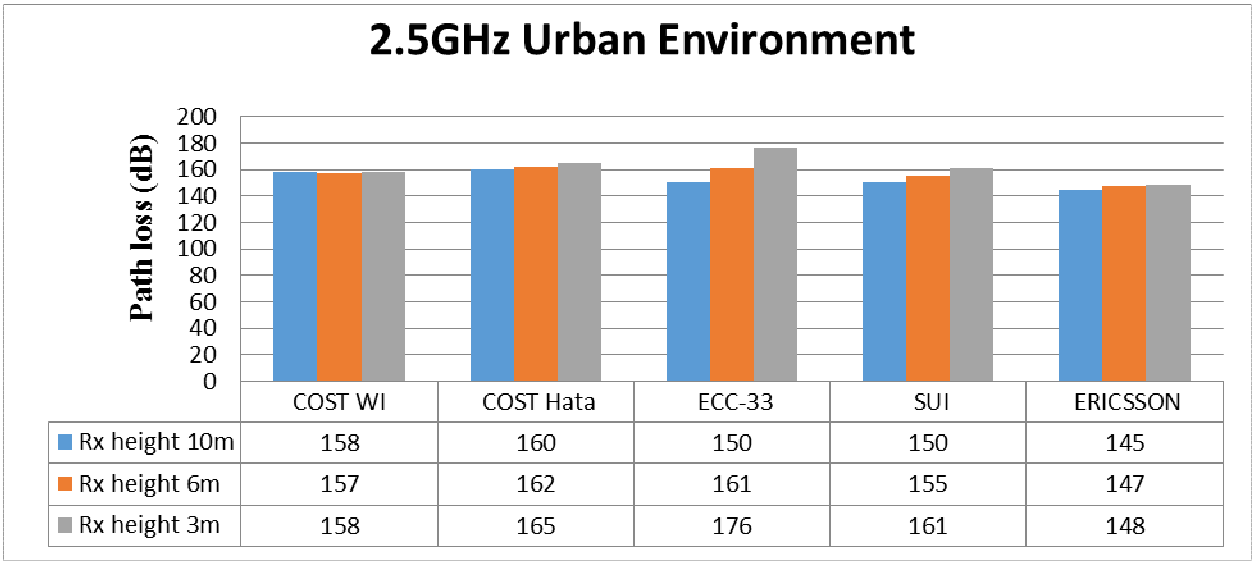
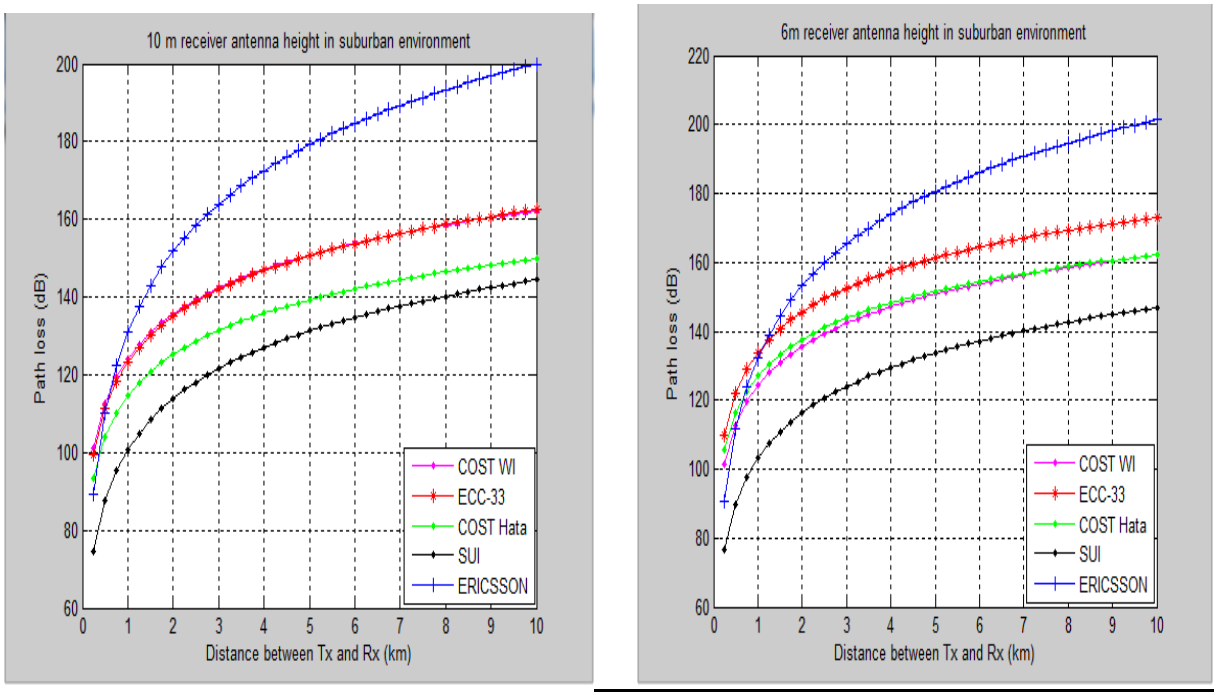


Figure 2: Graph of predicted losses in urban environment at 2.5GHz with 3m antenna receiver height.



	COST WI	COST Hata	ECC-33	SUI	ERICSSON
Rx height 10m	158	160	150	150	145
Rx height 6m	157	162	161	155	147
Rx height 3m	158	165	176	161	148

Figure 3: Graphical breakdown of the results for urban area at 2.5GHz with different antenna receiver heights at distance 5km



(a) (b)

Figure 4: Graph of predicted losses in suburban environment at 2.5GHz with (a) 6m and (b) 10m antenna receiver height.

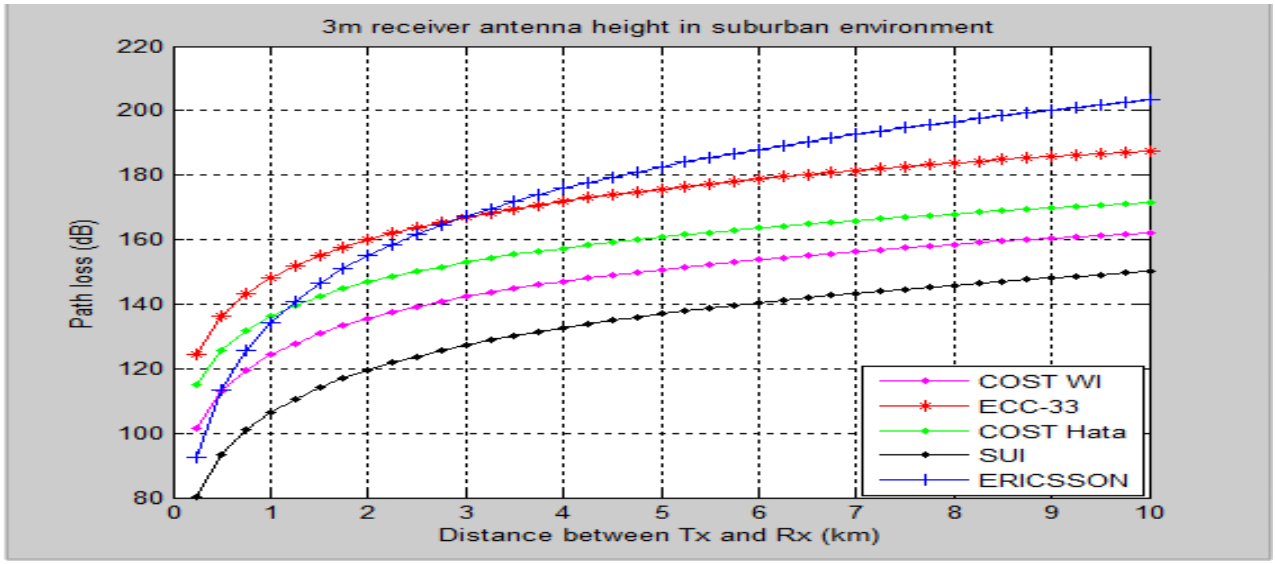
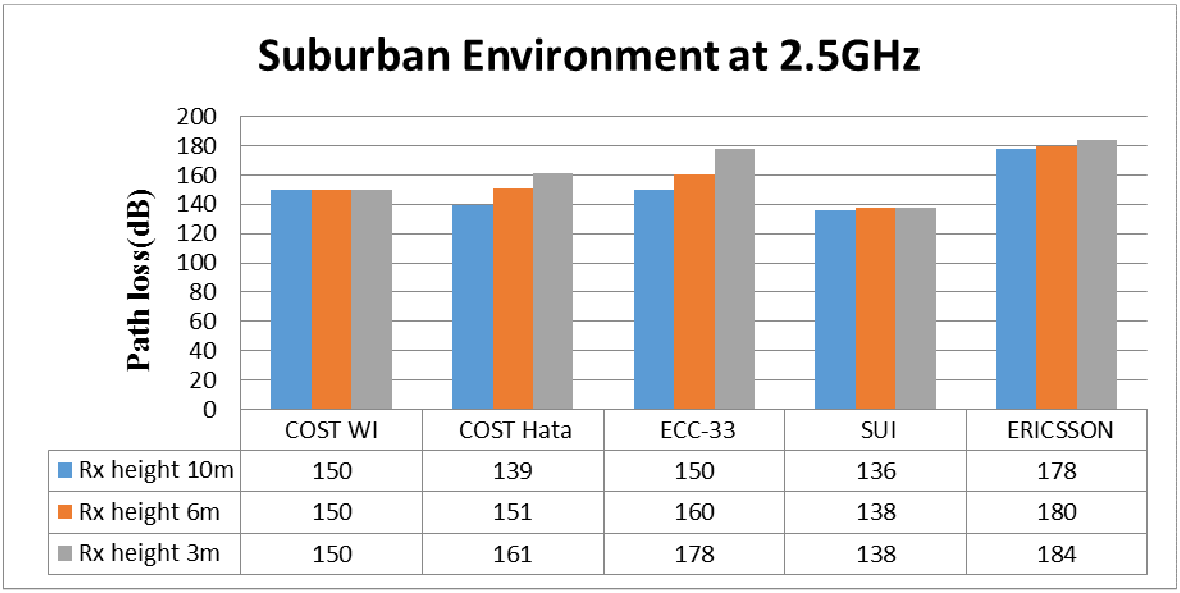
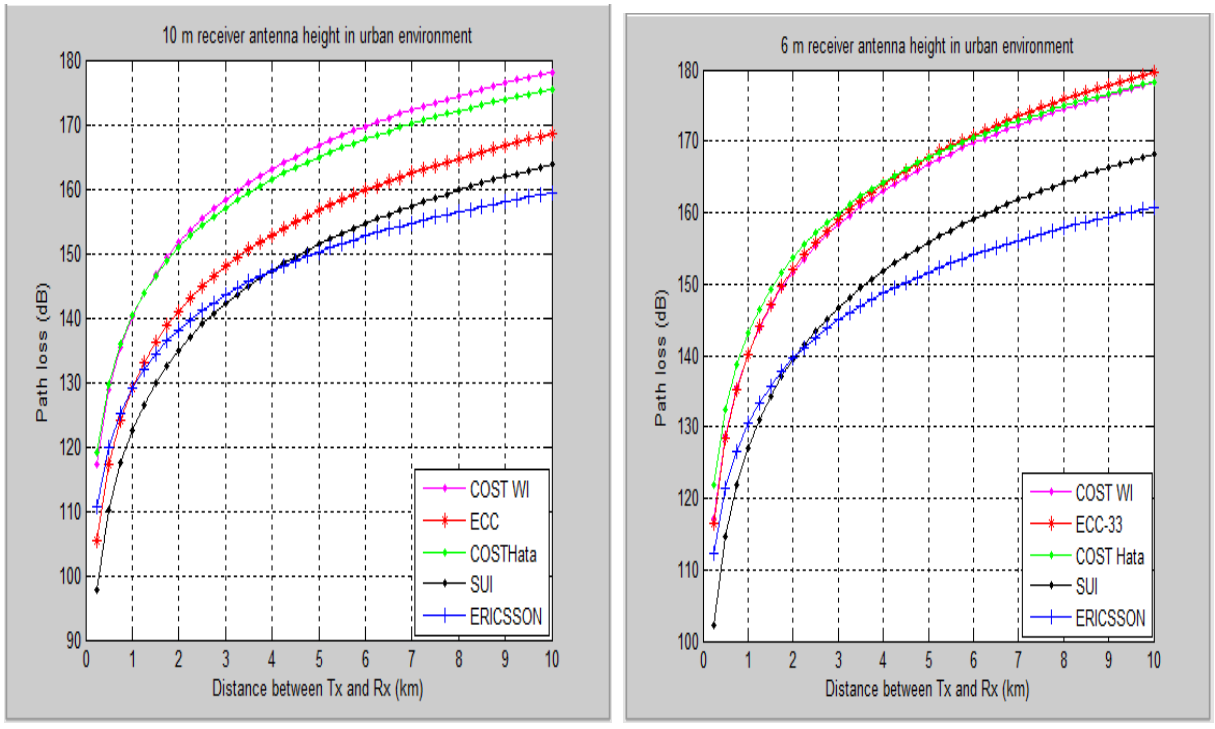


Figure5: Graph of predicted losses in suburban environment at 2.5GHz with 3m antenna receiver height



	COST WI	COST Hata	ECC-33	SUI	ERICSSON
Rx height 10m	150	139	150	136	178
Rx height 6m	150	151	160	138	180
Rx height 3m	150	161	178	138	184

Figure 6: Graphical breakdown of the results for urban area at 2.5GHz with different antenna receiver heights at distance 5km.



(a) (b)

Figure 7: Graph of predicted losses in urban environment at 3.5GHz with (a) 6m and (b) 10m antenna receiver height.

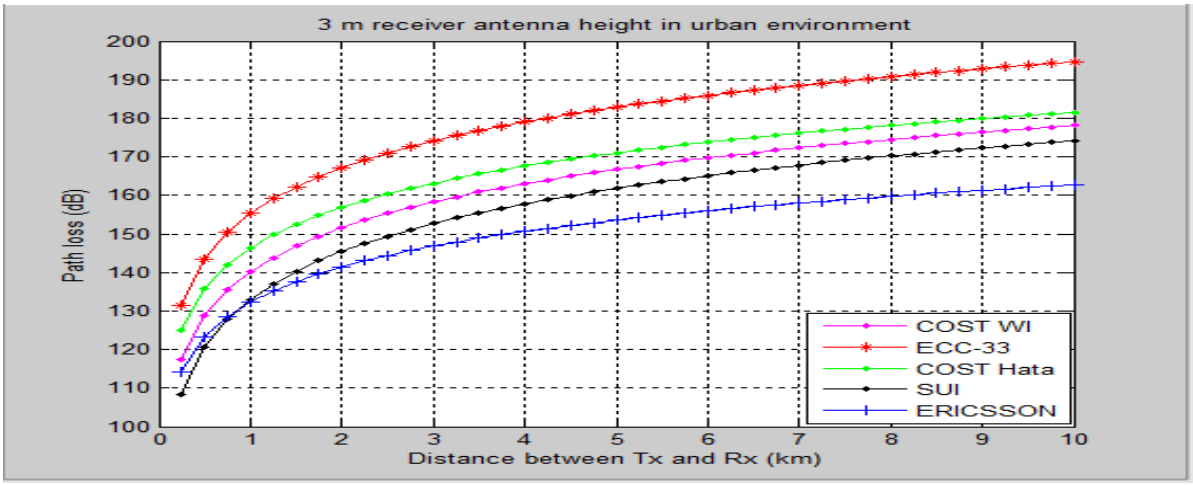
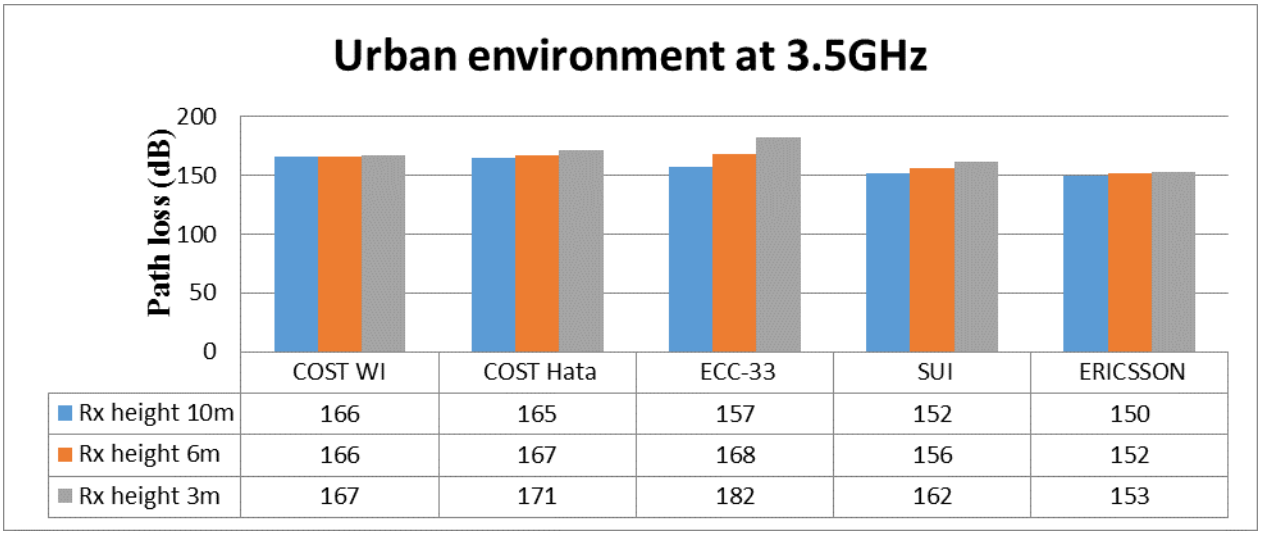


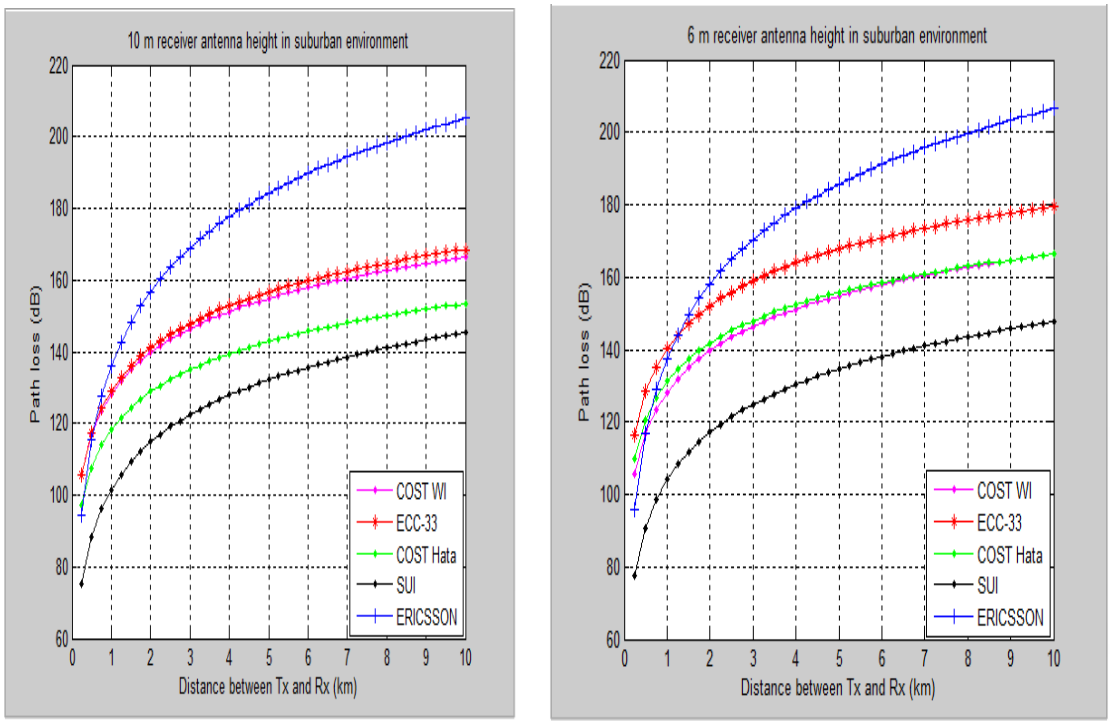
Figure 8: Graph of predicted losses in urban environment at 3.5GHz with 3m antenna receiver height



	COST WI	COST Hata	ECC-33	SUI	ERICSSON
Rx height 10m	166	165	157	152	150
Rx height 6m	166	167	168	156	152
Rx height 3m	167	171	182	162	153

Figure 9: Graphical breakdown of the results for urban area at 3.5GHz with different antenna receiver heights at distance 5km

Predicted path loss in suburban environment at 3.5GHz



(a) (b)

Figure 10: Graph of predicted losses in suburban environment at 3.5GHz with (a) 6m and (b) 10m antenna receiver height.

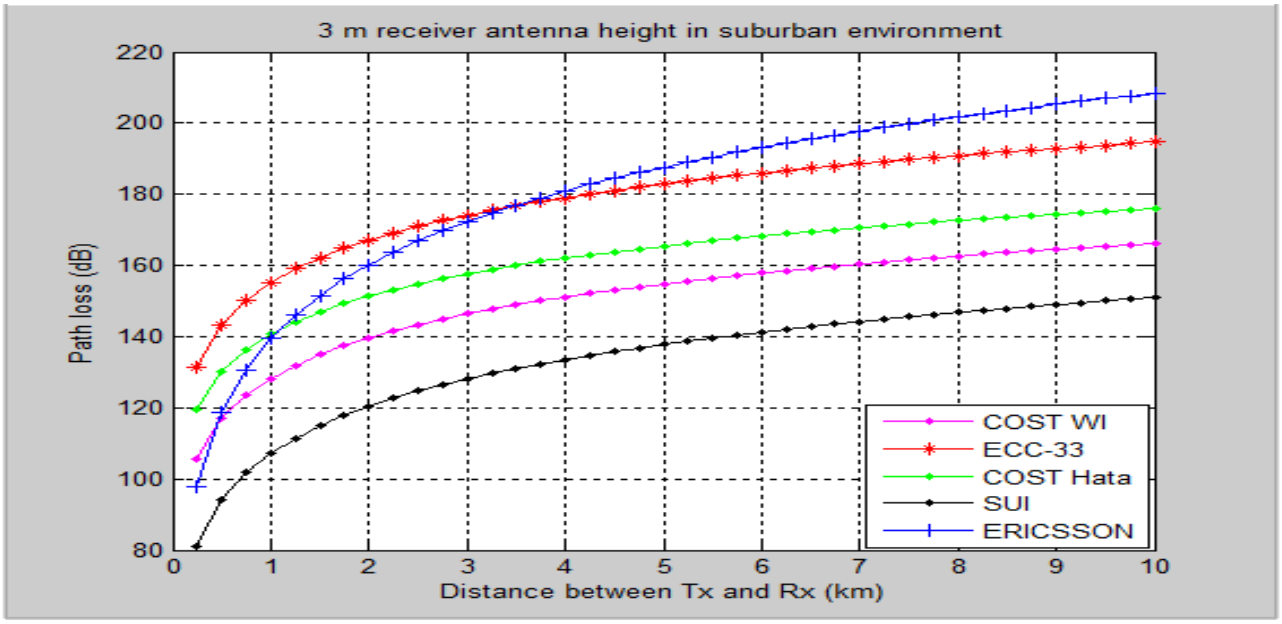
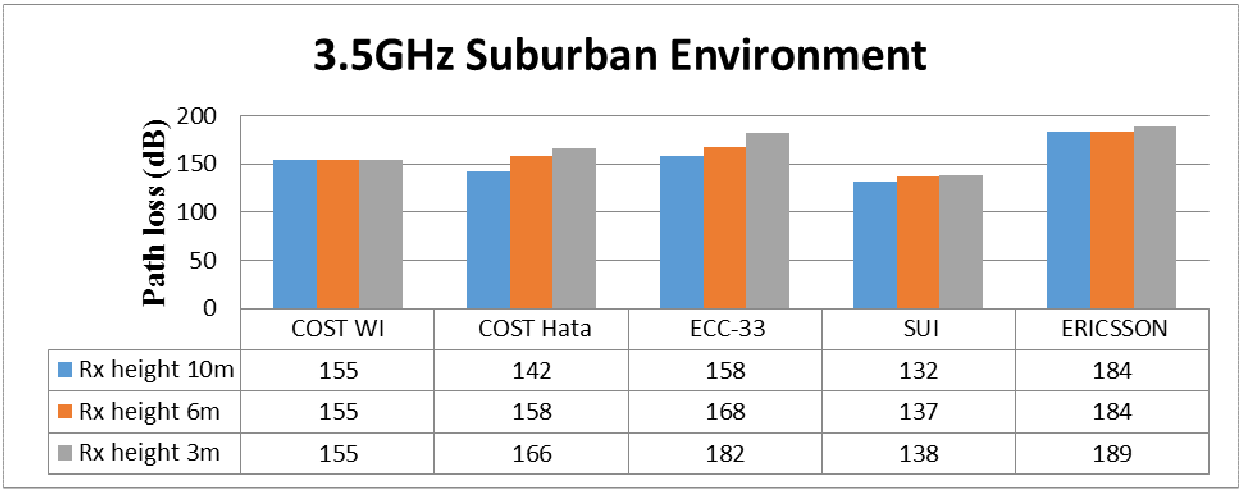


Figure 11: Graph of predicted losses in suburban area at 3.5GHz with 3m antenna receiver height



	COST WI	COST Hata	ECC-33	SUI	ERICSSON
Rx height 10m	155	142	158	132	184
Rx height 6m	155	158	168	137	184
Rx height 3m	155	166	182	138	189

Figure 12: Graphical breakdown of the results for suburban area at 3.5GHz with different antenna receiver height at distance 5km.

4. RESULTS AND DISCUSSIONS

In fig 1 and 2, the variation of the predicted path loss with distance shows that the Ericsson model revealed the least predicted value (i.e., between 145 dB to 147 dB) at 10 m and 6 m receivers' height of antenna operating on 2.5 GHz frequency within the urban environment. The Ericsson model demonstrated the minimum fluctuations paralleled to other models as a result of change in the receivers antenna height. Apparently, COST 231 Hata indicated the highest predicted path loss at 10 m and 6 m with the predictions 160 dB and 162 dB respectively. In the same case, ECC-33 revealed the highest prediction of 176 dB at 3m with same 5km distance and 2.5GHz frequency. In contrast, the Ericsson model as shown in figs. 4 and 5 presented the highest predicted propagation loss of 178 to 184 dB at suburban environment that showed the maximum compared to other models at disparate receivers antenna height. SUI model revealed the least variation of propagation loss of 136 to 138 dB. COST 231 Walfish-Ikegami showed a constant path loss value of 150 dB at each receiver antenna height.

Figs. 7 and 8 illustrated the predicted path loss value in an urban environment at frequency of 3.5 GHz and 30 m transmitter antenna height to 10m, 6m and 3m receivers' height of an antenna, with Ericsson model showing the least predicted path loss of 150 dB to 153 dB. It showed the lowest predicted value of path loss amongst compared propagation model each time the receiver antenna height was changed. The ECC-33 model revealed the peak propagation loss value using 6 m and 3 m receiver antenna heights of 168 dB and 182 dB respectively. However, the COST 231 Walfish-Ikegami showed the highest predicted value of 166 dB at 10 m receiver antenna height. In figs. 10 and 11, the suburban terrain indicated a constant path loss value by COST 231 Walfish-Ikegami at 155 dB at each time the antenna receiver height is changed. Ericsson model revealed the highest fluctuation due to the change in receiver antenna heights. The predicted values in all figures discussed, denotes that, an increment in the receiver antenna height will increase the probability of the receiver to detect a better transmit signal from the servicing transmitter.

5. CONCLUSIONS

The suburban environment showed a lower predicted value compared to urban environment. It revealed that, the more the reduction in the receiver antenna heights, the lesser the possibility of the device to receive a better quality of signal transmitted by the transmitter which can result to low received signal power and vice versa. Deployment of a full coverage area can be achieve when there is an increase in transmission power, which will possibly increase the level of interference between two frequencies adjacent to each other. Alternatively, a lesser transmit power can also be used for the deployment, but this might not serve the intended users in that coverage plan. It may cause some users out of signal reach in the serving cell particularly when congestion arises. In this case, trade-off is needed between both methods. However, the Ericsson and SUI model are best suitable for the deployment of FWA operating at both 2.5 GHz and 3.5 GHz and in an urban and suburban environment respectively.

REFERENCES

[1] X. Wang, and H. V. Poor "Wireless Communication Systems*" Advanced Techniques for Signal Reception,* 2003.

[2] M. Shahajahan and A. Q. M. A. Hes-Shafi, Analysis of Propagation Models for WiMAX at 3.5 GHz*, Department of Electrical Engineering Blekinge Institute of Technology,* 2009.

[3] N. T.Surajudeen-Bakinde, N. Faruk., A. A. Ayeni, M. Y. Muhammad, M.I Gumel, "Comparison of Propagation Models for GSM 1800 and WCDMA Systems in Some Selected Urban Area of Nigeria", *International Journal of Applied Information Systems (IJAIS), Foundation of Computer Science FCS*, New York, USA, – ISSN : 2249-0868. Vol. 2, No.7, pp 6-13, May 2012.

[4] A. Ayeni, N. Faruk, L. Olawoyin, M. Y. Muhammad and M. I. Gumel "*Comparative Assessments of Some Selected Existing Radio Propagation Models: A Study Of Kano City, Nigeria" European Journal of Scientific Research*, Vol.70 No.1, pp. 120-127, 2012**.**

[5] B.O.H. Akinwole and J.J. Biebuma "Comparative Analysis of Empirical Path Loss Model for Cellular Transmission in Rivers State" *American Journal of Engineering Research (AJER)* Volume-02, Issue-08, pp-24-31, 2013.

[6] M. A. Alim, M. M. Rahman, M. M. Hossain, and A. Al-Nahid "Analysis of Large-Scale Propagation Models for Mobile Communications in Urban Area" *(IJCSIS) International Journal of Computer Science and Information Security,* Vol. 7, No. 1, 2010.

[7] N. Shabbir, M. T. Sadiq, H. Kashif and R. Ullah "Comparison of Radio Propagation Models For Long Term Evolution (LTE) Network", *International Journal of Next-Generation Networks (IJNGN)* , Vol.3 No.3, September 2011.

[8] Jimoh A.A, Surajudeen-Bakinde Nasir Faruk, Bello O.W. and Ayeni "Clutter Height Variation Effects on Frequency DependenPath Loss Models at UHF Bands in Build-Up Areas*" Science Technology and Arts Research Journal,* Oct-Dec 2015, 4(4): 138-147.

[9] Nasir Faruk, Adeseko A. Ayeni and Yunusa A. Adediran "On The Study of Empirical Path Loss Models For Accurate Prediction Of Tv Signal For Secondary Users" *Progress in Electromagnetics Research B, Vol. 49, 155{176,* 2013.

[10] V.S. Abhayawardhana, I.J. Wassel, D. Crosby, M.P. Sellers, M.G. Brown, *"*Comparison of empirical propagation path loss models for fixed wireless access systems*," 61th IEEE Technology Conference,* Stockholm, pp. 73-77, 2005.

[11] Josip Milanovic, Rimac-Drlje S, Bejuk K, "Comparison of propagation model accuracy for WiMAX on 3.5GHz," *14th IEEE International conference on electronic circuits and systems*, Morocco, pp. 111-114. 2007.

[12] Joseph Wout, Martens Luc, "Performance evaluation of broadband fixed wireless system based on IEEE 802.16," *IEEE wireless communications and networking Conference*, Las Vegas, NV, v2, pp.978-983, April 2006.

[13] V. Erceg, K.V. S. Hari, M.S. Smith, D.S. Baum, K.P. Sheikh, C. Tappenden, J.M. Costa, C. Bushue, A. Sarajedini, R. Schwartz, D. Branlund, T. Kaitz, D. Trinkwon, "Channel Models for Fixed Wireless Applications," *IEEE 802.16 Broadband Wireless Access Working Group*, 2001.

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A SURVEY OF APPLICATION OF NATURE-INSPIRED COMPUTATIONAL METHODOLOGIES IN RADIO PROPAGATION

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ABSTRACT

The importance of wireless propagation path loss prediction and interference minimization study in various environments cannot be over emphasized. Numerous researchers have done massive work on scrutinizing the effectiveness of existing path loss models for channel modeling. The difficulties experienced by the researchers determining or having the detailed information about the propagating environment prompted the use of computational intelligence in prediction of path loss. This study discussed nature inspired computational approaches as used in radio propagation. In the paper, Artificial Neural Network (ANN), Swarm Intelligence (SI) and other computational methodologies and approaches employed in channel modeling were reviewed. It was found through the literature that the accuracy of the basic models could be improved by applying nature-inspired algorithms. However, among some of the optimization process, it was found that the ***Particle Swarm Optimization*** *gives better prediction compare to* ***Genetic Algorithm****.*

Keywords: *Nature inspired, Computational intelligence, path loss, artificial neural network, particle swarm intelligence*

1. INTRODUCTION

The wireless communication networks form a very important part of our daily life. The most widespread of this network across the globe is cellular mobile communications network. This network contributes greatly to our day-to-day activities. So, in order to have optimum use of wireless network it must be properly design. During the design phase, it is important to consider parameters such as: quality of service (QoS), transmitting frequency, coverage area, received power, and transmitter power to minimized possible losses. However, there is always a reduction in the strength of the signal received by mobile stations due to fading which occur in a large scale commonly

referred to as path loss. Various propagation models have been proposed and used for the prediction of path losses. However, over decades now, the use of these models revolved within the four classified groups (i.e.: empirical models, physical/analytical models, semi empirical models and deterministic models) [1]. Each of these models contributes significantly to channel propagation modeling. However, amongst these models, empirical path loss propagation models were found to be the most widely used due to their simplicity, but they are prone to high prediction errors as found in [2], the inability or difficulty in getting detailed information about the propagating environment leads to adoption of evolutionary algorithms such as Neural Network and Fussy systems in predicting path loss. This method learns and adapt to any change in the environment thus a better prediction compared to basic models. A nature-inspired computational methodologies also known has Computational intelligent, provides solution to the experienced complex problems where the traditional basic models cannot provide accuracy [3]. It integrates neural network, fuzzy logic and natural inspired algorithm to optimize the path loss so as to reduced errors in the aforementioned models above. Example includes genetic algorithm, Particle swarm optimization, and ANT colony etc.

2. PATH LOSS PROPAGATION MODELS

The incessant proliferation of wireless technologies and applications has fostered the increase in the usage of these inventions by subscribers. The more the demand from users, the more service providers deploy wireless communication technologies. In deploying wireless networks, there is need to understand how wireless signals are propagated over distance in a particular environment [4]. In [4], wireless signals are attenuated over distance in a particular environment. It is pertinent for network engineers to predict the attenuation of radio signals (path loss) along the channel over a distance in order to have a better plan that can accommodate current users, cater for future expansion with less or no interference of signals after the deployment of the network. The propagation of radio signals are subjected to different propagation mechanisms as they promulgate through free space and are influenced by topographic nature of the environment resulting to reduction in received power compared to the original transmitted power [5, 6, 7 and 8]. The prediction of how signals are attenuated over a distance is characterized by the **path loss** models. These models are classified into three main branches [9]:

A. Deterministic Models: These models estimates the field strength from the path profile of the terrain between the transmitter and the receiver. The model also consider losses due to diffraction, reflection and refraction in cases where there is no clearance between the radio path and the terrain.

B. Empirical (Basic) Models: It compute the path loss along the channel based on measurements data from the environment, which make use of the carrier frequency, transmitter, receiver heights and distance as its input. E.g. Ericson, Erceg Hata Models [4].

C. Physical Models: Physical laws are used to propagate electromagnetic waves and used to determine the received signal strength of signals at an environment. E.g. TIREM (Terrain Integrated Rough Earth Model, Terrain Models, Longley Model etc. [10].

The deficiencies of the aforementioned path loss models include: dependent on the terrain modeling such as positioning of antenna height, distance between buildings and many more haves geared the application of **computational intelligence** on the existing model to give a better predicting model for path loss prediction.

3. COMPUTATIONAL INTELLIGENCE

Computational intelligence acts as a solution to problems in which there are no mathematical models or algorithm in solving them. CI was defined in [11] as aspect of science that studied complications where effective computational algorithms are non-available. The application of computational intelligence in the development of propagation models for solving prediction problems had been reported in [3, 4, 5, 9, and 11]. Fig 1 illustrates the paradigm of CI consisting of Neural Network (NN), Artificial Intelligence System (AIS), Evolutionary Computation (EC), Swarm Intelligence (SI) and Fussy Systems (FS) [12].

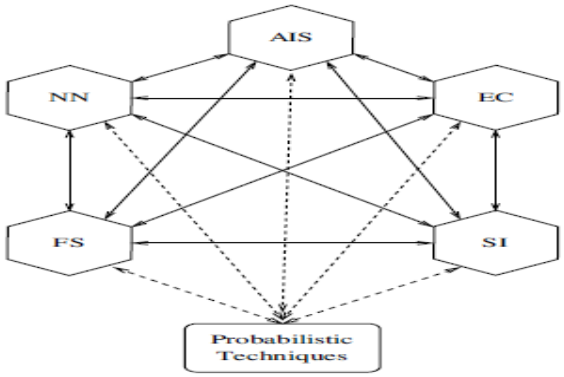


Fig1: Computational Intelligence Paradigms [12].

A. Neural Network also known as Artificial Neural Network (ANN) is an artificial technique which can effectively be used for development of path loss models, providing solution for prediction problems. Neural Network has the competence to learn and no need of an explicit knowledge of the input and output process relationship [13]. Several researchers [1, 12, 13, and 15] have performed several studies on ANN to develop propagation models. Therefore, it can be useful in the development of path loss for better prediction of received signal strength and interference analysis. An artificial neural network (ANN) sometimes consist of an input, hidden layers, and output layer which can be connected partially or fully to the NN in the next layer [12]. It also has the feature of feedback connection illustrated in Figure 2.

A neural network has a nonlinear mapping from R^I to R^K, expressed in [12].

$f_{AN}: R^I \rightarrow R^K$ (1)

For which R^I usually $[0,1]$ or $[-1,1]$ dependent on the activation function used;

$: R^I \rightarrow [0,1]$ (2)

or

$$f_{AN}: R^I \rightarrow [-1,1]$$

Where I serve as the times of input signals to the Artificial Network. Artificial Network uses a vector of I input signals either from the environment or other ANs.

$$z = (z_1, z_2, \cdots, z_i)$$

For every inputted signals, z_i is related with weight w_i, to modify the input signal. The Neural Network compute the total input signal $(z_i + w_i)$ and uses bias and activation function f_{AN} as threshold factor to compute the output signal, O

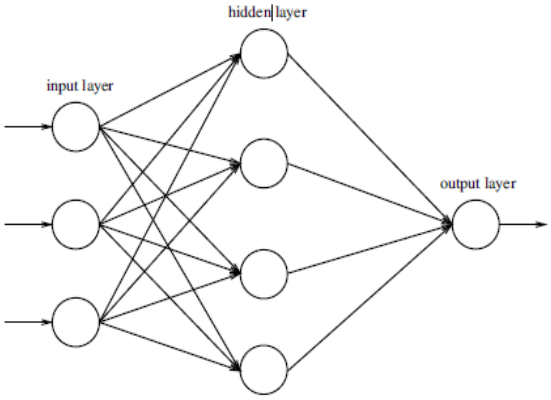


Fig 2: Artificial Neural Network [12]

(i) ACTIVATION FUNCTIONS

The function f_{AN} receives the net input signal and bias, and determines the output (or firing strength) of the neuron. This function is referred to as the *activation function*. Different types of activation functions can be used. The most common ones are: linear, step, ramp, Sigmoid, Hyperbolic tangent and Gaussian functions. In general, activation functions are monotonically increasing mappings, where (excluding the linear function).

$$f_{AN}(-\infty) = 0 \quad or \quad f_{AN}(-\infty) = -1 \quad (3)$$

and

$$f_{AN}(\infty) = 1 \quad (4)$$

B. Swarm Intelligence (SI): The social behavioral way of organisms (individual) in swarms incited the study and design of an efficient optimization and clustering algorithms. The foraging behavioral study of ants give rise to the invention of colony optimization algorithms, and the simulation study of choreography of bird flocks also give rise to particle swarm optimization Algorithm (PSO) [12].

(i) Particle Swarm Optimization

The particle swarm optimization algorithm is a population-based quest procedure where the individuals, known as particle are cluster into a swarm. PSO is a stochastic optimization method that is modelled on the fundamental social behavior of bird flocks

which is used to solve nonlinear problem [12, 28]. The particle for search in space consist of personal best vector, position vector (x) and velocity vector (v) and a fitness value. PSO algorithm can be deployed at the initialization and iteration phases [28]. Each particle is randomly allotted through n-dimensional search space at the initialization phase of the velocity and position vectors while in iteration each particle looms towards the best solution by modifying its velocity and position in accordance with the equation in [11]. PSO can be applied in various aspects such as function approximation, optimization of mechanical structures, clustering and solving systems of equation [12]. Essentially, two different PSO algorithms were developed namely Global Best PSO (gbest) and Local Best PSO (lbest).

(ii) Global Best PSO

For the global best PSO, the neighborhood for each particle is the entire swarm. For the star neighborhood topology, the social component of the particle velocity update reflects information obtained from all the particles in the swarm. In this case, the social information is the best position found by the swarm, referred to as $\hat{\mathbf{y}}(t)$.

$$v_{ij}(t+1) = v_{ij}(t) + c_1 r_{1j}(t)\left[y_{ij}(t) - x_{ij}(t)\right] + c_2 r_{2j}(t)\left[y_j(t) - x_{ij}(t)\right] \quad (12)$$

$$y_i(t+1) = \begin{cases} y_i(t) & if\ f(x_i(t+1)) \geq f(y_i(t)) \\ x_i(t+1) & if\ f(x_i(t+1)) < f(y_i(t)) \end{cases} \quad (13)$$

The global best position, $\hat{\mathbf{y}}(t)$, at time step t, is defined as

$$y(t) \in \{y_0(t), \ldots, y_{ns}(t)\} | f(y(t)) = min\{f(y_0(t)), \ldots, f(y_{ns}(t))\} \quad (14)$$

$$y(t) = min\{f(x_0(t)), \ldots, f(x_{ns}(t))\} \quad (15)$$

(iii) Local Best PSO

$$v_{ij}(t+1) = v_{ij}(t) + c_1 r_{1j}(t)\left[y_{ij}(t) - x_{ij}(t)\right] + c_2 r_{2j}(t)\left[y_{ij}(t) - x_{ij}(t)\right] \quad (16)$$

$$y_i(t+1) \in \{N_i | f(y_i(t+1)) = min\{f(x)\}, \quad \forall_x \in N_i\} \quad (17)$$

$$N_i = \{y_{i-n_{Ni}}(t), y_{i-n_{Ni}+1}(t), \ldots, y_{i-1}(t), y_i(t), y_{i+1}(t), \ldots, y_{i+n_{Ni}}(t)\} \quad (18)$$

C. Fuzzy Inference Systems and ANFIS

Fuzzy inference system is a computational model based on fuzzy set theory, fuzzy if then rules, and fuzzy reasoning. FIS approximate functions based on rule base, database, and reasoning mechanism. Adaptive-Network Based Fuzzy Inference System (ANFIS) is a class of adaptive networks that are functionally equivalent to FIS. An adaptive network is a multilayer feed forward network in which each node performs a particular function on incoming signals. ANFIS has five layers.

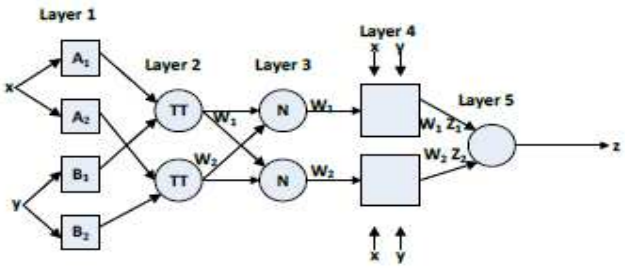


Fig.3: shows ANFIS Structure [25]

The inputs are x and y and z output. For each layers the rules are define below

Rule 1: If x is A_1 and y is B_1, then $z_1 = p_1x + q_1y + r_1$

Rule 2 : if x is A_2 and y is B_2, then $z_2 = p_2x + q_2y + r_2$

Table 1. ANFIS based on Takagi and Sugeno's function [25]

Layers	Operation	Desription	Equation
1	Fuzzy layer	Its adaptive nodes generate membership grades of the input vectors (bell-shaped (Gaussian)) function, range 0-1, used for implementing the node function:	$O_i^2 - f(x,a,b,c) - \mu_{Ai}(x) - \frac{1}{1+((x-ci)/ai)^{2bi}}$ $\mu_{Ai}(x) = \exp\{-\left(\frac{x-ci}{ai}\right)^{2bi}\}$
2	Product layer	It determines the firing strength of a rule, by multiplying membership functions.	$w_i = O_i^2 = \mu_{Ai}(x).\mu_{Bi}(x), i =$
3	Normalised layer	It determines the ratio of the i[th] rule's firing strength to total of all firing strengths	$w_i = O_i^3 = \frac{wi}{wi+wi}, \ i = 1,..$
4	Defuzzify layer	It computes the contribution of each rule to the overall output	$\bar{w}_i z_i = O_i^4 = \bar{w}(p_i x + q_i y +$
5	Total output layer	It computes the overall output as the summation of contribution from each rule:	$\sum \bar{w}_i z_i = O_i^5 = \sum i \frac{\bar{w}izi}{\sum izi}$

Where $O_i^{\,l}$is the output of the i^{th} node in the input layer, $\mu_{Ai}(x)$is the membership function, and $\{a_i, b_i, c_i\}$ are premise parameter.

4. COMPARATIVE STUDIES

In [15] a study was conducted on ANN model to determine the Rxlevel of GSM for which parameters such as atmospheric temperature, humidity and dew point were used. Data generated, ANN design formulation and a model for the Rxlevel using ANN synaptic weights was developed and was used with the bias values to form the model equation. The findings revealed that 33 neurons were used in the hidden layer and tansig activation, the ANN developed model demonstrated as the best model with the lowest Mean Square Error value of 0.056. Work done in [16], presented the use of Artificial Neural Network (ANN) of Levenberg-Marquardt algorithm for path loss prediction of FM radio station. The training of the ANN used a transmitter that transmit at 98.6 MHz FM band and the ERP emitted at 44 dBW with the distance closed to the transmitter and up to 25 kilometers away from it in Ankara. The ANN, Levenberg-Marquardt algorithm was compared with Epstein-Peterson models and ITU-R 1546. Results revealed the Root Mean Square Error (RMSE) for the ANN Model using Levenberg-Marquardt algorithm was 9.57 which is lower compared to Epstein-Peterson for which RMSE is 10.26. [17], also presented a survey on Mobile Communications Systems path loss prediction with the use of Neural Network Approach in Urban Environments. Results acquired were compared along-side the ray-tracing model and it indicated that, the NN exhibit better accuracy either uniform of non-uniform distribution of the environment. [18], research was conducted on Fuzzy adaptive neural network for the prediction of path loss at GSM 900 band in an urban areas at Harbiye urban area of Istanbul. A CW transmitter was used together with an omnidirectional antenna measuring at the frequency of 924.4 MHz and high speed data collection software from were used as the receiver. It was discovered in the study that the path loss mean square error of the ANFIS algorithm is lower compared along-side to Bertoni-Walfisch Model because the ANFIS algorithm does not necessarily consider equal height and distance between the buildings as it is for the other. E.Ostlin et.al conducted a study on Macro cell path-loss prediction with the use of ANN [19], in Australia, IS-95 pilot signal was utilized along-side a CDMA mobile network to collect data in rural environment for the study. Factors such as prediction accuracy, generalization properties and training time, were considered during the evaluation and also back propagation training algorithms such as gradient descent and Levenberg–Marquardt, are evaluated. The prediction results was compared with the ITU-R P.1546 and the Okumura–Hata model in which the statistical analysis revealed the non-complex Artificial Neural Network (ANN) Model demonstrated better in regards to prediction time, complexity and accuracy. It shows average results of maximum error 22 dB, mean error 0 dB and standard deviation of 7 dB. In [20], Neural Network modelling combined with fuzzy logic was used to estimate interference path loss on Airbus 319 and 320 airplanes. The interference patterns was classified based on windows, aircraft structure, communication/navigation systems and location of the

doors. The modeled results was compared with the measured data in which modeled algorithm revealed improve in estimate of measured data over estimates obtained with NN alone. [21], presented a comparative experimental study on path loss prediction as a function of distance and frequency using Multilayer Perception and Radial Basis Function of Artificial Neural Network. The results indicated that the Radial Bias Function (RBF) ANNs vividly demonstrated a lower mean square error of 0.0844 dB than the Multilayer Perception (MLP) with mean square error of 1.7618 dB which also predict path loss more accurately. In [22], a Neural Network (NN) approach was used on empirical model to develop a model for prediction of propagation path loss at 900MHz, 1800 MHz and 2100 MHz in Tripoli, Libya. The research is aimed to replace Hata's model which was initially used for Tripoli cellular network. The RSS were measured as function of distance in 10 locations in Tripoli, two locations for each type of areas. For every location the measured values were averaged every distance equal to 40λ. Results revealed that the ANN path loss model had acceptable agreement with the target path loss with MSE values ranging from 3.7 to 6.7.

An improved propagation path loss prediction model for ITU-R model for digital terrestrial television [23] was developed and optimized by particle swarm optimization (PSO). The results revealed the Root Mean Square Error (RMSE) values decline quickly from 13.5 to 10.41 dB after seven iterations. It was concluded that the ITU-R P.1812-4 recommendation model that was tuned by the bioinspired algorithm (PSO) for the estimation of path loss in Digital Terrestrial Television (DTT) systems in Caracas, Venezuela demonstrated a substantial improvement in its accuracy. [24&25], presented the use of computational intelligence in VHF band for path loss prediction, it proposed an adaptive neuro-fuzzy model that revealed the lowest Root Mean Square Error (RMSE) and Mean Error while SC-RMSE and SDE are dependent on the topography nature of the routes.

[26], presented the use of Feed-Forward Neural Network (FFNN) algorithm to develop a model for path loss predictions. Data collected from 11 different1800 MHz base station transmitters at varying distances were used for the predictions. The results revealed that the FNN architecture produced the lowest predicted error with MAE, MSE, RMSE standard deviation and R values of 4.21 dB, 30.99, dB, 5.56 dB and 0.89 respectively.

5. CONCLUSION

Since it is pertinent to predict path loss for the purpose of better coverage planning and interference analysis, the basic propagation path loss models had always been used. The limitation of basic models not able to fully characterize our environment initiated the application of nature-inspired algorithm for the prediction of path losses. It was deduced from the reviewed works that the nature inspired algorithm gives a better prediction than the basic as it is in [14 &15]. Also, the optimization performed by the natured inspired algorithm either with GA or PSO is better in predicting error to the lowest possible value. There is no single or combination of models that is 100% accurate in predicting path loss. Neural network shows a better performance compared to the basic models due to its ability to learn and adjusts to change in the environment.

REFERENCES

[1]. I. Joseph, C.C., Konyeha," *Urban Area Path Loss Propagation Prediction and Optimisation Using Hata's Model At 800 Mhz*", IOSR Journal of applied physics, (IOSR-JAP), Vol. 3, Issue 4, (Mar.-Apr. 2013) pp08-18

[2] Faruk, N., Adediran, Y. A., & Ayeni, A. A. "*Error bounds of empirical path loss models at vhf/uhf bands in kwara state, Nigeria".* Paper presented at the EUROCON, 2013

[3] https://en.wikipedia.org/wiki/Computational_intelligence, Accessed Jan 15, 4:15pm.

[4] C. Phillips,D. Sicker & Dirk Grunwald "A Survey of Wireless Path Loss Prediction and Coverage Mapping Methods" *IEEE communications surveys & tutorials*, vol. 15, no.1, first quarter 2013.

[5] B.O.H. Akinwole and J.J. Biebuma "Comparative Analysis of Empirical Path Loss Model for Cellular Transmission in Rivers State" *American Journal of Engineering Research (AJER)* Volume-02, Issue-08, pp-24-31, 2013.

[6] S I. Popoola, A. A. Atayero, Faruk. N, C. T. Calafate, L. A. Olawoyin and V. O. Matthews, "Standard Propagation Model Tuning for Path Loss Predictions in Built-Up Environments", Computational Science and Its Applications, *Lecture Notes in Computer Science series, Published by Springer,* Volume 10409, pp 363-375, 2017.

[7] S. I. Popoola, A. A. Atayero, C. Ndujiuba, F. E. Idachaba, N. Faruk, C. T. Calafate, "Calibrating the Standard Path Loss Model for Urban Environments using Field Measurements and Geospatial Data", *The 2017 International Conference of Wireless Networks*, London, U.K., 5-7 July, pp513-518, 2017.

[8] S. I. Popoola, A. A. Atayero and Faruk. N "Received Signal Strength and Local Terrain Profile Data for Radio Network Planning and Optimization at GSM Frequency Bands", Data in Brief, Elsevier, vol. 16, 972–981, 2017.

[9] E. Greenberg, & E. Klodzh "Comparison of Deterministic, Empirical and Physical Propagation Models in Urban Environments" *IEEE International Conference on Microwaves, Communications, Antennas and Electronic Systems*, 2 - 4 November 2015,

[10] K. Ahuja and M. Kumar "Significance of Empirical and Physical Propagation Models to Calculate the Excess Path Loss" *Journal of Engineering Research and Studies E-ISSN 0976-7916.*

[11] W. Duch, "What is Computational Intelligence and where is it going?" *Department of Informatics Nicolaus Copernicus University and School of Computer Engineering, Nanyang Technological University*, 2007.

[12] A.P. Engelbrecht, *Computational Intelligence.* 2007, p. 5, 143,

[13] J. O. Eichie,, O. D. Oyedum, M. O. Ajewole, and A. M. Aibinu "Comparative Analysis of Basic Models and Artificial Neural Network Based Model for

Path Loss Prediction" *Progress In Electromagnetics Research M, Vol. 61, 133–146,* 2017.

[14] Q. Bai., "Analysis of particle swarm optimization algorithm," Computer and Information Science, vol. 3, pp. 180-184, 2010.

[15] E. J. Ofure, O. O. David, A. M. Oludare and A. A. Musa "Artificial Neural Network model for the determination of GSM Rxlevel from atmospheric parameters" *Eng. Sci. Tech., Int. J. http://dx.doi.org/10.1016/j.jestc,*. 2016.

[16] A. R. Ozdemir, M. Alkan, M. Kabak, M. Gulsen, and M. H. Sazli, "The Prediction of Propagation Loss of FM Radio Station Using Artificial Neural Network" *Journal of Electromagnetic Analysis and Applications, 2014, 6, 358-365*

[17] S. P. Sotiroudis, K. Siakavara, and J. N. Sahalos "A Neural Network Approach to the Prediction of the Propagation Path-loss for Mobile Communications Systems in Urban Environments" *PIERS Proceedings, August 27-30, Prague, Czech Republic,* 2007.

[18] T.E. Dalkilic, B.Y. Hanci, A. Apaydin "Fuzzy adaptive neural network approach to path loss prediction in urban areas at GSM-900 band" *Turk J Elec Eng & Comp Sci, Vol.18, No.6,* 2010.

[19] E. Östlin, Hans-J. Zepernick, and H. Suzuki, "Macrocell Path-Loss Prediction Using Artificial Neural Networks*" IEEE Transactions on Vehicular Technology, VOL. 59, NO. 6,* JULY, 2010.

[20] M. J. Jafri, J. J. Ely and L. L. Vahala "Interference Path Loss Prediction in A319/320 Airplanes Using Modulated Fuzzy Logic and Neural Networks*" IEEE 1-4244-1214,* July, 2007.

[21] N. Zaarour, N. Kandil, N. Hakem and C. Despins "Comparative Experimental Study on Modeling the Path Loss of an UWB Channel in a Mine Environment Using MLP and RBF Neural Networks" *IEEE 978-1-4673-1291* December,2012.

[22] T.A. Benmus, R. Abboud, M.K. Shater, "*Neural network approach to model the propagation path loss for great Tripoli area at 900, 1800, and 2100 MHz bands*", International Journal of Sciences and Techniques of Automatic control & computer engineering IJ-STA, Vol. 10, No. 2, pp. 2121-2126, July 2016

[23] N. T. Surajudeen-Bakinde , N. Faruk , M. Salman , Segun Popoola, Abdulkarim Oloyede, and Lukman A. Olawoyin "On Adaptive Neuro-Fuzzy Model For Path Loss Prediction In The VHF Band" ITU Journal: ICT Discoveries, Special Issue No. 1, 2 Feb. 2018.

[24] S. I. Popoola, E. Adetiba, A. A. Atayero, V. O. Matthews, N. Faruk, C. T. Calafate "Optimal Path Loss Prediction Model for Rural Propagation Environments using Feed-Forward Neural Networks. *Cogent Engineering, Taylor and Francis, vol. 5, pp 1444345*, 2018.

[25] M.O, Omae, E.N., Ndungu, & P.L., Kibet, "The application of ANFIS-PSO trained in signal propagation modelling for indoor wireless communication Network, *International Journal of Scientific & Engineering Research*, Vol. 5, issue 12, December-2014.

[26] M. A. Salman, S. I. Popoola, Faruk. N, N. T. Surajudeen-Bakinde, A. A. Oloyede, L. A. Olawoyin,"Adaptive Neuro-Fuzzy Model for Path Loss Prediction in the VHF Band", in Pro. *IEEE International Conference on Computing, Networking and Informatics (ICCNI 2017)* in Covenant University, Ota, Nigeria between October 29-31, 2017, pp. 1-6, 2017.

PROSPECTS AND CHALLENGES OF DIFFERENT TECHNOLOGY OPTIONS FOR PUBLIC SAFETY AND DISASTER RELIEF NETWORKS IN NIGERIA

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ABSTRACT

Nigeria has been facing various security challenges, like the Niger Delta attacks in the South South, Boko Haram attacks in the Middle East to Fulani Herdsmen attacks which cut across all zones of the federation. All these unforeseen circumstances require reliable means of communication for the relief agencies to be promptly informed, to enable them come to the aid of the victims. This becomes very difficult if not impossible as most telecommunications infrastructure are been disrupted as a result of the attacks. Loss of lives and properties is enormous especially when the emergency agencies cannot be reached immediately. There must be alternative means of communication in the event of an emergency, when the available means telecommunication media have been rendered useless. The prospects and challenges of available technology options for public safety communication networks in Nigeria are discussed in this study.

Keywords: *Public Safety; Disaster; Telecommunication; Technology options*

1. INTRODUCTION

Globally, there are several cases in which the communication infrastructures are damaged and affects the public safety of people which include: the Indian Ocean tsunami of December 2004 (Townsend and Moss, 2005), New York City, September 11 terrorist attack (NCTA, 2004), the 1995 Kobe, Japan, earthquake (Kobe, 2017), the 1989 Loma Prieta earthquake (Barnum, 1994), the Kocaeli-Golcuk Earthquake of August 17, 1999 (George P. C, 2017) and many others. Public Safety Networks (PSNs)

are essentially, wireless communications networks used by emergency services organizations. It is basically providing 24-hour communications facilities in response to natural and man-made disasters, such as medical emergencies, threats to public order and a host of other life-threatening situations (Arthur, 2012). The primary objective of the public safety is for prevention and protection of the public from threats or disasters. National Emergency Management Agency (NEMA) in Nigeria, Federal Road Safety Corps (FRSC), Law Enforcement Agencies (i.e., police and the military), fire departments and Emergency Medical Services (EMS) are all agencies saddled with the responsibilities of looking after the safety of the populace especially during emergencies. Therefore, the ability of the first responders to communicate effectively in an emergency situation would determine the safety level. In all these situations, telecommunication infrastructures were physically damaged or disruption of supporting infrastructure such as transportation and electricity grid. High traffic volumes of users causing congestions also contribute in the same way of disrupting the telecommunication service. Whether partial or complete, disruption of telecommunications infrastructure as a result of disaster causes delays and errors in emergency response and disaster relief efforts, leading to loss of lives and damage to properties, which are all preventable with the help of first responders (Townsend and Moss, 2005). .

In Sept 2012, the Nigeria government, through the ministry of communication technologies, released the 2013-2018 National Broadband Plan (NBP) (NBP, 2012), which maps out strategies and recommendations for improving access across the country. The NBP plan had identified the role of broadband in public safety and emergency response by dialling a three-digit emergency code number, known as E112 in which there were no provisions and clear-cut strategy for creating a public safety broadband infrastructure in the country. In order to provide reliable public safety network infrastructure, there is the need to consider available options since the geographical location and local terrain of environment are major issues to be considered when deploying telecommunication infrastructure to provide access. Each option has its own unique approach to serving the public and has its own advantages and shortcomings. Some of these options are widely deployed for commercial purposes in Nigeria, while others are still in the developmental stages. This paper therefore, outlines some of the existing, new and affordable technological options, available today that can be deployed for public safety and disaster telecommunications networks in Nigeria.

2. DISASTER MANAGEMENT CYCLE

Disaster can be defined as an unforeseen event that occurs suddenly which highly overwhelming depending on the level of occurrence of the disaster, calamities such as economic and social, serious illness and even death could be experienced such as conflict, earthquake leading to buildings collapse, livelihoods destruction outbreak of fire, flood and even epidemic (Abdallah and Burnham, 2008) bombs, kidnapping and other means to attack e.t.c.

Figure 1 provides a conceptual diagram of disaster management cycle. A *warning phase* usually precedes a disaster, which is subsequently followed by *a response* which can only be substantiated with the level of *preparedness* in place. During the emergency phase, efforts are made to bring succour to the affected and this transforms into the *reconstruction or rehabilitation phase* .To prevent same type of disaster from reoccurring, experiences of the previous occurrences are used for *mitigation* and to be very ready in case of reoccurrence (Abdallah and Burnham, 2008).

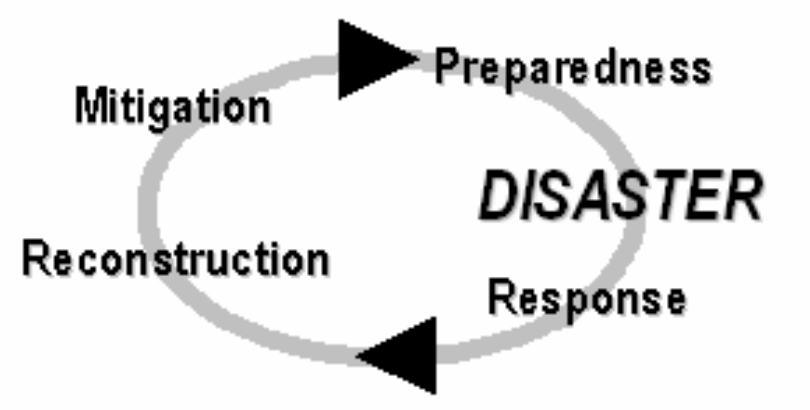


Figure.1. Disaster management cycle

3. PUBLIC SAFETY NETWORKS

A. Roles of the Public Safety organizations

Public Safety (PS) organizations are very important in preparing for disaster, ensuring recovery and helping in taking care of emergency events like disasters that are catastrophically. All governmental organizations are those usually found in an emergency scene while non-governmental organizations are those found when the disaster is a large one in local, national and regional levels (Baldini et al, 2013).

B. Areas of applications of PSDN

PS networks have devise areas of applications (Baldini *et al*, 2013), which include: Verification of biometric data during patrol by the PS officer, remote monitoring and video surveillance done wirelessly is also an application used by PS organizations and also, the use of camera to take pictures of plate numbers of vehicles and the images are transmitted to the headquarters where verification is done is a description of another application called automatic number plate recognition. The Decision management team makes use of the positions transmitted from time to time to the headquarters. This application is especially found very useful when there is fire outbreak or earthquake and people are trapped. Remote emergency medical service in which video and data are transmitted is also found to help the medical personnel to work with the team on the field in case there is an emergency patient. Figure 2 provides areas of application of PS Networks and respective data rates requirements (DRQ).

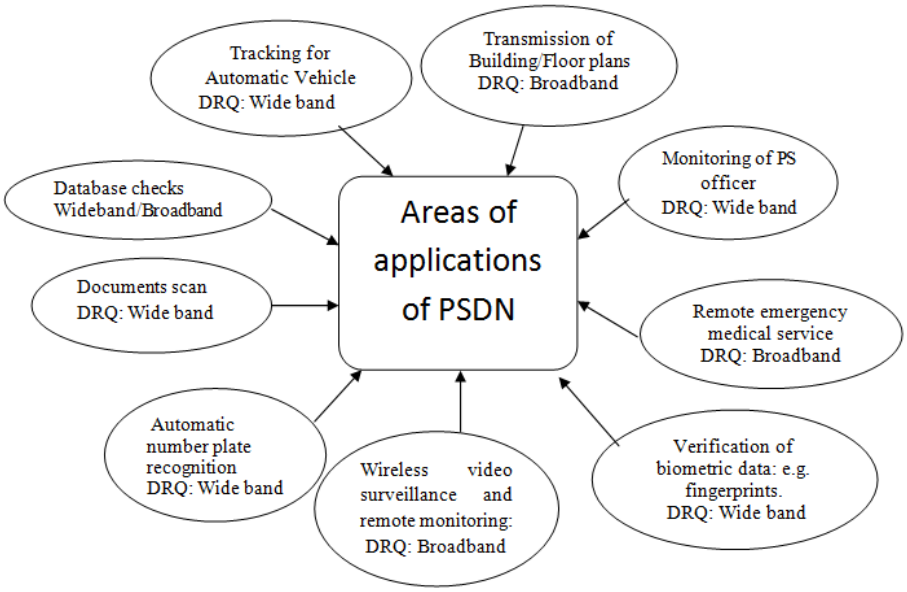


Figure 2. Areas of Application of PS Networks

C. Special features of PSDRN

Backup in the transmitters and power supplies with very rugged handheld devices, protection against being brought down by hoodlums are required by highly dependable public safety systems. Sufficient capacity for unusual periods must be available on public safety communication systems, especially when emergencies occur that a lot of first responders are needed. In most cases, the public safety systems have unused capacity because they carry less traffic, especially the mission-critical ones. Spectral efficiency would be increased and possible cost reduction would be experienced if sharing of resources is allowed (Peha, 2007). Voice, Data connectivity, Text Messaging, Push-to-Talk and Security services are the basic services for PS communication systems (Baldini et al, 2013).

4. TECHNOLOGY OPTIONS FOR PSDRN

A. Land Mobile Systems for PSDRN

i. Paging Systems

Paging systems are generally single-band (frequency), simplex radio system which is able to display messages received as numeric messages or announces it as voice messages (pager, 2016). The deployment of Paging Systems was achieved at different frequency bands, the VHF, UHF and FM (Kathy and Hart, 2003).

ii. Two-Way Simplex Radio Systems

This system can operate both in VHF and UHF bands, except the 220 MHz band unlike pager. Very long distance communication can be achieved with high power and high transmitter in the case of base station. However, one major problem is that the system

has very low antenna heights, and this limits the communication range to usually few miles in flat terrain (Kathy and Hart, 2003).

iii. Trunked Radio Systems

The trunk radio system was proposed by research community to mitigate these problems. The trunk system consists of computer-controlled two-way radio system that allows sharing of few radio frequency channels among a large group of users (Solid Signals, 2015).

B. Wireless Cellular System

Wireless cellular communication systems provide primary access to telephone services through portable handsets. This is because of the inefficiency and near-collapse of wire line technology. Figure 3 shows a typical architecture of mobile cellular system consists of base transceiver stations covering a geographical area call cells. Each base station is connected to the mobile telephone switching centre via backhaul network. This is typically, suitable for public safety communications as it covers wide area with minimal number of sites.

Two common cellular technologies that have become the toast of Nigeria are the GSM, which uses the time division multiple access (TDMA) technique to multiplex up to 8 calls per channel in the 900 MHz and/or 1800 MHz spectrum bands and CDMA, a 3G network which uses Direct Sequence Spread Spectrum, DS-SS, and communication system to support voice and data communication.

Cellular mobile phones i.e. the GSM systems have been used for over a decade for public safety communication in Nigeria and this has been the sole, dominant technology option. However, due to the favourable propagation characteristics of CDMA 450, wider coverage could be provided and it has lower overall capital and operational expenditure when compared with other access technologies such as the HSPDA, WCDMA and GSM. Also, it is expected that CDMA 450 will provide less penetration loss through buildings when compared with others. More enhanced technologies such as the LTE systems are evolving; these technologies provide more flexibility and data capacity than the already deployed 3G and 3.5G systems. In addition, LTE systems have an inbuilt public safety features, the performance of LTE in terms of capacity, reliability and security is enough to fulfill the strict requirements of the public safety users (Simić, 2012).

Since major problems in using terrestrial cellular network are the limit of the cellular coverage area and failure of the network in the event of major disaster, Casoni *et al.,* (2015) proposed a cellular System with integrated Satellite Backhaul for both infrastructure-based and infrastructure-less scenarios, whereby, provision was made for field operators and people in distress to have easy access and guaranteed QoS when the underlying terrestrial infrastructures failed which helps to expand coverage, capacity and network resilience when compared to the conventional systems. The different technology options discussed are compared in Table 2.

Table 1: Comparison of Technology Options

Technology	Operation	Benefits	Drawbacks	Comments
Land Mobile Systems	Simplex radio system	It can display messages received as numeric messages or announces it as voice messages. It can work on very long-distance communication with high power and high transmitter in the case of base station.	It has very low antenna heights which can limits the communication range. Limited to small coverage area.	It is still in use for public safety
CELLULAR SYSTEMS	Full duplex radio system	It provides primary access to telephone services through portable handsets. It has lower overall capital and operational expenditure when compared with other access technologies. The LTE systems provide more flexibility and data capacity than the already deployed 3G and 3.5G systems.	**Infrastructure is needed that is,** Small cells require a complex infrastructure to connect all base station. **Handover is needed that is, t**he mobile station has to perform a handover when changing from one cell to another very frequently.	It is use for public safety
Wireless LAN (WLAN) and (WMAN) Technologies	Wireless network technology	It provides high speed wireless connection in a local area. It provides broadband Internet service in urban, suburban and rural areas.	Reduction in data transfer to the computer when the number of computers increase. Security is more difficult to guarantee and requires no configuration.	It is use for public safety.

Emerging Technologies	Wire network technology (i.e. Direct communication)	It requires minimal involvement from the network. There is improvement in the spectrum utilization and efficiency of the system. It helps in saving energy	The under-laying architecture for the network is very important and costly.	It is use for public safety but not in many countries.

C. Wireless LAN (WLAN) and (WMAN) Technologies

Wireless LAN (WLAN) technology was designed to provide high speed wireless connection in a local area which supports centralized system, which is based on a central controller called access point, and decentralized architecture which does not require any infrastructure to be in place while WMAN technology is based on broadband wireless access (Kuran and Tugcu, 2007) which consists of IEEE 802.16 (WiMAX) and IEEE 802.20 (Mobile-Fi). However, IEEE 802.16 WiMAX is the most globally acceptable standard which aims to provide broadband Internet service in urban, suburban and rural areas. The IEEE 802.16 standard (Ghosh *et al,* 2005) supports two architectures, namely, last mile access and mesh network architectures. In mesh network architecture (i.e. IEEE 802.16j), the SSs can relay traffic from other SSs to the BS in a multi-hop fashion.

D. Emerging Technologies for PSDN

(i) LTE Device-to-Device (D2D) communication

D2D communication enables direct communication between nearby mobiles. It does this by enabling mobile devices to discover the presence of other devices in their vicinity and to communicate with them directly, with minimal involvement from the network (BRYDON, 2014). Fodor *et al*., (2014) proposed D2D communications as an underlay to Long Term Evolution (LTE) networks as a means of harvesting the proximity, reuse, and hop gains.

Some of the benefits that could be derived in D2D communications is that the spectrum utilization and efficiency will be greatly improved which helps in saving energy. One of the major challenge of this type of system is defining the under laying architecture for the network. However, it was shown in Babun et al, (2015) that coverage could be improved in D2D multi-hop communications with underlying cellular networks.

(ii) eCall for Public Safety

eCall (Öörni, 2014) is a European in-vehicle emergency call system to deploy a wireless device or sensors in all vehicles that will automatically dial emergency number in the event of a serious road accident such as head-on-collision. These devices are expected to be mandatory in new vehicle models type-approved in the EU after October 2015 (Öörni, 2014). In the future, deployment of a public safety answering point (PSAP) infrastructure capable of receiving and processing eCalls will become mandatory for EU member states (Öörni, 2015).

5. DEPLOYMENT CASE STUDIES

Currently, there is no global dedicated PSDRN infrastructure. However, countries from various regions deployed and implemented different technologies for public safety communications. In Africa, mostly, amateur radios (i.e. Land mobile systems) are often used for emergency communication when landline phones, mobile phones and other conventional communications fail or are congested. However other regions like the Europe and the United States of America have a PSDR infrastructure. Table 3 provides a summary of the regional PSDRN deployment case studies.

Table 2: Case Studies

Publications	**Countries/ Regions**	**Technologies deployed**	**Comments**
(WIA, 2015)	Australia	Amateur Radio Landline and mobile phones	Amateur radio deployed for emergencies when landlines and mobile phones fail or are congested
(Tredger, 2015)	Africa	Unified Communications Amateur Radio	Officials and emergency services providers will find this technology very useful to take care of data that are in very large quantities and incidents can be given quick response that is required.
(Camilla *et. al.,* 2015)	Europe	TETRA	Wide area fast call set-up, Direct Mode Operation (DMO) allowing communications between radio terminals independent of the network and High level voice encryption to meet the security needs of public safety organisations.
(Baldini,*et. al.* 2015)	France	TETRAPOL	A fixed network infrastructure is considered here.

(Ryan and Jon, 2013)	USA	LTE/The Mobile Emergency Alert System (M-EAS)/Raytheon/ Motorola's Premiere One	M-EAS is provided for many users at the same time as it relies on digital broadcasting and not on wireless networks. The mobile digital broadcasting is for the provision of media alerts.
(Premkumar and Raj, 2014)	China	Self-Powered Micro Wireless Ballooned Network	The nodes are powered by a solar panel power supply unit or by a power battery for emergency or vehicle on the ground via a very thin wire

6. CONCLUSIONS

The need to have a robust and reliable means of communication in the event of natural and artificial disasters, medical emergencies, Boko Haram attacks has been established with the existing and emerging technological options for safety of lives and properties. TETRA systems allow greater flexibility in radio usage and provide more capacity but in the event of disaster, the network infrastructure could be physically damaged and high volume of traffic will certainly cause network congestion. However, the LTE system has an inbuilt public safety features, the performance of LTE in terms of capacity, reliability and security is enough to fulfil the strict requirements of the public safety users. The nationwide public safety wireless broadband network needs to be closely aligned to commercial deployments of LTE wireless services to keep pace with changes in technology and leverage cost efficiencies.

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REFERENCES

Abdallah. S. and Burnham. G. 2008. Johns Hopkins Bloomberg School of Public Health and International Federation of Red Cross and Red Crescent Societies, 2nd edition. Essential guideline for humanitarian assistance. Pp 1-20. Available on http://pdf.usaid.gov/pdf_docs/pnacu086.pdf

Arthur P. T. 2012. Public Safety Networks as a Type of Complex Adaptive System, *National Science Foundation Bentley University*, pp 2-3, January 24, 2012.

Babun. L.,Yürekli. A. İ and İ Güvenç. 2015. Multi-hop and D2D communications for extending coverage in public safety scenarios, *Local Computer Networks Conference Workshops (LCN Workshops), 2015 IEEE 40th*, Clearwater

Beach, FL, 2015, pp. 912-919. doi: 10.1109/LCNW.2015.7365946.

Baldini. G, S. Karanasios, D. Allen and F. Vergari. 2013. Survey of Wireless Communication Technologies for Public Safety, IEEE Communications Surveys & Tutorials", IEEE Communications Surveys and Tutorials, Vol. 16, No. 2, pp. 619 – 641.

Barnum. A. 1994. Bay Area firms took heed after Loma Prieta". San Francisco Chronicle, January 19, 1994.

Brydon. A. 2014. Opportunities and threats from LTE Device-to-Device (D2D) communication, http://www.unwiredinsight.com/2014/lte-d2d Accessed 30/03/2016.

Camilla Bonde, Reza Tadayoni and Knud Erik Skouby (2015)." Next Generation Public Safety and Emergency Technologies." Journal of NBICT, Vol. 1, 43–72.

Chapal. M. N. 2010. Cellular telephone system, technology Everywhere, Thursday, October 7, 2010 available on http://technoeverywhere.blogspot.fi/2010/10/cellular-telephone-system.html

Casoni. M., Grazia. C. A., M. Klapez, N. Patriciello, A. Amditis and E. Sdongos. 2015. Integration of satellite and LTE for disaster recovery, *IEEE Communications Magazine*, vol. 53, no. 3, pp. 47-53, March 2015. doi: 10.1109/MCOM.2015.7060481.

Fodor. G, Parkvall. S, S. Sorrentino, P. Wallentin, Q. Lu and N. Brahmi. 2014. Device-to-Device Communications for National Security and Public Safety. *IEEE Access*, vol. 2, no., pp. 1510-1520, 2014. doi: 10.1109/ACCESS.2014.2379938.

George. P. C. (2017). The Earthquake and Tsunami of August 17, 1999 in the Sea of Marmara, Turkey. http://www.drgeorgepc.com/Tsunami1999Turkey.html Accessed on 01/06/2017.

Ghosh. A, D. R. Wolter, J. G. Andrews, and R. Chen .2005. Broadband wireless access with wimax/802.16: current performance benchmarks and future potential, IEEE Communications Magazine, vol. 43, no. 2, pp. 129–136.

Kathy. J. I. and Hart. J. W., 2003. Understanding Wireless Communications in Public Safety :A Guidebook to Technology, Issues, Planning, and Management, https://transition.fcc.gov/pshs/docs-best/imel-wireless03.pdf

Kobe (2017). Kōbe earthquake of 1995. https://www.britannica.com/event/Kobe-earthquake-of-1995.Accesed on 1/06/2017.

Mikuli. M and B. Modlic. 2008. General System Architecture of TETRA Network for Public Safety Services", 50th International Symposium ELMAR-2008, 10-12 September 2008, Zadar, Croatia pp 207-210**.**

NBP 2012. National broadband Plan 2013-2018, http://www.researchictafrica.net/countries/nigeria/Nigeria_National_Broadband_Plan_2013-2018.pdf Accessed 15/03/2016.

NCTA 2004. National Commission on Terrorist Attacks Upon the United States. 2004. The 9/11 Commission Report: final Report of the National Commission on

Terrorist Attacks Upon the United States (Authorized Edition). (W.W Norton & Co.: New York)

Öörni, R., Korhonen, T. 2014. 'eCall minimum set of data transmission – results from a field test in Finland', IET Intell. Transp. Syst., 2014, 8, (8), pp. 639–647

Öörni. R., Meilikhov. E. and T. O. Korhonen (2015). Interoperability of eCall and ERA-GLONASS in-vehicle emergency call systems, *IET Intelligent Transport Systems*, vol. 9, no. 6, pp. 582-590, 8 2015.doi: 10.1049/iet-its.2014.0209.

Premkumar. R and Raj Jain (2014) "Wireless Networks for Disaster Relief", April 2014 Available at http://www.cse.wustl.edu/~jain/cse574-14/ftp/disaster/index.html Accessed on 17/06/16.

Peha. J. M. (2007), Fundamental Reform in Public Safety Communications Policy, *Federal Communications Law Journal,* vol. 59, no. 3, pp. 517 – 546, 2007.

Ryan. H, and Jon M. Peha (2013) "Enabling Public Safety Priority Use of Commercial Wireless Networks." *Homeland Security Affairs* 9, Article 13 Available on https://www.hsaj.org/articles/250, August, 2013

Simić. M. B. (2012). Feasibility of long term evolution (LTE) as technology for public safety, *Telecommunications Forum (TELFOR), 2012 20th*, Belgrade, 2012, pp. 158-161. doi: 10.1109/TELFOR.2012.6419172.

Solid Signals (2015). P25 Radio Systems: Overcoming BER and RSSI Measurement Challenges, available on http://anritsu.typepad.com/solidsignals/2015/02/p25-radio-systems-overcoming-ber-and-rssi-measurement-challenges.html February 19, 2015.

Tredger. C (2015) "UC the solution for Africa's public safety and security", Available on http://www.itwebafrica.com/unified-communications/641-africa/234552-unified-communications-the-solution-for-africas-public-safety-and-security [Accessed on 18/05/16].

Townsend. A.M and Moss. M.L (2005). Telecommunications Infrastructure in Disasters: Preparing Cities for Crisis Communications, pp 1-45https://www.nyu.edu/ccpr/pubs/NYU-DisasterCommunications1-Final.pdf

WIA (2015) "Emergencies and Amateur Radio" Available on http://www.wia.org.au/members/emcom/about/ [Accessed on 15/05/16].

ASSESSMENT OF THE UTILIZATION OF E-LEARNING FACILITIES AMONG LECTURERS IN KADUNA POLYTECHNIC FOR SUSTAINABLE NATIONAL DEVELOPMENT IN NIGERIA

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ABSTRACT

The study was an assessment of the utilization of E-learning facilities among lecturers in Kaduna Polytechnic for Sustainable National Development in Nigeria. To achieve this purpose three objectives were formulated with respect to determining the types of e-learning facilities available, the extent of utilization of e-learning facilities in Teaching-learning process by the Lecturers and to discover the challenges encountered by the Lecturers in utilizing e-learning facilities in Teaching- learning process. The study employed descriptive survey research method. The population of the study consisted of all the lecturers in Kaduna polytechnic totaling 1252, Nigeria. Simple Random sampling technique was used in selecting a sample of 150 lecturers. Structured questionnaire was used as instrument for data collection. A total of 150 copies of the structured questionnaires were administered to the respondents, 123 copies were retrieved and found useful for the study. Mean and standard deviation were used in analyzing the data collected. The findings of the study revealed that, Mobile phone/smart phone, Multimedia tools like radio, CD-ROM, Computer room, Multimedia projectors/PowerPoint, Digital camera and lots of others, Digital Library, Off-line ordinary computer and E-mail facilities were the most available types of e-learning facilities in Kaduna polytechnic and incessant interruption in power supply, High cost of hardware in Nigeria, Slow connectivity, inadequate funding, High transmission cost, and Lack of Government commitment to the development of the educational sector were the major challenges encountered by the respondents in utilizing e-learning facilities in teaching-learning process. It was concluded that, the most available types of e-learning facilities in Kaduna polytechnic were utilised at medium and low level respectively. In view of the above a number of recommendations were made among which Government agencies such as The National Board for Technical Education, Power holding company and National Information Technology Development Agency should be more committed toward the development of Science and Technical education, provide steady and constant power supply, subsidized e-

learning facilities as well as, provide adequate bandwidth and strong internet connectivity for Sustainable National Development.

Key words: *E-learning, e-learning facilities, Utilization, Lecturers and Polytechnic*

1. INTRODUCTION

The applications of Information and Communication Technologies (ICTs) have embedded almost all aspect of human endeavor. According to United Nations Educational, Scientific and Cultural Organization (UNESCO, 2011) ICT more than any other technology provide, lecturers, teachers and students access to a vast stores of knowledge beyond the school, as well as with multi-media tool to add to this store of knowledge. It has become so attached to contemporary educational delivery worldwide that it has virtually become impossible to deliver or receive formal education without the application of such advanced technologies (e-learning facilities) in the processes. Higher educational institutions in particular have dramatically transformed their mode of operation in terms of teaching-learning process. Today, the use of chalk and duster in our seminar rooms and lecture theatres are completely extinct in some higher institutions. Electronic learning (E-learning) has emerged and progressed drastically with the development of the internet and information and communication technologies. (Imran and Ali, 2014)

Recent development in the telecommunication industry in Nigeria has brought about an unprecedented upsurge in the use of e-learning facilities in tertiary Institutions of the most part of the country for sustainable National development. Institutions of higher learning all over the world are adopting and utilizing e-learning technologies to deliver their various academic programmes. According to Miwa as cited in Huang (2010) asserted that tertiary institutions in Asian countries like Japan, Korea, and Singapore have been using e-learning facilities to facilitate higher education in a networked environment. Therefore, the adoption and utilization of e-learning facilities by lecturers in Kaduna polytechnic for sustainable National development in Nigeria is very crucial to ensure conformity with the present international trends.

E-learning is the application of electronic media and information and communication technologies in teaching and learning. The European Union (EU) as cited in Olatubosun, Olusoga, and Samuel, (2015) defines e-Learning as the use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration. E-learning is a term encompasses of a wide and various set of applications and processes, which include computer-based learning, web-based learning, virtual classrooms, and digital collaboration. It also involves the delivery of content via internet, intranet/extranet (LAN/WAN), audio and video, satellite broadcast, interactive TV, CD-ROM, and many more. On their own part, Allen and Samuel (2008) expanded this list further to include TV, mobile phone, webcam, email, DVD/CD, website, telephone, audio-conferencing, audio graphics, video-conferencing as technological means of delivering e-learning. For e-learning, then, a wide set of applications and processes were included which were both web and computer-based,

offering virtual classrooms, and digital collaboration. Its content could be delivered by modes as various as internet, intranet, audio and video, CD-ROM, satellite, product interactive TV and more.

Despite the obvious and numerous benefits derived from using ICT in teaching and learning process. Shahadat, Muhbub and Clement (2012) observed with great concern that several higher educational institutions are finding it difficult to even implement basic of ICT. Inadequate access to e-learning facilities in developing nations like Nigeria had earlier been observed by scholars such as Adika, 2003, Mohammed & Mumtaz, (2010) who remarked that efforts should be made to salvage staff and students in African Universities from the problem of access to e-learning facilities. E-learning literatures also reveal that access to e-learning can be challenged by many hindrances. These include issues such as perennial epileptic electricity supply, high cost of hardware like personal computers (PC) and laptops (which students find astronomical), technophobia systems in the country and poor attitude of students towards ICT, among others (Salawudeen 2006), Achebe 2012).

2. STATEMENT OF THE PROBLEM

E-learning has become an integral part of the 21st century education and training which was adopted by different institutions (Abubakar and Hassan, 2013). Utilization of e-learning facilities in schools and colleges increased learning effectiveness and convenience for the students or lecturer, enhanced image for the school or college, cost savings for the school or the Government, classroom space savings for the school or the institution, reduced traffic and parking congestion on the campus coursed by students, lecturers and visitors. (Kim, 2007)

Mohammed and Mumtaz (2010) asserted that low funding, poverty, low tele-density etc. are among the factors militating against the effective use of e-learning facilities. On their own part, Adelabu, adu and Adjorgri (2014) stated that insufficient funds, high cost of facilities, high cost of maintenance are factors that inhibit the use of e-learning facilities in developing countries.

Consequently, upon these reports and observations there is need for a study to investigate the utilization of e-learning facilities among the lecturers in Kaduna Polytechnic, Nigeria.

3. RESEARCH QUESTIONS

1. What types of e-learning facilities are available in Kaduna polytechnic, Nigeria?
2. To what extent do lecturers in Kaduna polytechnic, Nigeria utilise e-learning facilities in teaching-learning process?
3. What are the challenges encountered by the Lecturers in Kaduna polytechnic, Nigeria in utilizing e-learning facilities in teaching-learning process?

4. OBJECTIVES OF THE STUDY

The study seeks:-

1. To determine the types of e-learning facilities available in Kaduna Polytechnic, Nigeria.
2. To find out the extent of utilization of e-learning facilities in Teaching-learning process by the Lecturers in Kaduna polytechnic, Nigeria
3. To identify the challenges encountered by the Lecturers in Kaduna polytechnic in utilizing e-learning facilities in Teaching- learning process.

5. REVIEW OF THE RELATED LITERATURE

The application of e-learning facilities in higher educational institutions in teaching and learning process has become one of the most important and widely discussed issues in the contemporary educational policy. E-learning is an important factor in this era (information age) it holds a great promise to improving teaching and learning in our tertiary educational institutions, when properly adopted and applied. It is an important instructional tool to facilitate the transfer of numerous type of information and an effective means of communication in schools and colleges. E- Learning can be seen as the application of a whole range of technologies involved in information processing and electronic communications, such as computers, internet, e-mail, computer software, satellite, mobile communication gadgets, and other allied electronic devices for dissemination of knowledge and information. It involves the application of computer and information technology in teaching and learning process (Olusesan and Emmanuel 2015).

Effective utilization of e-learning facilities in our tertiary institutions particularly polytechnics is necessary for effective teaching and learning to take place. Abidoye (2010) maintained that, utilization of e-learning devices such as the web, internet, multimedia, computer, projector, television aid the lecturers to deliver good teaching-learning process.

There are numerous and various e-learning facilities utilized for effective teaching and learning. According to Olusesan and Emmanuel (2015) some of the e-learning facilities include:

- Screen Projector
- White Board
- Laptop/desktops
- Mobile phone
- Recommended tutor software
- Virtual classroom
- Multimedia tools like radio, CD-ROM
- Digital camera and lots of others.

Many tertiary institutions in Africa are finding it difficult to implement the basic ICT, in support to this assertion Shahadat, Muhbub and Clement (2012) observed with great concern that several higher educational institutions are finding it difficult to even implement basic of ICT. Moreover, Adelabu et al. (2014) asserts that e-learning facilities are not available in most schools and colleges due to poor infrastructure

amenities and attitude of students and lecturers. Consequently, this has affected the availability of e-learning facilities in our tertiary institutions.

Utilization of e-learning facilities among lecturers in higher institutions of learning is facing so many challenges, Ezenwafor, Okeke, and Okoye, (2014) conducted a research on the Utilization of E-Learning Resources For Instruction by Technology and Vocational Educators in Tertiary institutions in South -East Nigeria the findings revealed that, the respondents utilize e-learning resources to a low extent and that lack of skills for utilizing the resources and their inadequate supply in institutions, among others, are their major constraints. Utilization of e-learning facilities in our tertiary institutions in Nigeria is facing so many setbacks which comprises of High cost of hardware in Nigeria, Incessant interruption in power supply, Technophobia, Cost of computers very high, Lack of internet facilities, Slow connectivity, High import tariffs, High level of computer illiteracy, Inadequate funding, High transmission cost, and Lack of Government commitment to the development of the educational sector. (Bibiana, 2012 and Allison, 2014)

In his on part, Ifinedo (2007) categorized the constraints into three categories:

a. Human capital problems – These involve low literacy level, poor information technology skills and poverty.

b. Institutional problems –These cover organizational problems, resistance, and lack of awareness and

c. Infrastructural problems – These include poor internet access, low bandwidth, high cost of ICT services, inadequate investment in ICT by government and poor power generation.

Ekundayo and Ekundayo (2009) outlined the challenges to the effective utilization of e-learning facilities in Nigerian tertiary institutions to include inadequate human resources, brain drain, staff-student ratio, lack of finance, poor infrastructural provision, electricity challenge, ICT and bandwidth constraints, highly bureaucratic management systems, digital divide and political instability. Contributing, Adelekan (2013) and Ilechukwu (2013) mentioned high cost of e-learning hardware and other gadgets, dearth of skilled manpower for the implementation of e-learning and management of ICT infrastructure, inadequate initial lack of relevant competencies by lecturers, inadequate funding of education as well as high cost of installation and maintenance of relevant e-learning gadgets as some of the challenges.

6. RESEARCH METHODOLOGY

The study employed survey research design. The population of the study consisted of all the lecturers in Kaduna polytechnic, Nigeria. Simple Random sampling technique was used in selecting a sample of 150 lecturers. Structured questionnaires were used for data collection; it was validated by the senior collogues and researchers before administering it. The researchers with the help of two research assistants distributed the questionnaires to the various academic departments and the Academic staff union secretariat. 123 copies were retrieved and found useful for the study.

7. DATA PRESENTATION AND ANALYSIS

The data obtained from the completed questionnaires were presented and analyzed. Thus, the analysis of the data collected is given as follows:

Table 1: Types of E-learning facilities available in Kaduna Polytechnic, Nigeria

NO	Types of E-learning facilities	Frequency	Percentage (%)	Mean	SD
1.	Screen touch electronic board	40	32.5%	0.33	3.59
2	Multimedia projectors/PowerPoint	90	73%	0.73	8.08
3	Computer room	91	74%	0.74	8.17
4	Off-line ordinary computer	60	49%	0.49	5.39
5	Digital Library	80	65%	0.65	7.18
6	E-mail facilities	60	49%	0.49	5.39
7	On-line/Internet computers	75	61%	0.61	6.74
8	Laptops+ modem+ flash drives,	67	54.4%	0.55	6.02
9	Mobile phone/smart phone	97	79%	9	8.71
10	Recommended tutor software	40	32.5%	0.33	3.59
11	Virtual classroom	40	32.5%	0.33	3.59
12	Multimedia tools like radio, CD-ROM	94	76.4%	0.79	8.44
13	Digital camera and lots of others.	81	66%	0.66	7.27

Table 1 revealed that Mobile phone/smart phone, Multimedia tools like radio, CD-ROM, Computer room, Multimedia projectors/PowerPoint, Digital camera and lots of others, Digital Library, Off-line ordinary computer and E-mail facilities are the most available types of e-learning facilities in Kaduna polytechnic with the with the higher mean scores of 0.49 and above while Screen touch electronic board, Recommended tutor software and Virtual classroom are the least available types of e-learning facilities in Kaduna polytechnic with the lowest mean score. This finding contradicts that of Adelabu et al. (2014) who find out that e-learning facilities are not available in most schools and colleges due to poor infrastructure amenities and attitude of students and lecturers.

Table 2: The extent of availability of e-learning facilities in Kaduna Polytechnic

NO	Types of e-learning facilities	Extent of Availability				
		GE	ME	LE	MEAN	SD
1.	Screen touch electronic board	30 (24%)	46 (37%)	50 (41%)	1.89	1.01
2.	Multimedia projectors/PowerPoint	11 (9%)	110 (89%)	-	2.06	1.00
3.	Computer room	63 (51%)	73 (59%)	-	2.72	1.33
4.	Off-line ordinary computer	85 (69%)	53 (43%)	-	2.94	1.37
5.	Digital Library	20 (16%)	33 (27%)	-	1.02	1.56
6.	E-mail facilities	52 (42%)	65 (53%)	-	2.33	1.08
7.	On-line/Internet computers	66 (54%)	41 (33%)	-	2.28	1.06
8.	Laptops+ modem+ flash drives,	85 (69%)	43 (35%)	21 (17%)	2.94	1.53
9.	Mobile phone/smart phone	79 (64%)	46 (37%)	-	2.68	1.30
10.	Recommended tutor software	21 (17%)	14 (11%)	15 (12%)	0.86	1.72
11.	Virtual classroom	11 (9%)	10 (8%)	11 (9%)	0.52	2.07
12.	Multimedia tools like radio, CD-	34	52	10	1.76	1.04

	ROM	(28%)	(42%)	(8%)		
	Digital camera and lots of others.	33 (27%)	43 (35%)	-	1.50	1.17

Key: **GE=Great Extent, ME=Medium Extent, LE=Low Extent, SD=Standard deviation**

It can be observed from Table 2 that, off-line ordinary computer and Laptops+ modem+ flash drives are available to a great extent. Computer room, mobile phone/smartphone, e-mail facilities and on-line/Internet computers are available at a medium extent. Whereas respondents stated that multimedia projectors/PowerPoint, screen touch electronic board, multimedia tools like radio, CD-ROM digital camera and lots of others, digital library, recommended tutor software and virtual classroom according to the respondents are available at a low extent.

Table 3: The extent of the utilisation of e-learning facilities in teaching-Learning Process

	Types of E-learning Facilities	**Extent of Utilization of E-learning Facilities**				
		GE	**ME**	**LE**	**MEAN**	**SD**
	Screen touch electronic board	14 (11%)	90 (73%)	10 (8%)	1.89	1.01
	Multimedia projectors/PowerPoint	25 (20%)	94 (76%)	14 (11%)	2,25	
	Computer room	50 (41%)	37 (30%)	10 (8%)	1.90	
	Off-line ordinary computer	25 (20%)	70 (57%)	11 (9%)	1.84	
	Digital Library	50 (41%)	50 (41%)	12 (10%	1.90	
	E-mail facilities	40 (33%)	50 (41%)	10 (8%)	1.87	

	On-line/Internet computers	18 (15%)	25 (20%)	-	0.85	
	Laptops+ modem+ flash drives,	44 (36%)	30 (24%)	3 (11%	1.67	
	Mobile phone/smart phone	30 (24%)	14 (11%)	9 (7%)	1.03	
	Recommended tutor software	10 (8%)	30 (24%)	-	0.73	
	Virtual classroom	20 (16%)	30 (24%)	0 (8%)	1.06	
	Multimedia tools like radio, CD-ROM	33 (27%)	33 (27%)	8 (6%)	1.68	
	Digital camera and lots of others.	44 (36%)	30 (24%)		1.97	

Key: GE=Great Extent, ME=Medium Extent, LE=Low Extent, SD=Standard deviation

It can be seen from the responses in table 3 that, 50 of the respondents in Kaduna polytechnic utilize Computer room and Digital Library to a great extent, 94 utilize Multimedia projectors/PowerPoint to a medium extent while 13 respondents utilize Multimedia projectors/PowerPoint and Laptops+ modem+ flash drives, to a low extent.

Table 4: the challenges encountered by lecturers in utilizing e-learning facilities in teaching-learning process

S/NO.	**Challenges of utilizing e-learning facilities**	F	%	Mean	SD

1.	High cost of hardware in Nigeria,	80	65%	0.65	7.18
2.	Incessant interruption in power supply	83	67%	0.68	7.45
3.	Technophobia	50	41%	0.41	4.49
4.	Cost of computers very high	40	33%	0.33	3.59
5.	Lack of internet facilities	50	41%	0.41	4.49
6.	Slow connectivity	60	49%	0.49	5.39
7.	High import tariffs	52	42%	0.42	4.67
8.	High level of computer illiteracy	10	8%	0.08	0.90
9.	Inadequate funding	78	63%	0.63	7.01
10.	High transmission cost	60	49%	0.49	5.39
11.	Lack of Government commitment to the development of the educational sector	80	65%	0.65	7.18

Table 4 shows the responses of the respondents on the challenges encountered in utilizing e-learning facilities in teaching-learning process. It appears that, incessant interruption in power supply, High cost of hardware in Nigeria, Slow connectivity, inadequate funding, High transmission cost, and Lack of Government commitment to the development of the Educational sector were the major challenges encountered by the Lecturers of Kaduna polytechnic in utilizing e-learning facilities in teaching-learning process with 60 and above frequency. This finding agrees with that of Bibiana (2012) and Allison (2014).

8. DISCUSSION OF FINDINGS

The findings of the study revealed that Mobile phone/smart phone, Multimedia tools like radio, CD-ROM, Computer room, Multimedia projectors/PowerPoint, Digital camera and lots of others, Digital Library, Off-line ordinary computer and E-mail facilities are the most available types of e-learning facilities in Kaduna polytechnic with the with the higher mean scores while Screen touch electronic board, Recommended tutor software and Virtual classroom are the least available types of e-learning facilities in Kaduna polytechnic with the lowest mean score. This finding contradicts that of Adelabu et al. (2014) who find out that e-learning facilities are not available in most schools and colleges due to poor infrastructure amenities and attitude of students and lecturers. While in the level of availability off-line ordinary computer and Laptops+ modem+ flash drives are available to a great extent. Computer room, mobile phone/smartphone, e-mail facilities and on-line/Internet computers are available at a medium extent. Whereas respondents stated that multimedia projectors/PowerPoint, screen touch electronic board, multimedia tools like radio, CD-ROM digital camera and lots of others, digital library, recommended tutor software and virtual classroom according to the respondents are available at a low extent, this fidings is in line with that of Ezenwafor, Okeke, and Okoye, (2014) conducted a research on the Utilization of E-Learning Resources For Instruction by Technology and Vocational Educators in Tertiary institutions in South -East Nigeria the findings revealed that, the respondents utilize e-learning resources to a low extent. It appears that, incessant interruption in power supply, High cost of hardware in Nigeria, Slow connectivity, inadequate funding, High transmission cost, and Lack of Government commitment to the development of the educational sector were the major challenges encountered by the Lecturers of Kaduna polytechnic in utilizing e-learning facilities in teaching-learning process with 60 and above frequency. This finding agrees with that of Bibiana (2012) and Allison (2014), Adelekan (2013) and Ilechukwu (2013) and Adelabu, adu and Adjorgri (2014)

9. CONCLUSION

Based on the major findings of the study, it was concluded that, Mobile phone/smart phone, Multimedia tools like radio, CD-ROM, Computer room, Multimedia projectors/PowerPoint, Digital camera and lots of others, Digital Library, Off-line ordinary computer and E-mail facilities 60 (49%) are the most available types of e-learning facilities in Kaduna polytechnic but they were utilised at medium and low level respectively. This will definitely affect the teaching-learning process and consequently this will affect the attainment of the aims and objectives of the

polytechnic as well as the Sustainable National Development. Hence, lecturers in Kaduna polytechnic should try as much as possible to make the maximum use of the available e-learning facilities if they want be relevant in the 21st century information/knowledge society.

10. RECOMMENDATIONS

In line with the findings of the study the following recommendations were made:

1. The National Board for Technical Education together with the management of Kaduna polytechnic should try to provide more e-learning facilities such as Screen touch electronic board, recommended tutor software and Virtual classroom and motivate the lecturers to utilize them to the great extent for Sustainable National Development.
2. The management of Kaduna polytechnic and other relevant stakeholders should try to organise seminars and conferences on the important of utilising e-learning facilities in teaching-learning process for Sustainable National Development.
3. Government agencies such as The National Board for Technical Education, Power holding company, National information Technology Development Agency etc should be more committed toward the development of Science and Technical education, provide steady and constant power supply, subsidized e-learning facilities as well as, provide adequate bandwidth and internet connectivity for Sustainable National Development.

REFERENCES

Abidoye JA 2010. The role of electronic learning in improving distance education in Nigeria. *Journal of Teacher Perspective*, 4(2)

Abubakar B. M. and Hassan, B. B. (2013) Strategies for Developing an e-Learning Curriculum for Library and Information Science (LIS) Schools in the Muslim World: Meeting the Expectations in the Digital Age. *International Journal of Humanities and Social Science 3 (1).*

Abubakar, B.M. (2014) Rethinking E- Learning in Library and Information Science (LIS) Education in Nigeria: Developing a Model for the 21st Century *Information and Knowledge Management* 4 (9) Retrieved on 31st March, 2016 from www.iiste.org

Achebe, A.E (2012). Strategies for enhancing Information Communication Technology (ICT) awareness among secondary school Home Economics Teachers Minna, Niger state, Nigeria.*Journal of Home Economics Research* 17,

Adika, G. (2003) Internet Use among faculty members of University of Ghana. *Library Review*, 52 (1),

Adelabu OA, Adjogri SJ and Adu EO 2014. The availability and utilization of e-learning

Infrastructures for teaching and learning. *Mediterranean Journal of Social science 5(23)*

Allen, I.E. & Seaman, J. (2008). *Staying the course: Online education in the United*

States, 2008. Needham MA: Sloan Consortium.

Allison, C. and Allison, C. (2014) Asian Journal of Science and Technology Vol. 5 (6) Retrieved on 23th July, 2017 from http://www.journalajst.com

Bibiana, N. N. et al, (2012). Challenges of E-learning in Tertiary Institutions in Nigeria. The Future of Education. 2nd Edition.

Ekundayo, H. T. & Ajayi, I. A. (2009). *Towards effective management of university education in Nigeria*. Retrieved on 12/11/2012 from www.google.com.

Ekundayo, M. S. & Ekundayo, J. M. (2009). Capacity constraints in developing countries: A need for more e-learning space? The case of Nigeria. *Proceeding of Ascilite Auckland,*

Ezenwafor, J.I, Okeke, A.U. And Okoye, K.R.E. (2014) Utilization of E-Learning Resources For Instruction by Technology and Vocational Educators in Tertiary institutions in South -East Nigeria *World Educators Forum,* (5) 1

Gunga, S. O. (2010). Challenges of implementation of e-learning in Mathematics, Science and Technology Education (MSTE) in African schools: A critical review. *Journal of Contemporary Issues in Education, 5(1)*

Huang, L.K. (2010). Planning and implementation framework for a hybrid e-learning Model: The context of a part-time LIS postgraduate programme. *Journal of Librarianship and Information Science,* 42(1)

Ilechukwu, I.C. (2013). The assessment of utilization of e-learning opportunities for effective teaching and learning of religion in Nigerian tertiary institutions. *European Journal of Education Studies, 5 (3)*

Imran, S. M and Ali, N.P.M. (2014) E-learning Strategies for Imparting LIS Education in India: A Pragmatic Perspective of Faculty Members. *Trends in Information Management (TRIM) 10 (1)*

Kim W.(2007) Towards a Definition and Methodology for Blended Learning. (Keynote paper) in The Proceedings of Intl.Workshop on Blended Learning (ICWL-07). Edinburgh, UK.

Mohammed, J. I. & Mumtaz, A. (2010). Enhancing Quality of Education through E-Learning: The Case Study Of Allama Iqbal Open University. *Turkish Online Journal of Distance Education,* 11(1)

Olatubosun, O., Olusoga, F.A. and Samuel, O.A. (2015) Adoption of eLearning Technology in Nigerian Tertiary Institution of Learning *British Journal of Applied Science & Technology10(2)* Retrieved on 23rd March, 2016 from www.sciencedomain.org

Olusesan A. A. and Emmanuel O. A. (2015) Review of the Usage of E-learning Facilities by Economics Teachers in Eastern Cape Secondary Schools, South Africa Int J Edu Sci, 9(3)

Shahadat,H.Muhbub,H.& Clement, C.(2012). Barriers to the introduction of ICT into Education in Developing Countries: The example of Banladesh. *International Journal of instruction. 1(2)*

UNESCO (2011). ICT in schools: A Handbook for Teachers on How ICT, can create New, Open Learning Environments (Edited by Anferson J. and Khvilo E.) UNESCO, Paris

AWARENESS, USE AND SATISFACTION OF COLLECTIONS AND SERVICES OF COLLEGE LIBRARIESIN FEDERAL UNIVERSITY OF PETROLEUM RESOURCES

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ABSTRACT:

This study provided an overview on the user'sawareness, useand satisfaction with the college libraries collections and services at Federal University of Petroleum Resources. Both the survey and case study research designs were used through quantitative research method for the study. The total population for this study comprises of 1,425, users of the library. A total sample size of 636 was drawn from the total populationwhile simple random sampling technique was employed to select the sample. Questionnaire was used to collect data from the respondents. Findings revealed that majority of the respondents (86%) were aware of the services offered by the two college libraries, while only (21%) of the respondents use the college libraries frequently and(47%) respondents were satisfied with the collections and services provided,whereas (34%) respondents were dissatisfied with the services. The study recommended that the collections and services of the college libraries should be improved by acquiring more current materials including theses and dissertations; the libraries should be installed with air-conditioners due to the excessive heat in order to bring about conducive reading atmosphere, among others.

Keywords: *Library collections, Library services, Users awareness, Library use, Users satisfaction, and College libraries.*

1. INTRODUCTION

One of the aims of setting up any university is to encourage and promote scholarship and conduct of research in all fields of learning and human endeavors. As a result of this, a university designs its program of study and provides the necessary infrastructure

as to meet these goals. It is in light of this that each of the infrastructures in the university is an integral part of the university system; the library is indisputably the most significant of them all. According to Ojo and Akande a survey examined the awareness, use and satisfaction with the collections and services provided by the University College Hospital Library, Ibadan, Nigeria, the study revealed that academic branch libraries were established alongside the establishment of their respective universities and these libraries are seen as the heart of the university and no other single non-human factor is as closely related to the quality of infrastructures for university education as the library. Apart from the main library of academic institutions, other faculty, college and departmental libraries also provide access to information for academic support, teaching and learning. Together with the main library, they all provide users with the tools and skills that can assist students, researchers and scholars in achieving success in their academic activities. Applegatedefines user satisfaction as whether users are satisfied or not with collections and services provided by a library. If users' desires and expectations are met then naturally they would be satisfied because their information requests have been met. Therefore, we can only understand the library users' awareness, use, and satisfaction with the collections and services through surveys. It is natural that only satisfied users come back for the re-use of the services and there are greater chances that a dissatisfied user will ultimately find some other supplies of information to meet their information desires. In our opinion, what is essential is that libraries should give considerable thought and attention to appropriate collections, services and user satisfaction. On the other hand the subject matter that willingly comes to mind is how do we know whether our best is the best for our clients? Since the customer is the ultimate judge of the services it is crucial that a study of this nature is carried out to find out users awareness and satisfaction with the collection and services offered at the college of technology and college of science libraries. From available literature at the disposal of the researchers, this is the first study that focused on user awareness, use and satisfaction with the services of the two colleges' libraries. As a result, this study investigate users' awareness, use and satisfaction with the currently available collections and services of the two college libraries. The results of the survey will improve practice as the University Library Management plans to expand all the college libraries of the University.

1. HISTORICAL BACKGROUND OF FEDERAL UNIVERSITY OF PETROLEUM RESOURCES, LIBRARY EFFURUN (FUPRE)

According to FUPRE Library HandbooktheUniversity of Petroleum Resources, Library (FUPRE) Delta State, Nigeria was established in March 2007, under a Federal Government of Nigeria initiative. It is aimed at building a specialized University to produce a unique high level manpower and relevant expertise for oil and gas sector in Nigeria and worldwide. The groundwork for the commencement of the University Library started with the assumption of duty by a Principal Librarian, Mr. Mathew I. Okoh on September 6th, 2010. However, the library became operational in October 2011 after the recruitment of staff. At the time of opening to users, the library had in stock the following titles: books- 3000, journal- 85 and a database of over 2000

electronic journal articles in Oil and Gas, General sciences, Engineering, ICT and Earth Science.

Presently the library serves its constituents colleges of science and that of technology. An e-library with functional internet facilities that provides access to varieties of educational materials is in place. FUPRE library is the hub of academic activities of the institution. Students, staff and researchers make use of the library for learning, teaching, research and development. According to FUPRE Library Handbookthe services of the library include:

- Loan Service
- Reference Service
- Inter- Library Loan Service
- E- Library Service
- Current Awareness Service
- Training Service

The library operates shift duties in order to ensure that staff, students, and researchers make maximum use of the materials. Relevant information is downloaded from databases that were subscribed by the library and made available to academic staff and students. The library organizes orientation program and also gives referral letters to students for research activities to other libraries.

Branch libraries

FUPRE Library has two branch libraries, and they are the College of Science Library and College of Technology library:

College of Science: The College of Science library of the Federal University of Petroleum Resources, Effurun was established in the year 2014 by the former Acting Librarian Mr. Matthew Okoh. The library was established to serve faculty members, students and other researchers in the sciences. FUPRE library disseminate reference materials and other books related to sciences which includes; Mathematics, computer science, Geology and Earth Science, Physics, chemistry and Environmental Sciences. The College of Science Library is in line with the Library Management mission to bring library services closer to its patrons with the aim of easing their stress of coming to the main library whenever they have information needs.

College of Technology: The College of Technology library of the Federal University of Petroleum Resources, Effurun was also established in the year 2014 by the former Acting Librarian Mr. Matthew Okoh. The library was established to serve faculty members, students and other researchers in the engineering and technology related fields. The library houses reference sources and other books related to Engineering and Technology which includes: Engineering Mathematics, Marine Engineering, Electrical and Electronics Engineering, Mechanical Engineering and Petroleum Engineering. The College of Technology Library is in line with the Library Management mission to bring library services closer to its patrons with the aim of easing their stress of coming to the main library whenever they have information needs.

2. STATEMENT OF THE PROBLEM

All tertiary institutions attempt to resource their library's collection and services in order to meet the needs of all categories of users. Therefore these libraries (College of technology and College of science libraries at Federal University of Petroleum Resources) are extension of the main library; attempt to have relevant stock to facilitate teaching, learning, research and knowledge dissemination in the parent institution. As a result of this, the library has put in place several resources to make their collections and services available for students' use. It is however not obvious whether student's (users) who patronize the college libraries are aware, use and satisfied with the collections and services in these libraries. Only users of the libraries can determine how satisfied they are with the services provided by the libraries. This is consistent with Bashahen he noted that only the users of a library are the best judge to assess its services In the light of this, the researchers consider it crucial to conduct this study to unravel users' awareness, use and satisfaction with the collections and services provided at the two college libraries.

3. AIM AND OBJECTIVES OF THE STUDY

The primary aim of this study was to investigate users' awareness, use and satisfaction with the two college libraries' collections and services. The specific objectives are to:

- determine the users awareness of the college libraries
- ascertain the frequency of use of the college libraries
- investigate the levels of users' satisfaction with the collections and services provided by the college libraries
- identify areas that needs improvement at the two college libraries

4. REVIEW OF RELATED LITERATURE

According to Adeniranthe ultimate objective of academic libraries is to meet the information and research needs of users through the provision of adequate collections and services as well as to meet the information desires of users that will satisfy their information requirements. This implies that libraries are established to provide information resources and services to meet users' information needs. The purpose of a library is defeated if its users are not satisfied with the collections and services it provides. User satisfaction has therefore been recognized as an important measure of library performance. To remain relevant, libraries should as matter of necessity have to periodically measure their collections and services as a way of ensuring that they are meeting the set objectives of the libraries. The extent to which academic libraries satisfy users' information desires is fundamentally more important. This is because the ultimate goal is to bring about satisfaction. A survey conducted by Oluebube on user satisfaction with library collections and services in Nigerian Agricultural Research Institutes found that users were dissatisfied with the electronic resources and availability of materials in the Libraries.

In 1998, Simmons and Andaleeb evaluated library collections and services in the United State of America. The findings revealed that students' awareness, use and satisfaction with the services provided by the college libraries are influenced by the

quality of the services the libraries provide. The study concluded that academic libraries may have to adopt a more strategic orientation in which creation and delivery of satisfactory services for their users play an important role. Simmons and Andaleebcontend that by providing quality and satisfactory services to users, academic and research libraries can distinguish their operations through friendly, helpful and knowledgeable advice and the best technological resources available. Since academic library users have varying needs and expectations, it is the responsibility of the library staff to know these needs and expectations and strive to meet them. Fundamentally academic libraries are established to provide information resources that would suit their collections and services to meet users' information needs. Therefore the purpose of a library is defeated if its users are not satisfied with the collections and services provided. Similarly,Devendraand Kumar examined the expectations of faculty members and research scholars towards library collections and services at SardarVallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, India. The study investigated the various aspects of library collection usage, frequency and purposes of library visits, and user satisfaction, it revealed that, major problems that hindered faculty members and research scholars from using the library included lack of directly relevant materials to the needs of users. Also, Kumar and Rajkumar investigated the use of the National Science Library (NSL) services, New Delhi, India, the study revealed that various aspects of NSL collections were not directly addressing the specific needs of users within the available resources which led to dis-satisfaction with the use of the NSL services and information resources.

Naqvi revealed that there existed significant difference interms of adequacy of the college library collections and observed that print collections played vital role in fulfilling the demands of the students' community in the library.In a similar study, Ogbomo and Adomi found that all the respondents consulted text books more than other library resources in the library, followed by periodicals which were widely used by the researchers and agricultural scientists. Singh and Singhalso stated that most research scholars found the use of periodicals more useful and adequate to them especially in e-format. According to Ikhizama and Oduwole the agricultural scientists as part of the respondents in their study adjudged library collections that addresses the information on agriculture as adequatewhile Khot and Patilindicated that the library collections are not adequate to meet the information needs of research scholars. Singhconcluded that the majority of library users visited the library to update their knowledge, to consult documents for research use and to borrow/return documents. Circulation, photocopy, and reference were the most helpful and very popular services. Naqvi further revealed that the inadequacies and setbacks on the use of collections and services of the library could be as a result of lack of attention to the identified areas which need improvements. Some of the recommendations suggested are mentioned below: Number of copies of most utilized books should be increased so that more users can use them at the same time, the library should develop a better network with all the famous national and international agricultural organizations/libraries to use their resources and services among others.

On the need for adequate library orientation for awareness and proper use of the library, Alemna and Oseiidentified the timing of the orientation programme during the

first week of the freshmen's year as a factor militating against awareness and maximum use of the library's collections, as the freshmen are not able to understand or grasp a lot of what they are taught within this week. The results of Markwei's study of the Balme Library showed that freshmen to the University of Ghana patronized the orientation programme very well. However, the effectiveness of the programme in helping them acquire use oflibrary skills was negligible because they were in large groups and the time allocated for each group was inadequate.Fjallbrant and Malleynoted that user education stimulates users' awareness of the library's collections and services. Herringoutlines the aims of user education and says: User education has four aims: to enhance student learning, to encourage user independence, to widen the use of a range of library resources and to introduce the library and its staff to its users. These, no doubt, emphasize the importance of user education or orientation to proper awareness and use of the library services.

5. RESEARCH METHODOLOGY

The descriptive survey research design was adopted for this study and the instrument used for data collection was questionnaire which was distributed to the respondents faced to face at the two colleges. (College of technology and College of science libraries) The target population of this study comprises of all the registered library patrons at the two college libraries in Federal University of Petroleum Resources, (FUPRE). The population of the study was 1,425, 2015/2016 registered users of the library. Sample size of 636 was drawn from the total population using the Research Advisorstable for sample size, while simple random sampling technique was employed to select the sample. Questionnaire was used to collect data from the respondents and descriptive analysis of the responses was made using the statistic package for social science (SPSS) version 16.0. Out of the 636 questionnaire that were distributed to the respondents, a total of 625 was duly completed and found usable, consequently, 98% response rate. The data collected for this study was analyzed using simple percentage and frequency counts.

6. FINDINGS AND DISCUSSION

The findings of the study are discussed below: Figure 1 shows the gender distribution of respondents.

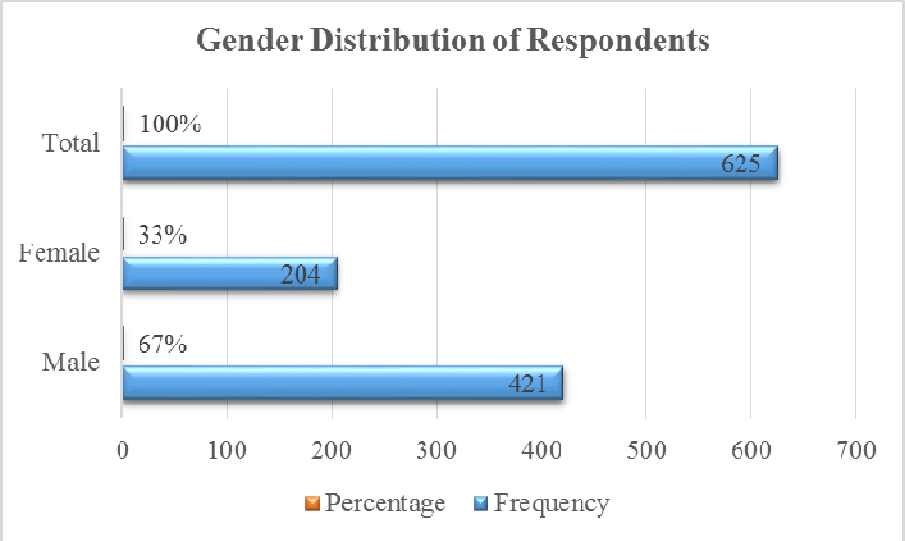


Figure1: Gender Distribution of Respondents (N=625)

Fig 1, shown that (67%) of the respondents were male and (33%) female library users. This implies that majority of the respondents who uses the library were male and it may be as a result of the nature of the courses offered in the institution which could be assumed as more male friendly courses.

Figure 2 below shows the distribution of respondents by the colleges.

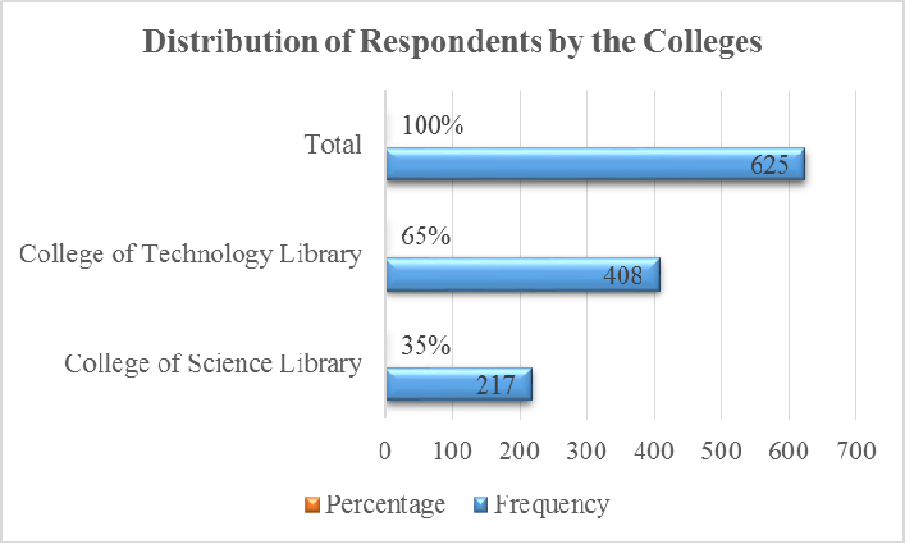


Figure 2: Distribution of Respondents by the Colleges(N=625)

As observed from figure 2, (65%) were from college of technology while (35%) were from college of science. This indicates that the respondents from the college of technology are more than that of the college of science. Figure 3 shows users' awareness of the two college libraries.

RQ 1: What are the levels of user's awareness of the college libraries?

This question intends to measure the level of awareness of the two college libraries.

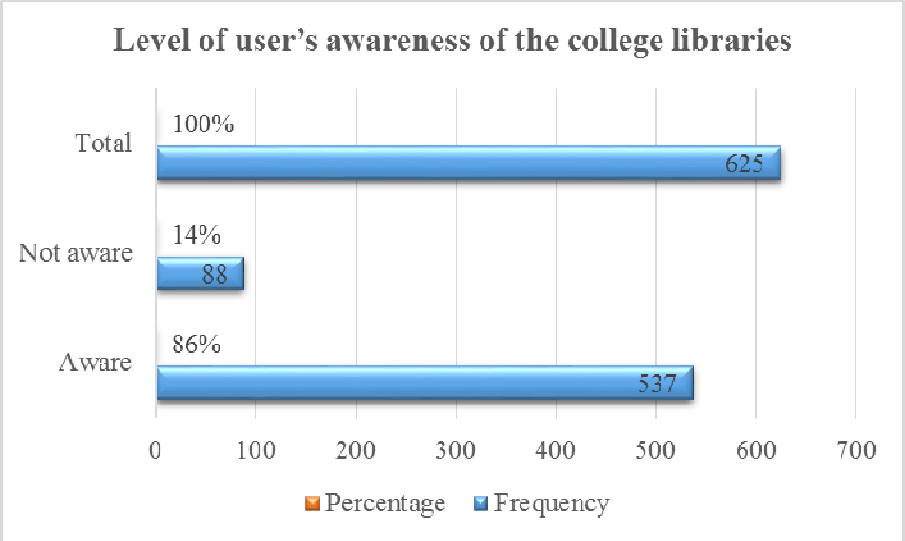


Figure 3: Level of users' awareness of the college libraries (N=625)

As shown infigure 3, majority of the respondents (86%) were aware of the availability of the college libraries while (14%) were not aware. This implies that awareness of the libraries is high but requires improvement. This is because the 14% respondents who were not aware of the collections and services of the branch libraries may be using the main university library for the whole academic period of their programmes, whereas there might be useful materials in the branch libraries which they may not use because of lack of awareness.

RQ 2: How often do you use the college libraries?

This question was asked in order to ascertain the frequency of use of the two college libraries.

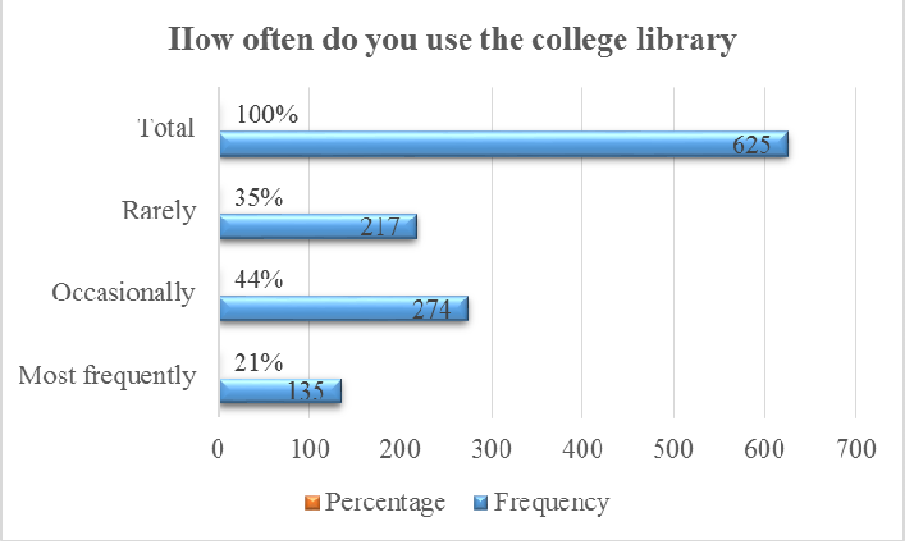


Figure 4: Frequency of use of the college libraries (N=625)

Figure 4 shows that (44%) of the respondents use library occasionally while (35%) rarely and (21%) use the library most frequently. This may be due to small size of the

college library and inadequacy of orientation to the students. This is in line with Alemna and Osei (1991) inadequacy was confirmed and acknowledged the timing of the orientation programme during the first week of the freshmen's year as a factor militating against awareness and maximum use of the library's collections, as the freshmen are not able to understand or grasp a lot of what they are taught within this week. Figure 5 below shows the degree of satisfaction with the use of the collections and services provided by the two college libraries.

RQ 3: What are the levels of satisfaction with the collections and services provided in the college libraries.

The question aimed at determining the satisfaction level of users with the use of the collections and services provided by the two college libraries.

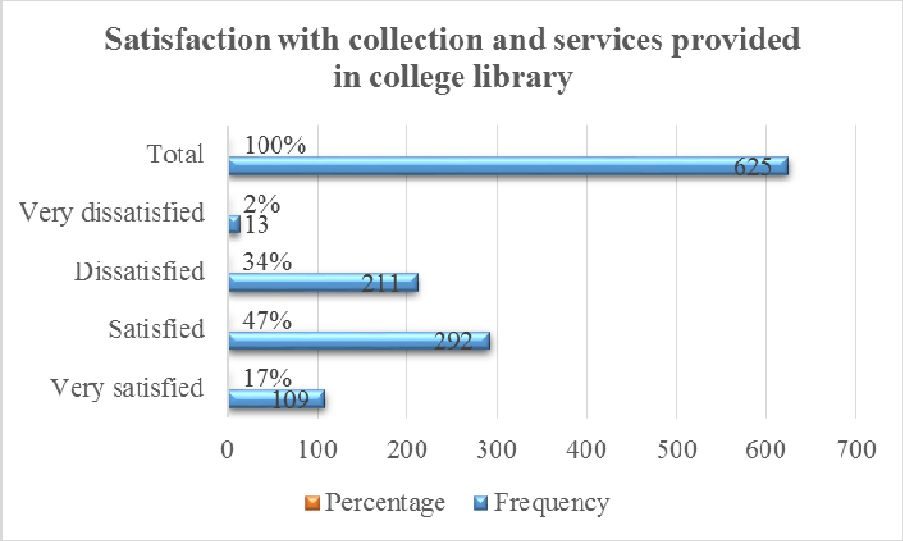


Figure 5: Satisfaction with the collections and services provided in college libraries

Figure 5, shows that majority (47%) satisfied with the collection and service of the college library while (34%) dissatisfied whereas (20%) very dissatisfied and (17%) very satisfied with collection and services of the college library. This is collaborate with Applegate (1997) identify user satisfaction as whether users are satisfied or not with collection and service in a library. If users' desires and expectations are met then naturally they would be satisfied because their requests have been met. Figure 6 presented the suggestions by the respondents on the improvement of the collections and services of the two college libraries.

RQ 4: What suggestions can you offer to improve the collections and services at the college libraries?

This question addressed the required solutions to the identified challenges in the collections and services offered by the two college libraries.

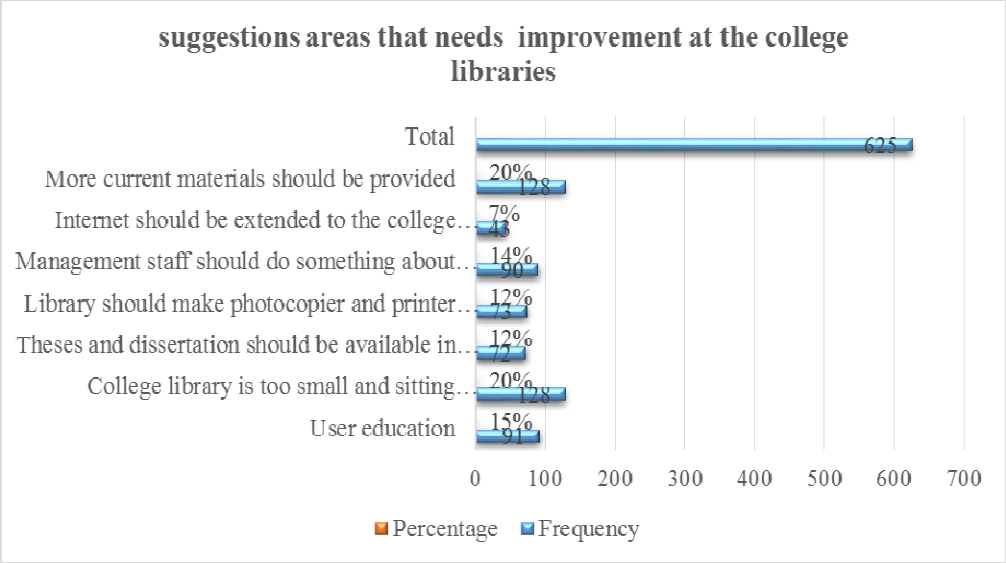


Figure 6: Areas that needs improvement at the college libraries (N=625)

As shown in the responses in figure 6, a number of suggestions were identified in other to improve the collection and services of the college libraries; these includes more current materials should be provided /college libraries are too small and sitting capacity should be expanded (20%), users education (15%), management staff should do something about excessive heat in the college library (14%), theses and dissertation should be made available in the college libraries /library should make photocopier and printer available in the college libraries. (12%) internet should be expanded to the college libraries (7%). This is supported by Naqvi who suggested that inadequacies and drawbacks on the use of collections and services of the library helped to identify areas which need improvement. Some of the recommendations suggested are mentioned below: Number of copies of most utilized books should be increased so that more users can use them at the same time, the library should develop a better network with all the famous national and international agricultural organizations/libraries to use their resources and services among others.

7. CONCLUSION

From this survey results, it was revealed that users of these two libraries are aware and use the libraries, but the level of satisfaction with the services provided was low. This is an indication that a lot still need to be done in the area of provision of adequate and relevant materials in order to meet the information needs of users so that their satisfaction level with the use of the services will improve. The findings also revealed that these two branch libraries at FUPRE areplaying vital roles to enable the Universityachieve its objectives, this is because aware and usage levels are high. This does not in any way explain that areas of improvement should be neglected in order to effectively enhance and support learning and other academic activities carried out by the university.

8. RECOMMENDATIONS

As a result of inadequacies and setback on the use of collections and services of the college libraries which led to lack of users' satisfaction as revealed in the findings of this study, the following recommendations are therefore made:

- Number of copies of most utilized books should be increased so that more users can use them at the same time.
- The library must provide orientation programme to the users as well as compulsory user education or information literacy course.
- Management should expand sitting capacity of the college library or provide for more library accommodation for the users at college libraries in order to create more space and thereby increase patronage by the users.
- Dissertation and theses should be made available at the college libraries. This would enhance reading and research among the users.
- Photocopiers and printers should be provided at the college libraries for easy access to collection and services of the library.
- The library should extend network facilities to the branch libraries (College of science and college of technology) to enhancing more teaching and learning.

REFERENCES

Adeniran P, (2011), "User satisfaction with academic libraries services." International Journal of Library and Information Science, 3 (10) 209 – 216.

Aleman AA, (1990). "User education in university libraries in Ghana". Education Libraries Journal, 33, (1), 40-47

Applegate R, (1997), "Models of satisfaction, In A. Kent, (Ed), In Encyclopedia of Library and Science: New York, Marcel Dekker. United States of America, 199 - 227.

Basha I and Zubi-Al A, (2010), "Six sigma in Libraries: a management perspective." Canadian Journal on Computing Mathematics, Natural Sciences, Engineering and Medicine, 1 (3) 86 – 92.

Devendra and Kumar K B, (2010), "Marketing of library and information services in global era". A current approach. Webology, 5 (2) 32-36

Fjallbrant N and Malley I, (1984),"User education in libraries". 2nd ed. London: Clive Bingley.

FUPRE Library Handbook. (2016),"Federal University of Petroleum Resources Library". 2-5.

Herring J, (1986), "Information technology and user education". A COPOL Exchange of Experience Seminar, 25 March 1986 at the Polytechnic of Central London audiovisualLibrarian, 12 (3) 155.

Ikhizama B O and Oduwole A A, (2003), "Pattern of usage of information sources by scientist in Nigerian University of agriculture (UOA).Library Programme (International), 23 (1) 1-6. 15

Khasiah Z and Kassim N A, (2009), "Users' perception on the contributions of UTN libraries in creating a learning environmental research". Report.ShaAlam University Technology

Khot N B and Patil S, (2004),"Library and information services in Shivaji University's Barr. Balasaheb Khardekar Library: A survey. In Responding to Users' Need in Changing Information Landscapes: Sojourn of Libraries from Palm-Leaf to Palm-Top, edited by A. Shokeen, et al. 49th All India Library Conference Bundelk hand University, Jhansi. ILA, Delhi.

Kumar K, Hussain A and Singh N, A (2014), Survey of Collection Development Practices in Technical Institutes in Ghaziabad, Utter Pradesh, India. *Library Philosophy and Practice*. Available at: http://www.webpages.uidaho.edu/~mbolin/kumar-hussain-singh.htm(Accessed on 13 February 2017)

Naqvi T H, (2014),"Use of collection and services by P.G. Students and research scholars in GBPUAT Library" India DESIDOC, 34 (6) 7-11

Ogbomo M O and Adomi E E, (2003), "Student's utilization of library resources at Baptist School of Nursing, EKU, Delta StateNigeria".International Library Movement, 25 (3)117-26

Ojo R A and Akande, S O, (2005), "Students Access, Usage and Awareness of Electronic Information Resources at the University College Hospital, University of Ibadan, Nigeria". Lagos Journal of Library and Information Science,3 (1) 16-24.

Olufunmilayo Y and Oluebube E, (2012), "User satisfaction with Library resources and services in Nigerian Agricultural Research Institutes". (Online) Available at: http://unlib.unl.edu/LPP (Accessed on 16 December 2016)

Osei I, (1991), "An evaluation of reader services at the University of Science and Technology (UST) Library, Kumasi". Unpublished thesis for the award of M.Phil. In Library Studies.

Simmonds P and Andaleeb S, (2001), "Usage of academic libraries: the role of service quality, resources and user characteristics." Library Spring, 49 (4)626-634.

Singh M P and S G, (2004), "Attitude of research scholars towards the information resources and services of University of Delhi library: A study". In Responding to Users' Need in Changing Information Landscapes: Sojourn of Libraries from Palm-Leaf to Palm-Top, edited by A. Shokeen, et al. All India Library Conference Bundelkhand University, Jhansi. Indian Library Association (ILA), Delhi,

Singh S P, (2008), "Evaluation of collection and services provided by IIT libraries: User's point of view". Journal of Library and Information Science, 19 (1) 1-18.

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UNDERGRADUATE STUDENTS' PREFERENCES FOR WEB-BASED AND CONVENTIONAL LIBRARY SERVICES IN KWARA STATE UNIVERSITY, MALETE

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ABSTRACT
The purpose of this study is to investigate undergraduate students' preference for web-based and conventional library services in Kwara State University Library. Specifically, the study aimed to identify the types of web based and conventional library services used by undergraduate students in Kwara State University; determine the extent to which undergraduate students are using web-based and conventional library services in Kwara State University, Malete. The study adopted descriptive survey design using a sample of three hundred and forty-six (346) which were selected using convenience sampling technique out of which three hundred and twenty (320). Questionnaire titled as Questionnaire on Undergraduate Students' Preference for Web-based and Conventional Library Services" was used to collect data from the respondents. Data collected were analyzed using frequency count and percentage while t-test was used to test the hypothesis of the study. The findings of the study revealed that majority of the respondents attested to the availability of Internet service. Also, majority of respondents preferred Frequently Ask Questions (FAQ) as web based library services. In the same vein, the study also indicated that majority of the respondent utilized Library orientation and instruction while current awareness service is the least or rarely used conventional library services..Cumulatively, the study shows that web based library services are the most preferred services by the students of the Kwara State University Library. The study recommends that university authority and library management should make provision for the full migration of library services from its old services provision approach (traditional library services) to conform to modern standard which in this context is anchored on ICT and reflected in web based library services.

Keywords: *Academic Library, Library services; Conventional library services; Web based library services; undergraduate students.*

1. INTRODUCTION

The importance of academic library to the university cannot be overemphasized; due to the fact that it supports the institution to achieve her goals and objectives. To buttress

this statement, Edoka (2000) summarized some functions of academic library that make it imperative for better accomplishment of university goals and objectives. These include; provision information materials required for the academic programme of the parent institution; to provision of research information resources in consonance with the needs of faculty and research students;provision of information resources for recreation and for personal self-development of users; cooperate with other libraries at appropriate level for improved information services; provision of specialized information services to appropriate segments of the wide community.On the other hand, the term "library services" refer to facilities, which are provided by the library for the use of books and dissemination of information in order to meet users' information need (Sundari, Jeyapragash&Karthikeyan, 2012). The well-known existing library services are, circulation services, reservation, renewal, new arrivals, current contents, current awareness service, selective dissemination of information, indexing and abstracting, reference service, document delivery, inter library loan, externally purchased database, CD-ROM databases, access to other library catalogues, access to online databases, internally published newsletter, reports and journals, bibliographic services, and so on. All these services have changed its mode to an extent with web environment.

In the past, all libraries including academic libraries were termed as traditional library or conventional library (Ogunsola, 2011). Conventional libraries or traditional libraries can be described as physical space emphasizing physical collections, and is often invoke as a counterpoint to the modern or digital library (Ogunsola, 2011). Asamoah-Hassan (2010) opined that conventional libraries have been with us for long and proved to be reliable and most librarians have relaxed into it. The researcher explained further that, their service provision has not been held to ransom by lack of electric power or poor telecommunication systems. Though often slow, its information not very current and space consuming, records kept on cards and in catalogue cabinets have lasted for years directing people to the stock in the library.Furthermore, traditional library services demand self-comprehensive collection building in anticipation of demand from users (Asamoah-Hassan, 2010). Other characteristics of these include; emphasis on storage and preservation of physical items, particularly books and periodicals; cataloging at a high level rather than one of detail, such as author and subject indexes as opposed to full text; browsing based on physical proximity of related materials, such as books on sociology are near one another on the shelves; passivity; information is physically assembled in one place; users must travel to the library to learn what is there and make use of it.

However, with the advent of the Internet and associated technologies, in particular the World Wide Web has opened up an entirely new medium for providing improved information services and resources for the users (Kumari, 2016). This means that the emergence of Information and Communication Technology (ICT) has brought tremendous changes to the way library and other information centers performed their operations. This means that the application of ICT to the services provided in the librarygave birth to web based library services which is also known as digital library and virtual library. Madhusudhan and Nagabhushanam (2012a) described web-based library services as the services provided using internet as a medium and library website

as a gateway with the help of library automation software. Halub (1999) opined that web-based library services are innovative, progressive services that promote the image of libraries towards their commitment to excellent in education and research.Since the web-based library services are serving 24 hours service to the users, users can have access to library services from their own computers without physically visiting the library. The web-based library services save a lot of time and traveling cost (Ahmed, 2007; Pathak, Mishra &Sahoo, 2011; Madhusudhan&Nagabhushanam, 2012b).

Several studiessuch as Lukasiewicz(2007); Grudzien and Casey (2008); Kichuk (2010); and Knight (2013)have revealed that despite the fact that print materials are still popular within universities, an increasing number of university students use Web resources for their research while some still using print materials. This had brought confusion on the services that students preferred between Web based and conventional library services. It seems that there have been dearth empirical studies on the students' preference for web based services and conventional library services in Nigeria context. Furthermore, it is regrettable that no study had examined the preference of undergraduate students in Kwara State University between conventional library services and web based library service. This means that information scientist researchers have neglected this area. Therefore, it is in light of this, that this study was designed to examine the undergraduate students' preference for web based services and conventional library services in Kwara State University, Malete.

2. PURPOSE OF THE STUDY

This study was designed to examine the undergraduate students' preference for web based services and conventional library services in Kwara State University, Malete. The objectives of the study are to:

1. Identify the types of web based and conventional library services used by undergraduate students in Kwara State University;
2. Determine the extent to which undergraduate students are using web-based and conventional library services in Kwara State University;
3. Examine the perceived advantages of web based library services;
4. Examine the perceived advantages of conventional library library services; and
5. Identify the challenges encountered while using web based library and conventional library services in Kwara State University.

3. REVIEW OF RELATED LITERATURE

The term "library services" refer to facilities, which are provided by a library for the use of books and dissemination of information in order to meet users' information need (Sundari, Jeyapragash&Karthikeyan, 2012). Therefore, conventional library services can be described as library services that are rendered manually in which their resources are available in physical storage, in this type of library services, library users need to be physically available to access the needed information. This type of library services are differ from digital or virtual library where information materials can be gotten from anywhere and at any time the user needs the information. To buttress this statement,

Latimer and Niegaard (2008) opined that the classical design of these services (traditional services) focused on the collection, on its projected growth and on its protection manually. Ogunsola (2011) postulated that traditionally, libraries were collections of books, manuscripts, journals, and other sources of recorded information. The researcher further explained that, previously, for card catalogue is used to find library materials which are used as one of the access tools, but much of the information that the Internet offers cannot be found through one commonly-accepted tool or resource.

Web based library services means the services provided through particular website accessible on internetwhich provide integrate access to the multiple databases(Kumari, 2016). In the same vein, Madhusudhan(2012) described Web-based library services as a means by which library services are provided using internet as medium and library website as agateway with the help of Integrated Library Management System (ILMS).Furthermore, White (2001) defined web basedservices as an information service in which users ask questions via electronic means e.g. email or webforms. This means that Web-based library services provides users with the convenience of accessing information in theirown time, saving them travelling cost and time and new options for answering reference questions.

Madhusudhan and Nagabhushanam (2012) examined the use of web-based library services by users in different sections of the university libraries in India and examine how some of the University libraries provide web access to their collections and user support for that access and the problems faced by users in accessing web-based library services. Findings show that many of the surveyed university libraries are yet to exploit full potential of the web forms, and lagging behind in effective use of library website. Ravichandran, Muruesapandian, Sivakumaren and Gopalakrishnan (2012) investigated the various communication services and system based services which are used by the students who are pursuing engineering education in engineering colleges located in and around Chennai. The questionnaire method was adopted to collect data from the respondents. It was found from the study that majority of students are using e-mail service for communication and digital library service to collect information for their academic purposes. Further, it is found that the Bulletin Board and Inter library Loan (ILL) services were used by less numbers of students.

Thanuskodi and Ravi (2011) studied the utilization of digital resources by faculty and research scholars and found that majority respondents are browsed the Internet for teaching, research, and learning. Similarly, Sharma, Shawla and Madaam (2011) in their study found that mostly the faculty members and students in various discipline use internet services like e-mail, chatting, search engines, remote login, FTP, FAQ and also found less numbers of users use archives, Listserv. Sivakumaren, Jeyaprakash, Gopalakrishnan and Geetha (2011) reported that majority of respondents in their study have positive attitude on ICT and also recommended that the librarians should encourage the LIS professionals to attend various innovative programmes such as seminars, conferences /workshops to update their skills. Furthermore, in the study of Sudhier and Seethalakshmi (2011), reported that majority of respondents use e-mail services for research activities and also suggested that academic institutions and libraries should facilitate to increase the usage of resources.

Furthermore, Dewald (1999) examined the use of library instruction modules tutorials among the undergraduate students in Russia. The study reviewed 20 web-based library tutorials and identified interactivity as the hallmark of good web-based instruction because it distinguishes between a program that simply presents information and one that is a learning experience. The study also described the kinds of interactive experiences possible in web-based library instruction. The study shows that students can respond to questions online with radio buttons, image maps, and forms, and they can receive immediate feedback. Liu (2006) explored the extent to which graduate students in a metropolitan university setting use print and electronic resources. Reading preferences and use of print and electronic resources vary among different disciplines. Graduate students seem to expect a hybrid of print and electronic resources. They desire to meet their information needs through a mix of print and online resources, even though reasons for supplementing another type of resource differ.

Dilevko and Gottlieb (2002) conducted a web-based survey of undergraduate library users at the University of Toronto. They find that while undergraduate students typically begin assignments and essays using electronic resources, traditional print resources (e.g., books and printed journals) remain crucial components in their research because of their reliability and permanent accessibility. Strouse (2004) showed that users (especially younger users) have developed a clear preference for receiving information in electronic formats. Liew, Foo, and Chennupati (2000) conduct a survey of 83 graduate students to study their use and perceptions of electronic journals. Thefindings revealed that a vast majority of graduate students (73%) prefer electronic journals over print journals. Commonly cited reasons include links to additional resources, searching capability, currency, availability, and ease of access. Sathe, Grady, and Giuse (2002) reported that fellows, students, and residents favor electronic journals, and faculties prefer print journals. Ease of access, ease of printing, and ease of searching are among the most commonly cited reasons for preferring electronic journals.

In an investigation of the faculty electronic journal usage at the University of Georgia, Smith (2003) reportedthose junior faculties tend to use electronic resources more than senior faculty. Lenares (1999) establishedthat convenience, timeliness, and the ability to search text are the most important factors influencing faculty's choice of electronic over print materials. On the other hand, the ability to browse, portability, physical comfort, and convenience are the most important characteristics leading them to choose print over electronic resources. Bonthronet al. (2003) examined the views of academic staff and students at the University of Edinburgh on the advantages and limitations of electronic journals. They find that academic staff incorporate electronic journal usage into their working patterns in different ways than students and that these differences may affect attitudes towards support services (library web pages, virtual learning environments) designed to promote electronic journal usage. Daramola (2016) carried out a study on perception and utilization of electronic resources by undergraduate students at Federal University of Technology Library, Akure. The study reported that undergraduate students mostly use e-journals and bibliographic databases (Science Direct) when they visit the libraries.

Users' expectations of libraries and their patterns of library use are changing as they find more information readily available from the web. Boyce, King, Montgomery, and Tenopir (2004) examined how electronic journals are changing the reading patterns of scholars over the past decade. Friedlander (2002) reportedthat ''faculty and graduate students seem to expect a hybrid environment of print and electronic resources, while undergraduates seem more willing to live in a wholly online world. Dillon and Hahn (2002) finding showed that 70% of the faculty at the University of Maryland wants core journals in both print and electronic format. A report released by the Pew Internet & American Life Project finds that 73% of college students reported they use the Internet more than the library for research, however, only 9% said that they still gather information the old-fashioned way (Balas, 2003). Access to electronic resources not only influences the way students and scholars conduct research, it also changes the way they use the traditional library. Schaffner (2001) observed that on several occasions, students have requested assistance in changing the focus of their research to a topic that could be searched using only electronic sources.

Ajiboye and Tella (2007) examined the information seeking behaviour of undergraduate students in the University of Botswana. The result of the study revealed that the internet is the most consulted source, followed by students' class notes and handouts. This finding is further confirmed by Valentine (1993) who conducted a similar study and found out that undergraduates looked for the fastest way that would lead to satisfactory results when doing research by going for electronic information sources first. In same vein, Lohar and Roopashree (2006) studied the use of electronic resources and how the electronic resources are improving the academic career of the faculty and the problems that are faced in using the electronic resources. They reported that electronic resources are often use in the libraries and concluded that application of information technology and use of e-resources in the libraries have brought remarkable changes in librarianship and they also highlighted the use of computers and e-resources in library operations/services.

Onifade et al (2013) reported in their study that the respondents used more of internet facilities than any other library resources. This represented 65(20%) of the total responses, followed by textbooks and monograph resources which accounted for 60(18%) of the total responses; while e-journals and e-books were the next most used resources representing 56(17.1%) of the total responses. Chikonzo and Aina (2006) researched into the information needs and sources of information used by veterinary students at the University of Zimbabwe. Findings from the study revealed that writing assignments and studying for tests or examination were the primary tasks for which they required information and the major sources used to obtain information were books, videos, and lecture notes.

4. METHODOLOGY

This study adopted descriptive survey research design. The population of the study consists of all the registered undergraduate students of Kwara State University Library. According to the library register, as at 2016/2017 academic session, the total number of registered undergraduate students in Kwara State University Library is 3,572 out of

which 346 were selected using convenience sampling technique. The justification for this selection of sample is based on Israel size table (2003) which stated if the population of the study is more than 3000, researcher should select 346. A questionnaire tagged "Undergraduate Students' Preference for Web based Services and Conventional Library Services Questionnaire (USPWSCLSQ)" was used to collect data for the study The questionnaire was divided into seven sections, Section A toG. The instrument was validated using content and construct validity types to determine if the instrument is valid by giving two copies of the questionnaire to two research expert in the Department of Library and Information Science, with a reliability co-efficient r=0.621; 0.783; 0.633; 0.731; and 0.582 for section B, C, D, E, F, and G respectively using split-half technique. Three hundred and forty-six copies of the questionnaire were administered to the respondents in the library and they were asked to fill the questionnaire and return it immediately in order to reduce the mortality rate of the questionnaire. Out of 346 copies of administered questionnaire, 320 copies were retrieved. This gives a response rate of 92.5%. Data collected was analyzed using frequency count and percentage.

5. RESULTS AND DISCUSSION OF FINDINGS

5.1 Demographic Information of the Respondents

Gender	**Frequency**	**Percent**
Male	181	56.6
Female	139	43.4
Total	**320**	**100.0**
Age		
15-20	229	71.6
21-25	43	13.4
26-30	48	15.0
Total	**320**	**100.0**
Level of Study		
100	90	28.1
200	91	28.4
300	91	28.4
400	48	15.0
Total	**320**	**100.0**

Table 1 shows the bio-data of the respondents. The table revealed that 181 (56.6%) of the respondents were male while female were 139 (43.4%). The table also shows that 229 (71.6%) of the respondents were between the age of 15-20 years, 43 (13.4%) were between the age of 21-25 years and 48 (15.0%) were between the age of 26-30 years. Lastly, the table shows that 90 (28.1%) of the respondents were in 100 level, 91 (28.4%) in 200 level, 91 (28.4%) in 300 level and 48 (15.0%) in 400 level.

5.2: Types of Web-based and conventional library services used in Kwara State University?

Table 4.2a: Types of Web Based Library Services students in Kwara State University

S/N	Web Based Services	Yes	No
1	Frequently Ask Questions (FAQ)	227 (86.6%)	43 (13.4%)
2	Internet Services	307 (95.9%)	13 (4.1%)
3	E-referencing	272 (85.0%)	48 (15.0%)
4	OPAC	302 (94.4%)	18 (5.6%)
5	Web forms	228 (71.2%)	92 (28.8%)
6	E-Library Portals	135 (42.2%)	185 (57.8%)
7	Online Circulation Transaction	288 (90.0%)	32 (10.0%)
8	Online bibliographic database	152 (47.5%)	168 (52.5%)
9	Online current awareness bulletins	195 (60.9%)	125 (39.1%)
10	Online help and information skill tutorials	135 (42.2%)	185 (57.8%)
11	Electronic article alert service	185 (57.8%)	135 (42.2%)

Table 2a shows the type of web based library services rendered in Kwara State University Library. The table revealed that majority of the respondents 307 (95.9%) attested to the availability of Internet service, 302 (94.4%) to the availability of OPAC, 272 (85.0%) to e-referencing, 288 (90.0%) to online circulation transaction, 228 (971.2%) to web forms, 227 (86.6%) to frequently ask questions (FAQ), 195 (60.9%) to online current awareness bulletins, 185 (57.8%) to electronic article alert service. On the other hand, majority of the respondents attested that online bibliographic database (47.5%) and online help and information skill tutorials (42.2%) are not rendering in their library.

Table 2b: Types of Conventional Library Services students in Kwara State University

S/N	Conventional Library Services	Yes	No
1	Current Awareness Services	285 (89.1%)	35 (10.9%)
2	Selective Dissemination of Information	225 (70.3%)	95 (29.7%)
3	Referral Services	261 (81.6%)	59 (18.4%)
4	Reprographic Services (Photocopy)	262 (81.9%)	58 (18.1%)
5	Bibliographic Service	226 (70.6%)	94 (29.4%)
6	Indexing Services	258 (80.6%)	62 (19.4%)
7	Charging and Discharging	273 (85.3%)	47 (14.7%)
8	Bulletin board services	91 (28.4%)	229 (71.6%)
9	Abstracting Services	252 (78.8%)	68 (21.2)
10	Manual Reference Services	308 (96.2%)	12 (3.8%)
11	Library orientation and instruction	288 (90.0%)	32 (10.0%)

Table 4.2b shows the types of conventional library services rendered in Kwara State University Library. The table revealed that manual reference services (96.2%), Library orientation and instruction (90.0%), charging and discharging (85.3%), current awareness services (89.1%), reprographic services (photocopy) (81.9%), referral services (81.6%), indexing services (80.6%), abstracting services (78.8%), bibliographic service (70.6%) and selective dissemination of information (70.3%) were the majorly rendered conventional library services in Kwara State University Library as attested to by the students. While bulletin board services is the least rendered conventional library services in Kwara State University Library.This finding is in line with the work of Si and Ranaweera (2016) and Ogunsola (2011) who reported that that internet services, Frequently Ask Question (FAQ) E-referencing, OPAC among others are the web-based services rendered in the academic library of their study while manual reference service, selective dissemination of information charging and discharging are conventional library services that academic libraries in their study rendered in order to support their parent institutions.

5.3 Extent to which undergraduate students use Web-based and conventional library services

Table 3a: Extent to which Undergraduate Student Utilized Web-based Library Services

S/N	Web Based Services	Always	Frequently	Rarely	Never
1	Frequently Ask Questions (FAQ)	133 (41.6%)	187 (58.4%)	-	-
2	Internet Services	186 (58.1%)	91 (28.4%)	43 (13.4%)	-
3	E-referencing	47 (14.7%)	183 (57.2%)	47 (14.7%)	43 (13.4%)
4	OPAC	134 (41.9%)	91 (28.4%)	95 (29.7%)	-
5	Web forms	91 (28.4%)	182 (56.9%)	-	47 (14.7%)
6	Library Portals	143 (44.7%)	44 (13.8%)	86 (26.9%)	47 (14.7%)
7	Online Circulation Transaction	87 (27.2%)	90 (28.1%)	143 (44.7%)	-
8	Online bibliographic database	133 (41.6%)	139 (43.4%)	-	48 (15.0)
9	Online current awareness bulletins	95 (29.7%)	90 (28.1%)	135 (42.2%)	-
10	Online help and information skill tutorials	90 (28.1%)	48 (15.0%)	47 (14.7%)	135 (42.2%)
11	Electronic article alert service	91 (28.4%)	90 (28.1%)	139 (43.4%)	-

Table 3a shows extent to which undergraduate student utilized web-based services. The table3a revealed that 187 (58.4%) of the respondents frequently used "Frequently Ask Questions (FAQ)", 186 (58.15) of the respondents always used 'Internet Service", 183 (57.2%) of the respondents frequently used "E-referencing, 134 (41.9%) of the respondents used OPAC always, 182 (56.9%) of the respondents used "Web Forms" frequently, 143 (44.7%) of the respondents used "Library Portals" always, 143 (44.7%) of the respondents used "Online Circulation Transaction" rarely, 133 (41.6%) of the respondents used "Online Bibliographic Database" always, 135 (42.2%) of the respondents used "Online Current Awareness Bulletins" rarely, 135 (42.2%) of the

respondents never used "Online Help and Information Skill Tutorials" and 139 (43.4%) of the respondents used "Electronic Article Alert Service" rarely.

Table 3b: Extent to which Undergraduate Students Utilized Conventional Library Services

S/N	Conventional Library Services	Always	Frequently	Rarely	Never
1	Current Awareness Services	87 (27.2%)	47 (14.7%)	186 (58.1%)	
2	Selective Dissemination of Information	90 (28.1%)	92 (28.8%)	138 (43.1%)	
3	Referral Services	92 (28.8%)	185 (57.8%)		43 (13.4%)
4	Reprographic Services (Photocopy)	95 (29.7%)	43 (13.4%)	182 (56.9%)	
5	Bibliographic Service	135 (42.2%)	139 (43.3%)	12 (3.8%)	34 (10.6%)
6	Indexing Services	218 (68.1%)	31 (9.7%)	59 (18.4%)	12 (3.8%)
7	Charging and Discharging	125 (39.1%)	79 (24.7%)	68 (21.2%)	48 (15.0%)
8	Bulletin board services	194 (60.6%)	43 (13.4%)	71 (22.2%)	12 (3.8%)
9	Abstracting Services	136 (42.5%)	138 (43.1%)	35 (10.9%)	11 (3.4%)
10	Manual Reference Services	238 (74.4%)	37 (11.6%)	33 (10.3%)	12 (3.8%)
11	Library orientation and instruction	229 (71.6%)	69 (21.6%)	11 (3.4%)	11 (3.4%)

Table 3b revealed the extent to which undergraduate student utilize conventional library services. The table shows that 186 (58.1%) and 138 (43.1%) of the respondents rarely use "Current Awareness Services" and "Selective Dissemination of Information" respectively. The table4.3b also shows that 185 (57.8%) of the respondents frequently use "referral Services", 182 (56.9%) of the respondents rarely use "Reprographic Services (Photocopy)", 139 (43.3%) of the respondents "Bibliographic Service". The table also shows that 135 (42.25%), 218 (68.1%), 125 (39.1%), 194 (60.6%), 136 (42.5%), 238 (74.4%) and 229 (71.6%) always use "Bibliographic Service", "Indexing Services", "Charging and Discharging", "Bulletin board services", "Abstracting Services", "Manual Reference Services" and Library orientation and instruction" respectively.This finding is in agreement with the work of Sharma, Shawla and

Madaam (2011) who found that their respondents mostly use Frequently Ask Question, Internet network search engines, remote login, FTP. However, this finding contradicts the work of Ravichandran, Muruesapandian, Sivakumaren and Gopalakrishnan (2012) who found in their study that their respondents always using e-mail services. The result shows that majority of the respondents are always using bibliographic services, indexing services, charging and discharging, bulletin board services, abstracting services, manual reference services and library orientation and instruction. This finding corroborate the work of Chikonzo and Aina (2006) who found that students in University of Zimbabwe prefer to obtain information through traditional method such as using printed textbooks among others.

5.4. Perceived advantages of web-based services over conventional library services?

Table 4: Perceived Advantages of Web-based over Conventional Library Service

S/N	Perceived Advantages	SA			SD
1	Quick access	205 (64.1%)	69 (21.6%)	46 (14.4%)	-
2	Remote access	100 (31.2%)	185 (57.8%)	23 (7.2%)	12 (3.8%)
3	Wider access	163 (50.9%)	112 (35.0%)	45 (14.1%)	-
4	Multiple use for single sources	124 (38.8%)	185 (57.8%)		11 (3.4%)
5	Links to additional information	197 (61.1%)	112 (35.0%)	11 (3.4%)	-
6	Search capability	112 (35.0%)	174 (54.4%)	34 (10.6%)	-
7	24 hour access	152 (47.5%)	112 (35.0%)	23 (7.2%)	33 (10.3%)
8	Saves time of the users	81 (25.3%)	171 (53.4%)	45 (14.1%)	23 (7.2%)
9	Easy to use	191 (59.7%)	106 (33.1%)		23 (7.2%)

Table 4 shows the perceived advantages of web-based services over conventional library service. The table revealed that majority of the respondents agreed that multiple use for single sources (96.6%), links to additional information (96.1%), easy to use (92.8%), search capability (89.4%) remote access (89.0%), wider access (85.9%), quick access (85.7%), 24 hours access (82.5%) and save time of the users (78.7%) are the advantages of web-based services over conventional library service. This finding

corroborates the work of Liu (2006) who reported that electronic library services have numerous advantages over traditional library services such as remote access, 24-hour services, and multiple users for a single information material.

5.5.Perceived advantages of conventional over web-based library service?

Table 5: Perceived advantages of Conventional over Web-based Library Services

S/N	Perceived Advantages	SA			SD
1	Physical browsing	103 (32.2%)	183 (57.2%)	34 (10.6%)	-
2	Getting immediate help from "Real" person	146 (45.6%)	151 (47.2%)	23 (7.2%)	
3	Quiet place for study	215 (67.2%)	83 (25.9%)	22 (6.9%)	-
4	Access to archival and older information	104 (32.5%)	172 (53.8%)	33 (10.3%)	11 (3.4%)
5	Getting more detailed information	250 (78.1%)	36 (11.2%)	23 (7.2%)	11 (3.4%)

Table 5 shows that majority of the respondents agreed that quiet place for study (93.1%),getting immediate help from "Real" person (92.8%), physical browsing (89.4%), getting more detailed information (89.3%) and access to archival and older information (86.3%). The reason why majority of the respondent identify this advantages is likely to attributed to the fact that traditional library services rendered in the library satisfied their information need better than using web-based library services.

5.6 Challenges encountered while using web-based and conventional library services?

Table 6: Challenges encountered while using Web-based and Conventional library Service

S/N	Challenges encountered while using Web-based	Yes	No
1	Interface design problems (e.g. difficult to use)	80 (25.0%)	240 (75.0%)
2	Hard to ask for immediate help (e.g. lack of real librarian)	198 (61.9%)	122 (38.1%)
3	Instability of online resources	114 (35.4%)	206 (64.4%)

4	Need equipment and internet access (e.g. shift financial burden to users)	187 (58.4%)	133 (41.6%)
5	Discomfort with online reading	144 (45.0%)	176 (55.0%)
6	Credibility and quality issues	164 (51.2%)	156 (48.8%)
7	Technical problem (e.g. system malfunction)	95 (29.]7%)	225 (70.3%)
S/N	**Challenges Encountered while Using Conventional Library Services**		
1	Time consuming	167 (52.2%)	153 (47.8%)
2	Inconvenience (e.g. Opening hours; closed during holiday)	116 (36.2%)	204 (63.8%)
3	Annoying patrons and unpleasant staff	241 (75.3%)	79 (24.7%)
4	Availability (e.g. needed items have been checked out or not on the shelf)	173 (54.1%)	147 (45.9%)
5	Short loan period	215 (67.2%)	105 (32.8%)
6	Limited number of items to borrows	184 (57.5%)	136 (42.5%)
7	Overdue fines	183 (57.2%)	137 (42.8%)

Table 6 shows that majority of the respondents agreed that hard to ask for immediate help (e.g. lack of real librarian) (61.9%) and need equipment and internet access (e.g. shift financial burden to users) (58.4%) are the challenges encountered while using Web-based. On the other hands, annoying patrons and unpleasant staff (75.3%), short loan period (67.2%), limited number of items to borrows (57.5%), overdue fines (57.2%), Availability (e.g. needed items have been checked out or not on the shelf) (54.1%) and time consuming (52.2%) are the challenges encountered while using conventional library services.This finding is in line with the work of Liu (2006) who opined that it is difficult for the users of web-based library services to ask real librarians difficult questions and overdue fines are the major challenges associated to web-based library services conventional library services respectively.

Table 4.7: Overall question on most preferred services by undergraduate students.

Overall Question	Frequency	Percent
Web based	230	71.9
Conventional library services	90	28.1
Total	320	100.0

Table 4.7 shows the overall question on the services that student prefer most. The table shows that out of 320 respondents, 230 (71.9%) prefer web-based library services to conventional library services while 90 (28.1%) prefer conventional library services to web-based library services. This means that majority of the respondents prefer web-based library services to convention library services. This finding corroborates the work of Strouse (2004) shows that users (especially younger users) have developed a clear preference for receiving information in electronic formats. The reason for this may attached to the numerous advantages that they perceived that conventional library services have over traditional library services.

6. CONCLUSIONS

Based on the findings of the study, it could be conclude that Internet service is available at Kwara State University. In the same vein, it could be concluded that undergraduate students in Kwara State University preferred Frequently Ask Questions (FAQ) to other web based services. Furthermore, it could be concluded that undergraduate students in Kwara State University utilized library orientation and instruction while they rarely use current awareness services.

Furthermore it revealed that undergraduate students in Kwara State University Library agreed that multiple use for single sources is the major advantage of web based services over conventional library services, in the same vein, it could be ascertained that these students also preferred quiet place for study as this is the preferred advantage of conventional services over the web based library services. Finally, it could be conclude that undergraduate students agreed that hard to ask for immediate help (e.g. lack of real librarian) is the challenge faced while using web based library services. On the other hand, it could be conclude that undergraduate students agreed that annoying patrons and unpleasant staff is the challenge faced while using conventional library services.Cumulatively, the study shows that web based library services are the most preferred services by the undergraduate students of the Kwara State University Library.

7. RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

- The university authority and library management should make provision for the full migration of library services from its old services provision approach (traditional library services) to conform to modern standard which in this context is anchored on ICT and reflected in web based library services.

- The university authorities and library management should improve on the existing web based library services and facilities by purchase of and sharing of resources with cooperating universities.
- The university authority and library management should commit more funds for training staff either through consultation of experts from outside or within the organization, or staff being sent on conferences and foreign studies. This will help them to serve their patron better.

- On the issue of credibility of the e-resources, acquisition librarian should try as much as possible to critically evaluate all the information materials acquired into the library. This will give library users quality information materials.
- Short loan period is one of the challenges that students encountered in the use of traditional library services. In light of this, library management should extend the loan period of the information materials for library users.

REFERENCES

Ahmed, T. (2007). Networked e-information services to support the e-learning process at UAE University. *The Electronic Library*, 25(3), 349-62.

Ajiboye, D.O., & Tella, A. (2007). University undergraduate students' informationseeking behaviour: Implications for quality in higher education in Africa. *TheTurkish Online Journal of Educational Technology, 6*(1)

Asamoah-Hassan,H.R (2010). Transforming traditional libraries into electronic libraries: the contribution of the african university.

Balas, J. L. (2003). Is the reference librarian real or virtual? In K. Bonthron, C. Urquhart, R.Thomas, C. Armstrong, D. Ellis & J.Everitt (Eds.). *Computers in libraries, 23,* 48–51.

Boyce, P., King, D. W., Montgomery, C., &Tenopir, C. (2004). How electronic journals are changing patterns of use? *The Serials Librarian, 46*(1–2), 121–141.

Chikonzo, A. C., & Aina, L. O. (2006). Information needs and sources ofinformation used by veterinary students at the University of Zimbabwe. *QuarterlyBulletin International Association of Agricultural Information Specialists (IAALD),46*(1-2), 24-28

Dewald, N. H. (1999). Transporting good library instruction practices into the webenvironment: An analysis of online tutorials. *Journal of Academic Librarianship, 25*(1),26-31.

Dilevko, J., & Gottlieb, L. (2002). Print sources in an electronic age: A vital part of the research process for undergraduate students. *Journal of Academic Librarianship, 28*(6), 381–392.

Dillon, I. F., & Hahn, K. L. (2002). Are researchers ready for the electronic-only journal collection? Portal: *Libraries and Academy,2*(3), 375–390.

Edoka, B.E. (2000).*Introduction to library science. Onitsha:* Palma and links.

Friedlander, A. (2002). Dimensions and use of the scholarly information environment, Available from http://www.clir.org/pubs/reports/pub110/contents.html.

Halub, L.P. (1999). The value of Web-based library services at Cedars-Sinai Health System.*Bulletin of the Medical Library Association, 87*(3), 256-260.

Kumari, N. (2016). Web-based services in library and information science. *International Journal of Next Generation Library and Technologies, 2*(1).

Liew, C. L., Foo, S., &Chennupati, K. R. (2000). A study of graduate student end-users; use and perception of electronic journals.*Online Information Review, 24(*4), 302–315.

Liu, Z. (2006). Print vs. electronic resources: A study of user perceptions, preferences, and use. *Information Processing and Management, 42,*583-592.

Lukasiewicz, A. (2007). Exploring therole of digital academic libraries:Changing student needs demandinnovative service approach. *Library Review, 56*(9), 821-827.

Madhusudhan, M., & Nagabhushanam, V. (2012). Use of web based library services in selected University libraries in India. *International Journal of Library and Information Science,1*(2), Jan-Mar, 2012.

Ogunsola, L. A. (2011). The next step in librarianship: is the traditional library dead? Library Philosophy and Practice.

Onifade, F. N., Ogbuiyi, S. U. &Omeluzor, S. U. (2013). Library resources and services utilization by postgraduate students in a Nigerian private university. *Academic Journals, 5*(9), 289-294.

Pathak, S.K., Mishra, A., &Sahoo, G. (2011). Future of web based library and informationservices: An Indian scenario. 6th convention PLANNER-2008, Nagaland University. Retrievedfrom http://ir.inflibnet.ac.in/handle/1944/1156

Ravichandran, M., Murugesapandian, N., Sivakumaren, K. S. &Gopalakrishnan, S. (2012). Use of web based library services: a study among engineering students. *International Journal of Current Research, 4*(1), 255-258.

Sathe, N. A., Grady, J. L., &Giuse, N. B. (2002). Print versus electronic journals: A preliminary investigation into the effect of journal format on research processes. *Journal of the Medical Library Association, 90*(2), 235–243.

Schaffner, B. L. (2001). Electronic resources: A wolf in sheep_s clothing. *College & Research Libraries, 62*(3), 239–249.

Sharma, C., Chawla, R. and Madaan, P.(2011). Internet usageby the faculty members and the students in professionalcolleges at Mathura region: An emprical study.*International Journal of Information Dissemination and Technology,1*,77-85.

Sivakumaren, K.S., Jeyaprakash, B., Gopalakrishnan, S. andGeetha, V. (2011). Attitudes towards information andcommunication technology (ICT) among libraryprofessionals in and around Chennai. *International Journal of Information Dissemination and Technology,1*,66-76.

Smith, E. T. (2003). Changes in faculty reading behaviors: The impact electronic journals on the University of Georgia. *Journal of Academic Librarianship, 29*(3), 162–168.

Strouse, R. (2004). The changing face of content users and the impact on information Providers Online. 27–31.

Sundari, S.K., Jeyapragash, B., &Karthikeyan(2012). Web based library services in Tamil Nadu universities: Descriptive study. National conference on innovative library services in digital era, 163-171.

Thanuskodi& Ravi, S. (2011). Use of digital resources byfaculty and research scholars of ManonmaniamSundaranarUniversity , Tirunelveli. *DESIDOC Journal of Library & Information Technology, 31*, 25-30.

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INFORMATION ACCESS USING WEB 2.0 AS PANACEA FOR ATTAINING SUSTAINABLE DEVELOPMENT GOALS: A REVIEW OF RELATED MODELS

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ABSTRACT
Attainment of Sustainable Development Goals (SDG) has been projected to be achievable to a greater extent through accessibility of information. Researchers have pointed at web 2.0 as panacea for accessing information and knowledge which by implication will be a panacea for attainment of SDG. This study review on models that supports the fact that use of web 2.0 for accessing information will go a long way in achieving SDG. The Technology for Pro-environment Action Model (TPAM), Critical Success Factor model and Social Media (SM) for Knowledge Management (KM) were all reviewed as a basis through which Web 2.0 usage can foster the attainment of SDG. The models have provided additional insight to the fact that information access on web 2.0 can be processed to become a resource, a critical success factor and KM process which are important in achieving SDG.

Keywords:*Information Access, Web 2.0, Sustainable Development Goals, Review of Related Models*

1. INTRODUCTION

Web 2.0 has been described to have functions in virtually all aspect of human endeavour due to its basic characteristics that have made it be highly social. The sociality of web 2.0 can make it to have usefulness and function in improving the standard of living of users and even that of community at large. Sustainable development is a global desire to see to the wellness of all the citizens of the world irrespective of their location or country of region. It is equally expected that no known reason should be sufficient enough to prevent any individual from achieving the best of him/herselfat least to an average standard of living.

Various factors could be responsible for development of a nation; these ranges from natural and human resources to technological advancement. Studies in recent time have identified information and knowledge as key developmental resources(Shafack, 2016; Drucker, 2006) for the growth of the nation at large. Wand (2016) reported a strong correlation between access to information and national development. Sustainable

development is the desire of the world at large to ensure that the citizen of the world achieve the best possible and maintain the world ecosystem for the future generation

It can therefore be premised that sustainable development is a function of access to information and knowledge. IFLA (2012) has come up with the conclusion that access to information is a fundamental human right that can break the cycle of poverty and support sustainable development. The development of information and knowledge has been a measure of the development of nations in the world. Information and knowledge advanced nations have been described to be developed nations of the world. The importance of access to information has led to the development of information distribution and dissemination since the time of town criers to horse rider dispatch of news to megaphone, radio stations and television stations. The modern day internet or web 1.0 has been described as a phenomenon that revolutionalise information dissemination while the appearance of web 2.0 has been unprecedented in terms of information "production and consumption"

The United Nations (UN) agenda set against 2030 which is also known as sustainable development consist of 17 main areas of human activity revolving around economic, environmental and social development (United Nations, 2015b). These sustainable development goals were set for the people of the world with the intention of making our world better and living a comfortable live at the same time.

2. IMPORTANCE OF ACCESS TO INFORMATION.

Library and Information Science (LIS) charter (2014), stated that right ofaccess to information can make a difference; the difference cut across all strata of life. Information is a fundamental right of every citizen of the world and should be so treated by all parties involved in achieving SDG. Access to information goes a long way to provide the basic knowledge that is required in carrying out the activities that will assist in achieving the set out objectives of the SDG. IFLA (2014c) described access to information as a fundamental requirement for personal and social development and for participation. LIS charter (2014) stated that development is impeded in the developing nations due to lack of information.

Dapo-Asajuand Bamgbose (2016) opined that any society that will record significant stride in the quest to achieve the 17 SDG must be a society that has empowered his citizen with unfettered access to information. Information accessibility, usage and usability coupled with the level and quality of infrastructure available or accessible will determine the extent of how a society will use and adapt the increased knowledge and information to better its present situations. The better situation of a society is what SDG has captured and web 2.0 has provided phenomenal accessibility, usage and usability at a relatively cheap price. The society can achieve much through the processing of information on web 2.0.

Shafick (2016) in his analysis of the various ways through which information and knowledge drives the development of a nation identified information literacy as the most important. Information literacy can be said to be related to information access. Access to information in any society will have the following impact:

- Create a knowledge society

- Create a literate environment
- Create an enabling society where rights and priviledges are taken up on time and also protected,
- There will be less loss in terms of manpower, energy, resources, etc,
- It helps in making appropriate forecast about different issues,
- It helps in understanding of the basic flow and interaction of the various sectors and ecosystem of the society.
- It can help to reduce conflict and disturbances.
- It makes people to work smarter.
- It helps in timely and correct access of resources needed for improvement, growth and sustainability.

LIS charter (2014) summarized the importance of access to information in the information age as being crucial and is a source of wealth and power; it makes for better people, more efficient and effective workers; and more responsive and responsible citizens.

3. WEB 2.0 AS PANACEA

LIS charter (2014) recognized lack of information as impediment to development in developing nations. In the current information age, which has been characterized with information overload or information flooding, lack of information may not be excuse for non-development rather it should be lack of access to information. The present trend and availability of internet and web 2.0 has come to the rescue(LIS charter, 2014). According to Mason (2018), the use of ICTs and computer-mediated communication (CMC), most notably the Internet, as effective tools in the hands of organizations of civil society in order to advance both local and global agendas, has proven itself in Latin America, China and South East Asia and among global organizations of civil society such as human rights groups and ecologically oriented organizations. In short, those with access to these technologies are becoming more powerful and those who lack access are likely to become increasingly marginalised - politically and economically (Mason 2018).

Web 2.0 can be described as a set of versatile tools and technologies that helps in information access and generation. Infact the modern day has given birth to what is known as "prosumer" of information as a result of availability of web 2.0 tools. Prosumer in the sense of users being able to produce information and at the same time can consume information.LIS charter (2014) recognized that emerging technologies and social networks have democratized access to information.

United Nations Institute for Training and Research (UNITAR, 2015) accentuated on how social media and weh 2.0 can play role in sustainable development concluded that; web 2.0 or social media can be used to spread the word about the SDG as well as human rights worldwide so as to empower people with knowledge they need to make change possible. A participant explained that "without knowing what is out there, people cannot make up their minds on what they want, what they value and want to achieve". The more people are aware of their responsibility, trend of event and expectation, there will be a likely-hood of greater commitment to achieve the set goals

compared to when they are not regularly informed. Another conclusion was that the ubiquitous "access" of ICT makes it to be considered as a modern day utility services like water, electricity etc. which are undeniable factors of achieving a set objectives. ICT is indirectly something you cannot do without to achieve SDG based on the power of "accessibility" that it possessed. The ubiquitous access of web 2.0 is many pronged: to information, to resources, to people, to experience, to experts etc. which are things that are required to achieve SDG.

Other conclusions by UNITAR (2015) were also that, web 2.0 and internet provides the greatest repository of information on earth. Since information is power, then access to web 2.0 is access to repository of power and power can be appropriated based on the direction it is applied and also influenced by other users to get the best from it and thereby achieve the SDG. Thus there is little chance for a country, or region, to develop in the new economy without its incorporation into the technological systems of the information age. In sum, information and communication technology is the essential tool for economic development and material well being in our age; it conditions power, knowledge and creativity (Mason 2018)

4. RELATED THEORY SUPPORTING USE OF WEB 2.0 FOR ACHIEVING SDG

Technology per se does not solve social problems. But the availability and use of information and communication technologies are pre-requisite for economic and social development in our world (Mason, 2018).It is the continuous collective capacity of society to generate its own information, to disseminate it, to recombine it, to use it for its specific goals, that has transformed social practice through the transformation of the range of possibilities for the human mind(LIS charter 2014). The possibility of achieving SDG in any nation depends on the accessibility of the continuous knowledge and information of the society and that of the larger world. Access to "localized" information and knowledge within the physical library may not be sufficient in any society to achieve the desired SDG. In the face of dwindling economy of most nations of the world and most affected are the developing nations; there is the need to develop or look for a convenient means of accessing information by its citizenry so as to be able to achieve the stated goals.

Ability to access information and its public diffusion are essential for well-being in our information society(LIS charter 2014). The well-being of the present world is what the United Nations have identified and put together as SDG. The achievement of the SDG goes a long way to impart the wellness and the continued existence of the world at large. Information in the Internet age comes from people, people generating information and disseminating it over the net; this is where the revolution lies (LIS charter 2014). Development in a society will be lopsided if not holistic in-terms of the group of people that are involved and the sector of economy that is carried along. All the facet of life and economy of any nation are interwoven, therefore there is the need to balance out development through collaboration of people, production of information and proper dissemination of such to every class of people in the society. These have all been made possible on web 2.0.

Three theories or modelswere reviewed in the course of this work to support information access through web 2.0 as panacea for achieving SDG.

5. THE TECHNOLOGIES FOR PRO-ENVIRONMENTAL ACTION MODEL (TPAM)

The Pro-environmental Action Model (TPAM) is a conceptual model that describes how certain functions of web 2.0 or social media technologies may be leveraged to generate and/or facilitate pro-environmental action. (Ballew, Omotosho, & Winter, 2015) This model premised on the informational, relational and experiential characteristics of web 2.0. These characteristics can make them to find application or usefulness in virtually any aspect of human endeavour. SDG goal is a collective responsibility of the citizen of a particular country; so it is relational in nature to achieve. The achievement of SDG is premised on accurate and appropriate availability and accessibility of information; hence it is informational in nature. There is the need to learn from those who have done it best in time past, in-form of sharing and learning from their experience, then it is experiential.

All of these necessities of achieving SDG can be found in the characteristics of web 2.0. Also there may be need for contextualization or pathways through which a particular system will function. Web 2.0 or modern technologies cannot achieve the SDG but the use of them in appropriate ways. It has been pointed that ICT for development is not about computers, mobile phones, and the internet, but about help, support, and training people in linking them and communities for communication, learning, and services. This will lead to improved well-being, increased work productivity, support for innovation, and impetus for inclusive growth (Schaefer-Preuss, 2010). The use of web 2.0 to achieve SDG may go through what is regarded as personal, social and contextu

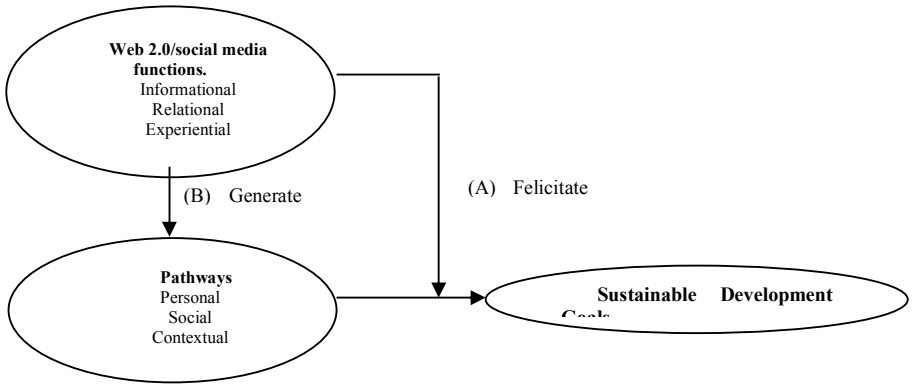


Figure 1: adapted Technologies for Pro-environmental Action Model (TPAM) for sustainable development goals.

Web 2.0 allows for personal, social and contextual interaction in a bid to achieve any objective. The personal pathways could be usage at a personal level, as individuals to search,generate and perform various information processing activity on web 2.0 without any interference from third party. One very strong point of web 2.0 is the social characteristics of it that allows for multiple usage among group of people. Forums, groups, discussion board, blogs etc are all avenues through which there may be social

meeting or interaction to allow for cross-fertilisationofideas or harvest of collective intelligence. Contextual allows for people or group of similar interest to discuss or use the platform in a way that is suitable to them whether in-terms of time of meeting, issues to be discussed, the flexibility of web 2.0 is a good characteristics of it that made it to be contextualized easily.

6. CRITICAL SUCCESS FACTOR MODEL

Critical success factor is activity or element or critical factor that is highly necessary for the successful execution of a project or running of an organization. The following factors have been identified as capital factors for modern economy: Human capital- knowledge, skills and capabilities of people; social capital- relationship and collective wealth between people, organizational capital- workplace management skills and knowledge in an organization, intellectual capital- knowledge of people that can be exploited for capital or beneficial gains and network capital- trusted contact or source that individuals can draw from (Arvanitis&Loukis 2008; Wong 2008; Acquaah 2008).

The above factors are possible through and on web 2.0; which makes it an ideal platform for SDG achievement. The human capital is the user participation on web 2.0, social capital is the friendliness of web 2.0, organizational capital is software as a service on web 2.0, intellectual capital is the long tail of web 2.0 and network capital is the mass participation of web 2.0. Ferreira and du Plessis (2009) summarized it that these factors can be referred to as knowledge capital, and knowledge resides in people, so people should be the focus of modern economy or knowledge-based economy which SDG tries to achieve for all individuals. Various model of critical success factors exist depending on the situation or the project.

Web 2.0 is a veritable platform for all the factors to interact so as to achieve a new set of objectives; that is the attainment of SDG. There is the need for participation by the citizen of a particular country in the process of achieving and this requires a platform that is convenient, cheap and ready to use by all and at all time.

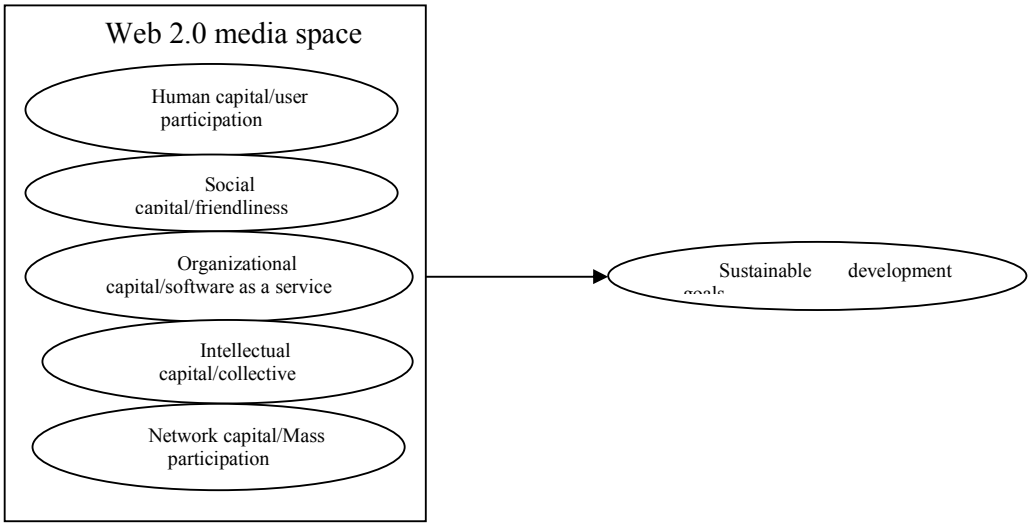


Figure2: Critical success factor model for using web 2.0 for sustainable development

Web 2.0 on itself does not produce the sustainable development goals, but the interaction of users with the content via the platform and vice-versa will produce the sustainable development.

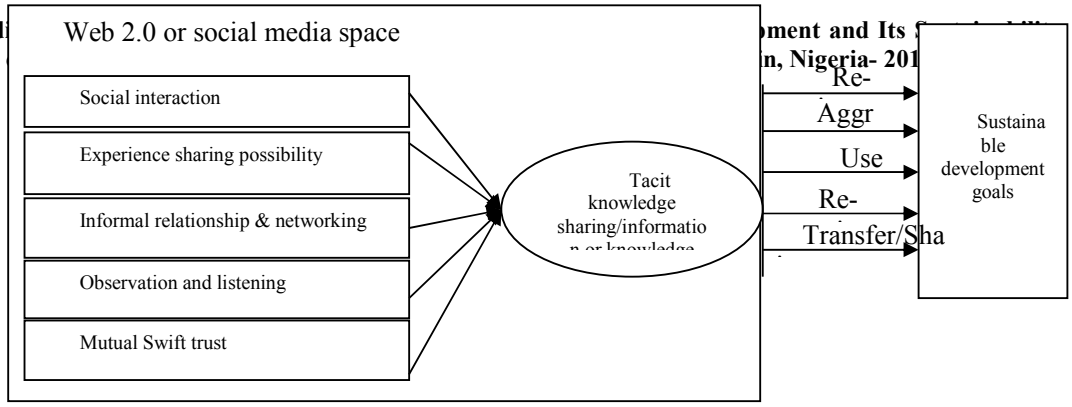
ICT for development is not about gadgets but the help and support, with people and community involvement in-terms of communication, learning and service that will lead to improved well-being, increased work productivity, support for innovation, and impetus for inclusive growth (Schaefer-Preuss, 2010). The major objectives of SDG are possible when people are trained, connected, supported and helped through web 2.0. Web 2.0 today can be described as a repository of both information and knowledge, researchers have indicated the possibility of sharing tacit knowledge on web 2.0 (Gordeya, 2010; Steinger,Ruckel, Dannerer&Roithmayr, 2010; Panahi, Watson & Patridge2012; Olajide, 2015), tacit knowledge is a basic pre-requisite of growth and achievement of SDG.

7. SOCIAL MEDIA OR WEB 2.0 AS A KNOWLEDGE MANAGEMENT TOOL

The survival of humans has been based entirely on knowledge systems. Knowledge-systems other than the dominant discourse need to be recognised not just as knowledge-systems per se, but as things that could be pivotal to the preservation of the environment and ensuring means of existence for the great many people who live on the edges of a rapidly modernising world (Mason, 2018). The attainment of any human endeavour is therefore dependent on the knowledge systems or rather on how the knowledge is managed. The ability or technique to process information to become knowledge is not an end in itself unless the knowledge is properly managed to become useful. Existing knowledge that is not available or accessible and usable may not bring out the best result and impart.

Knowledge should be acquired basically to impart, rather than just for the sake of it. SDG were coined out of the knowledge that it practicable and also existing in some places so why not generalized it all over the world so that the world can become a sustained environment for all itshabitat. These knowledge/information needs to be passed to underdeveloped or developing nations so as to help them to achieve the SDG. Web 2.0 or social media has been pointed in the direction of knowledge management (Yates &Paquette, 2011). Through SM or web 2.0, creation and recreation, sharing and learning, dissemination and storage, transfer and receiving of information and knowledge are now possible. Olajide(2015)and Bakhuisen (2012) concluded that growth and competition for survival of any organizations in the present evolving world must take cognizance of the development of knowledge. The need for development of knowledge is far beyond just creation but all the activity that will make the knowledge to become useful to the individual, organization or society.

Panahi, Watson and Patridge (2012), developed a conceptual framework for Social media as tacit knowledge sharing tool. This conceptual model was modified by Olajide (2015) and it will be adapted to achieving SDG objectives.



Adapted social media as a knowledge management model (Olajide, 2015); Figure 3: Web 2.0 or social media as a panacea for SDG model

It is concluded that this technology can be used to increase collaboration between individuals who share a common interest or goal. Increased collaboration will stimulate knowledge sharing between individuals, with the possible effect of increased productivity (Ferreira & du Pleissis2009).Knowledge sharing and exchange *among*employees, appropriate management practices can be implemented to encourage such behaviour and thereby enhance *productivity,* innovation and overall organizational *competitiveness (Paroutis,*& Al Saleh,2009)

8. CONCLUSION

Researchers have been pointing in the direction of web 2.0 or social media as a panacea to achieving SDG. Both technology and access to information has been identified as very important in achieving SDG. The theoretical models above have established the significance of the marriage of the Web 2.0 and access to information. This review has shown that access to information using web 2.0 is a big catalyst to attainment of SDG. Characteristics of web 2.0 can be well harnessed to bring about attainment of SDG. Various activities performed on information using web 2.0 contributes in no little way to attainment of SDG. Attainment of SDG is possible through attitudinal change, factorization of new economic capitals and informational processes that leads to KMusing web 2.0.

It is imperative that Government, Non-governmental agencies, Policy formulators, research and advancement institutions, etc employs web 2.0 as a platform to disseminate and gather information to be able to cause the needed change in the society towards attaining SDG.

9. RECOMMENDATIONS

The following are some recommendations from this review:

- Stakeholders like UN, WHO, Government of each country, international organisatios, NGOs, etc that are involved or active in achieving SDG can use Web 2.0 as a platform for information processing so as to achieve the best.
- Ideas, innovations, programmes, activities, etc that are designed to achieve SDGs, can be well promoted, anchor, or disseminated through Web 2.0 so as to reach a large number of audience and for greater impact. Web 2.0 will allow the

information to be preserved, widely circulated, use and re-use, etc until a better outcome is achieved.

- Citizens all over the world should get involved more in the use of technology especially Web 2.0 to afford them the opportunity of implanting SDGs.
- Training should be provided in the direction of using Web 2.0 as an empowerment tools. This can be inform of how to use it purposefully for making a change, turning the information on it to a resource, and proper KM which will all contribute to achievement of SDGs.
- The various characteristics of Web 2.0 like multimedia, mass participation, networking, etc can be harnessed and contextualize to provide a particular type of service. Services like learning, mentoring, demonstration, collective intelligence are all possible through Web 2.0. These are all necessary parameters for achieving SDGs.

REFERENCES

Acquaah, M. (2008).Managerial social capital, strategic orientation, and organizational performance in an emerging economy.*Strategic Management Journal* 28(12):1235-1255

Arvanitis, S. &Loukis, E.N. (2009). Information and communication technologies, human capital, workplace organization and labour productivity: a comparative study based on firmlevel data for Greece and Switzerland. *Information Economics and Policy* 21(1):43 - 61.

Bakhuisen, N (2012). Knowledge sharing using social media in the workplace: A chance to expand the organisation memory, utilise weak ties, and share tacit information. Master Thesis, Department of Communication Science, UV University, Amsterdam

Ballew, M T.., Omoto, A. M. &Winter, P.L. (2015).Using Web 2.0 and Social Media Technologies to Foster Proenvironmental Action. *Sustainability 2015*, 7, 10620-10648; doi:10.3390/su70810620

Dapo-Asaju, H. S. &Bamgbose, O. J. (2016). Provision of sustainable development goals (SDG) information to Nigerian citizens through a collaborative approach: a proposal. *IFLA WLIC 2016. :* http://creativecommons.org/licenses/by/4.0

Drucker, P. F. (2006) Classic Drucker: Essential Wisdom of Peter Drucker. Harvard Business Review. Boston, MA: Harvard Business School Publishing.

Ferreira, A; & du Plessis, T. (2009) Effects of online social networking on employee productivity. I*nterWord Communications,11 (1)* https://sajim.co.za/index.php/sajim/article/ download/397/384.

Gordeyeva, I (2010).Enterprise 2.0 Theoretical foundations of social media tools in°uence on knowledge sharing practices in organizations.Master, Department of Business Information Technology, School of Management and Governance, University of Twente, Enschede.

IFLA (2014c) The Lyon Declaration on Access to Information and Development. Available from: http://www.lyondeclaration.org/ (accessed 13 February 2015).

IFLA. (2012). Libraries: The Amazing gateway to knowledge and power. Retrieved November, 2015, from http://conference.ifla.org/past-wlic/2012/libraries-the-amazing-gateway-to-knowledge-andpower.htm

LIS charter (2014). The library and information services (LIS) transformation charter: Commissioned by the Department of Arts and Culture (DAC) and the National Council for Library and Information Services (NCLIS). http://www.nlsa.ac.za/Downloads_01/2014_Final_LIS_Transformation_Charter.pdf

Mason, M. K. (2018). Potential of information and communication technologies (ICTs) for developing countries.http://www.moyak.com/papers/ngo-icts.html

Olajide, A. A. (2015). Social media platform as a knowledge management tool: Nigerian Librarians Experience. *Journal of information & knowledge management, 14(3), 9 pages.*

Panahi, S, J Watson &H Patridge (2012). Social media and tacit knowledge sharing: Developing a conceptual model. *World Academy of Science, Engineering and Technology*, 64, 1095–1102.

Paroutis, S.& Al Saleh, A. (2009). Determinants of knowledge sharing using web 2.0 technologies *Journal of knowledge management* 19(4), 52-63.

Schaefer-Preuss, U. (2010). Importance of the role of ICTfor development.Remarks by ADB Vice President for Knowledge Management and Sustainable development at the ICT week on 15th April, in Manila, Philippines.https://www.adb.org/news/speeches/importance-role-ict-development

Shafack, R. M. (2016). The LIS and Information Science (LIS) profession and the Cameroon Development vision 2035: a perception study. *Journal of Sustainable Development*, 9(4), 225-233.

Steinger, K. D., Ruckel, E. Dannerer&Roithmayr, F. (2010).Healthcareknowledgetransferthroughaweb2.0 portal: An Australian approach. *International Journal of Health Technology and Management* 11, 13–30.

Sustainable development goals (2015). Sustainable development goals; https://www.bing.com/images/search?view=detailV2&ccid=Ujq1%2fVns&id=4A36D1CC74DB2CE6D98DBDF3AA57890117349DD8&thid=OIP.Ujq1_Vnsge9iRMb_RwyAZAHaE8&mediaurl=http%3a%2f%2fwww.thetruthdenied.com%2fnews%2fwp-content%2fuploads%2f2015%2f09%2fAgenda-21-poster.jpg&exph=683&expw=1024&q=sustainable+development+goals+agenda+2030&simid=608015020195317131&selectedIndex=0&qpvt=sustainable+development+goals+agenda+2030

UNITAR (2015). Social media and the web 2.0 are key tools for the SDG! https://www.unitar.org/social-media-and-web-20-are-key-tools-sdgs

United Nations (2015b) Sustainable Development Goals. Available from: https://sustainabledevelopment.un.org/sdgs.

Wand, P. A. (2016). Information centers and socioeconomic development in MENA: finding a quantitative relationship. *IFLA and Institutions, 42(2), 109-117.*

Wong, S.S. (2008). Task knowledge overlap and knowledge variety: the role of advice network structures and impact on group effectiveness. Journal of Organizational Behavior 29(5):591-614.

Yates, D. & Paquette, S. (2011). Emergency Knowledge Management and Social Media Technologies: A Case Study of the 2010 Haitian Earthquake. *International Journal of Information Management*, *31*(1), 6-13.

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SOCIAL NETWORKING AS A TOOL FOR LIBRARY SERVICES AND KNOWLEDGE MANAGEMENT IN ACADEMIC LIBRARIES IN NIGERIA

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ABSTRACT

The emergence of social networking tools has created new opportunities for information generation, processing and dissemination. It has provided avenue for communication in a more interactive ways. Its application in libraries has transformed the method of providing services to users in the present age that is driven by Information and Communication Technology (ICT). This conceptual paper critically describes application of social networking tools such as Facebook, Twitter, YouTube etc. in academic libraries. It discusses types of social networking, its features and historical background. The paper examines the benefits and challenges of social networking such as technophobia and low internet bandwidth. Recent development shows that social networking has under gone a dramatic growth in recent years. Such networks provide an extremely suitable space to instantly share multimedia information between individuals and their neighbors in the social graphs. The study suggests more training on ICT applications for librarians and library users to alleviate technophobia. Also, an upgrade of Internet bandwidth to support effective application of social media in library services should be implemented. The study concluded that libraries are under the influence of social media networking, which have transformed the functional activities in library services and knowledge management.

Keywords: *Academic Libraries, Libraries services, Knowledge management, Social networking, ICT.*

1. INTRODUCTION

Nowadays social networking is a new term that evolves in the 21st Century. The social and communication pattern of our society are being shifted by the emergence of social networking products and services such as Whatsapp, Facebook, Twitter, YouTube, Bloggers, Flickr etc. Indisputably, this trend of development has enormous impact on various aspects of services and knowledge management in our academic libraries. Social networking as a term is new, but the ideas behind it such as collaborating, sharing and disseminating knowledge with others have been around as long as man

exits. A social networking site may also be known as a social website or a social media tool or a social networking website. It is striving to give explicit definition of the term social media. Boyd and Ellison (2007) defined social network site as networked communication platform in which participants;

- have uniquely identifiable profiles that consist of user-supplied content, content provided by other users , and /or system-produced data;
- can publicly articulate connections that can be viewed and traversed by others, and
- canconsume, produce, and or interact with streams of users' generated content provided by their connection on the site.

Social networking site could be described as a medium for social interaction, using highly accessible and scalable publishing techniques. Social media support the democratization of knowledge and information and transform people from content consumers to content producers (Wikipedia, 2010).

The knowledge management in the academic library is about behavior and services such as document explanation, indexing and classification performed in libraries or information centres. These library services include library database, referral service, bibliographic verification, current awareness service, selective dissemination of information, and document delivery. As a learning organization, libraries especially academic libraries provide a strong leadership in knowledge management. Knowledge Management is the process of capturing, developing, sharing, and effectively using organizational knowledge. These activities in knowledge management are the key objectives in the field of librarianship. Librarianship is a discipline which deals with the collection, organization and dissemination of recorded or explicit knowledge which is the prime focus of academic libraries.

Several studies (Martin et al., 2018; Nowel et al., 2017; Wang et al., 2014; Chai & Kim, 2010) reported that there are huge applications of social networking in library services. In line with the assertion of high usage of social networking in the library services, Onuoha, (2013) reiterated that libraries in the world over, are increasingly adopting social media to design services that allow them to reach users easily unlike before, in the virtual space.

Academic libraries are the libraries that are available and established by tertiary institutions to support learning, teaching and research. The most important mission of academic libraries is to expand the access of knowledge for their users. In support of this mission, Patel et al.(2013) reiterated that libraries should aim their knowledge management goal high. There are various examples of what libraries can do to improve their knowledge management in all key areas of library services such as referral and interlibrary loan services, delivery of materials to a user computer desktop in digital form etc. These libraries services could be enhanced with the application of social networking tools. Much as scholars have identified various benefits of social networking in organizations including libraries, there is still need to examine the impact of social networking on library services and knowledge management

2. OBJECTIVES OF THE STUDY

The main objective of the study is to examine social media networking as a tool for knowledge management in academic libraries. The specific objectives are to:

1. examine the various types of social media in academic libraries in Nigeria;
2. explore the ways in which social networking can be used for library services and knowledge management and
3. identify the challenges of social networking applications in academic libraries for knowledge management in Nigeria.

3. REVIEW OF RELATED LITERATURE

Social Media Technologies

Social media has a variety of broad definitions, such as "united online applications and technologies which facilitate and encourage sharing, exchange openness, creation and socialization amongst a district of users" (Bowley, 2009:15). According to Storey, Treude, Deursen and Cheng (2010) social media are web-based tools and practices enabling participation and collaboration based on persons' activities. Social media use social network as a platform for effective sharing and communication of information. Vuori (2011) characterizes social media by considering the extent to which they support communication, collaboration, connecting, completing and combining-5C (Jalonen, 2014). Social networking site (SNS) could be described as any website designed to allow multiple users to publish content of themselves (Computing Dictionary, 2011). Therefore, social media could be described as a communication forum that allows users to electronically disseminate information and share knowledge with each other.

Social media networks are platforms that expedite the building of social relationships among people of different races. To better understand the potential of social media and its effectiveness at driving transformational change, it is important to review the relevant literature in social media. Van Zyl (2009) examined the effectiveness of social networks in organizations. This research also aimed to educate IT, business decision makers, knowledge workers and librarians about the various applications, benefits and risks associated with social networking. The findings showed that applying this type of web 2.0 tools in the organization will help people to help each other to engage in knowledge management. Anbari (2010) assessed the specialized Farsi online social networks and its role in knowledge management and providing an appropriate model. The findings revealed that performance of internal networks in satisfying the needs of users, encouraging them to participate in knowledge sharing, attracting trust and confidence of users and effectiveness in improving levels of specialized knowledge. Wang and Wei (2011) in their study titled " knowledge sharing in wiki community: an experimental study" investigated the role of wiki tools in knowledge sharing. The findings showed that wiki tools have a positive effect on the sharing of knowledge among members of the research community.

Social media play a key role in the globalization of education as they give institutional libraries a chance to reach students around the globe. Tripathi and Kumar(2010) examined the use of social network in libraries of higher education

institutions across different social and education culture. The findings revealed that social network has the capacity to improve library services to the users. Opeke and Onuoha(2013) examined the librarians' use of social networking for professional development in Nigeria using survey design approach. The study concluded that librarians usually rely on social media as a means of professional development. In general, with regards to reviewed studies, it seems that social interactive media tools have been effective in the process of sharing knowledge among the people such as librarians and other stakeholders. Furthermore, Amuda and Tella (2017) investigated the application of social media used for innovative library services by university library staff in South-Western Nigeria. The findings revealed that social media application to library services is now prominent among university library staff in South-Western Nigeria.

4. METHODOLOGY

The paper is based on a review. The review was done through the search and review of extant

literature on the key words of the research topic. In order to ensure that all concepts were included within social media, the researchers used the following general related terms as core keywords for all literature searches "social networking" combined with any of the following terms; media, tool, site, application, benefits and challenges. Google Scholar, Google Search and other notable databases were searched using the keywords. Also, researchers conducted literature search using online databases (Science direct, Ebscohost, Emerald, and Africa Journals Online) available at University of Ilorin e-Library to retrieve journal articles in social media. The review was also situated in a notable but related theory.

5. SOCIAL NETWORKING AND ITS APPLICATION IN ACADEMIC LIBRARIES

The library professionals may use the social networking sites in three broad activities in the Library and Information centres. Social networks can be used to promote academic library services through information sharing, information dissemination and knowledge management. Social network advertising has potential to be a cost-effective means of marketing academic libraries services (Islam &Habiba,2015). According to Mentzas et al. (2007) the new ways of inspiring and exploit knowledge sharing are forcing organizations to expand their knowledge sharing technology and practice. In support of this assertion by Mentzas et al. (2007), the Table 1 briefly explain social networking tool for information sharing and dissemination in the library settings.

Table1: Social Networking Tools for Information Sharing and Dissemination

Social Media Tools	**Launched Date**	**Functions**
Facebook	February, 2004	Frequently used by students and it can be used for marketing library services and information services in

		various ways(Potter, 2011).
Linked in	May, 2003	It can be used to get library users connected with people that can help them find information
Skype	August, 2003	It is instant message service, which can prop up the instant communication across national borders
Google Docs	February,2007	It can be used for sharing the documents without transfer them via e-mails, but only sharing the link of the document
Weblog	2002	It can be used to post and share information by librarians, facilitate library services like new acquisitions, opening hours, library events and programmes (Ekoja, 2011).
You Tube	2005	Library can use it for sharing audio-visual collections, disseminate their video, conferences and workshops events.
Google-plus	28th June, 2011	Library can use this powerful tool to host video. It allows conversation with library users.
Twitter	15th July,2006	A micro-blogging application used for updating collections, new arrival, current content services, enable users to read and send short messages of (140character). It can also be used to create library service alerts (Ezeani & Igwesi, 2012).
Pinterest	2011	Libraries build up their digital collections
Flickr	February, 2004	This image distribution tool can be used as a great way to share new image collections to users by librarians.
Instagram	October,	It allows members users to upload,

	2010	edit and share photos
Tumblr	February, 2007	It helps users to discover new people to chat with on mobile devices. Sharing information about libraries and librarianship with users.
Vine	June, 2012	A short form video sharing service where video can be shared on other services such as Facebook and twitter.
Meetme(formerly my Yearbook)	2005	It can be used as a mobile device tool for chatting with different people.
Meet up	12th June, 2002	It can be used as offline for group meetings in various localities
Tagged	October, 2004	It allows members to browse the profile of any other members
Wikipedias "blogger'	2006	A discussion or informational site published on www used to make connections with clients.
WhatsApp	2009	It can be used as a direct and user-friendly service for library users. Recent and a cross-platform messaging application which allows users to exchange messages without having to pay for SMS(Chan, 2013).
MySpace	2004	It allows users to make friend, talk online and share resources
Digg	2004	It is a platform to dig for good stuff and release breaking news. Digg is basically about discovering and sharing websites.

Data Analysis, 2018.

Social Networking for Knowledge Management

Accordingto Pratibha and Gulshan(2016), mechanistic approaches to knowledge management are characterized by the application of technology and resources to do more of the same better. The ICT tools especially social media are useful in many types of activities in the academic library that are done by specialists as well as computer system. For examples:

- **Library Thing:** This social cataloguing networking is great for librarians, and you can catalogue along with Amazon, Library of Congress and many other libraries around the world.
- **aNobii:** This site for book lovers, is a place to share reviews and communications. It helps book lovers to share reviews and proposals. It also prepare due date alerts, lending and discussions.
- **Connotea:** It is a great reference tool, allowing you to save and organize reference links and share them with others.
- **Netvibes:** Librarian can use this blog to create public web page that can post helpful internet resources, news of new arrivals and more.

Social Networking Features

Kim and Hastak(2018) carried out study on social network analysis and identified the various characteristics of online social network. This informs the researchers to examine the features that differentiate a social networking from a regular Website. Some of these features are as follows:

- User-based
- Interactive
- Community-driven
- Relationships builder
- Emotion over content

6. BENEFITS OF SOCIAL MEDIA NETWORKING (SMN) IN ACADEMIC LIBRARIES

There are enormous benefits associated with use of Social Media Networking (SMN)in academic libraries as supported by Dankowski(2013). The benefits are listed:

- SMN assists to share and discuss information among others, no need for patrons to visit library.
- It helps to reach the library patrons as well as patrons can reach library easily from their home or working place.
- SMN is effective for marketing and promoting library services and facilities.
- It helps to create social groups, like library forums, groups, events and listings.
- SMN is one of the low cost and most useful ways to create and promote library activities.
- It allows users to have online profiles, especially for Selective Dissemination of Information (SDI) service and invite friends.
- It helps patrons to locate the library resources (for print as well as digital resources).
- SMS allows patrons to be visible to others libraries or maintained connection with other users
- Some SMNs allow chatting and video conferencing
- SMN enhances real time interaction
- It aids librarian to inform users of the new arrivals

7. CHALLENGES OF USING SOCIAL MEDIA NETWORKING

Several studies (Kaplan &Haenlein,2010; Kietzman& Kristopher, 2011, Sanusi et al.,2014) reported that social media are facing various challenges. For instance, Sanusi et al. (2014) reported that Nigeria, like many Third World countries constantly battle outage of power across the country so much that even when the learner has the means to access information through these social sites, the unavailability of power supply has always had a debilitating effect on the desire to source for information. Other challenges of social media networking are summarized as:

- *Inadequate awareness:* Most librarians in the developing countries like Nigeria are not aware of social networking services, even the few that are aware are still struggling to find out the productive uses of social media for library services.
- *Bandwidth Problem:* Most institutions have limited bandwidth to support this practice. Poor connectivity can frustrate online participation.
- *Technophobia:* Many librarians and users are afraid of handling computers. They make the traditional library services their comfort zone and are not eager to embrace and use social networking tools. Also, level of interest and skills with using social media contrast extremely across library staff.
- *Inadequate training of staff*: Need technological knowledge to provide access to online materials.
- *Maintenance culture:* Inadequate funds to maintain more advanced social media usage
- *Copyright*: There are copyright issues while using social media such as YouTube to construct collections (Kumar et al., 2013)
- *Government policy:* Government limitations on the use of social media may limit access
- *Social culture:* Librarian may face challenge in using an informal but respectable attitude, or deliver social media content in a bilingual or multilingual region.
- *Substantial time:* Successful application of social media in library services require substantial time dedication from library professionals

8. CONCLUSION

Adoption and use of social networking as a tool for library services and knowledge management by both orthodox libraries and users will save productive time to provide and search for library materials. Similarly, application of social media improves access to various books and non-books available in libraries. The older concept says “Human are Social Animals” now the new concept will be “Human are Social Networking Animals”. People are gainfully addicted to social networking from seeking for information to avail the best library services and knowledge management. It is up to the library professionals to continue adjusting and upgrading themselves to the social media networking application for the advancement of their career and as well as the service offered to modern day library users.

9. RECOMMENDATIONS

- University libraries should upgrade their Internet bandwidth to support effective application of social media in library services. This is necessary because poor connectivity can frustrate effective online participation.
- Successful application of social networking tools in University libraries can only be sustained through good maintenance culture. The few available technologies should be maintained regularly because moribund conditions of technology may not support remote access to information.
- More training on ICT applications should be organized by the library management to minimize or alleviate technophobia issue among librarians and library users.
- Copyright Management should brace up with new approach to forestall people copy, paste and edit without acknowledging the authority.

REFERENCES

Amuda, H.O. & Tella, A. (2017).Application of social media for innovative library services in South-Western Nigerian University Libraries. *Journal of Balkan Libraries Union.* Retrieved 11th March, 2018 from http://www.balkanlibraries.org/journal

Anbari, A. M., (2010). *Survey of specialized Farsi online social networks and its role in knowledge management and suggest an application model.*Master's Thesis, LIS Department, Islamic Azad University Science and Research Branch, Tehran, Iran.

Bowley, R. C. (2009). A comparative case study: examining the organizational use of social networking sites', Thesis, The University of Waikato, Hamilton, [Online].Retrieved 24th Febuary, 2018 from:http://researchcommons.waikato.ac.nz/bitstream/handle/10289/3590/thesis.pdf?sequence=1&isAllowed=y

Boyd, D. M. & Ellison, N. B. (2007).Social network sites: definition, history, and scholarship.*Journal of Computer-Mediated Communication*.13(1), 210-230

Chai, S., & Kim, M. (2010). What makes bloggers share knowledge? An investigation on the role of trust.*International Journal of Information Management*, 30(5), 408-415

Chan, C. (2013). Chapng up a storm: collaborating on Chat Reference. JULAC Libraries Forum. Retrieved fromhjp://www.julac.org/?uamfiletype=ajachment&uamgevile=hjp://w ww.jul ac.org/wp-ontent/uploads/JForum2013_LSC_collabora?ng_on_chat_reference.pdf

Dankowski, T. (2013). How Libraries are using social media. *American Libraries,* 44(5), 38-41. Retrieved 22nd March,2018 from http://www.jstor.org/stable/24602212

Ekoja, I.I. (2011). Modern ICT tools: online electronic resources sharing using web 2.0 and its implications for library and information practice in Nigeria. *Samaru Journal of Information Studies,* 11(1&2), 53-58.

Ezeani, C. N., &Igwesi, U. (2012).Utilizing social media for dynamic library services delivery: The Nigeria experience.*InternationalJournal of Library and Information Science*, 2(2).

Islam, M.M. &Habiba.U. (2015). Use of social media in marketing of library and information services in Bangladesh. *DESIDOC Journal of Library && Information Technology*, 5(4), 294-299.

Jalonen, H. (2014). Social media and emotions in organisational knowledge creation.In M. Ganzha, L. Maciaszek, and M. Paprzycki(Ed.)*Computer Science and Information Systems (FedCSIS), 2014 Federated Conference on*, 1371-1379. Poznan, Poland.

Kaplan, A. M.&Haenlein, M. (2010).Users of the world, unite!The challenges and opportunities of social media.*Business Horizons*, 53(1).59-68.

Kietzman, H. & Kristopher, H. (2011). Social media get serious! understanding the functional building blocks of social media. *Business Horizons,* 54(3), 241-251.

Kim, J. & Hastak, M. (2018). Social network analysis: Characteristics of online social networks after a disaster. *International Journal of Information Management*, 38(1), 86-96.

Kumar, V., Vikram, B., Rohan, M., & Milap, S. (2013). Creating a measurable social media marketing strategy: increasing the value and ROI of intangibles and tangibles for hokey pokey.*Marketing Science*, 32 (2), 194–212.

Manca S. & Ranieri, M. (2017) Networked scholarship and motivations forsocial media use in scholarly communication. *International Review ofResearch in Open and Distributed Learning* 18 (2).

Martin, F., Wang, C., Petty, T., Wang, W., & Wilkins, P. (2018). Middle school students' social media use. *Journal of Educational Technology & Society,* 21(1), 213-224. Retrieved 17th March, 2018 from http://www.jstor.org/stable/26273881.

Mentzas, G. Kafentzis, K., &Georgolios, P. (2007). Knowledge services on the semantic web.

Communications of the ACM, 50(10), 53–8.

NowéHedvall, K, Gärdén, C., Ahlryd, S., Michnik, K., Carlén, U. & Byström, K. (2017).

Social media in serious leisure: themes of horse rider safety. Information Research, 22(4), paper 772. Retrieved 20th March, 2018

from http://InformationR.net/ir/22- 4/paper772.html (Archived by WebCite® at http://www.webcitation.org/6vNyWjtfN)

Onuoha, U. D. (2013). Librarians' use of social media for professional development in Nigeria. *Information Management and Business Review,* 5(3), 136-143.

Opeke, R. O. & Onuoha, U. D. (2013).Librarians' use of social networks for professional development in Nigeria. *PNLA Quarterly*, 77 (2).

Patel, M., Patel, M. & Barot, A. (2016).Knowledge management and the role of academic libraries.In Ravindra,M., Kulthida, T., Kanyarat, K., and Shivanand, S. (Ed.), *Future librarianship: Embedded sustainable and emerging trends*. Proceedings of the International Symposium on knowledge and communication.Shirpur, India.

Potter, N. (2011). Marketing academic libraries in a web 2.0 world.Retrieved 24th October,2017 from http://www.slideshare.net/thewikiman/marketing-libraries-in-a-web- 2-world.

Pratibha, P.B. & Gulshan, D. K. (2016).Knowledge management with social networking. In Ravindra,M., Kulthida, T., Kanyarat, K., and Shivanand, S. (Ed.), *Future librarianship: Embedded sustainable and emerging trends*. Proceedings of the International Symposium on knowledge and communication.Shirpur, India.

Sanusi,B. O. Adelabu, O.,& Okunade, J. K. (2014). Adapting social media for formal learning in Nigeria challenges and prospects.*Arabian Journal of Business and Management Review* (OMAN Chapter), 3(9), 22-30.

Tripathi, M. & Kumar, S. (2010). Use of web 2.0 tools in academic libraries: reconnaissance of the international landscape. *The International Information and Library Review*, 42(3), 195-207.

Van Zyl, A. S. (2009). The impact of social networking 2.0 on organizations.*The Electronic Library*, 27(6), 906-918.

Vuori, V. (2011). Social media changing the competitive intelligence process: elicitation of employees' competitive knowledge. *Academic dissertation,* [online].Retrieved on 24thFebruary, 2018from:http://dspace.cc.tut.fi/dpub/bitstream/handle/123456789/20724/vuori.pdf

Wang, W.T. & Wei, Z. H., (2011). Knowledge sharing in wiki communities: an empirical study. *Online Information Review*, 5(35), 799-820. Retrieved: 15thMarch, 2018 from : https://www.emeraldinsight.com/doi/abs/10.1108/14684521111176516.

Wang, G.A., Wang, H.J., Li, J., & Fan, W.2014). Mining knowledge sharing processes in online discussion forums. In Ralph H. Sprague, Jr. (Ed.), *Collaboration systems and technology tracking*. Proceedings of the 47thHawaii International Conference on System Sc iences (3 898-3907). Los Alamitos, California.

Wikipedia, (2010). Social network.Wikipedia, the free Encyclopedia. Retrieved 15th March, 2016 fromhttp://en.wikipedia.org/wiki/Social_network.

Storey, M. A., Treude, C., Deursen, A. & Cheng, L.T. (2010). The impact of social media on software engineering practices and tools, FoSER '10 Proceedings of the FSE/SDP workshop on Future of software engineering research New York: ACM, 359-364.

PERFORMANCE ANALYSIS OF TRAFFIC CONGESTION AS INDEX OF QUALITY OF SERVICE OF MOBILE COMMUNICATION NETWORKS IN OSOGBO METROPOLIS, OSUN STATE

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ABSTRACT

Due to increase in the rate at which mobile communication is being accessed by the user, the challenges of traffic congestion has been in the increase in recent time. This work presents the analysis of traffic congestion as an index of quality of service among various service providers (MTN, GLOBACOM and AIRTEL) around Osogbo metropolis. A drive test was conducted to obtain the various key performance parameters that were used for the analysis. The key performance indicators (KPIs) evaluated were the Call Setup Success Rate (CSSR), Call Drop Rate (CDR), Handover Success Rate (HOSR), Traffic Channel (TCH) Congestion and Standalone Dedicated Control Channel (SDCCH) Congestion. The result showed that GLO was able to provide a better quality of service (QoS) over other mobile communication service providers. Though other networks too performed credibly well based on the KPIs benchmark provided by the Nigerian Communication Commission, (NCC).

***Keywords**: Key Performance Indicators, Mobile communication, Network parameter, Traffic Congestion.*

1. INTRODUCTION

Cellular systems began in the United States with the advent of the advanced mobile phone service (AMPS) system in late 1983 (Lee, 2006), Total Access Communication Systems (TACS) in 1985 and Nordic Mobile Telephone (NMT- 900) in 1986. Asia, Latin America, and Oceanic countries embraced the AMPS standard, causing an expanded potential market in the world for cellular network (Mehrotra, 1997). However, the networks had a low traffic capacity, unreliable handover, poor voice

quality, and poor security. Due to the deployment of analogue technology, the transceiver cannot handle more than a call at a time. These restrictions led to the convergence of the European counties and International applications on a uniform standard for the development of a new cellular system that employs digital technology, called Global System for Mobile Communication (GSM, originally Groupe Spécial Mobile) which was firstly launched in Finland in December 1991 (Anton, 2003).

Network is said to be in a state of congestion when the number of subscribers that are attempting to access the network simultaneously is more than the carrying capacity of the network at a particular time. Also, congestion was defined by Kuboye (2010), as unavailability of network to the subscriber at the time of making a call. The unavailability of network depends on switch facilities, exchange equipment and transmission link. Traffic congestion mainly arises due to inadequate capacity of equipment and improper network management. Some of the effects of congestion on the network systems are queuing, slow speed, poor throughput and poor network among the mobile wireless communication (Habibur, 2015).

2. REVIEW OF RELATED LITERATURE

In the early 1980s, most mobile telephone systems were analogue rather than digital. The advantages of digital systems over analogue systems include ease of signalling, lower levels of interference, integration of transmission and switching, and increased ability to meet capacity demands (Scourias, 1997). The limitations of analogue system became clear as the number of subscribers increased. This gave way to the Global system for mobile communications (GSM). While experimenting on a dynamic channel allocation model with one-level buffering for controlling congestion in mobile cellular networks, Ojesanmi, et al., (2011) realized that the use of one-level buffering in the dynamic channel allocation model reduces call loss due to network congestion hence leading to better network performance. Mughele, et al., (2012) attributed the causes of congestion in GSM network in some countries like Nigeria to factors such as exceeding the carrying capacity of network facilities, use of mobile phones for data transfer and multimedia activities, vandalization of network equipment and unfavourable weather conditions.

Ofomaja, et al., (2015) analysed the percentage traffic congestion in the different sectors/cells of a well-established network around the metropolitan area of Asaba, Nigeria. A Network Management Software (NMS) was used for data collection based on three GSM traffic cells with three sectors each for a total of about one million monitored calls. Considering three cells, traffic was measured at every hour of the day for 2 months, so as to obtain numerically substantial data. The cells were chosen as representative of the whole network taking into account cell extension, number of served subscribers in the area, and traffic load. The parameter used was the percentage traffic congestion. In their analysis, they were able to conclude that the sectors cannot perform optimally when the amount of traffic unusually increases and then suggested that the network operator should carry out further optimization on all the sectors/cells as this will ultimately improve the QoS of the network provider. They further concluded that traffic analysis should not be based on cells alone, but especially on sectors.

Emuoyibofarhe, et al., (2015) employed interviews and data logging software as the major instruments to collect data, explored the use of Erlang-B and critically analysed the call data for a period of busy hour for a week for over 60 minutes between the hours of 8.00am and 9.00am. The number of calls the network receives daily, number of calls congested, calls connected, and maximum number of calls the system could sustain at the peak or busy periods were observed, collected and analysed. With the use of correlation analysis hypothesis, the total load per call setup attempts, the effective load or successful call setup (times), the available channels or successful TCH assignments and also the blocking rate or TCH congestion ratio (%) were determined. It was discovered that a lot of available channels were being underutilized especially in areas with low blocking ratio where the available channels exceeded the required channels for transmitting the effective load. Furthermore, the cells with very high traffic will reduce the quality of calls made bringing about poor QoS and grade of service (GoS). It was then recommended that the network provider should restructure and re-plan the cells in those particular geographical regions with high traffic intensity by increasing the number of channels in those cells (stations), and also by providing more cell sites in order to ensure proper caution in the frequency re-use factor so as to prevent other transmission challenges that can affect the GoS rendered to the subscribers resulting into congestion in the traffic.

Surajo, (2016) carried out traffic congestion audit of MTN cells located within Dutse metropolis, by following routes between the cells and assessing the QoS. Drive test was conducted to collect traffic data, the base transceiver station (BTS) power throughput was measured and the maximum carrying capacity of mobile stations (MSs) was identified which allowed the determination of the amount of deviation from the expected power. He identified the channels and/or interface(s) that mostly contributed to this traffic congestion by comparing his findings with the KPIs. In his analysis, he discovered that the channels that are significantly involved in call setup are at the same time played a vital role toward congestion effect. He then offered conceivable solutions for improvement.

In this study, the performance of the traffic congestion as index of QoS of leading mobile communication networks in Osogbo metropolis were analysed and the network performance was evaluated based on five major KPIs which are; call setup success rate, call drop rate, handover success rate, traffic channel congestion rate and standalone dedicated control channel congestion rate. Every KPI was explored and the results were likened to the standard threshold values recommended by NCC and based on these, suggestions were offered for performance improvement.

3. METHODOLOGY

A Drive Test, using a drive test software called TEMS (Test Mobile Systems), was adopted to collect data. The test was carried out as a benchmarking on three leading mobile network operators for the months of March, July and August 2017. Fig. 1 shows the Google map of the study area.

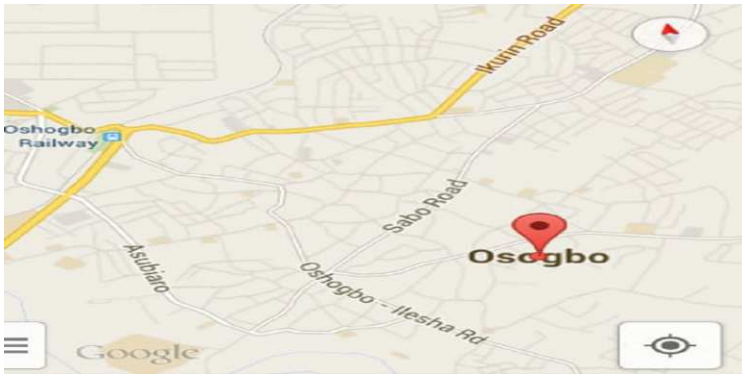


Fig. 1. The study area, Osogbo Google map.

Drive Test

Drive test could be performed on any cellular network regardless of technology e.g. GSM, CDMA, UMTS, LTE, etc. The required wares for Drive Test setup are:

- Laptop computer (RAM ≥ 4GB)
- Drive Test Software (TEMS 10.0.4 in this case)
- Dongle Key (Serve as security for unlocking the software)
- Mobile Phones
- GPS (Global Positioning System)
- A Scanner (Optional).

The main goal of drive test is to collect test data which can be viewed or analysed in real time during the test, allowing a view of network performance on the field. As such**,** the data were collected for benchmarking of the services of these mobile operators.

Key Performance Indicator Parameters

The KPIs serve as a measure of network performance and quality of service on a daily, weekly or monthly basis. Due to ever increasing number of mobile users and corresponding requirement for capacity improvement, continuous monitoring of the KPIs is necessary for the operators to ensure optimal performance. A network system is at the optimal performance when the parameters are measured to be within the set thresholds. The KPIs considered are: Call setup success rate (CSSR), Call drop rate (CDR), Handover success rate (HOSR), Traffic channel (TCH) congestion rate and Standalone dedicated control channel (SDCCH) congestion rate.

Call Setup Success Rate

Call Setup Success Rate (CSSR) indicates the probability of successful calls initiated by the mobile station. CSSR is used to measure the impact of congestion during a call attempt. It is an essential KPI parameter for appraising the network performance. A low CSSR dictates a poor QoS. It is expressed in percentage as in Eq. (1) (Agyekum, 2014).

$$\text{CSSR} = \frac{Number\ of\ call\ setup}{Number\ of\ call\ attempt} \times 100\% \quad (1)$$

Call Drop Rate

This is a fraction of the telephone calls which, due to technical reasons, were cut off before the speaking parties had finished their conversation and before one of them had hung up (Huawei, 2008). In other words, it is a prematurely terminated call before either the caller or the called party normally released the call. Equation (2) shows the mathematical expression of call drop rate in percentage. A too high call drop rate adversely affects the user's experience.

$$CDR = \frac{Number\ of\ dropped\ call}{Number\ of Successfully\ Completed\ call\ attempt} \times 100\% \quad (2)$$

Handover Success Rate

Handover success rate (HOSR) is the ratio of the number of successfully completed handovers to the total number of initiated handovers. HOSR is used to measure the impact of congestion at movement during a call. Equation (3) gives the mathematical representation of HOSR (NCC, 2012).

$$HOSR = \frac{Successful\ handover}{Total\ handover\ requests} \times 100\% \quad (3)$$

HOSR is inversely associated with CDR. Hence, a high HOSR portrays a low CDR and an improved QoS.

Traffic Channel Congestion

Traffic channel (TCH) congestion is defined as the probability of failure in accessing traffic channel(s) or radio access bearer during call connections. It is used to measure the demand for services and channels utilization in the network. Traffic channel congestion rate is expressed in percentage as given in Eq. (4) (NCC, 2012).

A high TCH congestion rate in a network gives a deteriorated network service quality.

$$TCH\ Congestion = \frac{Number\ of\ unavailable\ (blocked)\ TCH\ requests}{Total\ number\ TCH\ request} \times 100\% \quad (4)$$

Standalone Dedicated Control Channel Congestion Rate

This is the probability of failure of accessing a standalone dedicated control channel during call set up. Standalone Dedicated Control Channel (SDCCH) is used in the GSM system to provide a reliable connection for signalling and short message services (SMS). SDCCH congestion rate is as given in Eq. (5)

$$SDCCH\ Congestion = \frac{Number\ of\ failed\ connection\ due\ to\ assignment\ failure}{Number\ of\ call\ attempt} \times 100\% \quad (5)$$

SDCCH and TCH congestions are used to locate where exactly congestion appears in terms of logical channels as these channels are the ones most affected in a congestion situation.

4. RESULT AND DISCUSSION

Tables 1 to 5 show the value of each of the KPIs accountable for traffic congestion in the network with their corresponding graphical analysis when compared to each other is as depicted in Figs. 2 to Figs. 6.

Result of Call Setup Success Rate

Table 1 shows the values of the call setup success rate recorded during the period of the investigation while Fig. 2 shows the plot of this call setup success rate for the three networks.

Table 1. Result of Call Setup Success Rate

DATE	MTN	GLO	AIRTEL
MARCH 21/03/2017	98.31	99.84	98.84
22/03/2017	98.37	99.86	99.32
23/07/2017	98.33	99.76	99.32
JULY 16/07/2017	92.50	94.78	87.59
17/07/2017	92.86	94.82	89.13
18/07/2017	92.90	94.84	91.74
19/07/2017	92.94	94.85	91.86
20/07/2017	93.10	94.88	92.56
AUGUST 03/08/2017	94.51	95.67	95.13
04/08/2017	94.51	95.74	95.73
05/08/2017	94.83	95.77	95.71

06/08/2017	95.10	95.82	96.02
07/08/2017	95.26	95.85	95.88

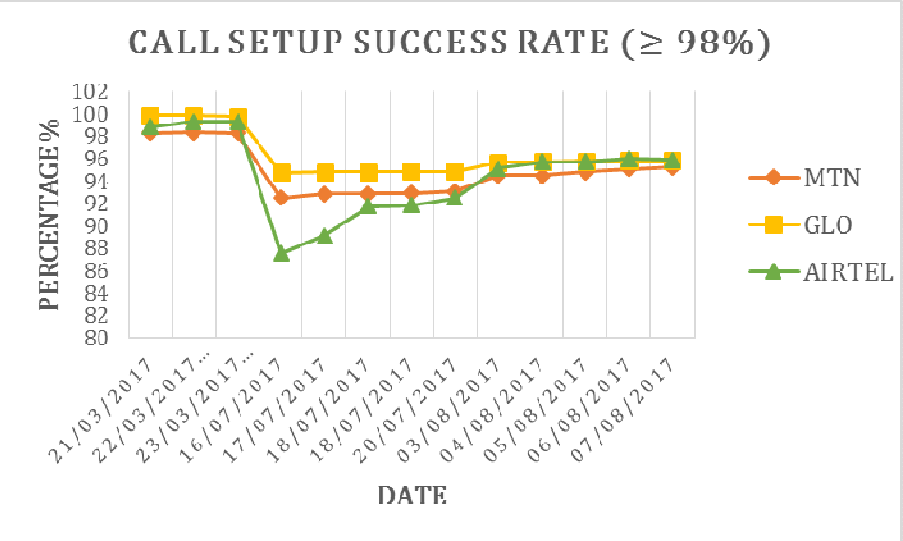


Fig. 2. Graphs of Call Setup Success Rate

From Fig. 2, it can be seen that during the period under consideration in the month of March, the CSSR of all networks falls within the NCC standard threshold of ≥98%. However, in July, the CSSR of all the networks were less than the threshold with Airtel having lowest value amongst them. Also in August, the three networks have almost the same values recorded which is also lower than the NCC threshold value which implies that the subscribers were not likely to make call successfully during these periods, thereby experienced congestion during call attempt, thus a poor QoS in the period under review (i.e. July and August). The anomalies in CSSR values in the months of July and August for the considered networks might be as a result of technical issues or influx of more subscribers (not planned for by the operators) into the region of the case study. Moreover, the low CSSR may be caused by the problems of Immediate Assignment Success Rate, SDCCH drop rate or that of the Assignment Success Rate.

Result of Call Drop Rate

Table 2 depicts the value of the call drop rate recorded for the networks during the period and the corresponding graphical analysis of the call drop rate of the networks as compared to the acceptable threshold is shown in Fig. 3.

Table 3. Result of Call drop rate

DATE	MTN	GLO	AIRTEL
MARCH 21/03/2017	1.14	0.09	1.05
22/03/2017	1.11	0.07	0.85
23/07/2017	1.09	0.21	0.97
JULY 16/07/2017	2.42	1.53	1.32
17/07/2017	2.40	1.51	1.31
18/07/2017	2.32	1.50	1.31
19/07/2017	2.31	1.48	1.30
20/07/2017	2.31	1.47	1.28
AUGUST 03/08/2017	2.16	1.35	2.52
04/08/2017	2.16	1.35	2.51
05/08/2017	2.13	1.34	2.51
06/08/2017	2.12	1.34	2.50
07/08/2017	2.10	1.33	2.48

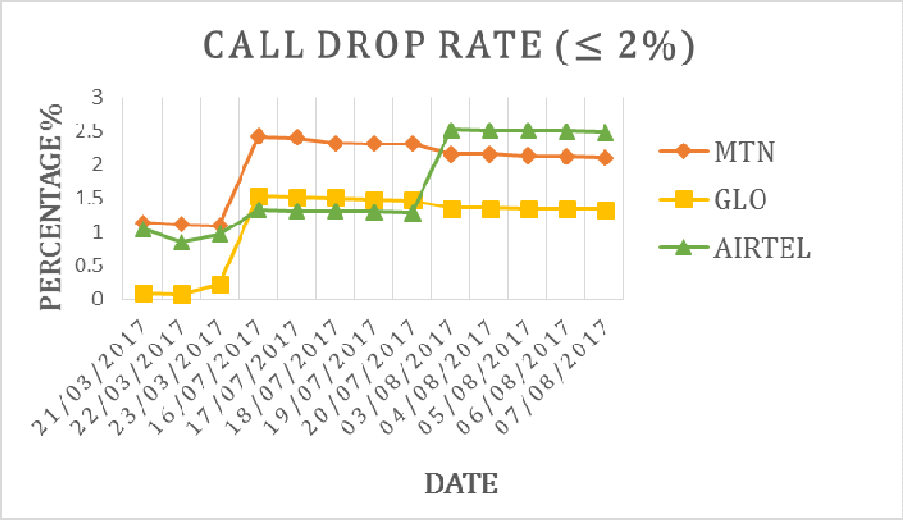


Fig. 3. Graphs of Call Drop Rate

It can be seen in Fig. 3 that Glo recorded no deviation at all throughout the period of investigation as all its CDR values fall within the NCC standard threshold of ≤ 2%. Nevertheless, AIRTEL had values for CDR that are within the threshold value, except in the month of August where a slight deviation was experienced. MTN, on the other hand experienced deviation from this standard throughout the period in July and August. CDR deviation can be caused by network factors such as: poor coverage, network interference, hardware and transmission fault, improper parameter configuration and transceiver imbalance of Uplink and Downlink path.

Result of Handover Success Rate

The results of the handover success rate recorded during the period of the investigation is presented in Table 3. Depicted in Fig. 4 is the plot of the analysis of the handover success rate of the network operators in comparison with the acceptable standards.

Table 3. Result of Handover Success Rate

Vertical (Value) Axis Title		MTN	GLO	AIRTEL
MARCH	21/03/2017	98.19	80.12	86.78
	22/03/2017	98.31	82.23	86.88
	23/07/2017	98.24	84.25	86.90
JULY	16/07/2017	93.72	95.98	94.86
	17/07/2017	93.76	96.01	94.84
	18/07/2017	93.76	96.01	94.82
	19/07/2017	93.80	96.06	94.80
	20/07/2017	93.82	96.07	96.10
AUGUST	03/08/2017	94.17	96.32	96.12
	04/08/2017	94.19	96.36	96.22
	05/08/2017	94.24	96.37	96.22
	06/08/2017	94.24	96.37	96.24
	07/08/2017	94.32	96.38	96.20

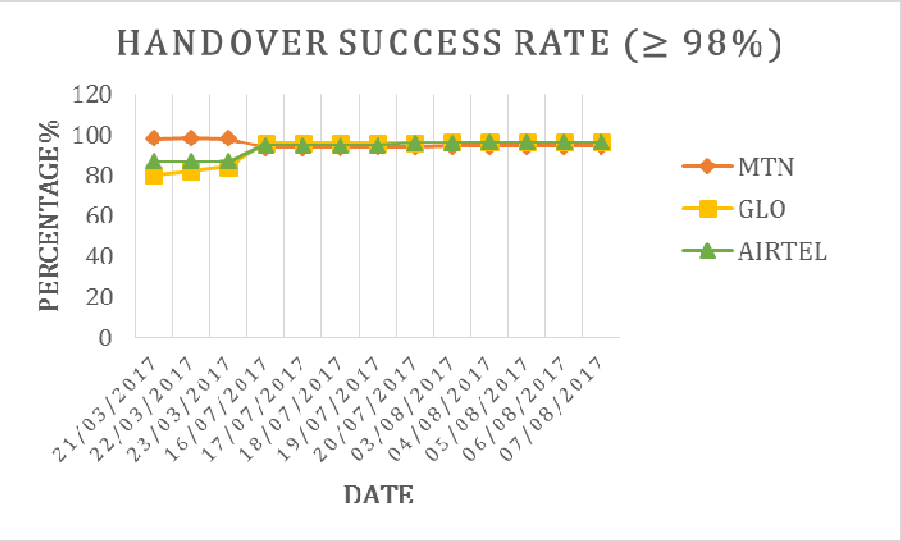


Fig. 4. Graphs of Handover Success Rate

As shown in Fig. 3, the handover success rate of MTN in the month of March was within the threshold value of ≥98%. However, GLO and AIRTEL experienced a severe deviation within the same period. Moreover, slight deviation in HOSR were experienced in all the networks throughout the months of July and August. This slight deviation in HOSR could dictate some handover failure during the period under consideration and as such, subscribers would experience dropped call and hence a deteriorated QoS at these periods. Degraded HOSR may be caused by, Improper Neighbour planning, Hopping Sequence Number (HSN) clash, DAC value and Sync mismatch, Overshoot and Low Coverage.

Result of Traffic Channel Congestion Rate

Table 4 shows the traffic channel congestion rate recorded for all the networks during the period of the findings. The graphical analysis of the traffic channel congestion values for the networks in comparison with one another is delineated by Fig. 5.

Table 4. Result of Traffic Channel (TCH) Congestion of both networks

DATE	MTN	GLO	AIRTEL
MARCH 21/03/2017	0.03	0.03	0.02
22/03/2017	0.02	0.00	0.01
23/07/2017	0.04	0.06	0.02
JULY 16/07/2017	4.63	1.52	4.83
17/07/2017	4.51	1.51	4.82
18/07/2017	4.26	1.42	3.89
19/07/2017	3.97	1.37	3.86
20/07/2017	3.13	1.36	3.45
AUGUST 03/08/2017	0.59	0.93	1.95
04/08/2017	0.59	0.91	1.94
05/08/2017	0.55	0.89	1.86
06/08/2017	0.54	0.89	1.84
07/08/2017	0.54	0.89	1.84

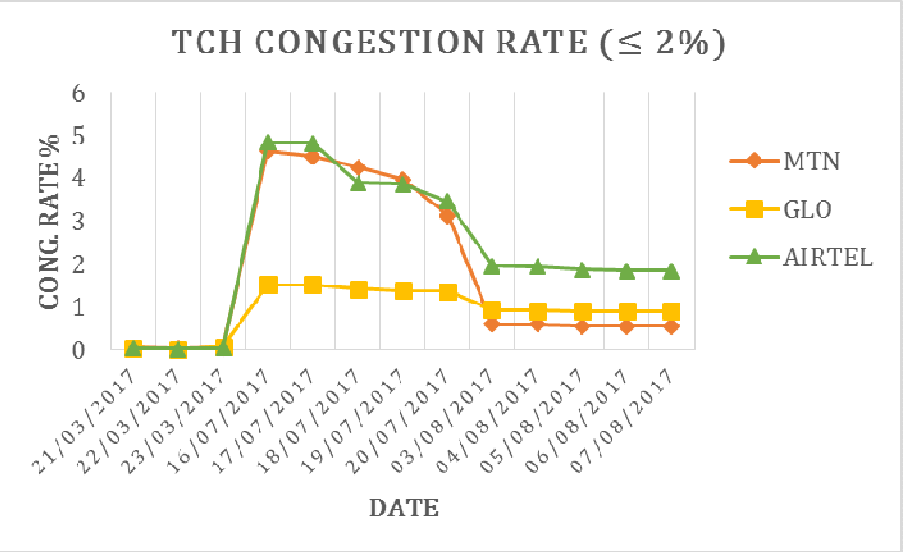


Fig. 5. Graphs of Traffic channel congestion

Figure 5 shows that the traffic channel congestion rate during the test period in the month of March and August for the three networks fall within the NCC standard. In July, Glo still upheld its value of TCH congestion rate threshold of ≤2%, while MTN and AIRTEL had their TCH values outside the threshold. This deviation in TCH congestion rate may be caused by network factors such as; poor coverage, network interference, hardware and transmission fault and improper parameter configuration. A poor TCH congestion rate means poor traffic channel assignment, thereby leading to a low network QoS.

Result of Standalone Dedicated Control Channel Congestion Rate

The results obtained for the standalone dedicated control channel (SDCCH) congestion for the networks under consideration during the test periods is as outlined in Table 5 while Fig. 6 shows the plots for its graphical analysis.

Table 5. Result of SDCCH Congestion Rate

DATE	MTN	GLO	AIRTEL
MARCH			
21/03/2017	0.10	0.00	0.04
22/03/2017	0.90	0.00	0.04
23/07/2017	0.80	0.02	0.02
JULY			
16/07/2017	2.31	1.10	4.51
17/07/2017	2.10	1.08	3.69

18/07/2017	1.98	0.97	2.94
19/07/2017	1.86	0.96	2.25
20/07/2017	1.76	0.84	2.25
AUGUST			
03/08/2017	1.17	0.58	0.77
04/08/2017	1.13	0.58	0.76
05/08/2017	1.11	0.57	0.74
06/08/2017	1.08	0.55	0.72
07/08/2017	1.03	0.55	0.68

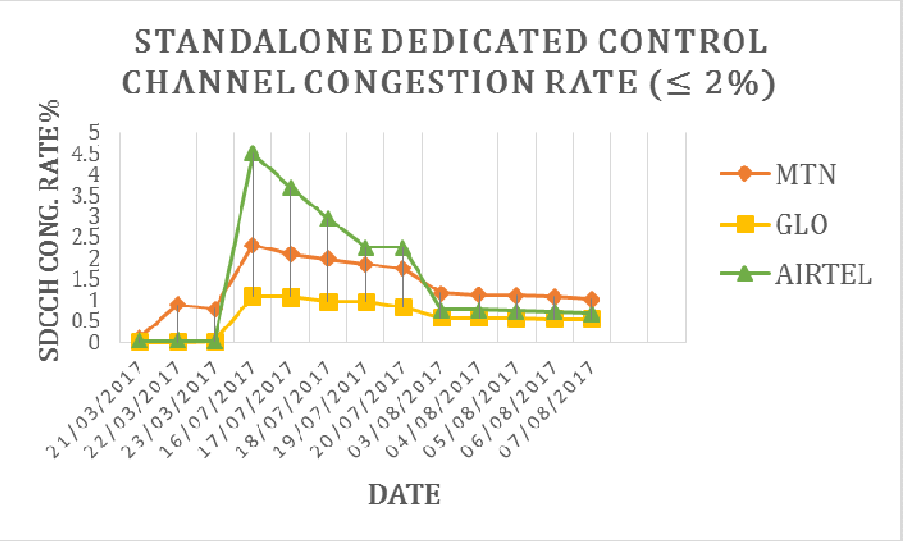


Fig. 6. Graphs of SDCCH congestion rate

Figure 6 shows that the SDCCH congestion of all the considered networks maintained the NCC standard thresholds of ≤ 2% in the months of March and August. More so, while MTN and Glo still sustained this standard value during the period under consideration in the month of July, AIRTEL however experienced a great deviation from the NCC standard thresholds. Factors such as network interference, insufficient signalling resources and improper parameter configuration may be responsible for poor SDCCH congestion rate.

5. CONCLUSION

The result revealed that throughout the period under investigation, Glo has mean traffic congestion values considerably within the NCC acceptable standards. However, the TCH and SDCCH congestion values recorded by AIRTEL in July exceeded the maximum NCC standard. Considering the values recorded by MTN and AIRTEL networks in the month of July for most of the KPIs, it is consequently concluded that Glo network delivered superior QoS during the period of investigation than all other networks. This may be attached to the influx of subscribers to the other networks at these period. It is therefore recommended that the network operator should perform routine network optimization, reset their network parameters as well as other cells and function parameters to ensure traffic congestion values that is within the stipulated threshold.

REFERENCES

Agyekum, S. K. (2014). *ITU- T Recommendations E.807: "Definitions and associated measurement methods of user-centric parameters for call handling in cellular mobile voice service".* NCA: ITU Regional Standardization Forum for Africa.

Anton, A. H. (2003). *The Worldwide History of Telecommunications.* John Wiley & Sons. Retrieved from http://www.en.m.wikipedia.org

Emuoyibofarhe, O. N., Oyetunji, K., Awokola, J. A., & Oladeji, A. E. (2015). .Performance Analysis of Traffic control congestion management in Mobile Wireless Communication in South West of Nigeria. *Journal of Multidisciplinary Engineering Science and Technology (JMEST), 2*(7), 1826-1836.

Habibur, R. (2015). *Traffic Congestion: Article_001.* Eskaton Garden Dkaka-1000, Bangladesh: Bangladesh Telecommunications Company Ltd. (BTCL), Telejogajog Bhaban. Retrieved from www.btcl.com/bd

Huawei. (2008). *GSM Radio Network Optimization, Expert Training Manual, C&C08.* EAST8000.

Kuboye, B. M. (2010). Optimization for Minimizing Congestion in Global System for Mobile Communication (GSM) in Nigeria. . *Journal Media and Communication Studies, 2*(5), 122 - 126.

Lee, W. C. (2006). *Wireless and Cellular Telecommunications* (3rd edition ed.). McGraw Hill Books Co.

Mehrotra, A. (1997). *GSM System Engineering.* Norwood, MA: Artech Home Inc.

Mughele, E. S., Olatokun, W. A., & Awogbola, T. (2012). Congestion Control Mechanism and Patterns of Call Distribution in GSM Telecommunication

Networks: The Case Study of MTN Nigeria. *African Journal of Computing & ICTs, 4*(2), 29 - 42.

Nigerian Communication Commission. (2012). *GSM Standard Quality of Service KPI.* Retrieved from www.ncc.gov.ng/technology/standard/qos#latest

Ofomaja, K., Osunkwor, E. O., & Azi, S. O. (2015). Analysis of Traffic Congestion in a Well Established Cellular Network in Asaba, Delta State, Nigeria. *International Journal of Scientific and Engineering Research, 4*(6), 1040-1045.

Ojesanmi, O. A., Oyebisi, T. O., Oyebode, E. O., & Makinde, O. E. (2011). Performance Analysis of Congestion Control Scheme for Mobile Communication Network. *International Journal of Computer Science and Telecommunications, 2*(8).

Scourias, J. (1997). Overview of the Global System for Mobile Communication. Retrieved from http://www.iec.org/online/tutorial

Surajo, A. M. (2016). Performance Appraisal of Mobile Telecommunication Network (MTN) Traffic Congestion in Dutse, Jigawa State . *ATBU, Journal of Science, Technology & Education (JOSTE), 4*(1), 67-83.

KNOWLEDGE MANAGEMENT AND 21ST CENTURY LIBRARIES AS PANACEA FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

The study examined knowledge management and 21st century libraries as panacea for sustainable development. With reference to thorough review of literature, the paper discussed issues like the rationale behind Knowledge Management (KM) in libraries in the 21st century, and looked at libraries contributions across the world to the Sustainable Development Goals (SGDs). Similarly, the study identified KM tools and technologies for sustainable decision making, and how to achieve sustainable development through 21st century libraries and the challenges hindering libraries from playing their roles in sustainable development. The study emphasised that Knowledge Management and sustainable development could be used to provide measure in achieving sustainability by 21st libraries.

***Keywords**: Knowledge management, 21st Century, Libraries, Sustainable development, Sustainable development goals.*

1. INTRODUCTION

There is no doubt the fact that we are in the knowledge and information driven era where knowledge has become a key resource. Therefore, for all the players in the era to be well functioning, the knowledge needs to be properly managed. Knowledge is appropriately dynamic because it is constantly changing through experience and learning. It is a powerful force that can be used to overcome barriers, influence decision making, and generally "enable" and refresh individuals and organizations so that they can accomplish goals and complete work successfully (Stewart, 2001). Knowledge management is based on applying the fullness of an organisation's knowledge to its decisions and this requires working hard to represent it, transfer it, make it accessible and encourage its use (Mupa et al. 2011). According to Quintas et al. (1997), KM is defined as the process of critically managing knowledge to meet existing needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities.

Notably, evolving information and knowledge has impacted all organisations, including libraries. This has made knowledge management become important. The conventional function of libraries irrespective of type is to collect, process, disseminate, store and utilise information to provide service to the community. This is because increased access to information and knowledge, underpinned by universal literacy, is an essential pillar of sustainable development. Knowledge management (KM) can bring about the much needed innovation, and transform tacit knowledge to explicit knowledge thereby contributing to sustainable development either at the individual or organizational levels.

In most of our organisations nowadays, education, political, information, health, commercial, research and so on; there are established libraries to take care of the information needs of the key stakeholders and especially manage the available knowledge being created in such organisations. Unfortunately, it has been observed that there are very few links between most of these institutions and private enterprises, non-government organisations and administrative structures and organisations; yet knowledge management of available knowledge in these organisations is required to bring about growth and sustainable developments in their environments. It is also unfortunate that in most of these organisations, despite having libraries, they are manned by non-experts; that is, people who are not librarians or information professionals who possess the knowledge and skills for managing the knowledge in such organization to enable sustainable development. Consequent upon this, many organisations are not growing because the existing knowledge in them are not managed the way they should in line with the 21st century expectations and development. This is premise on the fact that libraries which are supposed to be one of the key players or drivers of sustainable development, are not contributing anything tangible especially in Nigeria. The details of this reflect in the contents of this discussion. In fact, no existence of libraries in some organizations in Nigeria; and in those organizations that have libraries, their existence is not known and where it is known, their impact is not felt. Despite the fact that it was emphasized that within this quest for global sustainable development, the library sector should be a key-partner and active contributor. To be recognized as such by stakeholders, the library sector needs to promote libraries' role as development agents, namely by gathering evidences and evaluating their contribution to SDGs implementation. It is on this note that this paper seeks to discuss knowledge management and 21st century libraries as panacea for sustainable development. To achieve this therefore, they paper establishes the importance and key issues of promoting sustainability through knowledge management (KM) in libraries. The paper discusses issues like the rationale behind KM in libraries in the 21st century, libraries contribute across the sustainable development goals, KM tools and technologies used in sustainable decision making, achieving sustainable development through 21st century libraries and the challenges hindering libraries from playing their roles in sustainable development.

2. KNOWLEDGE MANAGEMENT AND SUSTAINABLE DEVELOPMENT CONCEPT

Knowledge management can be seen as a systematic approach to manage the use of information in order to provide a continuous flow of right knowledge to the right people at the right time, enabling efficient and effective decision making in their everyday business (Teece, 2010). Knowledge management is a viable means in which libraries could improve their services in the knowledge economy (Maponya, 2004). This can be achieved through creating and organisational culture of sharing knowledge and expertise within the library. Knowledge and management of knowledge appear to be regarded as increasingly important features for organisational survival (Martensson, 2000). In addition, knowledge is a fundamental factor, whose successful application helps organisations deliver creative products and services. Today organisations are fundamentally different as compared to organisations existed in one or two decades ago in terms of their functions, structures and style of management. Yu (2002) pointed out that organisations put more emphasis on understanding, adapting and managing changes and competing on the basis of capturing and utilising knowledge to better serve their markets. The central argument around which knowledge management revolves is that people hold a wealth of knowledge and experience that represents a significant resource for an organisation. Knowledge management, in the broadest sense, is a "trans-disciplinary approach to improving organisational outcomes and learning, through maximising the use of knowledge (Linger et al., 2013). It involves the design, implementation and review of social and technological activities and processes to improve the creating, sharing, and applying or using of knowledge" (Standards Australia, 2005). As such, KM is ideally suited to address the policy challenges as outlined above. A KM approach supports the consolidation of diverse information streams including formal (science) and informal (tradition, social norms, local lore), and provides the means to build a shared understanding of problems (natural resource management) and innovative solutions to those problems (sustainable management practices) involving all stakeholders.

As explained by deJung (2013), sustainable development was first defined in 1987 by the World Commission on Environment and Development (Brundtland Commision, 1987) as development which meets the needs of the present without compromising the ability of future generations to meet their own needs. The most commonly quoted definition of sustainable development stresses the meeting of needs and puts a clear focus on intergenerational equity along with responsibility in a broad sense. In September 2015, the adoption by United Nations Member States of the 2030 Agenda for Sustainable Development (UN, 2015) set the global, national and local framework for putting that responsibility into action. It is assumed based on the view of Yang et al. (2015), that KM can help build much needed industry consensus, develop capacity, communicate decisions, and promote specific measures for the pursuit of sustainability.

3. WHY DO WE NEED KM IN LIBRARIES IN THE 21ST CENTURY?

Today, customers (users) are paramount in all types of organizations and libraries are essentially customer-oriented organizations. Their main objective is to provide the right information in the right format at the right time to the library customers. Knowledge

management (KM) provides libraries numerous opportunities to rise from stereo-type status and change their service delivery approach by establishing new alliances with users (organisational staff) and researchers in new creative and dynamic spaces to create a customer-centered environment (Jain, 2016). According to Roknuzzaman and Umemoto (2009), the major drivers of KM are increased value of knowledge in the knowledge economy; the library itself as a knowledge-based organization; the dynamics of technological advancement; and, opportunities for improved library practices. Knowledge generation and management is a collaborative process and social networking applications have provided ample prospects for both internal and external collaboration. Incorporating networked knowledge networks, librarians can create, manage and share tacit knowledge. Kaane (2009) has appropriately portrayed the importance of KM in libraries how they can improve their services through KM: by creating an organizational culture of sharing knowledge and expertise; change their values, focusing on creating and using intellectual assets (tacit, explicit and potential knowledge); restructure their functions; and expand their roles and responsibilities. Kaane (2009 further makes suggestion for adopting leadership that empowers individuals; organizational culture that appreciates all forms of knowledge, and, open communication culture that supports networking. All these can be used to improve library services using KM. Also, due to librarians' vast experience and inbuilt capabilities, librarians have strong desire to be knowledge managers. The contemporary library management is all about change management. Therefore, Maury (2012) describes a library as a living force because of its continuously evolving services to accommodate ever changing user needs; a catalyst for innovations; and as a learning and social place, where information and knowledge transmit for teaching and learning. Thus, KM has gained increased popularity in libraries today.

4. LIBRARIES CONTRIBUTIONS TO SUSTAINABLE DEVELOPMENT

Within the broad *corpus* of sustainable development and sustainability evaluation, the literature review on the LIS / Sustainability topic and further application of an analytical tool led to the identification of three main approaches: one, aimed at greening libraries and reducing their environmental impact; other, anchored on culture as the fourth pillar of sustainability, largely driven by UNESCO; and another centred in libraries' contribution to global (sustainable) development goals, fostered by IFLA. Although these strains of thought and practice are frequently interrelated, for analytical purposes they were separated.

In the attainment of the Sustainable Development Goals (SDGs), it is believe that libraries have a critical role to play as individuals are given access to information without dichotomy and discrimination. Seeing a great potential in the role of libraries in achieving sustainable development, ministers and country representatives from Angola, Burkina Faso, Cape Verde, Cote D'Ivoire, Lesotho, Guinea, Madagascar, Malawi, Mozambique, Nigeria, South Africa, South Sudan and Swaziland came together in August 2015 to sign a declaration in support of providing the resources necessary to support the contribution of libraries in their nations (Bradley, 2016; IFLA, 2015). The

mandate was that each of these member nations should adopt the International Federation of Library Association and Institution (IFLA) tool kit and benchmarks in achieving the SDGs.

The seventeen SDGs were built on the Millennium Development Goals (MDGs) and call upon collaborative partnership between countries in balancing, economic growth, environmental sustainability and social inclusion for all (UN 2015). The seventeen SDGs goals of the Lyon Declaration (2015) are the following with targets aimed at all spheres of development:

- Goal 1: End poverty in all its forms everywhere
- Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- Goal 3: Ensure healthy lives and promote well-being for all at all ages
- Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
- Goal 5: Achieve gender equality and empower all women and girls
- Goal 6: Ensure availability and sustainable management of water and sanitation for all
- Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all
- Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
- Goal 10: Reduce inequality within and among countries
- Goal 11: Make cities and human settlements inclusive, safe, resilient and sustainable
- Goal 12: Ensure sustainable consumption and production patterns
- Goal 13: Take urgent action to combat climate change and its impacts
- Goal 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development
- Goal 15: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
- Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
- Goal 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development.

In terms of contributions, the Target 16.10 of the millennium development goal state: "Ensure public access to information and protect fundamental freedoms, in accordance with national legislation and international agreements".

Libraries response to this begins in terms of providing ***Access to Information***: Around the world, access to opportunity begins with access to information and knowledge. Public access to information enables people to make informed decisions that can improve their lives. Communities that have access to timely and relevant information for all are better positioned to eradicate poverty and inequality, improve agriculture, provide quality education, and support people's health, culture, research, and innovation (IFLA, 2014). As stated in target 16.10: a well-informed society contributes significantly to the development of the nation as the availability of information resources would promote peaceful and inclusive societies for sustainable development, providing access to justice for all and build effective, accountable and inclusive institutions at all levels (Bradley, 2014). Consequent upon this, there are various efforts and initiatives put up by libraries the world over to ensure access to information by all and sundry. Examples across Libraries in the World are provided in Table 1.

Table 1a: Contributions/Efforts and Initiatives by Libraries to Sustainable Development

Country	**Initiative**	**Reference**
Sri Lanka	The e-Library Nenasala Programme is a government-run initiative to increase digital literacy and access to technology among the nation's poorest residents living in remote rural areas. The Nenasalas offer instruction in basic computer skills, guidance on accessing information through the Internet, and a wide variety of locally relevant knowledge.	Bill and Melinda Gates Foundation (2014).
Romania	Librarians trained by Biblionet helped 100,000 farmers get US $187 million in subsidies via new Internet and computer services in 2011-2012. The 1,000+ librarians who participated in training decided to bring the services to their libraries together with local mayors. Most of the mayors understood that this service is in the farmers' interest. The programme helped farmers	IREX (2013)

	learn how to use the technology in libraries to access financial forms and submit them to the government, saving time and money.	
England	81% of local government library authorities in England provide access to e-information on health and wellbeing. Literacy skills also support health literacy and the capacity to access and use health information.	Arts Council England (2014)
Cuba	Infomed is the first electronic health information network in Cuba, which emerged as part of a project to facilitate the electronic exchange of information between a set of libraries, information centres and other entities that make up the National Information System of Medical Sciences in the Ministry of Health	Advancing Sustainable Development Through Information and Communication Technologies

Table 1b: Contributions/Efforts and Initiatives by Libraries to Sustainable Development

Country	**Initiative**	**Reference**
Botswana	Botswana Library Association developed a strategy to identify where libraries contribute to Botswana Vision 2016. Libraries drive the An Educated and Informed Nation Pillar of Vision 2016 directly as they collect, organise and disseminate information that society access and uses to inform themselves on various issues of life. However, attainment of the Vision extends beyond just informing and educating, it cuts across all the	Radijeng, Kgomotso (2013).

	pillars by empowering communities through knowledge and the ability to access information for themselves.	
Netherland	Boekstart in the Netherlands works with day care and healthcare centres, public libraries and the first two years of primary school to provide books and literacy training to 75,000 children per year. The programme is supported by national and local government, and aims for long-term collaboration between organisations that support children's literacy.	Boekstart Netherlands
Canada	An initiative of Library's Man in the Moon Literacy programme was instituted in 2001 in various locations around Vancouver to provide literacy education for men and women and children. The programme was developed to build on the growing research of how fathers' involvement in children's lives impacts children's health and literacy outcomes -- teaching fathers how to play, sing, talk, and read to their young children, the father-child bond builds the foundation for children's reading readiness, happiness and success later in school and in life.	
	Toronto Public Library (Canada) provides Newcomer Settlement Services including information and support about legal, childcare, housing, health, education; providing support with applications for citizenship, residence, subsidized housing, government benefits.	Toronto Library

Table 1c: Contributions/efforts and initiatives by libraries to sustainable development

Country	Initiative	Reference
China	The launching of mobile library, has enhanced the reading culture of the populace, cutting the bridge between distance and the library as users can access information resources while at the comfort of their home. Commenting on this initiative, Feifei and Yu (2013), emphasized that *the mobile library is great news, if I can set up a station near my home, I will go there as often as possible as it is really very convenient and saves a lot of time.*	
Colombia	Public libraries are an integral part of the city of Medellín, Colombia's urban renewal strategy. Strategically located in some of the most disadvantaged communities in the periphery of Medellín, they have become centres for social development that address an identified need for more cultural and education space. The Library Parks are a series of public libraries that offer educational tools and programs to benefit the local communities, as well as providing a hub for further urban development and green projects.	Library Parks (Parques Biblioteca)
Indonesia	The National Library of Indonesia has an important role in increasing the level of education and literacy for a population that is spread across islands where education is harder to access. As a result, many library services are provided by boat, this initiative lead to massive education of citizens living around waters, which is not easily assessable by road (Kamil, 2003).	Kamil, H. (2003).

Iraq	In Iraq, Iraq is currently experiencing a high threat to its cultural heritage by ISIS. Northern parts of the country are occupied and reports of destroyed documentary heritage have been circulated. The National Library of Iraq hopes to digitise and preserve heritage from loss, and make it accessible for everyone.	The National Library of Iraq

Table 1d: Contributions/Efforts and Initiatives by Libraries to Sustainable Development

Country	**Initiative**	**Reference**
Kenya	In Kenya, Schools hundreds of kilometres apart in remote areas of western Kenya and Uganda are engaging in lively debates, quizzes and spelling competitions through Kisumu Public Library's smartphone, laptop and video conferencing project. Few rural schools have internet connections, so the library researched ways of connecting to the internet through the mobile phone network.	Kisumu Public Library, Kenya.
Moldova	Libraries are stakeholders in Open Government Partnership (OGP) action, plans, a platform between government, civil society, and business to discuss developmental goals, plans and initiatives and giving mandate to library as a supporter of access to information, as a result of this development, librarian, were giving mandate to seek ideas from civil society citizens around their community to participate, discuss challenges faced and possible solutions as feedback to government to address (Bradley, 2016).	Bradley, F. (2014).
Nepal	After the Nepal earthquakes in April and May 2015, libraries have been	

	quick to react and safeguard their unique cultural heritage collections as well as their other holdings. Temporary tents were erected to guarantee access to materials for patrons. Unique and fragile material was moved to safe storage places. Libraries are now seeking support for emergency preservation of damaged collections and digitisation for wider use.	
Australia	An Australian report released in 2014 found that hospitals, government departments, associations and other organisations involved in healthcare gain a $5 AUD return for every dollar they invest in libraries.	SGS Economics (2014).

Table 1e: Contributions/Efforts and Initiatives by Libraries to Sustainable Development

Country	**Initiative**	**Reference**
Uganda	The National Library of Uganda has an ICT training program designed for female farmers, providing access to weather forecasts, crop prices, and support to set up online markets, in local languages. This programme increases the economic well-being of women through technology skills.	Beyond Access (2012).
Honduras	In terms of Support and strengthen the participation of local communities in improving water and sanitation management San Juan Planes Community Library (Honduras) plays a central role in bringing safe drinking water to the entire community via a water treatment project they established in the town's central square	Beyond Access MDGs.
Namibia	In Namibia, Many public and community libraries around the world	

	are the only place where people can get reliable access to light and electricity to read, study and apply for a job. The Katatura public library (Namibia) provides public access to ICT, study rooms, and classes on using mobile phones.	
EU	In EU, 250,000 people find jobs through their public library in the European Union each year. Public access to ICT and skills enables people to apply for jobs, as the application process for all jobs has moved online.	Public Libraries 2020 (2014)
Mali	Mali, In 2013 armed groups occupied Northern Mali and Timbuktu, a city famous for its cultural heritage and its vast amount of public and private libraries with invaluable documentary heritage. To safeguard the manuscripts during the occupation, volunteers smuggled them into safety to Bamako with the help of international support. The manuscripts have since been kept in the capital and are undergoing restoration and digitisation work. Libraries have been at the forefront of evacuating and preserving the unique heritage of Mali.	

Table 1f: Contributions/Efforts and Initiatives by Libraries to Sustainable Development

Country	**Initiative**	**Reference**
Ukraine	In Ukraine, protests in Kiev in 2014 around the Maidan put the National Parliamentary Library of Ukraine was at the midst of the clashes. The library opened its doors to those wounded during the clashes and people in need of some rest and a safe place.	
USA	The Obama administration of the	ConnectED Library

	USA launched the ConnectED Library Challenge, a commitment by more than 30 communities to put a library card into every student's hand so they will have access to the learning resources and books they can read for pleasure, all available in America's libraries.	USA

Other libraries services which contribute to improved outcomes across the SDGs also include the following (Dada, 2016).

- Promoting universal literacy, including media and information literacy
- Closing gaps in access to information and helping government, civil society, and business to better understand local information needs
- Providing a network of delivery sites for government programmes and services
- Advancing digital inclusion through access to Information & Communications Technologies (ICT), and dedicated staff to help people develop new digital skills (Advancing Sustainable Development, 2014)
- Serving as the heart of the research and academic community
- Preserving and providing access to the world's culture and heritage
- More specifically, libraries has supported the implementation of the SDGs by providing access to information, support for literacy and ICT skills, and access to community space.

Some of the existing initiatives of library support to SDGs may include:

- UN Depository Libraries that support dissemination of information and research to help decision makers achieve the SDGs
- Access to health, environmental, and agricultural information that are targets of the SDGs; including Open Access resources
- Media and information literacy programmes for marginalized populations to make an important contribution to achieving universal literacy (Bradley, 2016).

It is unfortunate that, arising from the information on Table 1a-f, nothing reflect Nigeria. The implication is that Nigerian libraries efforts towards sustainability has no antidotal record. In West Africa generally, only Mali was able to do something in this regards.

5. KM TOOLS AND TECHNOLOGIES AND SUSTAINABLE DECISION MAKING

In this knowledge based economy productivity is highly dependent on informed and sustainable decision making. All knowledge managers have to make decisions. An

individual's problem solving and decision making capability is limited by the knowledge available (Noman & Aziz, 2011). Hence, relevant and updated data are important for effective decision making (Bowett, 2009). There is a close relationship between decision making and knowledge management. Knowledge sharing is the key to knowledge management, which allows knowledge exchange among colleagues and enable informed and participative decision making (Jain, 2016). Knowledge sharing involves gathering and disseminating internal as well as external knowledge within library organization. Employees' (librarians) participation in decision making process can also help an organization to improve its performance by meeting the goals in an efficient way (Danish et al 2013). Knowledge management provides several techniques and technologies for informed decision making (Jain, 2016). For instance, spread-sheets are widely used for 'what if' simulations. Decision Support Systems are used for effective decision making (Jain, 2016). The computer does not take decisions; managers do. However, it helps librarians to have quick and reliable quantitative information about the knowledge (Bowett (2009). There are a wide range of IT tools to create, codify and share knowledge, such as, web 2.0 technologies, decision support and knowledge management systems (Jain, 2016). In relation to that, Ghani (2009) provides a comprehensive list of KM tools available to support the functionalities and processes of KM. Tools to access knowledge, provide access to explicit knowledge that can be shared and transferred through the enterprise information systems. For example, **Convera** is a tool used for retrieval ware, tools for semantic mapping, support presentation of information, analysis and decision making.

Ontology tools enable users to organize information and knowledge by groups and schemata that represent the organizational knowledge base.

Anacubis is a ground-breaking visual research and analysis software. Tools for knowledge extraction, support structured queries and replies. They help mining text by interpreting relationships among different elements and documents, for example, **ClearForest** Text Analysis Suite.

Tools for expertise localization, enable quick location of the knowledge holders in the enterprise and facilitate collaboration and knowledge exchange, for example, **ActiveNet** maintains a continuous and real-time view of organizational activities.

Tools for collaboration work, enable teams to globally share dedicated spaces for managing the project lifecycle; editing and publishing materials; conducting live discussions and interactions; and maintaining a repository of materials associated with every step of the process, for example, **QuickPlace** and jabber for real time collaboration among geographically dispersed participants (Ghani, 2009).

All the above KM tools and technologies facilitate informed and knowledge-based and sustainable decision making.

6. CHALLENGES OF LIBRARIES IN KNOWLEDGE MANAGEMENT FOR SUSTAINABLE DEVELOPMENT

Challenges hindering libraries from playing their roles in sustainable development are numerous and these challenges are irrespective of countries. There is no doubt, the fact that there are challenges facing libraries in their quest to managing knowledge for sustainability. There are some issues that are directly have to do with lack of training materials and remotely related to funding which emerged as a great challenge which could riddle such a programme. For instance, "the library has its own challenges, regarding inadequate teaching and learning materials, and lack of support from external bodies such as WHO and UNESCO, MOH. So if such a programme is to be carried out who bears the cost"? Putting it rather aptly, "funding, awareness creation and education are the major challenges in the achievement of promoting healthy living and wellbeing" by libraries.

Perhaps, a rather compelling challenge is, "who validates or authenticates the information churned around. The library may be good at information provision, but if information concerning sustainable development goal such as health is not critically scrutinized before they are sent out to the general public, it might lead to serious consequences. So yes, collaboration is important but the library must play the leading role" (Pinto et al. 2017; Dadzie et al. 2016).

It also emerged that a programme in the form of ensuring healthy lives and wellbeing may fail if the various segments of the community are not treated uniquely. For schools, it may be much easier because it is a bit more organized. But for a typical community, people are scattered and have different pressing needs. In admitting "apathy, lack of financial support, time constraints and to some extent professional ignorance" are some of the other challenges. However, probable remedies could include "Institutional, individual, Community and Stakeholder Commitment, as well as advocacy, lobbying, and public education on the part of the librarian (Pinto et al., 2017:12).

Inadequate number of librarians and knowledge management experts: The common scenario nowadays is that many organisations now have their own libraries, very interesting. Unfortunately, limited number of the organizations hire experts to man such libraries. Instead, what they do is just to put somebody to be taking care. This is unfortunate in the sense that, management of organization knowledge require expert with the knowhow and experience of records management such as librarians, archivist or records manager/expert. With this scenario, many organisation's libraries remain empty while some are full of people who does not possess the knowledge and hence the management of knowledge for sustainability is negatively affected.

Unequal effects - With social equity as a fundamental concept of sustainable development, the socio-economic and environmental challenges of unsustainable growth differ largely across the globe. Developing countries and vulnerable populations are most frequently disproportionately affected. This is because of the limited budget usually allocated to libraries in the developing countries and which is not always enough to take care of libraries activities. Consequent on this, little or no more fund available to do other stuff by libraries including planning for sustainability.

7. CONCLUSION

This study has been able to identified key issues in promoting sustainability through knowledge management (KM) in libraries. The paper discussed issues like the rationale behind KM in libraries in the 21st century, and looked at libraries contributions worldwide to the sustainable development goals. Similarly, the study has been able to identified KM tools and technologies for sustainable decision making, and how to achieve sustainable development through 21st century libraries and the challenges hindering libraries from playing their roles in sustainable development. Meanwhile, the paper has emphasized that Knowledge Management and sustainable development could be used to provide measure in achieving sustainability by 21st libraries as evidence have shown from different libraries across the world. This is just a discussion paper and not empirical due to the limited amount of literature available on the use of Knowledge Management in sustainable development. The significance of this study is the opportunity to see how much impact knowledge management can make in the process of reengineering libraries along sustainable goals.

8. RECOMMENDATIONS

The main variables, or ideas, that affect libraries in their quest for sustainability are the types of KM processes they have in place, the types of sustainable development they are trying to achieve and the key factors that could be used to measure the contribution of KMs role in the sustainable development process. Alignment of these ideas could determine if KM can play a role and affect the development of the sustainable enterprise. The effect of key factors could determine if it is possible to establish measures for future studies. This discussion in this paper is straightforward, however, grounded theory approach is needed to develop the theories as the research unfolds. Further research should highlight other variables that can affect sustainable library project. The establishment of a clear understanding of KM's contribution to sustainable development and the identification of the key factors that drive this would allow libraries to measure that contribution in their re-engineering process. This could see KM processes leading libraries redesign rather than supporting the redesign.

REFERENCES

Arts Council England (2014) Evidence review of the economic contribution of libraries. Retrieved: http://www.artscouncil.org.uk/media/uploads/pdf/Evidence_review_economic_contribution_libraries.pdf

Beyond Access (2012) Empowering Women and Girls Through ICT at Libraries. Retrieved http://beyondaccess.net/wp-content/uploads/2013/07/Beyond-Access_GirlsandICT-Issue-Brief.pdf

Boekstart Netherlands. Retrieved www.boekstart.nl

Bradley, F. (2014). *What are the UN SDGs and what do they mean for libraries?* Retrieved: http://eifl.net/sites/default/files/resources/201511/3._eifl-

fbradley-2030agenda.pdf [October 2016].
Bradley, F. (2016). *Contribution of Libraries to the SDGs*. Retrieved: http://www.ifla.org/files/assest/wlic/2015/Contribution of Libraries to the SDGs - United Nations Partnerships for SDGs platform [October 2016].

Dada, K.J. (2015).The role of library in achieving vision 2030 goals. *CEC Journal*, 46(2), Retrieved: http://scalar.usc.edu/works/cec-journal-issue-2/the-role-of-the-library-in-achieving-vision-2030 goals **h**

Dadzie, P.S.,Martin-Yeboah, E. & Tachie-Donkor, G. (2016). Ensuring healthy lives and promoting well-being for all: the role of Ghanaian academic libraries in achieving the 2030 Agenda for Sustainable Development. IFLA WLIC, Columbus.

deJung, W. (2013). The female face of sustainable development. Library Briefing. Retrieved http://www.library.ep.ec

role of the Library in Achieving Vision 2030 Goal

Feifei, F. & Yu, Z. (2013). *Mobile Library in Heibei is a Success Story*. Retrieved: www.chinadaily.com.cn/life/2013-08/27/content_16923318.htm [October 2016].

Ghani, S.R. (2009). Knowledge Management: Tools and Techniques. *Journal of Library & Information Technology,* 29 (6), 33-38.

IFLA Impact Report (2012). How libraries contribute to sustainable development & the SDGs IFLA ALP: Building Better Library Communities. Retrieved from: https://www.ifla.org/files/assets/alp/103-fbradley-alp.pdf

IFLA ALP Retrieved: https://www.ifla.org/files/assets/alp/103-fbradley-alp.pdf

Jain, P. (2015). Knowledge Management, Leadership and Decision Making: A Case of Academic Libraries. IFLA WLIC, Cape Town, South Africa.

Jay Yang, Mei Yuan, Tan Yigitcanlar, Peter Newman and Frank Schultmann (2015). Managing Knowledge to Promote Sustainability in Australian Transport Infrastructure Projects. *Sustainability*, *7*; 8132-8150

Kaane, S. (2009). Knowledge Management in Libraries: an introduction. Retrieved: http://www.slideshare.net/unulwbpartnership/km-un-university-librarians-3-sept-2009?related=1, Accessed on 15th May 2015.

Kamil, H. 2003. The Growth of Community-Based library services in Indonesia to support Education. In Proceedings from 69th IFLA Council and General Conference. Berlin, Germany.

Library Parks (Parques Biblioteca). Retrieved: http://medellin.ecocitizenworldmap.org/library-parks/

Linger, Henry; Aarons, Jeremy; McShane, Paul; and Burstein, Frada, (2013). A Knowledge Management Framework for Sustainable Development: A Case of Natural Resource Management Policy Work in Indonesia. *PACIS 2013 Proceedings*. 93.

Retrieved: http://aisel.aisnet.org/pacis2013/93

Lucidea, A. (2017). Part Two—Overcoming 6 Challenges to Special Library Sustainability. Retrieved:

https://blog.lucidea.com/overcoming-6-challenges-to-special-library-sustainability-part-two

Lyon Declaration. (2015). *Lyon Declaration on Access to Information and Development*. Retrieved: http://www.lyondeclaration.org [October 2016].

Martensson, M. (2000). A critical review of knowledge management as a management tool. *Journal of Knowledge Management,* 4(3), 204-216.

Mupa Paul, Chabaya Raphinos Alexander, Chiome Chrispen (2011). Knowledge management for sustainable growth and development: Implications for higher education. *Zimbabwe International Journal of Open & Distance Learning Volume 1 Number, (2), 99-106.*

Pinto, L.G. & Ochoa, P. (2017). Public libraries' contribution to Sustainable Development Goals: gathering evidences and evaluating practices. IFLA WLIC, WROCLAW.

Public Libraries 2020 (2014) See the numbers. Retrieved: http://www.publiclibraries2020.eu/content/see-numbers

Radijeng, Kgomotso (2013). The Role of public libraries in the attainment of Botswana's vision 2016. Retrieved http://library.ifla.org/258/1/201-radijeng-en.pdf

SGS Economics (2014). The community returns generated by Australian 'special' libraries https://www.alia.org.au/roispecials

Standards Australia (2005). AS5037-2005 Australian Standard Knowledge Management.

Stewart, T.A. (2001). The wealth of knowledge: Intellectual Capital and the twenty-first century organization. New York: Currency.

Teece, D. (2010). Strategies for Managing Knowledge Assets: The Role of Firm Structure and Industrial Context. *Long Range Plan, 33*, 35–54.

United Nations. (2016). *Partnership for SDGs: Contribution of Libraries to the SDGs.* Retrieved: https://sustainabledevelopment.un.org/partnership/?p=10909

United Nations. (2015). The Millennium Development Goals Report 2015. New York: Author. Retrieved: www.un.org/.../2015.../MDG%202015%20rev%20(July%201).pdf

UN OWG. (2014). S*ustainable Development Goals.* Retrieved: https://sustainabledevelopment.un.org/focussdgs.html

Wang, C. L. and Ahmed, P. K. (2003). Organisational learning: a critical review. *The Learning*

Organization, 10 (1), 8 – 17.

World Health Organization. (2016). *Health Impact Assessment (HIA)*. Retrieved: http://www.who.int/hia/evidence/doh/en/

WSIS Action Lines Enabling SDGs. Retrieved http://www.itu.int/net4/wsis/sdg/Content/wsis-sdg_draftbooklet.pdf

Yu, C. M. (2002). Socialising knowledge management: the influence of the opinion leader. *Journal of Knowledge Management Practice*. Retrieved http://www.tlainc.com/articl42.htm

NEW MEDIA AND SATISFACTION WITH DEMOCRACY AMONG STUDENTS OF SELECTED UNIVERSITIES IN KWARA STATE, NIGERIA

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ABSTRACT

This study examine the role of new media in perceived satisfaction with democracy among the youths in selected universities in Kwara State. Premised on the notion that the political public sphere is largely out of reach to majority of citizens, requires mass-mediated connection, functions best with informed citizenry and the belief that informed youths are fundamental to the future of democracy. The study explore the influence of dependency on new media landscape on perceived satisfaction with democracy from the prism of Media System Dependency Theory (MSDT). Sampling 335 respondents proportionately from University of Ilorin and Al-Hikmah University and relying on Questionnaires' responses, the study found significant difference in dependency on mainstream and new media among the respondents in favour of the new media. However, the results revealed that mainstream media are better predictors of perceived satisfaction with democracy among the youths. The study concluded that media factor should be included in the exploration of satisfaction with democracy in tandem with other key democratic institutions previously documented.

Keywords: *Media system dependency, satisfaction with democracy, mainstream media, new media*

1. INTRODUCTION

In antiquated societies, it is impossible to talk intelligently about democracy without considering the role played by the societal information architecture contemporarily epitomised by the mainstream and the new media of mass communication (Encyclopedia of Communication and Information, 2002). In most cases, however, the asymmetrical relationship between the media and their users creates citizens' dependence on the former (George & Jackob, 2010). According to Ball-Rokeach (1998: 17) "media users have hardly any effect on the way media producers handle their

resources". This means that the media provide the means by which the audience interpret the external environment, particularly with regards to functioning as democratic citizens without their input. This state of affairs results from the primacy of informed citizenry in any democratic arrangement.

A democracy is a system of government in which the people of a country vote to elect their representatives. This system of government is premised on informed citizenry, a request being fulfilled by the mass media in the post-industrial society. As the lifeblood of democracy (Mustapha, Ahmad & Abubakar, 2014), media play a crucial role in shaping and defining the quality of democracy in a society. The mass media re-construct, translate and convey issues in human society to the cognitions of their teeming audience. According to de Vreese, (2005), the mass media simultaneously structure public perception of social reality through their representation, construction and contextualisation of unfolding societal events, issues and activities. On centrality of the media to a functioning democracy, Jebril, Stetka and Loveless 2013, p. 6) surmise that "the mass media are regarded as one of the key democratic institutions vital in improving the quality of the electoral system, political parties, parliament, judiciary, and other branches of the state… civil society, and safeguarding their democratic performance."

Across clime and epochs, therefore, mass media of communication function as the public sphere, open marketplace of idea and societal watchdog (Mustapha, 2008; Mustapha et al., 2014), role so tangential to successful democratic enterprise. Being product of societal power and social exigencies, media of mass communication is not only r(e)volutionary, but function as democratic resources based on the prevailing structure of media ownership, organisational routine and feedback capabilities (Baran & Davis, 2012; Croteau & Hoynes, 2002) . The contemporary new media, propelled by advancement in information and communication technology, therefore, offers new perspective in media-democratic symbiosis. While opinion differs on the contributions of new media to politics along the continuum of passivism and activisms the political and democratic roles of the media in general and new media in particular have received generous exploration among political communication and media effects scholars, little attention has been accorded the role of media in satisfaction with democracy. This study, therefore, opens a new perspective on perceived media role in strengthening democracy among a demographic group that is fundamental to sustainability of the system in an era of increasing media dependency, based on mediamorphosis phenomenon wrought on the contemporary society due to revolution in the media landscape.

2. MEDIA SYSTEM DEPENDENCY THEORY

Dependency theory is a mass communication theory that seeks to explain the long term effects of media on the audiences and a society (Baran & Davis, 2012; Rosenberry & Vicker, 2009). According to Miller (2005), media dependency theory is a complicated structure where the media, the individuals, their interpersonal environment as well as their social environment have dependency relationship with each other. Amplifying

dependency, Ball-Rokeach and DeFleur (1976) submit that a relationship where the fulfilment of needs of one party is shouldered upon the resources of another party can be regarded as dependency (cited in Miller, 2005).

Baran and Davis (2012, pp. 288-299) aptly capture the main thesis of MSD theory, saying that "the more a person depend on having his or her needs met by media use, the more important will be the role that media play in the person's life, and therefore the more influence those media will have on that person". MSD theory also explains the concept of dependency relationship by identifying some conditions and consequences attached to the relationship. Perry (1996) cited in (Rosenberry & Vicker, 2009, p. 129) notes that "as society increases in complexity, media performs a greater number of functions and people tend to become more dependent upon them".

3. NEW MEDIA DEPENDENCY

The Internet opened a new platform in media ecology, having extensions such as "mobile technology and software/websites that instantaneously connect individuals" (Jebrin et al., 2013, p. 22). The new medium establishes numerous choices of information rising as the eminent apparatus in building a contemporary state, shaping human attitudes and behaviour beyond local and national level (DeFleur, 2010). Most importantly, the new media environment honours synchronous communication exchange due to the inherent interactive properties which increase the patterns of engagement among the citizens. According to *Encyclopedia of Communication and Information* (2002), the introduction of computer-based interactive media, which includes the Internet, has radicalised the relationship between democracy and the media via facilitation of incomparably fast and low-cost information to the citizens.

New media and Web 2.0 are important "information system" used in making sense of happenings in today's world (Lenharth & Maddern, 2005) because the flexibility, portability, interactivity and hyper textual characteristics of the new media, they allow horizontal communication which facilitates ease in mobilization of citizens (Mustapha & Mustapha, 2017). Onomo (2012) recognised these abilities by opining that social networking sites have become pervasive instruments for the exchange of information helping individuals to reach a heterogeneous large audience in ways that are hitherto unfathomable. The awesome communicative power of the new media platforms, perhaps, explains audience dependency on them to achieve instrumental and ritualistic gratifications.

Dependency on new media, according to Narasimhamurthy (2014), foretells different behaviors on the path of the citizens which include selective exposure in online participation of information exchange. In this scholar's view, dependency on new media has a great ability to enable citizens learn cultural production through diverse ways and processes which reduces geographical, temporal, informational and relational constraints of online community. The popularity of Social Network Sites (SNSs) among contemporary political actors signals contemporary dependency on the new media as political communication infrastructure and resources. Social network sites (SNSs), an extension of new media, have received enormous attention in recent times due in part to availability of new structure that counters the old-fashioned

patterns of information production and consumption (Jung & Moro 2012; Ha, Yoon & Zhang, 2013).

4. MEDIA USE AND SATISFACTION WITH DEMOCRACY

According to Whitehead (2002), democratisation is a consensual-based participatory process involving citizens in a long-term and dynamic ways towards achieving political progress. Being a consensus-based process and state, democracy is also a communicative endeavour, with information diffusion serving as its main lubricant (Mustapha, 2008; Mustapha et al., 2014). Hence, the mass media function as critical stakeholders in facilitation and nurturing of democratic ethos, even when their hitherto awesome power was short-circuited by commercialisation and liberalisation of the media industry with attendant political economy consequences (Bagdikian, 1997; Croteau & Hoynes, 2002; Herman & Chomsky, 2002). The absence of alternative platform that rivals media information dissemination power, however, still makes vast majority of the mass audience to depend on the institution to fathom going-ons in the society.

With the new media landscape that now accommodate on-the-go connection to the societal information grid, the new and social media have become additional avenues for instantiating audience media dependency (Ha, Yoon & Zhang, 2013). The incapacity of the traditional media to promote unadulterated democratic causes gave way for the internet and the new media to become the latest and most adopted structure to sustain political activities (McNair 2003; Mustapha & Mustapha 2017). Due to their information democratising quality and ability to stimulate audience activism, by turning them to information producers and consumers (prosumers), the new media have gained enviable democratic credence thus redefining media and democracy relations. While recognising the democratic potency of the new media, scholars are also of the opinion that the legacy/mainstream media still remain important democratic resources (Jung & Moro, 2012; Mustapha & Mustapha, 2017). Hence, the legacy and the novel media as respectively represented by the mainstream media and the Internet-enabled/Web-propelled media are of great importance to democratic processes and societies.

While the media have been identified as being critical to democracy, little, if any, attention has been accorded their roles in democratic satisfaction compared with other socio-political institutions. Previous studies on satisfaction with democracy, have, for example, explored the role of institutions such as rule of law, well-functioning regulation, low corruption, and other institutions that improve resource allocation (Wanger, Schneider & Halla, 2009); representativeness and perceived accountability (Aarts & Thomassen, 2008); party policy choices and parties character-valence (Linde & Ekman, 2003; Ezrow & Xezonakis, 2009); economic growth and respect for rule of law (Gulbrandtsen & Skaaning, 2010); citizens' evaluation of public administration, political trust and human development (Ariely, 2013) and collective action problem (Halla, Scheneider & Wanger, 2008), among other.

The literature above addressed satisfaction with democracy from politics and public affairs perspective with minimal consideration of other key variables that contribute to establishment and consolidation of democratic values, particularly from fledging democratic climes. This reality leaves a gap in the literature. Being the mediator in the

relationship between the citizens and political public sphere, therefore, the media system remains a critical variable that contribute to citizens' perceived satisfaction with democracy. This uncharted realm of democratic satisfaction research, from mediacentric perspective, becomes timely given increasing mediatisation of politics and development of virtual political activism that are being reinforced by revolutionary communication apparatuses of the contemporary society.

Hypotheses

H1: Citizens differ in their use of mainstream media and the new/social media for political information.

H2: The new media enhances satisfaction with democracy than the mainstream media.

5. METHODOLOGY

The study adopted a cross sectional survey method and gathered data from the students of Faculty of Communications and Information Sciences, University of Ilorin which has the population of 1627 and students of College of Humanities, Al-Hikmah University which has the population of 904. Based on Krejcie & Morgan (1970) table for selecting sample size, 335 students were proportionately chosen from the total population 2531. Using systematic sampling technique, the study collected data on respondents' demographic variables, pattern of media use as well as constructs such as mainstream media dependency for political information, new/social media dependency for political information, as well as satisfaction with democracy, which were measured using 10 item each on a five-point Likert scale.

6. RESULTS AND ANALYSIS

Respondents' Demographic Profile

The age of the respondents in this study ranges between 16 to 40 years (M=20.39, SD=2.93). When the age was categorized, those below the age of 20 constitute the highest class with 58.5%. The male (54.5%) in this study are slightly more than the female while the Muslims (51.4%) have a minimal dominance over the Christians. This demographic metrics mirror the demographic profile of the population from which the sample was chosen.

Media Use

Respondents in this study reported using various media platforms concurrently, albeit with differential level of usage. Overall, internet/social media (97.9%) are the most utilised media among the respondents. This was followed by television (75.2%), radio (61.5%) and newspaper (56.1%) being the least used medium.

In terms of time spent on the media, respondents claimed that they read newspapers for three days in a week on the average (M=3.46, SD=2.15) and spent most of their daily media consumption hours on the internet and social media (M=6.24, SD=2.98). They also claimed they watched television (M=2.22, SD=2.09) and spent the least media daily hour on the radio (M=1.13, SD=1.46). These results correspond to youths' media use habits found by Mustapha and Mustapha (2017) and Mustapha, Gbonegun and Mustapha (2016).

Mainstream Media Dependency

Table 1 presents the results of respondents' dependency on the mainstream media for political information. On the average, respondents slightly agreed to depending on the mainstream media for political information (M=3.38, SD=1.02). Explicitly, they agreed that they depend on mainstream media to broaden their political knowledge (M=3.55, SD=0.97); use mainstream media for clarification when confronted with conflicting political information (M=3.54, SD=0.98) and that mainstream media are very useful for political information than the new/social media (M=3.27, SD=1.09). However, they slightly agreed that without mainstream media, they would know nothing about politics (M=2.92, SD=1.16).

Table 1: Mainstream Media Dependency for Political Information

	Level of agreement*						
Mainstream Media Dependency for Political Information	**1**	**2**	**3**	**4**	**5**	**M**	**SD**
I rely on mainstream media for political information	5.7	8.4	28.1	43.6	14.3	3.52	1.02
I rely on mainstream media to update my political knowledge	4.8	11.0	28.1	45.1	11.0	3.46	0.99
Without mainstream media, I would know nothing about politics	11.0	31.0	19.7	30.4	7.8	2.92	1.16
When confronted with	4.2	10.4	25.1	47.8	12.5	3.54	0.98

conflicting political information, I use mainstream media for clarification							
I depend on mainstream media to broaden my political knowledge	3.6	11.9	22.7	49.9	11.9	3.55	0.97
Mainstream media are very useful for political information than the new/social media	8.1	14.6	30.1	36.4	10.7	3.27	1.09
Mainstream media delivers in-depth political information	3.3	10.7	37.0	36.4	12.5	3.44	0.95
Total						**3.38**	**1.02**

Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

New/Social Media Dependency

The result of dependency on new media for political information is presented in Table 2. Generally, respondents agreed that they depend on new/social media for political information (M=3.58, SD=0.93). Particularly, they agreed that new/social media deliver instantaneous political information (M=3.96, SD=0.80) and multi-media political content (M=3.90, SD=0.731). They also slightly agreed that new and social media offer low cost information than the mainstream (M=2.97, SD=1.03) and that they would know nothing about politics without new and social media (M=2.98, SD=1.21).

Table 2: New/Social Media Dependency for Political Information

	Level of agreement*						
New/Social Media Dependency for Political Information	**1**	**2**	**3**	**4**	**5**	**M**	**SD**
New and social media delivers instantaneous political information	1.8	2.4	15.8	57.6	22.4	3.96	0.80
New and social media delivers interactive political information	1.8	6.9	18.2	57.0	16.1	3.78	0.86
New and social media delivers multi-media political content	0.9	2.4	19.4	60.0	17.3	3.90	0.73
New and social media delivers	4.8	9.9	28.4	45.1	11.9	3.49	0.99

in-depth political information							
I use new and social media to expand my political knowledge	3.3	3.9	22.4	51.0	19.4	3.79	0.91
New and social media are very useful for political information than the mainstream media	2.7	7.8	35.5	38.8	15.2	3.36	0.93
New and social media offer low cost information than the mainstream media	5.1	32.5	28.4	27.5	6.6	2.97	1.03
When confronted with conflicting political information, I use	1.2	8.7	23.0	49.3	17.9	3.74	0.89

new and social media for clarification							
Without new and social media, I would know nothing about politics	12.2	26.0	23.9	26.6	11.3	2.98	1.21
I rely on new and social media for political information	2.4	6.0	31.9	41.5	18.2	3.67	0.921
Total						**3.58**	**0.927**

Scale: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

Media and Satisfaction with Democracy

Table 3 presents a description of respondents' satisfaction with democracy based on media performance and content. Overall, respondents slightly agreed that media content offers satisfaction with democracy (M=3.11, SD=0.961). Specifically, they agreed that the media assist and support political institutions (M=3.69, SD=0.81). They also concur that democracy contributes to freedom of the press, expression and information (M=3.44, SD=1.02) and that political information on the media enhances peace and tranquillity (M=2.94, SD=0.97), but slightly agreed that are aggregately that they are satisfied with democracy (M=2.51, SD=1.05).

Table 3: Media-based Satisfaction with Democracy

	Level of agreement*						
Media-based Satisfaction with Democracy	**1**	**2**	**3**	**4**	**5**	**M**	**SD**
The media disseminates political news that are accurate and transparent	5.7	16.1	47.2	24.8	6.3	3.09	0.937
The political programmes and information on the media say the truth about happenings in the country	9.9	20.9	40.3	21.8	7.2	2.95	1.05
The political contents on the media promotes democracy	3.9	19.4	44.8	25.7	6.3	3.11	0.920
The political information	7.2	23.6	41.2	23.3	4.8	2.94	0.972

disseminated on the media enhance peace and tranquility in the country							
Media facilitates political inclusiveness	2.7	14.1	41.6	32.6	9.0	3.31	0.916
I am satisfied with media democratic roles	6.3	24.8	38.8	25.7	4.5	2.97	0.967
Democracy contributes to freedom of the press, expression and information	4.2	11.0	6.7	31.9	16.1	3.44	1.02
Media assist and support political institutions	1.5	3.6	33.4	46.9	14.6	3.69	0.817
On the whole, I am satisfied with	18.5	30.1	37.9	7.8	5.7	2.51	1.05

democracy		
Total	**3.11**	**0.961**

Scale: 1=Very Dissatisfied, 2=Dissatisfied, 3=A Little Satisfied, 4=Satisfied, 5=Very Satisfied

Test of the Hypotheses

Table 4 presents the result of the test of hypothesis one, which states that *there are differences in the use of mainstream and new/social media for political information*. To test this hypothesis, a paired-sample t-test was conducted. The result shows that there is a significant difference in the use of mainstream media and new/social media for political information (t=-5.143, df=334, p=.001). Respondents agreed to depending on the new/social media (M=3.58, SD=0.51) for political information than the mainstream media (M=3.38, SD=0.67). This result correlates with the findings of Mustapha & Mustapha (2017) that in terms of the usage of mainstream media and new/social media for political engagement among youths, the new/social media proved to be the most used, supporting the notion that new media are powerful political and democratic resources.

Table 4: Differences in Mainstream and New Media Dependency for Political Information

Media Use	N	M	SD	t	df	p
Mainstream media	335	3.38	0.67	-5.143	334	.001
New/Social media	335	3.58	0.51			

Table 5 presents the result of the test hypothesis two, which states that *the mainstream media enhances satisfaction with democracy than the new/social media.* To test this hypothesis, linear regression was conducted. The result shows that both mainstream and new/social media use for political information contribute 15.2% variance in satisfaction with democracy (R2=0.152, p=.001). Mainstream media political information (B=.234, p=.000) than the new/social media (B=.195, p=.001). This result correlates with the findings of a number of scholars who believe that mainstream media maintain an impartial power over the dissemination of cultural and political information (Dutta-Bergman, 2004; Lin, 2001). Similarly Ceron & Memoli (2016) discovered that mainstream media have positive effects on satisfaction with democracy than Internet usage.

Table 5: Predicting the Effects of Media Dependency on satisfaction with democracy

Model	Beta	SE	t	p
Constant	1.624	.212	7.66	.000
Mainstream Media	.234	.042	5.51	.000
New/Social Media	.195	.056	3.45	.001

$F_{(2,334)}$=29.59, R^2=0.152, p=.001, Dependent variable: Satisfaction with Democracy

7. DISCUSSION

This study explored the notion that the media system, being a key democratic resource, contributes to cognition and appreciation of the entire gamut of democratic process. As the political public sphere, where political ideas are tested and contested, the media have been found to function in the democratic realm of information dissemination, education, and critical analysis with a view to imbue the citizens with commensurate political socialisation and participatory interest. Premised on the notion that the role that the mass media play in political socialisation is fundamental to citizens' political enculturation and establishment of good governance, this study explore perceived contributions of the institution to satisfaction with democracy.

Based on the assumption that the political public sphere is vast, diverse and beyond direct acquaintance by substantial majority of citizens, this study explicates the contributions of various forms of media to citizens' satisfaction with democracy from Media System Dependency theoretical lens. Included in the exploration are differential effects of media forms, based on the (r)evolutionary nature of the media ecology. In other words, the study explore the citizens' satisfaction with democracy from the predictive impacts of the mainstream as well as the new and social media for political information and enculturation.

Findings from this study revealed acknowledgement of the media system as a key democratic institution connecting key political actors together thus facilitating political socialisation, enculturation and mobilisation, which serve as antecedents to formation of political interest, political mobilisation and political participation. Significantly, the study confirms the established belief about shifting media use, particularly for politics and public affairs' issue orientation that skews in the favour of novel contemporary media exemplified by the social media. Also revealed is the supplementary relations between the Fourth Estate- mainstream media- and the emerging Fifth Estate- new and social media. It is also discovered that dependency on the media predicts modest but significant variance in satisfaction with democracy.

Additionally, it was discovered that the media system contributes significantly to people's perceived satisfaction with democracy, particularly with reference to media's role in supporting political institutions, facilitating political inclusiveness, aiding citizens' expressiveness, information dissemination and promotion of democracy in general. While both the mainstream media and the new media contribute to citizens' perceived satisfaction with democracy, mainstream media were found to predict more variance in perceived satisfaction with democracy.

8. CONCLUSIONS AND RECOMMENDATIONS

From the earliest century to the modern world, the media system has been shouldered with the responsibility of providing societal orientation to the citizens via reportage of issues needed in taking informed political and economic decisions. Prior the contemporary information revolution that offered a plethora of interactive and ubiquitous media platforms, the mainstream media have functioned as political public sphere, educating and mobilising citizens on the best political options and courses. Hence, the media system serves important political role and remains an important

political actor needed to be considered in political and democratic discourses, including exploration of citizens' satisfaction with democracy.

This study explored the gap in the literature of satisfaction with democracy created by the absence of a key political actor in the established field- the media. Hence, the contribution of media use to satisfaction with democracy is documented in this research. The impetus for this study emerged from the notion that, the mass media, like other democratic institutions, contribute to internalisation of democratic values, ideology and norms, and thus deserve to be considered when indexing satisfaction with democracy in the society.

Additionally, the study becomes imperative giving the dissensus of viewpoints on how changing media landscape alters the contours of media-politics relations such that the new and social media are considered more democratic than their precursors, the mainstream media. Although, the study documents significant contributions of media to citizens' satisfaction with democracy, it suffers from some theoretical, methodological and analytical inadequacies that future research should endeavour to crystallise.

Firstly, while the study utilised the media system dependency theory little constructs from the theory were tested. Future studies could explore MSDT constructs such as media trust, media reliance, and media dependency, among others. Secondly, the study is limited by dearth of literature in satisfaction with democracy from mediacentric perspective. Most of studies in satisfaction with democracy are rooted in political science and sociology. Hence, scholars need to further explicate the tangential role of media in all aspect of democratic and political studies. Methodologically, the study utilised cross-sectional survey design and method, which is limiting in an exploratory study of this nature. Subsequent exploration could factor in qualitative and/or mixed method design, which could help build measures for future replicating quantitative studies. Longitudinal design could also provide insight into changing perceptions of the role of media in democracy within election and in the inter-election years. In addition, study of this nature requires intensive, extensive and diverse sample in order to enjoy robust external validity. Therefore, future endeavour should utilise multi-contextual locales and diversified sample. Despite the aforementioned limitations, the study explicates the importance of considering the mass media as critical and fundamental democratic resources in exploration of citizens' satisfaction with democracy.

REFERENCES

Aarts, Kees & Thomassen, J. (2008) Satisfaction with democracy: Do institutions matter? *Electoral Studies* 27, 5-18.

Ariely, G. (2013). Public administration and citizen satisfaction with democracy: Cross-national evidence. *International Review of Administrative Sciences, 79*(4), 747-766.

Bagdikian, B. H. (1997). *The media monopoly, 5th ed.* Boston, MA: Beacon Press.

Ball-Rokeach, S. (1998). A theory of media power and a theory of media use: Different stories, questions, and ways of thinking. *Mass Communication and Society*, *1*, 5–40.

Baran, S. J. & Davis, D. K. (2012). *Mass communication theory: Foundations, ferment and future, 7th ed*. Boston, MA: Wadsworth Cengage Learning.

Ceron, A. & Memoli, V. (2016). Flames and debates: Do social media affect satisfaction with democracy? *Social Indicators Research, 126*(1), 225-240.

Croteau, D. & Hoynes, W. (2000). *Media/society: Industries, images and audiences, 2nd ed.* Thousand Oaks, CA: Pine Forge Press.

DeFleur, M. L. (2010). *Mass communication theories: Explaining origins, processes, and effects.* New York: Allyn & Bacon.

Dutta-Bergman, M. J. (2004). Complementarity in consumption of news types across traditional and new media. *Journal of Broadcasting and Electronic Media, 48*(1), 41-60.

Encyclopedia of Communication and Information. (2002). *Democracy and the media.* Retrieved on 21 Apr. 2017 from: http://www.encyclopedia.com

Ezrow, L. & Xezonakis, G. (2011). Citizen satisfaction with democracy and parties' policy offerings: A cross- national analysis of twelve European party systems, 1976-2003. *Comparative Political Studies, 44*(9), 1152-1178.

George, N., and Jackob, E. (2010). No Alternatives? The relationship between perceived media dependency, use of alternative information sources and general trust in mass media. *International Journal of Communication, 4*, 589-606.

Guldbrandtsen, M. & Skaaning, S. (2010). Satisfaction with democracy in Sub-Saharan Africa:

Assessing the effects of system performance. *African Journal of Political Science and International Relations, 4*(5), 164-172,

Ha, L., Yoon, K. & Zhang, X. (2013). Consumption and dependency of social network sites as a news medium: A comparison between college students and general population. *Journal of Communication and Media Research, 5*(1), 64-83.

Halla, M., Schneider, F. G. & Wagner, A. F. (2008). *Satisfaction with democracy and collective action problems: The case of the environment*. IZA Discussion Papers, No. 3613. Retrieved April 21, 2017 from: http://nbn-resolving.de/urn:nbn:de:101:1-2008080737

Herman, E. & Chomsky, N. (2002). *Manufacturing consent: the political economy of the mass media*. New York, NY: Pantheon.

Jebril, N., Stetka, V. & Loveless, M. (2013). *Media and democratization: What is known about the role of mass media in transition to democracy.* Oxford: Reuters Institute, The University of Oxford (UK).

Jung, J.-Y., Moro. M. (2012). Cross level analysis of social media towards the construction of an ecological framework. *The Journal of Social science, 73*, 053-074.

Krejcie, R. V. & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*(3), 607-610.

Lenhart, A. & Madden, M. (2005). T*een content creators and consumers: More than half have created contents for the internet, and most teen downloaders think that getting free music files is easy to do.* PEW Internet and American Life Project.

Lin, C. (2001). Audience attributes, media supplementation, and likely online service adoption. *Mass Communication & Society, 4*, 19-38.

Linde, J., Ekman, J., 2003. Satisfaction with democracy: A note on a frequently used indicator in comparative politics. *European Journal of Political Research, 42*, 391–408.

McNair, B. (2003). *An introduction to political communication, 3rd ed.* London: Routledge.

Miller, K. (2005). *Communication theories: Perspectives, processes and contexts, 2nd ed.* Boston, MA: McGraw-Hill Companies.

Mustapha, L. K. (2007) Building critical and active electorate in nigeria and a new agendafor the media. In H. A. Saliu et al. (eds.) *Nigeria beyond 2007: Issues, perspectives and challenges* (pp. 195-208). Ilorin: Faculty of Business and Social Sciences, University of Ilorin.

Mustapha, L. K., Ahmad, M. B. & Abubakar, I. Y. (2014). Media ownership and marketplace of idea: Is true democracy possible? In L. Oso, R. Olatunji & N. Owens-Ibie (eds.) *Journalism and media in Nigeria*, (pp. 115-141). Concord, Ontario: Canada University Press.

Mustapha, L. K., Gbonegun, V. O. & Mustapha, M. L. (2016). Social media use, social capital, and political participation among Nigerian university students. *Trípodos, 39,* 127-143.

Mustapha, L. K. & Mustapha M. L. (2017). Media and youths' civic engagement during the
2015 Nigerian general election. *Estudos em Comunicação, 24,* 177-195.

Onomo, A.A. (2012, January 15). People power and social media. *The Guardian*, pp. 38.

Rosenberry, J. & Vicker, L. A. (2009). *Applied mass communication: A guide for media practitioners.* Boston, MA: Pearson Education Inc.

de Vreese, C. H. (2005). News framing: Theory and typology. *Information Design + Document Design, 13*(1), 51-62.

Wanger, A. F., Schneider, F. & Halla, M. (2009). The quality of institutions and satisfaction with democracy in Western Europe: A panel analysis. *European Journal of Political Economy,* 25, 30-41

Whitehead, L. (2002) *Democratization: Theory and practice* Oxford: Oxford University Press.

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ON BACKHAULING OPTIONS FOR FUTURE HETEROGENEOUS NETWORKS

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ABSTRACT

Heterogeneous Network (HetNet) is a solution to coverage and capacity challenges arising from the global upsurge of mobile data traffic volumes, driven mostly by increase in use of data-intensive devices, such as, smartphones and tablets. However, effective backhaul implementation for small base station (SBS) still remains the main bottleneck, as the ever-increasing SBS density will lead to a more complex backhauling and, as such, high risk of rising capital, and operational and network energy costs. In this studyr, the conventional backhaul technologies are compared with the aim of investigating the best suited for future generations networks using the comparison parameters that are the major drivers for future networks. It was discovered that no backhaul technology performed excellently well in all of these parameters but all technologies have areas of high performance, hence the future network is expected to combine backhaul technologies in areas where they perform best.

Keywords: *Backhaul technologies, Small cells, Heterogeneous networks, future network.*

1. INTRODUCTION.

The explosive and continuous growth in the demand for data by android, iOS etc operating on smart phones, tablets, and other data-consuming devices, will continuously compel mobile network operators (MNO) to significantly increase their network capacity while decreasing the cost/bit delivered [1].The traditional cellular architecturescater for large coverage areas, which often fail to achieve the expected throughput as a result of high inter-cell interference, bandwidth, and backhauling air interface and network configuration [2].However, most methods for increasing network capacity and filling coverage gaps come at the expenseof increasednetwork energy consumption because of the many numbers of active nodes such as the macro base stations and cooling systems.The price paid leads to many problems for the traditional network energy solutions [3].

Researches have been done in [3 – 8] to reduce the high power consumption of future mobile networks..One of such methods developed is network densification

through cell shrinkingin which large numbers of low power base stations (called small base stations (SBS)) are deployed to complement the existing macro base stations (MBS). These SBS(includes femto, micro and pico base stations) have small coverage areas, improved the spectral efficiencies, low path losses and low power consumption. This low power can be as small as 500 W, which is feasible and sustainable even when powered by renewable energy sources. The 4 kW power consumption by the MBS is quite high when compared to the 500 W by the SBS[3] [4]. The resulting network consists of various types of base stations each with different coverage areas typically referred to as heterogeneous network (HetNet) [1,2].

Although, energy-efficient operation is possible using the SBS as they consume low power, however, there is a need for powering in the high-capacity backhaul connection between the SBS and the mobile core network since more SBS would be required to compliment a single high powered MBS. This SBS-backhaul links may in turn increase the energy consumption of the overall SBS sites beyond what could be supported with low-cost renewable energy solutions. Since increase in SBS deployment will almost certainly be accompanied by increased overall energy consumption mostly attributed to the SBS backhauling [3].

Therefore, it is of paramount necessity to provide a holistic and comprehensive approach towards achieving a more energy-efficient and sustainable green backhauling for future HetNets as compared to traditional homogeneous macro network which is the aim of this review work. This paper therefore explores and provides a critical and systematic review of the various backhauling options available today for future HetNet.

2. HETEROGENEOUS NETWORK (HetNet)

HetNet architecture involves the interconnection of different base station types, which are macro, micro, pico and femto base stations, with varyingcoverage footprints and power requirements with the aim of increasing network capacity while ensuring higher quality of service (QoS) and bandwidth usage in an energy efficient way. Table 1 presents the different base stations, their coverage distances, power radiated and consumed with the various backhauling technologies for connecting the base stations and the core networks. Figure 1 is a block diagram of a typical set-up of how the SBS are connected to the MBS, showing the different links vis-à-vis, backhaul, fronthaul, wireless access and relay backhaul links. It is a scenario of how the core network which is accessing the Internet can be connected to the various SBS.

Table 1.Various base station types [3-5].

Base State Type	**Coverage Distance (km)**	**Radiated Power (W)**		**Power Consumption (W)**	**Backhaul Type**
		Indoor	Outdoor		
Macro	< 35	-	5 – 40	1000 – 5000	Fiber/Microwave
Micro	< 2	-	0.5 – 2	100 – 300	Microwave
Pico	< 200	0.1	0.25 – 2	9 - 15	Microwave/Fiber/DSL
Femto RRH Relay	10 - 15 <2 < 2	< 0.1 - <1	- 5-20 0.25-7	6 – 14 550 - 760 10 – 120	Fiber/DSL Fiber via DeNB

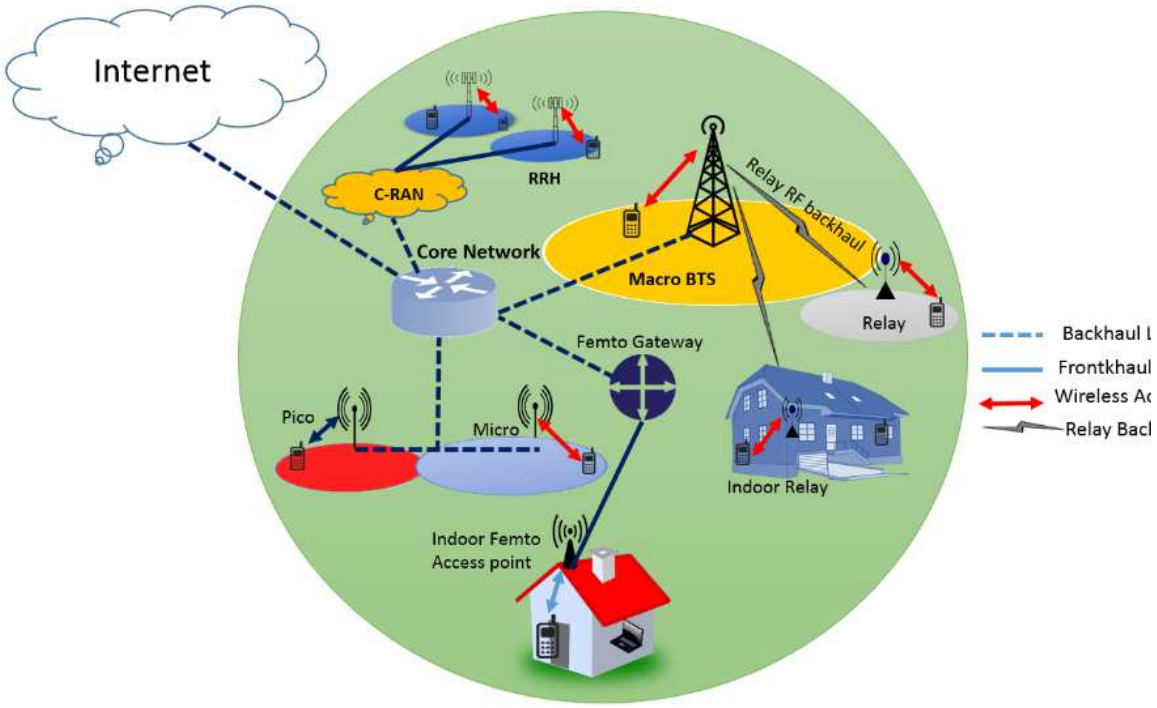


Figure 1: Typical Heterogeneous Network Deployment Scenario [5]

3. BACKHAUL TECHNOLOGY OPTIONS

HetNet is described as the combination of different types ofbase stations with various building components, form factor, coverage area, operation and cost of procurements. The coverage footprints of the SBS are the small cells while for the MBS are called macro cells.[1- 6].Backhauling, which is of two types, wired and wireless, is the connection between the SBS and MBS and also the link from core network to the MBS.

3.1 Wired Backhauling

Wired backhaul solution is a type of backhauling that uses cables to connect nodes together. It is the most suitable solution especially in dense urban deployment due to high reliability, high data rate and high availability but at an extra cost [5, 6]. Thetwo types of wired backhauling are copper and optical fibre cable cables. Table 2 presents the different types of copper cables available for backhauling with their corresponding maxima downstream and upstream data rates.

*A. **Copper Cables***

Copper cables ranges in a variety of cables such as the E1/T1and digital subscriber line(DSL). E1/T1 cablesare the ancient backhaul medium betweenBase Transceiver Stations (BTS) and Base Station Controller(BSC). They operate using Time Division Multiplexing techniques known as PlesiochronousDigital Hierarchy (PDH). There are two standard PDHdelivering differentbit rates: the T-carriers (T1-T4) and E-carriers(E1-E5). Leased T1/E1 copper lines dominate the backhaul solutions in the 1G and 2G networks as they provide suitable support for voice traffic, deterministic QoS, low latency and low delay variations (jitter). However, the increase in the required backhaul capacity with the latter generations of mobile networks has caused a huge growth in the number T1/E1 connectionsand cost As a result, leased T1/E1 is not a suitable backhaul option for future networks [7]. Digital subscriber line (DSL) over existing copper infrastructure is a good backhaul option for short distances mostly used for indoor backhauling [7] and for broadband applications. However, its backhaul capacity depends on the technology and the distance from the exchange.The continuous improvements in DSL technology leads to ADSL2+, GSHDSL.DOC, VDSL2, VDSL2+ ETC, making them viable for mobile backhaul for future networks [8].

B. Optical fibers cable

An optical fiber cable comprises of a transparent core and a cladding with rays of light kept in the core by total internal refraction; while information is transmitted as rays of light from one point to another within the cable. Fiber, which are generally wider, used for shorter lengthsand can support multiple propagation paths are known as multi-mode fibre (MMFA single-mode fiber (SMF) has a single path, provides high speed connectivity, making it suitable for future networks as any backhaul capacity can be served [10]. On the other hand, a huge capital expenditure (CAPEX) of up to $100,000 per kilometer is incurred by theMNOs. It also requires permits, trenching, boring and ducting leading to high deployment duration [11].

Table 2: Copper Cables Available For Backhaul [8, 12]

CABLE	STANDARD	TYPES	MAXIMUM DOWNSTREAM	MAXIMUM UPSTREAM
Data Over Cable Service Interface Specification (DOCSIS)	ITU DOCSIS 1.0	1.0	10 Mbit/s	10 Mbit/s
		1.1	10 Mbit/s	10 Mbit/s
		2.0	30 Mbit/s	30 Mbit/s
		3.0	200 Mbit/s	200 Mbit/s
		3.1	1–2 Gbit/s	1–2 Gbit/s
		3.1 Full Duplex	10 Gbit/s	10 Gbit/s
Digital subscriber line (DSL)	ITU G992	SADSL	12 Mbps	1.8 Mbps
		ADSL 2	12 Mbps	3.5 Mbps
		ADSL 2+	24 Mbps	1.3 Mbps
		ADSL 2 +M	24 Mbps	3.3 Mbps
		VDSL	55 Mbps	3 Mbps
		VDSL 2+	55 Mbps	3 Mbps
		G. FAST	1 Gbps	1 Gbps
FIBER Optics cable	ITU G.707, G.783, G.784 AND G.803	Single mode	> 10Gbps	> 10Gbps
		Multi mode		
		Plastic		

3.2 WIRELESS BACKHAULS

Wireless backhauls when compared to wired backhauls have lesser capacity and reliability, but become useful in areas where wired backhauls are difficult to deploy in terms of location or cost [5, 7, 8, 9 and 10]. Wireless backhauls are of two major types;Line of Sight (LoS) and Non-Line of Sight (NLoS). LoSbackhaul requires that both communicating antennas haveclear visibility to each other for communication to be made, while the NLoS does not require that the communicating bodies have a clear visibility to establish information exchange [13].Wireless backhaul includes Microwave, Satellite, TV White Space, Self-Backhauling etc.Parameters such as communication channel, spectrum efficiency, cost of the backhauling and backhaul capacity among others for the two types of wireless backhauls are compared in Table 3.

A. Self-Backhauling System

Self-backhauling system uses the existing cellular network infrastructures to provide backhaul traffic. It involves the use of existing macro radio access network (RAN) to provide backhaul to SBS. Its merits include; flexible deployment in dense SBS scenarios using NLOS requirement, cost saving through reusing of macro cell infrastructures such as spectrum, leverage the existing macro site management and control (such as security management, resource management, fault management) [3,9]

B. Microwave and Millimeter wave backhaul

Microwave and millimeter wave backhaul have been dominating mobile network for years especially in geographic challenge areas. They are easy to deploy and support a distance of up to 50 kilometers. New innovations (such as Adaptive Coding and Modulation (ACM), compression accelerators etc) are being made so as to increase the bandwidth on both links, hence making them operate in both LoS and NLoS (but microwave is mostly used in LoS backhaul) using point-to-point (PtP) or point-to-multipoint (PtMP) topologies.[9]

Microwave backhaul utilizes various frequency bands including licensed (6 GHz to 38 GHz) and unlicensed (2.4GHz and 5.8 GHz) bands.The setback to microwave is that operating in the licensed band cost more CAPEX while operating in the unlicensed band and E-band is of less CAPEX (which is lightly licensed and relatively easy permission, with frequency ranging from 70 GHz to 80 GHz).However, it suffers attenuation from atmospheric effects and other signals. In addition, it has been established that the operating frequency and bandwidth of E-band are inversely proportional to coverage distance.This makes the E-band mostly used in small cell backhauling and short distance links. Also, when the gap between coverage areas is large and unpopulated, it is not economically feasible to add towers to bridge the distance. Compared to T1/E1 copper links, implementing microwave links results in higher CAPEX due to equipment costs and spectrum licensing fees, however the operating expense (OPEX) is likely to be less over time [7,9, 10, 14 and 15].

C. Satellite Backhauling,

This type of backhaul is preferred in remote areas where other backhaul solutions are uneconomical to deploy [6]. Backhaul over satellite was demonstrated in 2012 to deliver a speed of 10Mbps at download speed and 7 Kbps upload speed [10].

In many areas where terrestrial infrastructure is limited satellite becomes the primary option for transporting voice and data services. Satellite communication is not affected by topological variations such as distance, terrain or LoS, making it the most viable option for backhauling. Although satellite might be more expensive than other wireless solutions, it is scalable, highly reliable and can be deployed quickly, even under the most challenging geographical and climatic conditions [13]. Also the invention of small cell technology has motivated some MNOs to consider the use of carrier-class satellite backhaul as a viable option to more traditional backhaul types. Compared to macrocell solutions, these small cell networks are less expensive; when coupled with a low cost satellite MODEM/router. Moreover, it enables MNOs to

expand coverage into rural areas quickly and economically or operate smaller networks on board ships, in aircraft, or in remote mining areas [16].In future network, satellite will contribute in areas like coverage extension, enhanced spectral utilization integrated signaling systems, and providing resilience [17].

Table 3: Comparison Between LOS and NLOS Wireless Backhuals

PARAMETERS	LOS	NLOS
Communication channel	Requires a clear unobstructed visibility between antenna	Requires only to be placed within range of the backhaul radio unit
Multipath fading and signal interference	A highly directional beam transmits the data in a straight line with little or no fading or multipath radio interference.	NLoS systems using OFDM present a level of tolerance to multipath fading and other wireless channel impairments not possible with LoS systems.
Spectrum efficiency	This is a highly efficient use of spectrum, as multiple microwave transceivers can function within a close proximity to each other and reuse the frequency band for transmitting separate data streams	It has limited spectrum efficiency hence, frequency planning would have to be planned to avoid too much interference.
Areas of application	Mainly used for high-bandwidth applications for outdoor small cell deployments rather than indoor cells	It can provide coverage for various types of small cell setups with proper design,
Tolerance to environment changes	Pole tilting or swaying are problems for deploying small cell backhaul on structures likeutility, lighting, and traffic poles. Also environments with many trees such as park, could block LoS making them impractical location for small cells backhauled through LoS technology	A single NLoS base-station can provide coverage for multiple small cells within the coverage area without the need for an unobstructed path between the transceivers, this makes the technology highly helpful for future planning and upgrades

Cost of the backhauling	The cost of the backhaul rises quickly when compared to NLoS in cases of huge deployment especially if daisy chains are involved as significant number of skilled technicians are usually required for antenna alignment for LoS technologies	NLoS technologies are easy to deploy as they are mostly "plug and play" and can be set up in a short time with reducedlabour costs.
Backhaul capacity	LoS technologies have no upper limit lower than that offered by the network.	NLoS technology has an upper limit to the amount of data that each coverage area can backhaul.

D. Wi-Fi Network Technology

Wi-Fi has been modified from its initial indoor usage to a feasible backhaul connectivity of up to 38 Km. it is base on the IEEE 802.11 standard using 5.8 GHz and 2.4 GHz unlicensed band. These together with its low cost and flexible deployment makes it a good alternative for microwave backhaul. However, it has design limitations relevant to the achieved throughput, distance coverage, packet overhead, and timing and synchronization [7, 18].

E. Massive MIMO Backhauling

A Massive MIMO system involves scaling up antenna system of MIMO whereby hundreds of MBS antennas serves thousands of Mobile terminals in the same time-frequency resource. With aggressive spatial multiplexing and array gain, massive MIMO could achieve capacity increase and energy efficiency improvement [19].

However, Massive MIMO provides limited throughput to mobile end users in high path loss channels but this could be improved with the introduction of small cells. This results in Massive MIMO-based HetNet [20]. Other merits of Massive MIMO includes: energy and cost efficient components, reduced air interface latency and in-band wireless backhaul [21]

F. WiMAX

This is a broadband-broadcasting technology designed using IEEE 802.16 standards and researches are done for outdoor purposes [7, 21]. It uses orthogonal frequency division multiplexing (OFDM) providing higher throughput (Theoretically, it can provide data rates from75 Mbit/s in single channel and up to 350 Mbit/s via multiple channel), guaranteed QoS and larger coverage area than Wi-Fi. It can work in both unlicensed (typically 2.4 GHz and 5.8GHz) and licensed (typically 700 MHz, 2.3 GHz, 2.5 GHz, and 3.5 GHz) bands hence, reducing the CAPEX more than microwave as it offers cheaper license spectrum as well as unlicensed option. It uses the IEEE 802.16-2004 standard for backhauling in fixed connectivity applications, PtP, PtMP and mesh

topology. It also supports high throughput data aggregation [6]. There are two main sets of WiMAX: the fixed WiMAX and the IEEE 802.6e-2005 [22, 23].

The fixed WiMAX was originally designed using IEEE 802.16-2001 standard for fixed wireless broadband air interface with LOS and PtMP applications only but was modified in subsequent standards up to 802,16d-2014 to target NLOS and add WiMAX system profiles and Errata for 2-11 GHz. While the 802.16e-2015 is an amendment of the fixed WiMAX for mobile wireless broadband providing up tovehicular speeds in licensed bands from 2-8 GHz. It also enables roaming for portable users (laptops, tablets etc) within and between service areas. [24].

4. PERFORMANCE EVALUATION FOR THE VARIOUS BACKHAUL OPTIONS

Minimum delay and latency, low cost and time to deploy, high energy efficiency andavailability of bandwidth for future improvements etc are the vital backhaul requirements to sustain a network for future HetNet.

These requirements vary with the available backhaul options. Hence there is need to provide critical and thorough comparison among the available backhauling options as shown in Table 4.

Table 4: Performance for the Various Backhaul Options

Parameters	**Fiber cable**	**Copper cables**	**Self backhauling**	**Microwave and millimeter wave (mm wave)**	**Wi-Fi**	**Massive MIMO**	**Satellite**	**Wi-Max**
Cost	Huge CAPEX as It requires permits, trenching, boring and ducting.	Low if already existing but high for new deployment or leasing	Low as existing cellular network infrastructures are used.	operating in the licensed band cost more CAPEX while operating in the unlicensed band and E-band cost low CAPEX	Low	Low	Small cell satellite cost low CAPEX	Low but standardization is expected to decrease the CAPEX
Energy efficiency	Highest	High	Moderate	Moderate but can be improved using	Moderate as it has low power low consumpti	Better spectral efficiency and energy	Energy saving mechanism such as split architecture	Moderate but better than Wi-Fi as it offers greater

				energy saving devices	on but low throughput also.	efficiency	can improve the energy efficiency	throughput
Quality of Service (QoS)	Excellent	Guaranteed	Depends on the presence of a regulatory framework for sharing of network resources.	Guaranteed	Not Guaranteed	Guaranteed	Suffers propagation delay	Guaranteed in P2MP mode
Delay and latency	Low	Low	Low	Low	Low	Low	High	Low
Network Capacity	Unlimited capacity	High with recent brands (10Gbit/s)	Limited but can be improved by adding more carriers	High (2Mbit/s-170Mbit/s	High (11Mbit/s, 54Mbits/s or 600Mbit/s)	High as it multiplies the capacity without requesting for more spectrum.	Medium (384 Kbit/s to 4.81 Mbits/s)	High (75 Mbits/s to 359 Mbits/s)
Available bandwidth for future improvement	High	Not imminent as capacity depends on number of cables	Medium with modifications	High available spectrum especially in the V and E-band.	High	Sufficient bandwidth using same frequency resources	Bandwidth depends on some parameters such as size of antenna etc	Higher than wi-fi.
Suitability for heterogeneous network	Aggregation and core	Indoor small sites and for low traffic MBS backhauling	Small cell backhauling	MBS and SBS backhauling	Small cell backhauling	MBS and SBS backhauling	Geographically challenged areas and low density area backhauling	Outdoor and indoor Small cell
Duration of deployment	Months and possibly years	Months and possibly years	Days	Weeks	Days	Weeks	Days	Weeks
License required	No, but permit required for laying	No but permit required for laying	No new licensing is required as same	Licensed for microwave but	Not licensed	Works with both licensed and	Yes	Works in both license and unlicensed

	cables	cables	licensing for RAN	light licensed /unlicensed for V-band		unlicensed spectrum		band. Both cheaper than microwave.
Synchronization and timing	Available	Available	Not available	Available	Not Available	?	Available	Uses GPSfor synchronization
Power consumption	Least	Least	Low	Moderate	Moderate	Low	Low	Low
Ease of deployment	Difficult	Difficult	Easy	Easy	Easy	Easy	Easy	Easy

5. Conclusion

In this study, an overview of the currents backhaul options, their prospects towards the future network and their challenges are presented.A comparison was made based on their current performance criteria and expected performance towards the future network. it was shown that while fiber optics cable performed excellently well, the CAPEX cost will limit it to few places therefore it was suggested to be used as macro cell backhaul and at aggregation cell. In addition, cheaper options like millimetre wave, WIMAX and MIMO backhauls provides promising feature like higher capacity, lower CAPEX, faster connectivity etc.

It can hence be concluded that the future network will have to choose and combine among the available backhaul options as their performances varywith conditions and locations, hence they all have various roles to play for effective deployment of the future network.

REFERENCES

[1] AmitabhaGhosh, NitinMangalvedhe, RapeepatRatasuk, BishwarupMondal, Mark Cudak, Eugene Visotsky, and Timothy A. Thomas, 'Heterogeneous Cellular Networks: From Theory to Practice' IEEE communication magazine vol 50 pp 54-64. June 2012. Available at http://www.engr.uconn.edu/~bing/cse330/papers/heter-net/heter-net-theory-practice.pdf [accessed 25.1.2018].

[2] Yong ShengSoh,Tony Q. S. Quek, MariosKountouris and Hyundong Shin, "Energy Efficient Heterogeneous Cellular Networks" IEEE Journal on Selected Areas in Communications, VOL. 31, NO. 5, pp840-851, 2013.

[3] N. Faruk, K. Runtik, E. Mutafungwa, R. Janti "Energy Savings Through Self-backhauling for Future Heterogeneous Networks,"Elsevier Energy Journal, VOL.115, pp.711-721, 2016.

[4] Faruk. N, A.A. Ayeni, M. Y. Muhammad, L.A. Olawoyin, A. Abdulkarim, J. Agbakoba, O. Moses, "Powering Cell Sites Using Solar Energy in Mobile Cellular Networks" International Journal of Engineering and Technology, IJET Publications UK. Vol. 2 No.5, May, 2012.

[5] Faruk. N, Abdulkarim A. Oloyede, AbubakarAbdulkarim, lukman A. OLawoyin and Yinusa A Adediran "Energy Savings in Heterogeneous Network with self organizing Backhuals" in Advances on computational intelligence in Energy; the Application of Natural-inspired metahueristic Algorithms in Enegy, Green energy and technology, Springer, 2018,

[6] Zhongshan Zhang, Xiyuan Wang, Keping Long, Athanasios, V. Vasilasko and LajosHanza, "Large scale MIMO based wireless backhauling in 5G network" IEEE Wireless communication, 2015, pp58-66.

[7] Tipmongkolsilp, Said Zaghloul and AdmelaJukan 'The Evolution of Cellular Backhaul Technologies: Current Issues and Future Trends' IEEE communication survey and tutorial, VOL. 13, NO.1, 2011 pp97-124

[8] SMALL CELLS BACKHAUL Alcatel-Lucent Strategic White Paper available at http://www.stjohnpatrick-.com/12/ec/7small-cells-backhual.pdf [accessed on 25.01.18].

[9] Faruk. N, M. Y. Muhammad, O. W. Bello, A. Abdulkarim,A. John and M. Gumel," Energy Conservation Through Site Optimization For Mobile Cellular Systems" in Epistemic in Science, Engineering and Technology (ESET) Canada,Vol 2, No 1, 2012, pp26-33.

[10] Mona Jaber, Muhammad Ali Imran and RahimTafazolli. (2016, may). '5G BACKHUAL AND RESEARCH DIRECTION: A SURVEY' IEEE Access,[online] VOL.4 pp1743-1766. Available : http://eprints.gla.ac.uk/132546/1/132546.pdf

[11] Laxmi, Ram Krishna, "Fibre to the BTS – Improving Network Flexibility & Energy Efficiency," FLA division study paper, (online) pp1-7.2012.Available:"http://docplayer.net/41253166-Rf-component-technologies-enabling-affordable-wireless-backhaul-gorden-cook-director-of-business-development-rf-micro-devices.html" [accessed on 04/03/2018].

[12] Cablelabs "Full duplex docsis 3.1-cableslabs" internet: http://www.cablelab.com/full-duplex-docsis. [accessed on 04/03/2018].

[13] GSMA "Wireless Backhaul Spectrum Policy Recommendations & Analysis", ABI Research technology and market intelligence,[online] October 2014. Pp1-66. Available: https://www.gsma.com/spectrum/wp-content/uploads/2014/12/Wireless-B

[14] Farias, F.S.I, P. Monti A. Vastberg, M. Nilson, Costa, J. C. W. A.I, L. Wosinska "Green backhauling for heterogeneous mobile access network: what are the challenges" International Conference on Information and Communications Security ICICS 2013 pp1-5 available https://arxiv.org/pdf/1509.05506.

[15] Amir H. Jafari, David López-Pérez, Hui Song, HolgerClaussen, LesterHo and Jie Zhang "Small cell backhaul: challenges and prospective solutions" EURASIP Journal on Wireless Communications and Networking, pp1-18, 2015 DOI 10.1186/s13638-15-0426-y

[16] Gilat Satelite Networks. Satelite Communication for Efficient Cellular Backhaul, Key Requirements and Advantages. [Online]. Available: "http://www.gilat.com/Cellular-Backhaul"http://www.gilat.com/Cellular-Backhaul"

[17] Barry Evans, Oluwakayode Onireti, Theodoras Spathopoulos and Muhammad Ali Imran "The role of satellite in 5G" 23rd European Signal Processing Conference (EUSIPCO) 2015 pp.2806-2810.

[18] Fabricio-Fairs, MatteoFiorani, Simbel Tombaz, MozhganMahloo Lena Wosinska Joao C.W.A Costa and Paolo Monti "Cost and Energy Efficient Backhaul Options for Heterogeneous Mobile Network Deployments" Photon Network Communication VOL.32, pp422–43, 2016.

[19] D. Perrson, B. K. Lau, E. G. Larsson, T. L. Marzetta O. Edfors, and F. Tufvesson F. Rusek, "Scalling up MIMO: Opportunities and Challenges with Very Large Arrays," IEEE Signal Process Mag., Vol. 30 No.1, pp40-46, Jan 2013.

[20] S. Ten Brink, and M. Debbah J. Hoydis, "Massive MIMO in the UL/DL Cellular Networks: How Many Antennas Do We Need?," IEEE J. Sel. Areas Communication, VOL. 31 No. 2 pp160 – 171,2013.

[21] D. Zhu and P. Liang B. Li, "Small Cell in-band in Massive *MIMO* System: A Cooperation of Next-Generation," IEEE transaction on wireless communication,VOL 14 No.12, pp 60-80, 2015.[online]. Available: IEEE xplore, http://ieeexplore.ieee.org/document/7177124/.

[22] Ahmed Hassan M. Hassan Elrasheed Ismail M. ZAYID, Mohammed AltayebAwad, Ahmed Salah Mohammed and SamreenTarigHassan "Performance Evaluation of QoS in WIMAX Network", Computer Applications: An International Journal (CAIJ), Vol.2, No.2, pp15-23, 2015.

[23] Reza golshan "Fixed and Mobile WIMAX Overview" Fujitsu white paper available :http://us.fujitsu.com/wimax. (accessed on 14/03/18).

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AN ENHANCED SALTING FINGERPRINT TRANSFORMATION ALGORITHM FOR SECURING BIOMETRIC SYSTEM

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ABSTRACT
Biometrics provides higher accuracy of personal recognition in real identity management system than traditional methods because of its properties. However, the security of biometric systems can be undermined, if the template derived from the biometrics traits such as fingerprint is compromised. The stolen template could possibly be used by an attacker to gain unauthorized access to the system or could possibly be used to break into other, unrelated systems that were also keyed to the person's fingerprint. Hence, securing the biometric templates is vital to maintain security and integrity of biometric systems. One methodology for biometric template protection is the template transformation approach, where the template, consisting of the features extracted from the biometric trait, is transformed using parameters derived from a user specific password or key, through transformation algorithm and only the transformed template is stored in the database. This study developed a framework that uses a generated random key without user specific password or key during enrolment / verification and it was implemented to secure medical records using biometric authentication. Collection of fingerprint images was carried-out through Fingerprint Live Scan Device (SecuGen 7.1). Experimental result shows that the proposed enhancement algorithm is better than existing system since the user needs not to remember any secrete key at enrolment or verification. The outcomes of this study incorporate the property of revocability or cancellability with Biometric system without degrading the performance and efficiency of the system.

Keywords: *Biometrics, Security, Template, Traits, Revocability, Cancellability, Transformation, Authentication*

1. INTRODUCTION

Biometrics-based personal authentication systems that use physiological traits such as fingerprint, face, iris, hand geometry, voice of individuals have been shown to be promising candidates for either replacing or augmenting the traditional identity management systems (Matyáš & Rıha, 2000). They are based on entities (traits) that are actually bound with the individual at a much deeper level than, for example, passwords and ID cards (Ratha, Connell, and Bolle, 2001). As a result, they are more reliable since biometric information cannot be lost, forgotten, or guessed easily. Further, Biometric recognition offers a reliable solution to the problem of user

authentication in identity management system (Maltoni, Maio, Jain, and Prabhakar, 2003).

With the widespread deployment of biometric systems in various applications, the focus now is on biometric template security which is an important issue because, unlike passwords and tokens, compromised biometric templates cannot be revoked and reissued. Protecting the template is a challenge (Jain, Ross and Pankant, 2006). The increasing use of biometrics in different environments presents new challenges. Therefore, storing biometric templates, which is unique to individual user, entails significant security risks, due to intra user variability in the acquired biometric traits, it raises a concern about the security and privacy of biometric technology (Krawczyk & Jain, 2005).

Though, Biometrics-based authentication systems are more reliable (biometric data cannot be lost, forgotten, or guessed) and more user-friendly (there is nothing to remember or carry). In spite of these advantages of biometric systems over traditional systems, there are many unresolved issues associated with the application of biometric technology. For example, how secure are biometric systems against attacks? How can we guarantee the integrity of biometric templates? (Ratha, Connell, Bolle and Chikkerur, 2006)

1.1 Fingerprint Recognition

Fingerprint identification is one of the most well-known and publicized Fingerprint identification is popular because of the ease in acquisition, the numerous sources ten fingers available for collection per individual biometrics (Maltoni, Maio,, Jain & Prabhakar, 2009).

1.2 Biometric Template

A template is a set of features extracted from the biometric trait.

1.3 Biometric systems modes

Biometric systems can be used in two different modes enrolment and identification modes as depicted in figure 1.

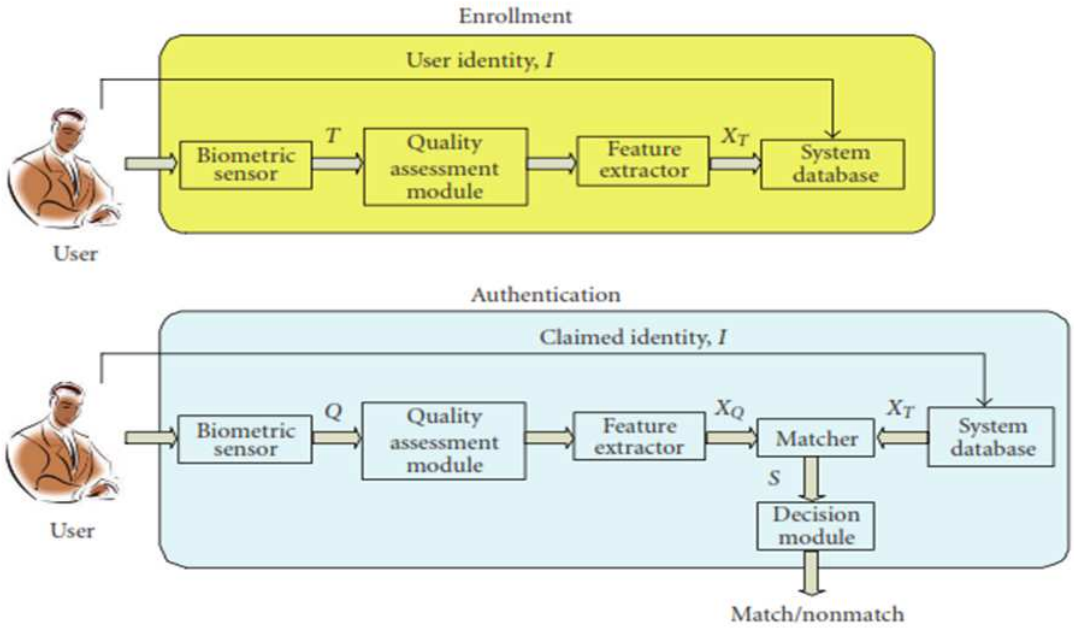


Figure 2.3: Enrollment and recognition stages in a biometric system. Here, T represents the biometric sample obtained during enrollment, Q is the query biometric sample obtained during recognition, XT and XQ are the template and query feature sets, respectively, and S represents the match score. Adapted from Anil K. Jain

With the widespread deployment of biometric systems in various applications, the focus now is on biometric template security which is an important issue because, unlike passwords and tokens, compromised biometric templates cannot be revoked and reissued (Jain, Nandakumar, & Nagar, 2008). Therefore, storing biometric templates, which is unique to individual user, entails significant security risks (Campisi, P. 2013).

One of the most potentially damaging attacks on a biometric system is against the biometric templates stored in the system database. Attacks on the template can lead to the following three vulnerabilities:

(i) A template can be replaced by an impostor's template to gain unauthorized access.

(ii) A physical spoof can be created from the template to gain unauthorized access to the system, also to other systems which use the same biometric trait.

(iii) The stolen template can be replayed to the matcher to gain unauthorized access (Angle, Bhagtani, & Chheda, 2005).

This work addresses this problem by proposing a framework for securing biometric system through fingerprint template transformation approach that uses a generated random key as parameter for the transformation rather than user supply password or key. This work focuses on achieving a secure biometric system and flexibility of use by the user without the needs to remember special password or key. It does not address the security of the system database itself but securing the fingerprint template from being compromised.

Section II provides a critical analysis of related work while Section III gives detailed explanation of our proposed model. Evaluation of the model is discussed in Section IV with Section V concludes the paper by summarizing our contribution.

2. RELATED STUDIES

2.1 Securing Biometric System

Passwords and PIN have the property that if they are compromised, the system administrator can issue a new one to the user. It is desirable to have the same property embedded in biometric system (Matyáš & Rıha, 2000).

The following section provides a detailed description of the approaches that have been proposed for securing biometric templates:

The template protection schemes proposed in the literature can be broadly classified into two categories, namely, (i) feature transformation approach and (ii) biometric cryptosystem (Kareem, Ghany, Hesham, Hassanien, Neveen & Ghali, 2012).

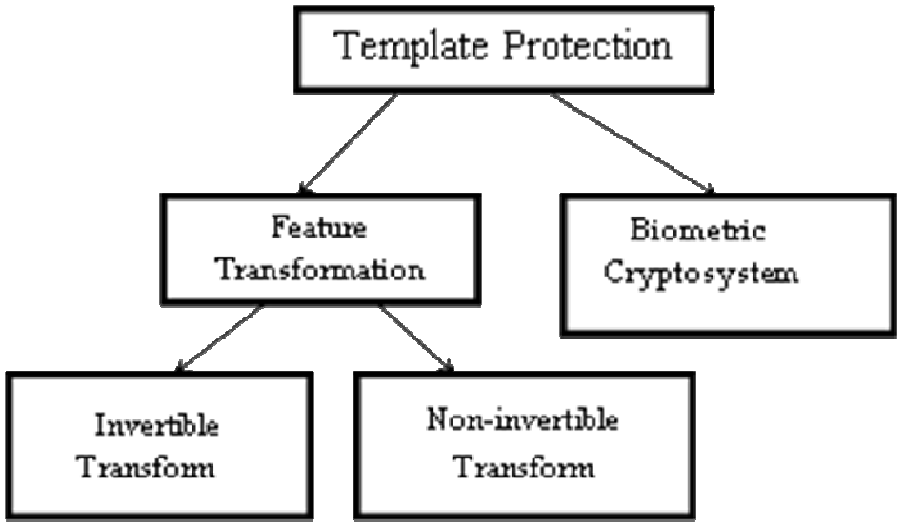


Figure 2: Categorization of template protection schemes

2.2 Feature Transformation Approaches

In the feature transform approach, a transformation function (F) is applied to the biometric template (T) and only the transformed template (F (T; K)) is stored in the database. The parameters of the transformation function are typically derived from user specific key (K) or password. The same transformation function is applied to query features (Q) and the transformed query (F (Q; K)) is directly matched against the transformed template (F (T; K)). The feature transform schemes can be further categorized as (i) Invertible and (ii) Non-invertible transforms (Angle, Bhagtani & Chheda 2005), (Jain, (2015)) and (Campisi, 2013).

2.2.1 Invertible (Salting) Transform

This is a template protection approach in which the biometric features are transformed using a function defined by a user-specific key or password. Since the transformation is invertible to a large extent, the key needs to be securely stored or remembered by the user and presented during authentication. The limitation in this approach is that there is

need for additional information in the form of special password or key which increases user's inconveniences (Ghany, Hefny, Hassanien, & Ghali, 2012). Also, if the user-specific key is compromised, the template is no longer secure.

2.2.2 Non-invertible Transforms

In this approach, the biometric template is secured by applying a noninvertible transformation function to it. Noninvertible transform refers to a one-way function, F, that is "easy to compute" (in polynomial time) but "hard to invert" (given F (x), the probability of finding x in polynomial time is small). The parameters of the transformation function are defined by a key which must be available at the time of authentication to transform the query feature set. The main characteristic of this approach is that even if the key and/or the transformed template are known, it is computationally hard in terms of brute force complexity for an adversary to recover the original biometric template. The main drawback of this approach is the trade off between discriminability and non invertibility of the transformation function. The transformation function does not preserve the discriminability (similarity structure) of the feature set, that is, features from the same user should have high similarity in the transformed space, and features from different users should be quite dissimilar after transformation (Gudavalli, Kumar, & Raju, (2014) and (Zhe Jin , Andrew, Bok-Min,Yong-Haur,2016).

This paper proposes a fingerprint transformation method that does not require user to supply a secrete key during enrollment or verification, yet secure the template and preserve the similarity structure of the feature set.

3. METHODOLOGY

3.1 Model Overview

The model is composed of two phases:

1. The Enrollment Phase.
2. The Verification Phase.

The model as shown in figure 3 works towards a new design fingerprint transformation approach while employing some existing algorithms for feature extraction. The sensor scan the biometric trait (fingerprint) of the user, this is followed by the quality assessment module which determines whether the scanned biometric trait (fingerprint) is of sufficient quality for further processing. Feature extraction module processes the scanned biometric data to extract the salient information (feature set) that is useful in distinguishing between different users. The feature set are called template (t). The template transformation algorithm takes the extracted feature (template (t), random generated key (k), fixed index and compute index to generate a new transform template (tr) which will be stored in the database.

During enrollment, the transformed template is stored in the system database as a template (tr) indexed by the user's identity information (Omotosho, Babatunde & Gbolagade, 2017).

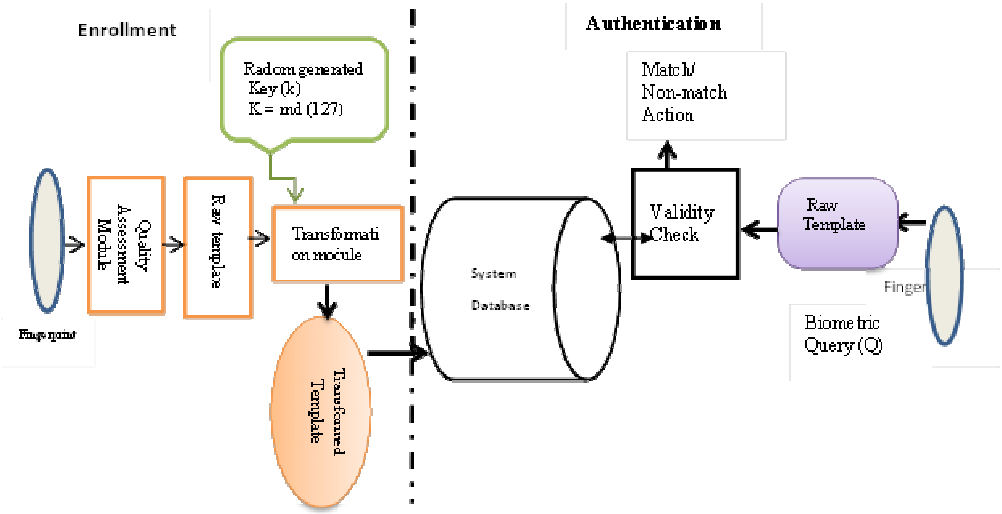


Figure 3: Framework of the proposed Fingerprint template transformation approach

3.2.1 The Enrollment Phase

The sensor which represents a fingerprint scanner attached to a system on which the application runs will accept the fingerprint of the user. The quality assessment module determines whether the scanned biometric trait (fingerprint) is of sufficient quality for further processing. Feature extraction module processes the scanned biometric data to extract the salient information (feature set) that is useful in distinguishing between different users. Two image samples will be captured per fingerprint for a higher degree of accuracy. The minutiae data from each image sample will then be compared against each other (i.e. matched) to confirm the quality of the registered fingerprints. This comparison is analogous to a password confirmation routine that is commonly required for entering a new password. Then the feature data (minutiae) is extracted from the image into a template. The template transformation algorithm which is the main work of this research takes the extracted feature (template (t), random generated key (k), fixed index and computed index to generate a new transform template (tr) which will be stored in the database, indexed by the user's identity as shown in figure 4 & 5. .

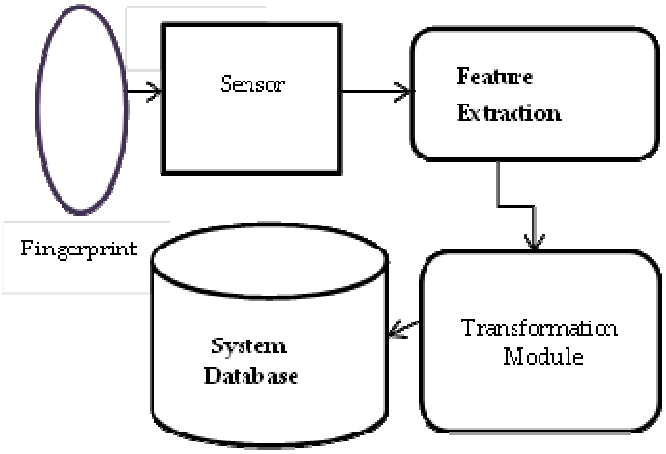


Figure 4: The Enrollment Phase.

Algorithm: (transformation)
Start
Initialize:
Kp = 400
K = rnd (127)
i1 = 103; i2 = 207; i3 = 131;
i4 = 37; i5 = 69; i6 = k;
i7 = k + i4; i8 = i3 - k;
i9 = i4 + i5; i10 = i3 - i1;
byte bb[401]
bb = getRwtemp()
bb[kp] = k
i = 0
Repeat
If (i == transformedindex) Then
bb[i] = 7*(9*bb[i] + bb[kp])
Else
bb[i] = 80 * bb[i]
Endif
i++
Until (i == 400)
Stop

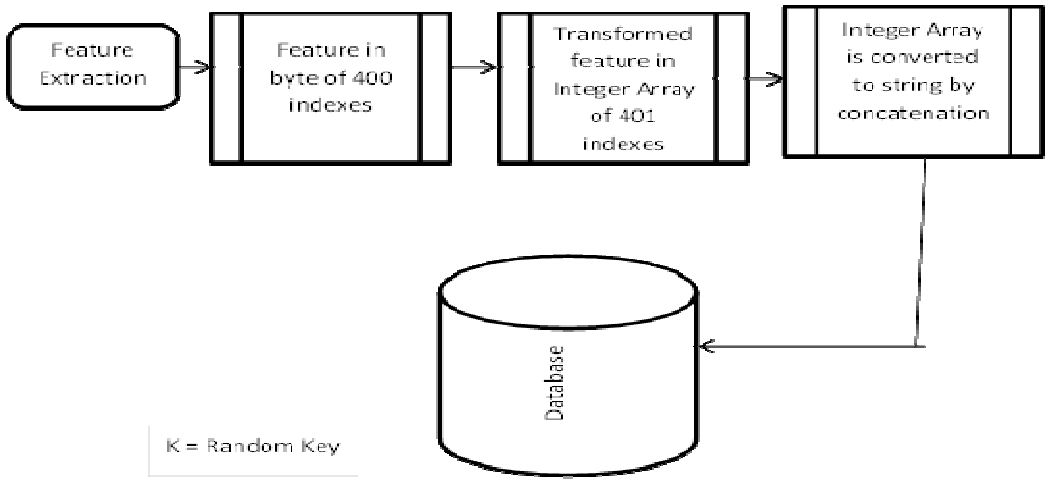


Figure 5: Template transformation module

3.2.2 The Verification Phase

Here, unlike the enrollment phase the sensor accept input of a single fingerprint from an individual who had previously enrolled, extract its features and then present the template to the validity module. The validity module performed validity check on the presented template by comparing it with stored transformed template in the system database. If the template is found it will perform a match action, if not it will performed a non-match action see figures 6 & 7

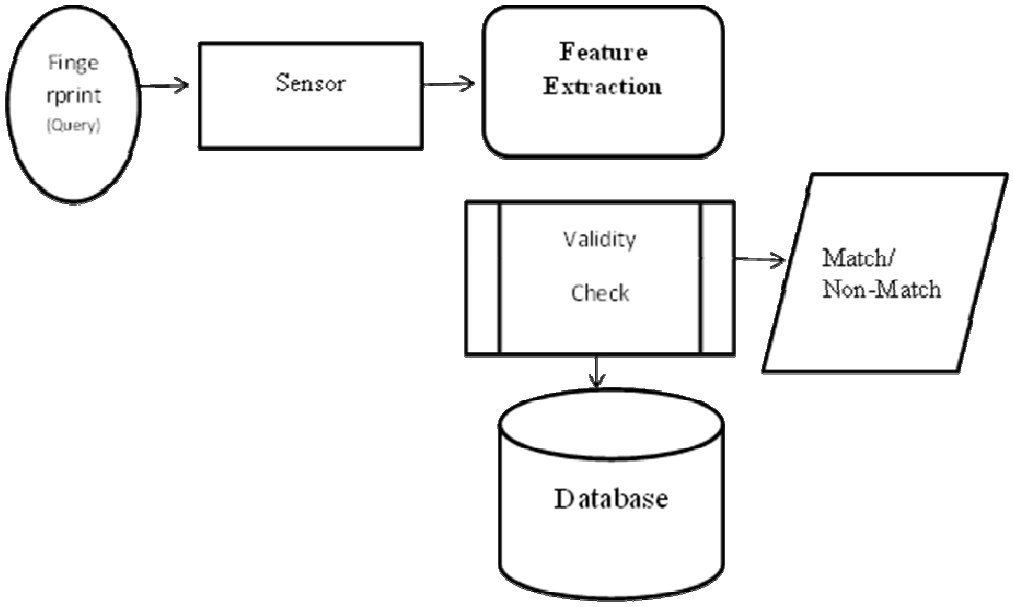


Figure 6: The Verification Phase

```
Algorithm: (decrypt)
Kp = 400
bb = getEncTemp()
int k = bb[kp] / 80
          i1 = 103;          i2 = 207;   i3 = 131
          i4 = 37;           i5 = 69;    i6 = k
             i7 = k + i4;        i8 = i3 - k
             i9 = i4 + i5;     i10 = i3 - i1
   i = 0
Repeat
     If ( i  == Transformedindex)  Then
             bb[i]  = ((bb[i] /9) – bb[kp]))/7
             Else
             bb[i]  = bb[i] / 80
          Endif
        i++
Until (i == 400)
Stop
```

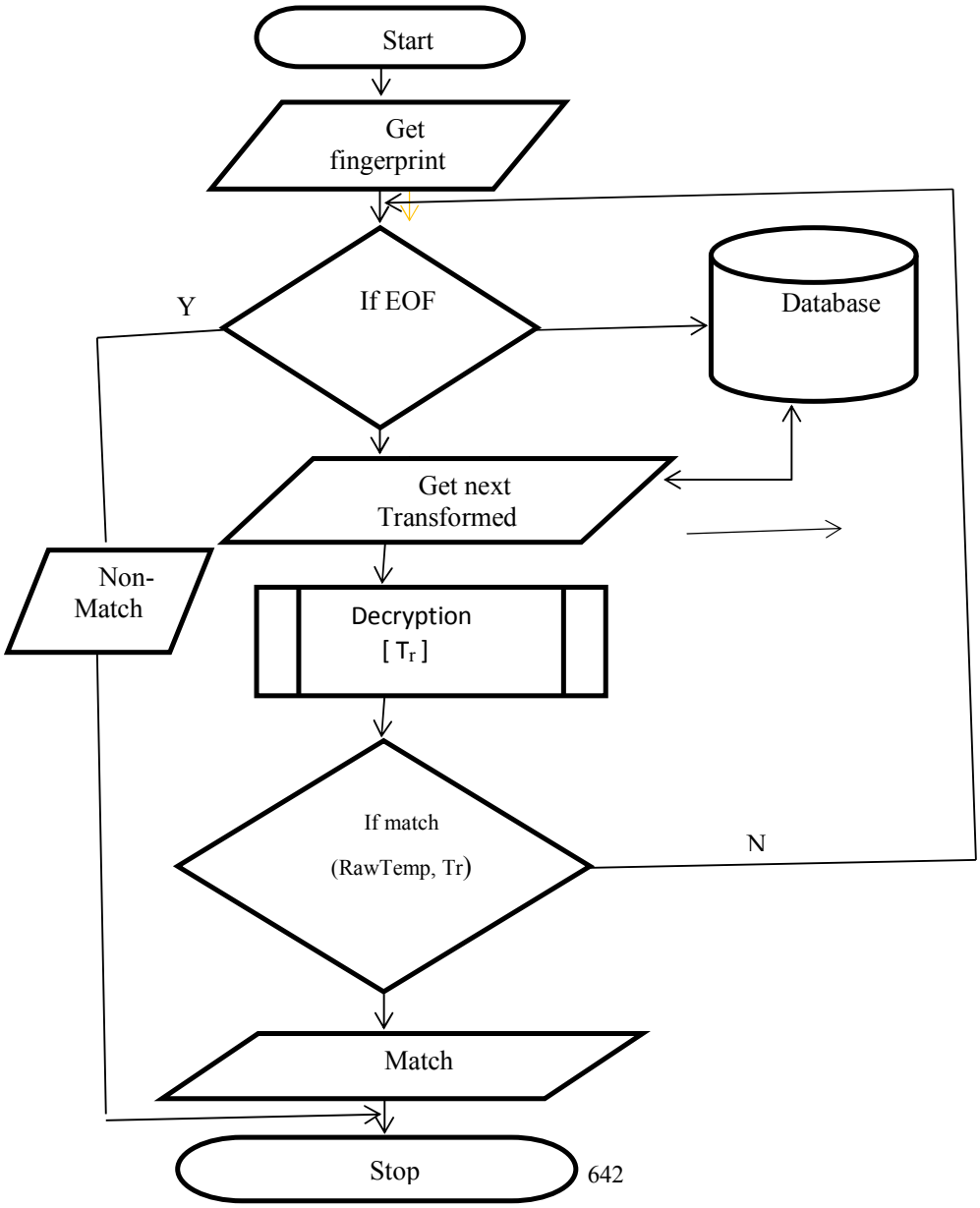


Figure 7: Flowchart of Validity check

Application of our Proposed Scheme to Medical Record: There is an increasing need to identify patients with a high degree of certainty. Identity verification solutions based on biometric technology will provide identity assurance in healthcare industry (Krawczyk & Jain, 2005). The framework was applied by implementing an application based on the proposed framework using Medical Record Biometric System as depicted in figure 8, 9A & 9B.

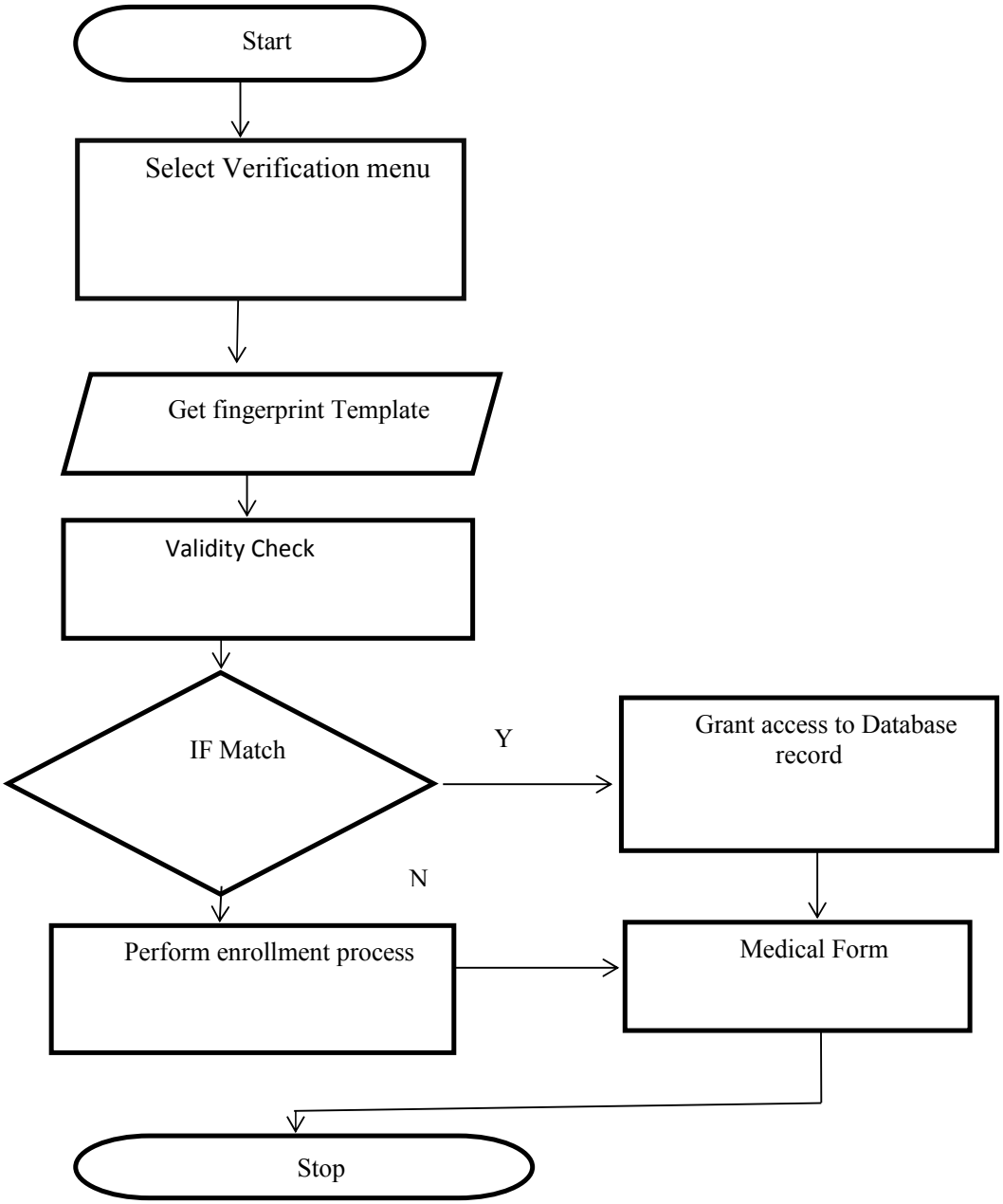


Figure 8 Prototype Program Flowchart

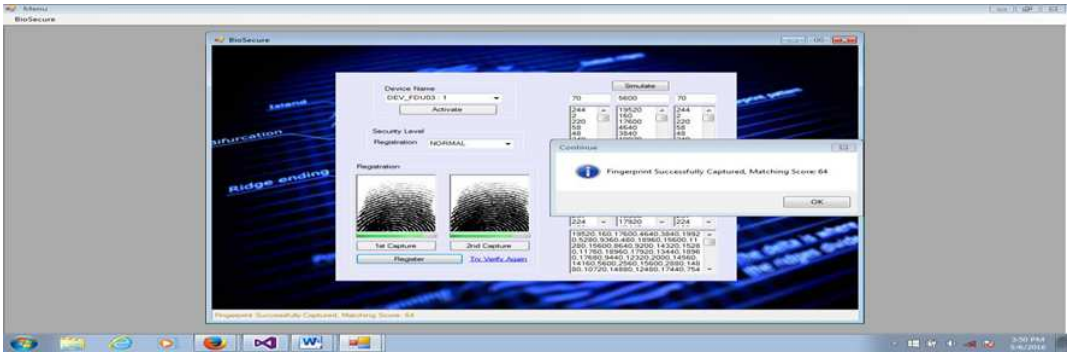


Figure 9 A: Enrollment



Figure 9B: Verification

4. PERFORMANCE EVALUATION

The prototype of the framework will be evaluated based on users' assessment in terms of system reliability and effectiveness, system ease of usage and efficiency of the system. We intend to carry out an initial pilot study where the experimental procedure and guideline will be properly mapped out through hardware performances, software management and how easy and productive user find it through user testing (Ghany, Hefny, Hassanien, & Ghali, 2012).

4.1 Evaluation Indexes for Fingerprint Recognition.

Two indexes are well accepted to determine the performance of a fingerprint authentication system: One is FRR (false rejection rate) and the other is FAR (false acceptance rate) [12].

FAR- describes the number of times, someone is inaccurately positively matched.

FRR- describes the number of times someone who should be identified positively is instead rejected.

FAR	FRR
(%) FAR = (FA/N) * 100 FA = number of incidents of false acceptance N = total number of samples	(%) FRR = (FR/N) * 100 FR = number of incidents of false rejections. N = total number of samples.

The model is capable of differentiating fingerprints at a good correct rate by setting an appropriate threshold value/Security level.

When total number of samples ***is one hundred and twenty (120)***

Table 1 Result Analysis

Security Level	Our Scheme		State of the art	
	False Acceptance Rate (FAR)	**False Rejection Rate (FRR)**	**False Acceptance Rate (FAR)**	**False Rejection Rate (FRR)**
Low	0.83%	2.5%	.77%	2.3%
Medium	0.34%	4.3%	.32%	4.01%
High	0.02%	6.6%	0.01%	5.2%

It should be noted that there is a trade-off between false acceptance rate and false rejection rate.

5. CONCLUSION

The success of biometric system cannot be affirmed without a critical examination of security of template stored in the system database. The main idea of this approach is to store the transformed/encrypted template instead of storing the original template in its raw form.

In case the stored template is stolen or lost, it is computationally hard to reconstruct the original raw biometric data from this template. In this research work, we proposed a fingerprint transformation method that does not require user to supply a secrete key during enrollment.

Security breaches have been usually traced to the in-house people like developers, administrators, users and so on due to having some constant values in the encrypting algorithms, this research takes an extra effort to having fixed and computed indexes. Computed indexes are determined internally by the algorithm at runtime which makes it impossible for these people to predetermine or guess indexes that will be encrypted.

Passwords and PIN have the property that if they are compromised, the user can change it; it is desirable to have the same property of revocability or cancelability with biometric templates.

This study incorporates the property of revocability or cancelability with Biometric system without degrading the performance and efficiency of the system.

In case the biometrics template is stolen it cannot be used to cross-match to another biometric system using the same biometric traits. It also, saves the users the inconveniences of the needs to remember specific password or key during verification.

5.1 FUTURE WORK

This work can be extended to other physiological traits such as facial, iris and palm.

REFERENCES

Matyáš, V., & Rıha, Z. (2000). Biometric authentication systems. In verfügbar über: http://grover. informatik. uni-augsburg. de/lit/MM-Seminar/Privacy/riha00biometric. pdf.

Ratha, N. K., Connell, J. H., & Bolle, R. M. (2001). Enhancing security and privacy in biometrics-based authentication systems. IBM systems Journal, 40(3), 614-634.

Maltoni, D., Maio, D., Jain, A., & Prabhakar, S. (2009). Handbook of fingerprint *rec*ognition. Springer Science & Business Media.

Jain, A. K., Ross, A., & Pankanti, S. (2006). Biometrics: a tool for information security. *IEEE* transactions on information forensics and security, *1*(2), 125-143.

Ratha, N., Connell, J., Bolle, R. M., & Chikkerur, S. (2006). Cancelable biometrics: A case study in fingerprints. In Pattern Recognition, 2006. ICPR 2006. 18th International Conference on (Vol. 4, pp. 370-373). IEEE.

Jain, A. K., Nandakumar, K., & Nagar, A. (2008). Biometric template security. *EURASIP* Journal on advances in signal processing, 113.

Campisi, P. (2013). Security and privacy in biometrics: towards a holistic approach. In Security and Privacy in Biometrics (pp. 1-23). Springer London.

Angle, S., Bhagtani, R., & Chheda, H. (2005). Biometrics: A further echelon of security. In UAE International Conference on Biological and Medical Physics.

Ghany, K. K. A., Hefny, H. A., Hassanien, A. E., & Ghali, N. I. (2012). A hybrid approach for biometric template security. In Proceedings of the 2012 International Conference on Advances in Social Networks Analysis and Mining (ASONAM 2012) (pp. 941-942). IEEE Computer Society.

Gudavalli, M., Kumar, D. S., & Raju, S. V. (2014). Integrated Biometric Template Security using Random Rectangular Hashing. Global Journal of Computer Science and Technology, 14(7).

Jain A. K, (2015), Biometric System Security, Dept. of Computer Science and Engineering Michigan State University, http://biometrics.cse.*m*su.edu

Zhe Jin , Andrew Beng Jin Teoh, Bok-Min Goi, Yong-Haur Tay. (2016). Biometric cryptosystems: A new biometric key binding and its implementation for fingerprint minutiae-based representation. Journal homepage www.elsevier.com/locate/pr, 0031-3203/ 2016 Elsevier Ltd.

Omotosho, F.S., Babatunde, R. S & Gbolagade K. A. (2017), 'Framework for secured biometric System' International Journal of Scientific & Engineering Research, Volume 8, Issue 7, July-2017 ISSN 2229-5518.

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AN INVESTIGATION INTO PACKET ROUTING IN MOBILE AD-HOC NETWORK USING A NOMADIC COMMUNITY SCENARIO

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ABSTRACT

Mobile Ad-hoc Network is one of the classifications of Ad-hoc Networks. MANETs are formed from mobile devices that can wirelessly connect without the need of any pre-established infrastructure or access point. This works investigates the behavioural characteristics of two reactive routing protocols named Ad-hoc On-Demand Distance Vector (AODV) and Destination Source Routing (DSR) protocols when used for simulating packet routing from a source node to the sink node in a nomadic setting. Past studies have identified that the routing protocols used by MANET behaved differently from the ones used in traditional wired and wireless networks. However, most of the previous studies laid much emphasis on investigating the performance of MANET routing protocols in entity mobility models. This work makes use of Nomadic Mobility Model which is a group mobility model that represents node movement patterns in group communication. Nomadic Community Mobility Model represents group of mobile devices that collectively move from one point to another by making use of reference point. In this study, NS2 and BonnMotion 3.0.0 are used as the simulation tool and mobility scenario generation respectively. The network throughput and packet delay are used as the performance metrics in the study. The results in this study identified how packets are routed from the source to the destination while AODV and DSR routing algorithms are used in the Nomadic Community Scenario investigated.

Keywords: *Nomadic Community Model, Ad-hoc network, Packet routing, Node Mobility*

1.0 INTRODUCTION

A Mobile Ad-hoc Network (MANET) is an autonomous, self-configuring network of mobile devices that can be formed without using any pre-established infrastructure (Perkins & Royer, 2003; Baruch & Amitabh, 2008; Muhammad, Rameez & Atif, 2016). MANET has various application scenarios for which it can be used. In MANET, the nodes (mobile devices) receive packets and move these packets to next hop, until all packets are forwarded to the final destination (Abolhasan, Wysocki & Dutkiewicz, 2004; Abdalla, Abu-Rgheff & Senouci, 2007). The specialised routing protocols in MANET are used for the transfer of packets from the source to the destination node. These routing protocols have been proposed for Ad-hoc networks by different authors in the past. As an example, DSDV was proposed by (Perkins & Bhagwat, 1994), DSR

was proposed by (Johnson & Maltz, 1996), while AODV was proposed by (Perkins, 2001; Perkins, Belding-Royer & Das, 2003).

The evolution of MANETs can be traced to military domains where the military needs for battlefield survivability may require that soldiers have mobile network access that are not restricted to by central network infrastructure (Perkins, 2001). However, beyond Military settings, MANETs have become a very popular network being proposed for use in many areas such as rescue operations, environmental monitoring, spontaneous networking in conferences, campuses and related educational meetings (Perkins & Royer, 1999; Perkins, 2001; Belding-Royer & Lee, 2002; Geetha & Gopinath, 2007). While investigating MANET, one of the key features is node mobility. There are several mobility models that have been proposed in literature that are used to handle node mobility. According to (Roy, 2011), a mobility model attempts to mimic the movement of the real mobile nodes that change the speed and direction with time . (Hong, Gerla, Pei., & Chiang, 1999) describes group mobility as another way to simulate group behavior in where each node belongs to a group where every node follows a logical center (group leader) that determines the group's motion behavior. The nodes in a group are usually randomly distributed around the reference point. In group mobility models, the different nodes use their own mobility model and are then added to the reference point which drives them in the direction of the group.

In MANET researches, two approaches can be used for performance simulation of routing protocols. These methods are traces and synthetic modeling. However, synthetic modeling approach is prominently used as against data traces that are used in traditional wired and wireless networks. MANET also allows individual nodes dynamically discover other nodes that they can directly communicate with. Most studies in MANET are done through simulation as real life data sets are not commercially available yet (**).While doing simulations, node mobility is one of the key factors. However, to have a realistic node mobility that can be used in MANET simulations, MANET node mobility models are used (**). One of such node mobility models is Nomadic Community model used in this work. Generally, the movement of the nodes are restricted to a geographical location in MANET simulations involving synthetic modeling. This work uses synthetic modeling approach by making use of nomadic mobility model for the node movements in the simulation. The study investigates the behavioural characteristics of the selected routing protocols in the scenario being investigated. The targeted performance metrics used for protocol comparison are network throughput and packet delay.

1.1 MANET Reactive Routing Protocols

In Mobile Ad-hoc Network, a protocol is used to find valid routes between communicating nodes. MANET Routing protocols are generally classified as Proactive, Reactive and Hybrid. This study considers only reactive routing protocols. In Reactive (On-Demand) Routing Protocols, there is an initialization of a route discovery mechanism by the source node to find the route to the destination node when the source node has data packets to send. When a route is found, the route maintenance is initiated

to maintain this route until it is no longer required or the destination is not reachable. The different types of reactive routing protocols are: Dynamic Source Routing (DSR), Ad-hoc On-Demand Distance Vector routing (AODV), Ad-hoc On-demand Multipath Distance Vector Routing Algorithm (AOMDV) and Temporally Ordered Routing Algorithm (TORA).

1.2 Nomadic Mobility Model

The mobility of nodes in MANET is classified as entity-based or group-based (Aschenbruck,Gerhards-Padilla., & Martini, 2008; Singh, Duvvuru & Singh, 2014). Nomadic Mobility Model is a good example of group mobility model in Mobile Ad-hoc Network. In Nomadic environment, mobile users move from one location to another. Each individual node uses entity mobile model which is required for individual node movement across its own point of reference. However, when the point of reference changes, the whole group moves to a new area and start wandering in that area and the roaming of the group is defined by picking random locations within some predefined roaming radius of the reference point while the maximum roaming distance is defined by the -r flag (Camp, Boleng & Davies, 2002). Good example of Nomadic Community Model scenario is as follows: A scenario model that simulates a guide tour of a city is a real life example of nomadic mobility (Camp, et al, 2002; Aschenbruck, 2015; Aschenbruck, et al, 2008). In a Nomadic community model, each group of mobile nodes has an invisible reference node that they follow around the simulation. This general description of group mobility can be used to create a variety of models for different kinds of mobility applications.

1.3 Statement of problem

Despite the number of works in MANET routing protocols performances, there is paucity of studies in simulation of MANETs that make use of group mobility models. Most of the previous studies laid much emphasis on investigating the performances of MANET routing protocols in entity mobility models such as Random Walk Model, Random Waypoint Model and so on in the generation of node mobility. However, the entity mobility models cannot realistically be used to model mobile user movement patterns in some group scenarios. Also, most of the past studies, use node mobility patterns that are manually and statically assigned. This study proposes to use random mobility movements to investigate the behavioural pattern of two MANET routing protocols using a group mobility model named Nomadic Mobility Model. Nomadic Mobility model mimics the movement patterns of users in a nomadic setting (e.g nomadic herdsmen, fishermen or nomadic computing users). A study that can simulate the manner in which packets are routed from source to the destination in nomadic setting is therefore desirable.

2.0 REVIEW OF RELATED LITERATURE

In their work, Oyelakin and Jimoh (2017) identified various approaches that have been used for modeling and simulation of Mobile Ad-hoc network scenarios. The study surveyed varying application scenarios that are found in MANET as well as how they are modeled and simulated. However, the work did not involve simulating a MANET

scenario for determinng how routing protocols perform. Sharma, Kansal & Bhatia (2015) in their studies, investigated how the choice of the mobility models impact on the performance results of ad-hoc routing protocols. The emphasis of the work is on simulated comparisons among the selected mobility models. Cherry, Bon, Mingyang, Ling, Peter (2015) carried out a study involving a survey of Group Mobility Models in Mobile Ad-hoc Networks. The survey is comprehensive but the work did not involve any simulation or performance evaluation of the models. Pandey and Srivastava (2014) carried out a study to evaluate routing protocol performances in MANET through NS2 simulation. The performance comparisons of DSR, AODV and DSDV were carried out by considering Packet Delivery Fraction, Throughput and Round Tip Time with constant mobility in an entity mobility model. The study further has its limitation in the fact that MANET is mostly charaterised by mobility changes as the mobile users participating in the temporary network may need to move in and out of the network.

Khaimar and Pradhan (2014) carried out a work to identify the routing protocols used in Vehicle ad-hoc Network (VANET) had better performance. This was achieved through simulation technique. However, the authors used only entity mobility model as well. Aggarwal (2009) classified routing algorithms in MANET and then performed simulation performances of some selected simulation tools in respect of the routing protocols. The simulation tools used in the work are: OPNET Modeler, NS-2 and GlomoSim. Geetha and Gopinasth (2008) evaluated the performances of two On-Demand routing protocols (AODV, DSR) in respect of the selected performance metrics. The simulation was carried out in respect of mobility variation of reference point group mobility model and random waypoint model. Bai and Helmy(nd) provided an overview of the current research status of mobility modeling and analysis n Mobile Ad-hoc Network. It identified that since mobility model s designed to describe the movement pattern of mobile users, and how their location, velocity and acceleration change over time, t plays a great role in routing protocol performance (**).

3.0 METHODOLOGY

3.1 Introduction

The work involves generating mobile movement files randomly and then simulates their connectivity processes in scenario similar to a nomadic environment. The study made use of NS2 as the simulation tool while BonnMotion 3.0.0 was used as the mobility scenario generation tool.

3.2 Materials and Methods

3.2.1 Materials

Simulation Environment Specifications

The simulation environment specifications for the study consist of hardware and software environments.

a. The hardware environment consists of the following:

HP Presario Dual Core 32bit processor, 320 GB Hard Disk Drive, 2GB RAM

4GB USB Drive (for the installation of Ubuntu 16.04 Linux)

b. The software environment consists of the following:

Ubuntu Linux 16.04 LTS (Long Term Support), NS-2 All in one installation package (ns-allinone-2.35), BonnMotion tool (BonnMotion-3.0.0), webupd8 (a Third Party Repository Software), Oracle Java 8 on Ubuntu Linux, XGRAPH tool (for the graphical representation of network traces)

3.2.2 Methods

A flat topological boundary of two dimensions measuring 1500m by 1400m is defined. Given a set of mobile devices that have wireless interfaces, the devices are used for communication and information sharing. These devices are connected and packets are routed among them without any need for central access point. The devices follow nomadic patterns and engage in group communications. The nomadic mobility patterns of nodes participating in the network were generated using BonnMotion. The parameter and movement files generated having the extensions-ns.params and ns.movements- are converted into the format usable in NS-2 with the use NSFile command. The Ns-2 tool is then used to simulate the routing of information in the network. The routing protocols used for comparison in the study are AODV and DSR. Their performances are then compared in respect of the targeted performance metrics.

a. Nomadic Mobility Scenario Generation using BonnMotion

BonnMotion 3.0.0 is used as the mobility and scenario generation tool. The scenario generator writes all parameters used to create a certain scenario to a file. These files include movement and network scenario parameter files. The number of nodes used in the simulation is 50. For the seed generations, the following command was used in BonnMotion/bin directory:

b. Simulation of the proposed usage Scenario in NS-2

The scenario used involves 50 nodes that are randomly distributed within a topological boundary of 1500m by 1500 metre (X=1500,Y= 1500 where Z=0) and the simulation stops at time 120seconds. The nomads who are the mobile users are assumed to be connected within that geographical topology. When a nomad leaves or comes within that region, the network is updated as network topology changes. In the study experiments, it is assumed that each mobile node is a CBR source and have constant transmission range. It is also assumed that the packet size all the nodes is constant and nomadic mobilty model is used to specify the possible movement paterns of the mobile devices. For the random BonnMotion files generated above to be exported into NS-2 it has to be converted to NS-2 format using the following command:

bm NSFile –f nomadicoyelakin1

Scenario Simulation Parameters

The scenario parameters used for the experimental simulations and analysis in this study are: Table 1: Simulation Scenario 1

S/N	Parameter	Value
1	Simulation Area (X and Y)	1500m by 1500m
2	No of Nodes (devices participating in the communication)	50
3	Node Mobility (Distribution) Models	Nomadic Community Model
4	Routing Protocols	AODV
5	Traffic Patterns	Constant Bit Rate (CBR)
6	Simulation Time	120 seconds

Table 2: Simulation Scenario 2

S/N	Parameter	Value
1	Simulation Area (X and Y)	1500m by 1500m
2	No of Nodes (devices participating in the communication)	50
3	Node Mobility (Distribution) Models	Nomadic Community Model
4	Routing Protocols	DSR
5	Traffic Patterns	Constant Bit Rate (CBR)
6	Simulation Time	120 seconds

4.0 RESULTS AND DISCUSSION

a. Simulation Files

The files generated from the BonnMotion utility are usually of two categories: the parameter files and the movement files and.

The two files generated are as follows: **nomadicoyelakin1.ns_params** and **nomadicoyelakin1.ns_movements**

It was identified that in all group mobility models, random motion of each individual mobile node within a given group occurs. Nomadic Community Mobility Model is a group mobility model in which a set of mobile nodes move together form one location to another (Aschenbruck et al 2008, Aschenbruck, 2015; Camp, Boleng & Vanessa (2002) similar to the ways nomadic societies operate in their day-to-day living.

b. Graphical Results of Simulations

Graphical results of simulating packet routing of AODV and DSR using NS-2 are shown in Figures 1 to 4. The Network throughput and End-to-end Delay are plotted against the simulations period.

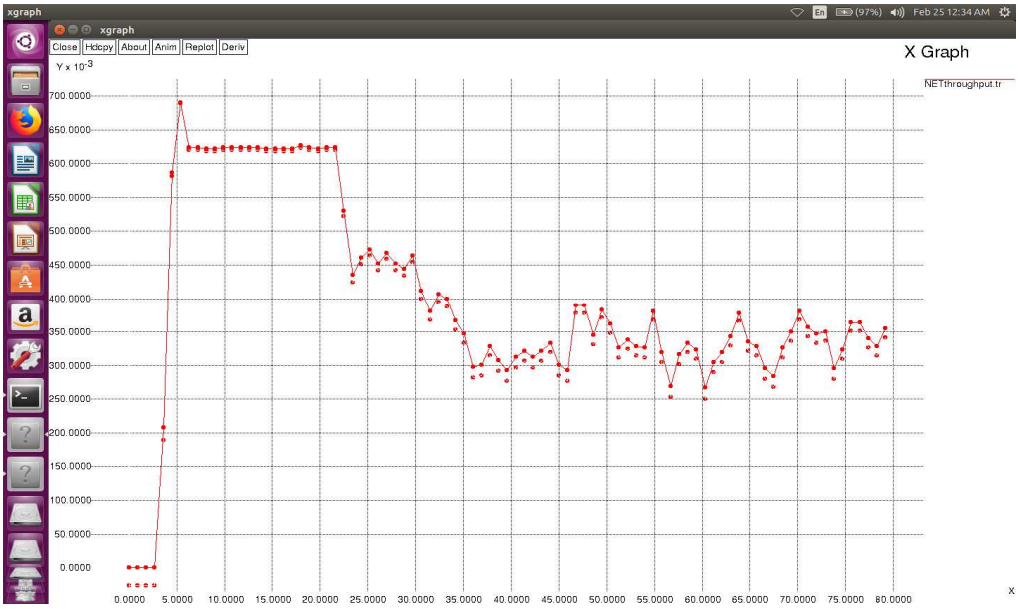


Figure 1: Network Throughput in AODV Routing Protocol

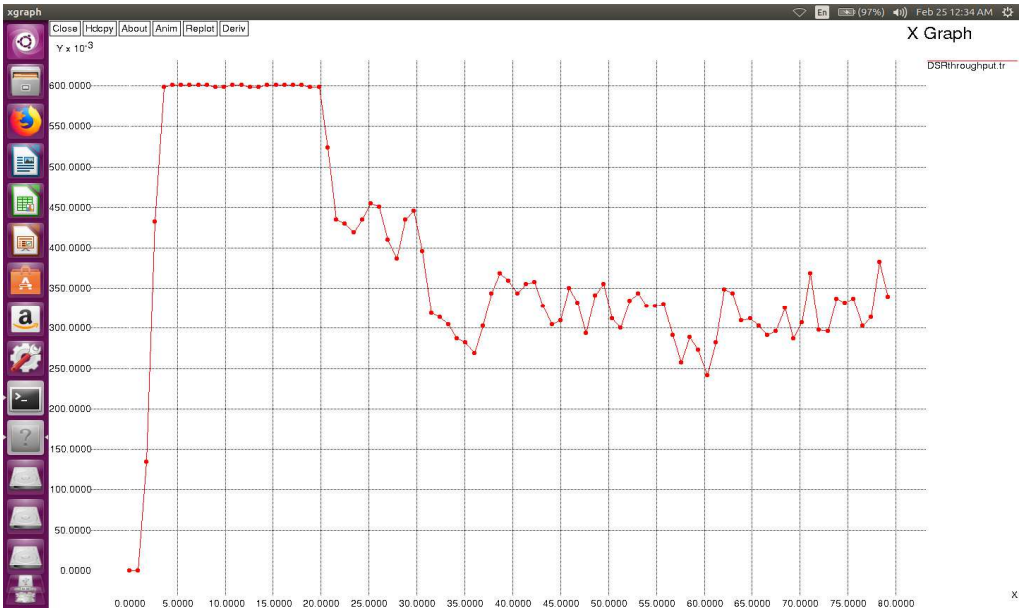


Figure 2: Network Throughput in DSR Routing Protocol

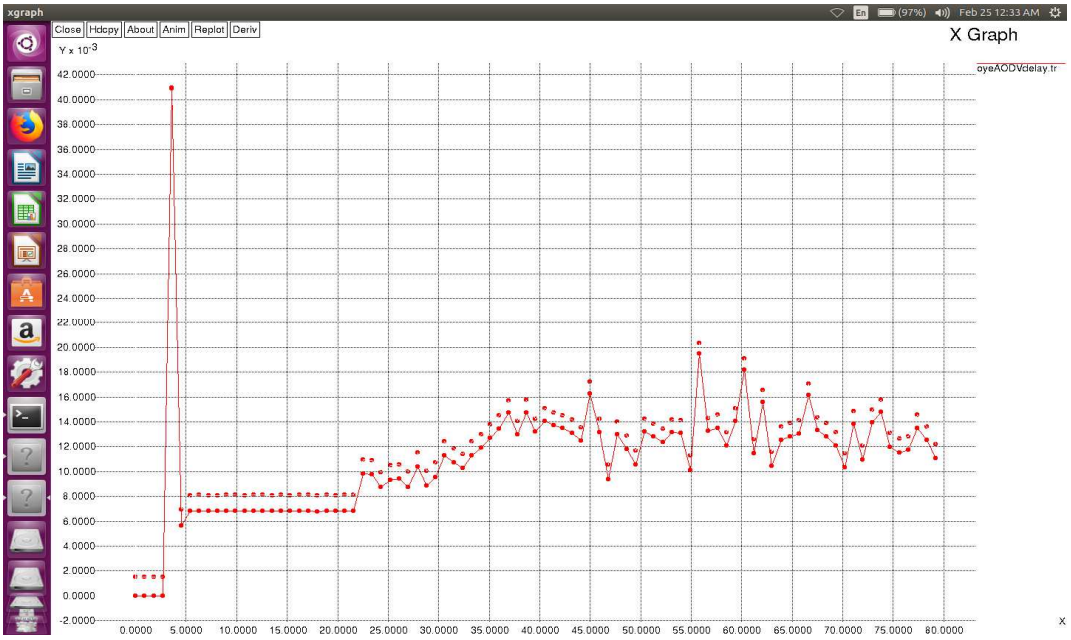


Figure 3: End-to-End Delay in AODV Routing Protocol

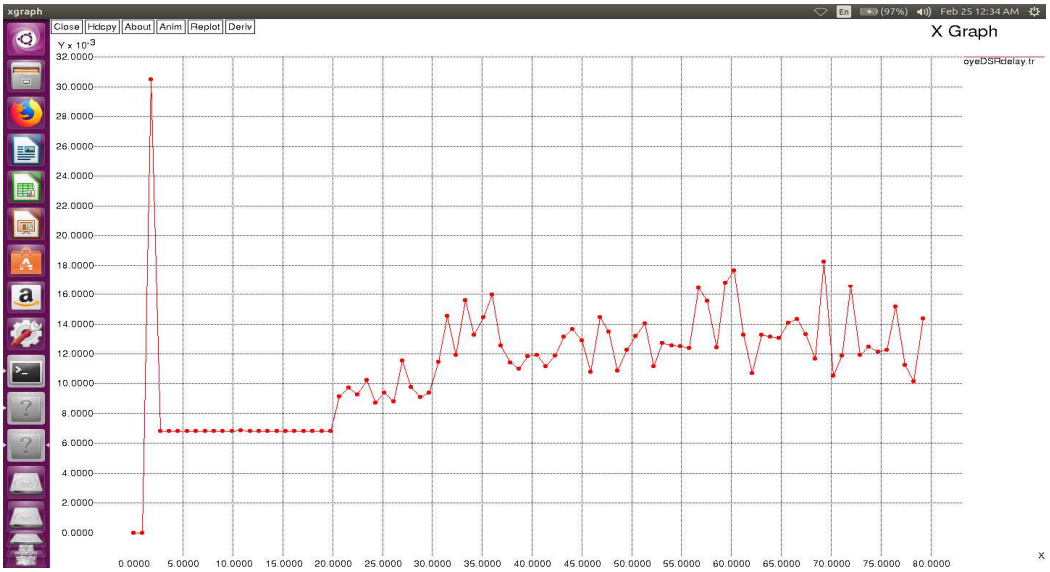


Figure 4: End-to-End Delay in DSR Routing Protocol

c. Discussions of results

Since mobility model is desgned to describe the movement pattern of mobile users, and how their lcoaton,velocity and acceleration change over time, it plays a great role in routng protocol performance (**). Figure 1 represents the Network throughput obtained while simulating AODV routing algorithm using Nomadic Community Mobility model. The simulations were carried out using AODV and DSR protocols in Network Simulator-2. Figure 1 shows the result of network throughout when packets are routed from the source to the destination node using Ad-hoc On-Demand Distance Vector (AODV) routing algorithm. Figure 2 shows the result of network throughout when packets are routed from the source to the destination node using Destination

Source Routing (DSR) algorithm. Figure 3 shows the graphical representation of End-to-end Delay that takes place in the network while routing packets from source to the destination using AODV routing protocol. Figure 4 shows the graphical representation of End-to-end Delay that takes place in the network while routing packets from source to the destination using DSR routing protocol. The study identified that Network throughput is higher in AODV routing protocol compared to DSR routing protocol. Similarly, end-to-end delay of packets is slightly higher in the network, when AODV routing protocol is used compared to when DSR is used for the routing of packets among the nodes in the nomadic setting.

5.0 CONCLUSION

This study simulated Mobile Ad-hoc Network (MANET) as it can be applied for network connectivity in a fairly large nomadic environment. The study performs comparative performances of AODV and DSR algorithms (protocols) in the scenario based on the targeted performance metrics: Network Throughput and End-to-end delay. This is done to determine which of the two protocols perform better in the circumstances used for the experiment. The study gives an insight into the simulation of MANET as it simulates how an infrastructure-less network can be used in such nomadic environment using randomly generated node movement traces as against entity models and manually assigned node positions used in most studies. This work has thus provided a direction on the impact of a group random mobility pattern named Nomadic community model on the performances of the selected protocols in the network.

REFERENCES

Abdalla, G.M.,Abu-Rgheff,M.A. & Senouci, S.M. (2007).Current Trends in Vehicular Ad-Hoc Networks. *Ubiquitious Computing and Communication Journal, 1-9.*

Abolhasan, M., Wysocki, T. and Dutkiewicz, E. (2004) A Review of Routing Protocols for Mobile Ad Hoc Networks., 2, 1-22. *http://dx.doi.org/10.1016/S1570-8705 (03)00043-X*

Aggarwal A.K. (2009). MANET simulation: An Overview*, a lecture material at University of Windsor*

Aschenbruck Nils (2015). A ReadME Documentation of BonnMotion, University of Osnabron

Baruch Awerbuch & Amitabh Mishra (2008).Introduction to Ad-hoc Networks, Lecture notes from *Department of Computer Science, Johns Hopkins University*

Aschenbruck N., Gerhards-Padilla E., & Martini P. (2008). A survey on mobility models for performance analysis in tactical mobile networks," *Journal of Telecommunications and Information Technology, vol. 2, pp. 54–61,*

Bai Fan & Helmy Ahmed (nd). A Survey of Mobility Models in Wireless Adhoc Networks *retrieved from https://www.cise.ufl.edu/~helmy/papers/Survey-Mobility-Chapter-1.pdf on 5th April, 2018*

Belding-Royer Elizabeth M. & Sung-Ju Lee (2002). Mobile Ad Hoc Networking

Camp T., Boleng J, & Davies V.(2002).A Survey of Mobility Models for Ad-hoc Network Research, *Wireless Communication and Mobile Computing (WCMC): Special issue on Mobile Ad-hoc Networking: Research, Trends and Applications, 2(5), 483(502)*

Cherry Ye Aung, Bon Chong Seet, Mingyang Zhang, Ling Fu Xie Peter Han Joo Chong (2015). A Review of Group Mobility Models for Mobile Ad-hoc Networks, *IEEE Wireless Personal Communications 85(3),pp 1317-1331.*

Christian Bettsteter & Tu Muricheen (2003).Ad-Hoc Networking: Principles, Applications and Challenges

Geetha Jayakumar & Gopinasth Ganapathi (2008). Reference Point Group Mobility and Random Waypoint Models in Performance Evaluation of MANET Routing Protocols, *Journal of Computer Networks and Communications*

Hong X., Gerla M., Pei G., & Chiang C. C. (1999). A group mobility model for ad hoc wireless networks, in Proceedings of the *2nd ACM International Workshop on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM '99), 53–60, Seattle, Wash, USA*

Jacob Jaya & Seethalakshmi V. (2011). Performance Evaluation of Various Routing Protocols in MANET, Journal Anu Books, Research Cell: *An International Journal of Engineering Sciences ISSN: 2229-6913 Issue Dec. 2011, Vol. 5*

Khaimar V.D. & Pradhan S.N. (2014).Simulation Based:Study and Analysis of Routing Protocol in Vehicular Ad-hoc Network Environment, *International Journal of Computer Technology and Applications 3(2),617-625, retrieved from https://arxiv.org/ftp/arxiv/papers/1403/1403.6013.pdf*

Mallapur S.V & Patil S.R (2012). A Survey of Simulation Tools for Mobile Ad-Hoc Networks, *International Journal of Computer Networks and Wireless Communications, 2(2)*

Muhammad Kashif Nazir, Rameez U. Rehman & Atif Nazir (2016).A Novel Review on Security and Routing Protocols in MANET, *Communications and Network ,8, 215-218*

Natarajan K. & Mhadevan G. (2017).Evaluation of seven MANET Routing Protocols using Scalability Scenario, *International Journal of Computer Science and Network 6(2)*

Network Simulator Manual retrieved from http:www.isis.edu/nsnam/ns/ on 12 December 2016

Oyelakin A.M. & Jimoh R.G (2017). A Survey on Mobility Model, Application Scenario and Simulation of Mobile Ad-hoc Networks, *in the proceedings of 11th International Multi-conference on ICT Applications, Obafemi Awolowo University, Ile Ife, Nigeria ,128-124*

Park V.D. & Corson M.S. (1997). A Highly Adaptive Distributed Routing Algorithm for mobile wireless networks. *In INFOCOM (3), pp 1405-1413*

Perkins C & Bhagwat P. (1994). Highly Dynamic Destination Sequenced Distance-Vector Routing (DSDV) for mobile computers. *In ACM SIGCOMM '94*

Conference on Communications Architectures, Protocols and Applications, pp 234-244

Perkins E. and Royer E. (1999). Ad hoc On-Demand Distance Vector (AODV) Routing. *Proceedings of 2nd IEEE Workshop on Mobile Computing Systems and Applications, February 1999*

Perkins Charles (2001), Editor, Ad Hoc Networking, Addison-Wesley

Perkins C.E., E.M. Royer E.M. and S.R. Das (2002). Ad-Hoc On-Demand Distance Vector (AODV) Routing, *Internet Draft, draft-ietf-manet-aodv, work in progress*

Perkins C, Belding-Royer E. & Das S. (2003) Ad Hoc On-Demand Distance Vector (AODV) Routing

Roy R.R (2011). Handbook of Mobile Ad Hoc Networks for Mobility Models, *Springer Science & Business Media, LLC,*

Sandeep Kale (2010). Create Ad-hoc Network, Tips and Tricks *retrieved on Dec 5 2017 from http://www.trickswindow.com/networking/create-ad-hoc-network/*

Sharma Munish, Kansal Manish & Bhatia Tarunpreet (2015). Simulation Analysis of MANET Routing Protocols under different Mobility Models, *International Journal of Wireless Communications and Networking Technologies,4(1)*

Singh S.K., Duvvuru R. & Singh J.P. (2014). Performance Impact of TCP and DP on the mobility Models and Routing Protocols in MANET, *in proceedings of Intelligent Computing, Networking and Informatics, Springer, 243, 895-901.*

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DEVELOPMENT OF AN INTEGRATED DIGITAL LIBRARY IN A NETWORKED ENVIRONMENT

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ABSTRACT

As an agent of educational, social, economic, and political changes or revolutions in the community, there is the need for easy access and retrieval of information in a library. Although, library can be found in most places, academic community uses libraries in a relatively great extent. With the recent trend in internet, ICT and library technology, digitization of libraries, which usually make available some facilities for accessing and retrieving library information within the shortest period, is now becoming popular in higher institution of learning. A digital library is a collection of library documents or objects in digital form in order to enhance speedy access to library information. This paper deals with designed and development of an integrated digital library in a networked environment. A local area network was setup and the software was developed with HTML5, CSS3, Java Script for client side, PHP (Hypertext Pre-Processor) as server side programming language and MySqli (My Structural Query Language Improved) as relational database. The latter language was chosen because of its flexibility and features for developing online based applications. However, WAMP (Window Apache MySql and PHP) server was used for local hosting and testing. The digital Library developed demonstrated a speedy and organized access to books, journals, videos and other information in an efficient manner.

Keyword: *Library, Digital Library, Local Area Network, Digitalization, Internet*

1. INTRODUCTION

The emergence of academic libraries in Nigeria dated back to pre-independence era in 1948 when the University of Ibadan and its library were established (Gani & Magoi, 2014). A library can be seen as a body of recorded information (in various formats) which can be selected, organized, retrieved, disseminated or made available to users in need of it (Iwasokun & Akinyokun, 2013).The objective of library in an higher institution of learning is to support academic activities in that community and to achieve this, academic libraries are mostly designed to meet learning, teaching and research needs of the users, by providing services that can lead to an increase in students, teachers and researchers productivity (Gani & Magoi, 2014). In recent times, the trend of library automation which started in the 1960s in USA has been spreading all over the world (AL-Juboori, 2014).In library context or term, digital libraries may be viewed as a library system where technical services are performed electronically

with an entirely electronic application (Gani & Magoi, 2014). However, users' direct interaction with the library, physically going to the library, searching for certain information and taking the hard copy of the information out of the library are slowly becoming past history with the introduction of library technology (AL-Juboori, 2014). Due to the new challenges the web created for information retrieval, the trend of library digitization has been spreading all over the world since it started in 1960s in the USA (Meyyappan, Chowdhury & Foo, 2017).

There are various definitions of digital libraries, but within the context of libraries, digital libraries may be viewed as technical services performed electronically with an entirely electronic application (Gani & Magoi, 2014). Candela et al, (2008) defines digital libraries as a collection of services and information objects that support users of the library in dealing with information objects and the organization and presentation of those objects which are available directly or indirectly via electronic/digital means. Because the academic community is the largest and the most important user group of digital libraries, digital library should contain additional resources like course calendars, university statutes, various courses being offered, course registration, thesis and dissertation guidelines, style guides, laboratory facilities, availability of software, hardware, equipment, course materials, reserve book/handout collections, local publication databases, locally produced theses and dissertations and so on (Meyyappan, Chowdhury & Foo, 2017). However, since storing and accessing information available for a large community of users should be made easier by digital libraries, large numbers of researches focus on the development of efficient information retrieval techniques and optimized data storage [4, 18]. Libraries which take the form of a combination of general and special collections of multiple resource types in both digital and print form are known as hybrid libraries (Meyyappan, Chowdhury & Foo, 2017). Most digital libraries share common functional components highlighted below (Issah, 2010):

i. Selection and Acquisition: This component has to do with the selection of documents to be added, the subscription of database and the digitization or conversion of documents to an appropriate digital form.
ii. Organization: This component involves the assignment of the metadata (bibliographic information) to each document being added to the collection.
iii. Indexing and storage: The indexing and storage of documents and metadata are carried out here for efficient search and retrieval.
iv. Search and retrieval: This is the digital library interface used by the end users to browse, search, retrieve and view the resources provided by the digital library.

Digital libraries are used as a means of easily and rapidly accessing books, archives and images of various types now widely recognized by commercial interests and public bodies alike. According to Elaiess (2017), a digital library has the following characteristics:

i. It is a prearranged and managed collection of digital objects.
ii. Its resources are made available over the internet or server.
iii. It is a universal information infrastructure.
iv. It is supposed to offer certain services.

Most researches in digital library and development all over the world in recent years have noticeably improved the facilities for accessing and retrieving digital information resources in a timely, accurate and comprehensive form (Meyyappan, Chowdhury & Foo, 2017). It has also been observed generally that there is no standard method for designing a digital library (Elaiess, 2017).Organizing digital libraries' information and resources can take different forms which include the use of an alphabetical listing, subject categories, broad groupings, by tasks, and so on .Right from time, academic community has being the largest user group of libraries, a digital library therefore should contain additional resources like course calendars, university statutes, various course offerings, course registration, thesis and dissertation guidelines, style guides, reserve book/handout collections, local publication databases, laboratory facilities and equipment, course materials etc (Akanbi, Raji & Yusuf, 2017).

This seminar paper presents the designed and development of an integrated digital library in a networked environment. A local area network was setup and software was developed with HTML5, CSS3, Java Script for client side, PHP (Hypertext Pre-Processor) as server side programming language and MySqli (My Structural Query Language Improved) as relational database. The latter language was chosen because of its flexibility and features for developing online based applications. However, WAMP (Window Apache MySql and PHP) server was used for local hosting and testing. The digital Library developed demonstrated a speedy and organized access to books, journals and other information in an efficient manner. The objectives of the research are to:

i. Examine the infrastructural facilities required for digital information system such as computer, software, OCR, output media, access points, network support etc.
ii. Design digital library that will facilitate access to the collection of literature and related information in tune with the Polytechnic vision and mission.
iii. Design and implement a Local Area Digital Library Network (DLN) which will cater for training and research needs.

2. REVIEW OF RELATED LITERATURE

In order to provide a baseline understanding of the current state of research into and practice in the sustainability of digital preservation, the concrete components that drive costs in the area of digital preservation is reviewed. Researcher in (AL-Juboori, 2014) opined that since digital documents should be easily retrieved and archived, large numbers of researches focus on the development of efficient information retrieval techniques and optimized data storage. The researchers designed and presented an E-Library Search System whose database contains books names and thesis titles, to make it special for the academic organizations like universities and research centers. This system serves the researchers and other users with many facilities in searching stage by many means such as author name, book name, interested area, number of copies, and year of issue. According to Gani and Magoi (2014), digital libraries present several prospects to the users far beyond what poly-media libraries provides. Having a global reach to all national and international networks through the digital library is a great advantage to educational advancement in the Northwest zone. They further stressed that

digital libraries do not only support the conventional university system but also the distance learning programmes in Nigeria. Researchers in (Iwasokun & Akinyokun, 2013) stressed that the term electronic library (e-library) has been applied to a wide variety of domains such as collection of electronic materials and software agents that support inquiry-based education. The existing library systems serve as reservoir for several materials resulting in their non-effective in time taken to search and retrieve needed materials. The researchers presented an Internet-Based Library System (ILS) that offers greater and efficient services. The system has modules for database, web browser and services affiliated to institutions of learning.

However, Meyyappan, Chowdhury and Foo, (2017) outlined the architecture, the basic components and functionalities of a Digital Work Environment (DWE) that forms the basis of a user centred digital library development at Nanyang Technological University in Singapore. Based on the experience of a continued research on the design and development of the DWE, a set of generic guidelines for the design of a user-centred digital library system was provided. The researchers revealed that current digital libraries or information systems do not generally organize information according to the various user tasks. As a result, users usually employ the trial and error method to move from one Web page to another or from one information resource or system to another. The user-centred approach to digital library design is therefore desirable as it aims to shift the focus from a system-oriented to a user-oriented design in an attempt to meet users' real needs and facilitating means and ways to support their information seeking and use behavior. Raji et al, (2017) asserted that many libraries especially in the developing countries are suffering from being unable to deliver the required services to their users due to various barriers and obstacles. The researcher further stressed that drawing a policy that position opens source software as part of a strategic plan for improving library services is expected to assist in solving many problems, such as scarcity of electronic resources and absence of access to up-to-date information resources in addition to meeting the requirements and needs of the users. Finally, researchers in (Adams & Blandford, 2013) revealed that although web accessible digital libraries (DLs) have greatly increased potential information accessibility within academia, the use of these resources varies widely across disciplines. The researchers are of the opinion that Web-accessible DLs are identified as changing the roles and working patterns of academic staff (i.e. lecturers, librarians and computer support staff).

3. RESEARCH METHODOLOGY

The search for literatures for this paper was performed mainly with reading existing research work, journal papers, proceeding of conferences, text books on agent technologies, and browsing the World Wide Web (www). Investigation on the existing design tools was done mainly on the websites of each platform on World Wide Web. However, the study draws on the theory, experimentation and findings of the various architectural designs that have been published. The overview of the proposed digital library architecture design was presented. The proposed network consists of three layers of components, namely application software, network software and network

hardware. Application Software consists of computer programs that interface and permits the sharing of resources, such as files, graphics, and disks. Network software consists of computer programs that enable implementation of protocols or rules. It consists of transmission media (which carries the computer's signals e.g. cables) and network adapter (which accesses the physical media, linking computers, receiving packet from network software, transmitting instructions and requests to other computers). To set up the local area network for the digital library (figure 1), the following basic hardware are required:

i. Seven (7) sets of computer systems
ii. One (1) 24-port switches
iii. Unshielded Twisted Pair (UTP) Cat-6e cable connection
iv. Rj-45 connectors
v. Printer and Scanner.

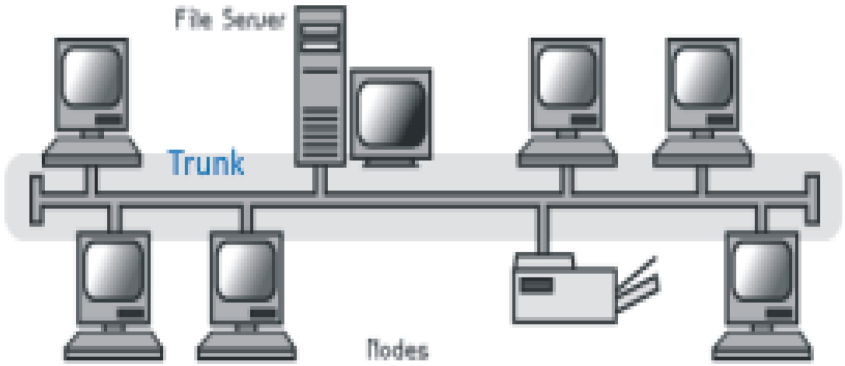


Figure 1: Computers Connected on a network (Source: Meyyappan, Chowdhury, & Foo, 2017)

4. SYSTEM NETWORKING AND CONFIGURATION

The local area network consists of (6) workstations connected to a special computer called a server. The server stores and manages programs and all networked group's data which enables LAN workstations to stand without large storage capabilities. The proposed workstations and a server were connected together with the aid of a 24-port switches using linear bus topology. The physical arrangement of the systems is as follow:

i. The server was connected to the Switch.
ii. Six workstations were also connected to the Switch.
iii. Other ports will provide additional ports for other users whom may come to the place with their laptop to have access to digital library.
iv. The server was connected to the Internet through wireless Internet access subscription.
v. The workstations on the network were configured, installed Network Operating System (Window 2013 Server) and established links between the workstations and the server.

To complete the DLN, some networking materials will be required. The tables below list items of hardware and software requirements:

Table 1: Hardware Requirements

S/N	Server	Workstations
1.	Core i3 Processor of 5.0 GHz speed	Dual Core Processor of 2.4 GHz speed
2.	4.0 GB RAM	2.0 GB RAM
3.	750 GB Hard Disk or Higher	250 GB Hard Disk
4.	DVD Writer	CD-ROM/ Writer
5.	Wireless LAN Card	Network Interface Card

Table 2: Software Requirements

S/N	Server	Workstations
1.	Network Operating System e.g. Window 2013 Server	Operating System e.g. Window XP/Vista
2.	Software and Database Package Containing Information about various Courses	General Application Packages
3.	Distributed Resources	Accesses to the Available Resources
4.	Internet Connectivity	LAN Connection
5.	Web Browser e.g. Mozilla Firefox	Web Browser e.g. Mozilla Firefox
6.	Strong Anti Virus Program	Strong Anti Virus Program

After successful local area network connection, the software was developed with HTML5, CSS3, Java Script for client side, PHP (Hypertext Pre-Processor) as server side programming language and MySqli (My Structural Query Language Improved) as relational database. This language was chosen because of its flexibility and features for developing online based applications. However, WAMP (Window Apache MySql and PHP) server was used for local hosting and testing. The digital Library developed demonstrated a speedy and organized access to books, journals and other information in an efficient manner.

5. SYSTEM IMPLEMENTATION

The developed Digital library software application was run on the system using local host and found to operate as expected. The computer software application is required to be independent of any platform. The system design uses structured system analysis and design methodology (SSADM) (figure 2) with adaptation of (Meyyappan, Chowdhury & Foo, 2017) with little modifications. The database structure is given in figure 3.

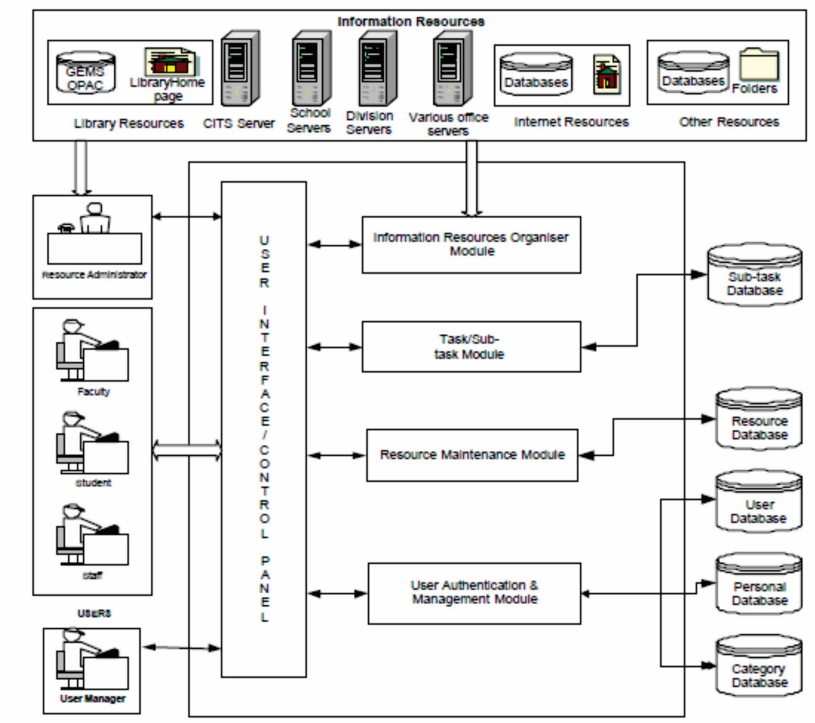


Figure 2: Architecture of the Integrated Digital Library (Source: Meyyappan, Chowdhury & Foo, 2017)

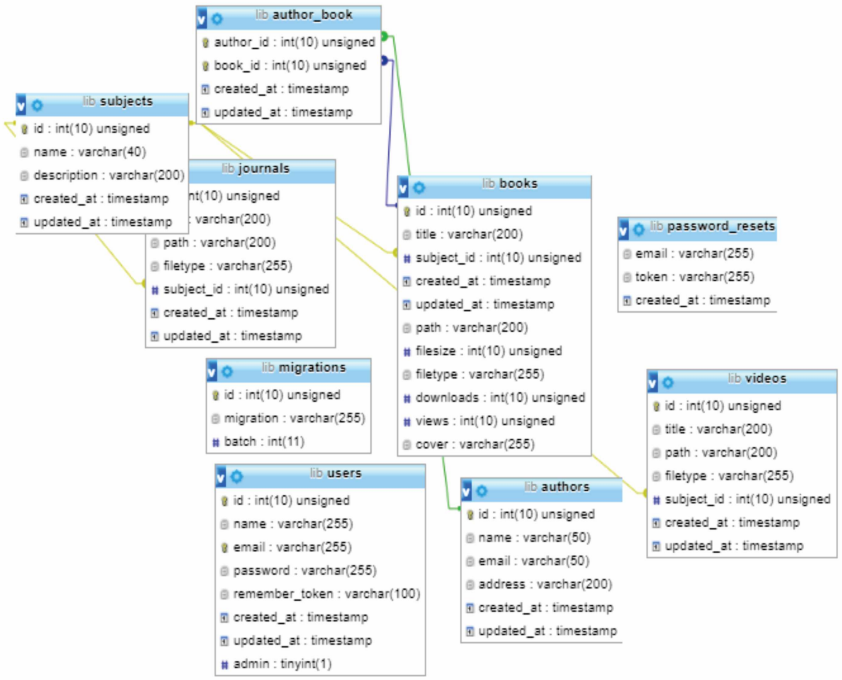


Figure 3: Database Structure (Source: Akanbi & Raji, 2017, Database Design)

The login page is used for the login process to ascertain the type of user by interacting with the user category database. With this information, the system will

automatically present the list of tasks that are associated with the user type for subsequent selection by the user. Figure 4 below shows the login page when the program is started. User needs to login before user can have access to the digital library. The login window requests a valid username and password from User to be able to gain access into the digital library. However, new user can register and then login to have access to the digital library.

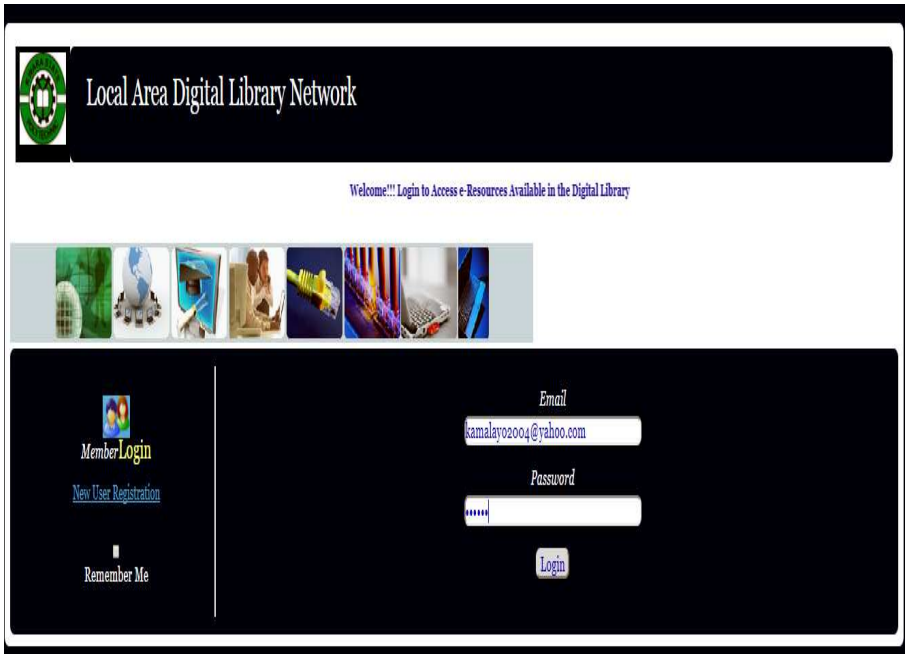


Figure 4: Login Menu to digital library (Source: Akanbi & Raji, 2017, Program Design)

The Digital Library Network (DLN) has an up-to-date scientific approach within research, by implementing and disseminating new interdisciplinary views in the field of Computer Science and Technology. By means of integrating the specialty studies of highly reputed researches, this DLN has the latest information in the field of Computer Science, applicable to many investigation domains. After successful log-in as there are seven links available as shown in figure 3 below, these are E-Books, E-Videos, E-Articles, E-Library, Virtual Library, Student e-Resources, and About the Researchers.

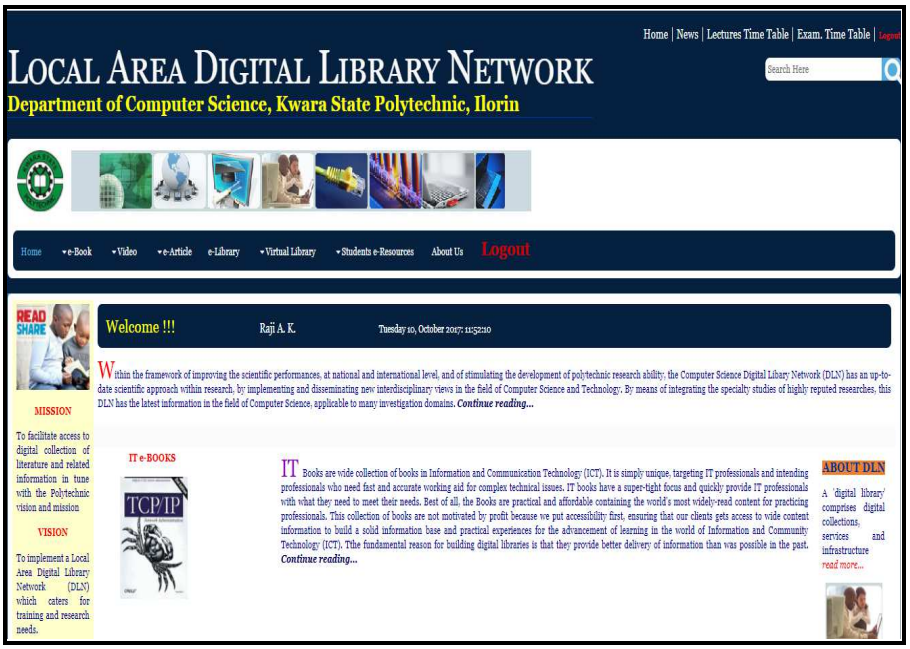


Figure 5: Screenshot showing home page of the digital library (Source: Akanbi & Raji, 2017, Program Design)

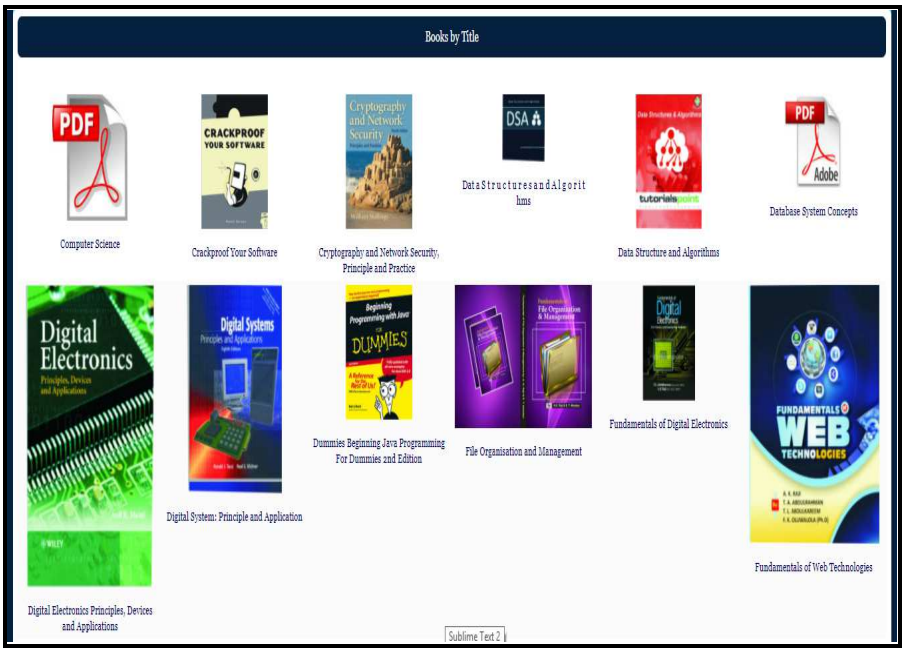


Figure 6: Screenshot showing list of books by title (Source: Akanbi & Raji, 2017, Program Design)

E-Books: This link allows users to view/download books either by title (as shown in figure 6), by author's name or by subject.
E-Videos: This link allows users to watch/download video tutorials either by title, or by subject.
E-Articles: This link allows users to view/download journal articles or Thesis/Dissertation.
E-Library: This link allows users to connect to the Polytechnic e-library to access numerous database such as Eaglesoft, Ebrary, Khoa, Egranary and Ebsohost.
Virtual Library: This link allows users to connect to either National virtual libraries or International virtual libraries. It contains links to various virtual libraries available around the world.
Student e-Resources: This link allows user to have access to numerous digital course materials within the Department. It is very useful to students and staff.
About the Researchers: This link contains the curriculum vitae of the researchers.

6. CONCLUSION

It is worth mentioning that digital libraries are not going to replace the physical existence of document completely but no doubt to meet the present demand. To satisfy the non local user digitization must be introduced so that at least libraries becomes of hybrid nature. However, digital libraries emerged with increased availability of digital information and user demand for services in digital format. They became widely used in the research and academic world with the feasibility of data dissemination speedily over networks. Just as library networks emerged for resource sharing networked digital libraries also share the same aims and objectives. However, the planning and implementation of a digital library network poses new challenges and involves policy making regarding the members, content, content management, governance, maintenance and the technical know-how. The designed DLN system provides an efficient means of displaying digital resources. Lastly, the system is flexible and runs on a web browser. It is reasonably secure, enforces data integrity from the use of a relational database management system, it also minimizes data redundancy and it is user-friendly. However in the networked world where more and more information is made available online and through distributed systems, properly implemented DNL would be very impactful in promoting research and education.

REFERENCES

A. F. Edward (1999), "The Digital Libraries Initiative - Update and Discussion," Bulletin of the America Society of Information Science, Vol. 26, No. 1.

A. Issah (2010), "Electronic Library Use by Academic Staff at the University of Ilorin, Nigeria, A journal of Library and Information Sciences," A publication of the University Library O. O. U, Ago-Iwoye, Nigeria. Vol. 7 No. 1 & 2, 2010, pp 138-149.

A. K. Raji, F. S. Oyedepo and T. A. Abdulrahaman (2012), "Wireless Internet Access Use by the Staff and Students of Kwara State Polytechnic, Ilorin-Nigeria," International Journal of Advanced Research in Computer Science, Vol.3, No. 4, , July-August 2012 pp 279- 282.

Adams, A. & Blandford, A. (2013), "Digital libraries in academia: challenges and changes", *Digital Libraries: People, Knowledge, and Technology*. pp 392 - 403, 2013.

Akanbi, M. B., Raji, A. K & Yusuf, I. T (2017). Design and Implementation of A Local Area Digital Library Network (DLN) at Department of Computer Science, Kwara State Polytechnic, Ilorin, Tetfund Sponsored Kwara State Polytechnic Journal of Research and Development Studies Vol. 5. No. 1 pp1-13.

Alhaji, I. U. (2009), "Digitization of Library Resources and the Formation of Digital Libraries": *A Practical Approach. International journal of wireless and mobile computing, 2009.*

AL-Juboori , A.F.M.A (2014), ".Design and Implementation of an E-Library Search System", *International Journal of Innovation and Applied Studies* Vol. 7 No. 4, 2014 pp. 1321-1329.Available at http://www.ijias.issr-journals.org/

Definitions of Digital library on the Web en.wikipedia.org/wiki/Digital_library, Retrieved on 18th November 2016.

Elaiess, R (2017). Design And Implementation Option For Digital Library Systems .International Journal of Systems Science and Applied Mathematics, 2(3):70-74.

G. Chowudhury & S. Chowdhury (2003), "Introduction to digital libraries," London, Facet Publishing, 2003.

Gani, E. & Magoi, J. S. (2014), "The Emergence of Digital Libraries Services In Northwest Nigerian Universities: Challenges and Prospects", *Library Philosophy and Practice 2014*. Available at http://digitalcommons.unl.edu/libphilprac/1184.

Iwasokun, G. B. & Akinyokun, O. C. (2013) "Development of a Multi-Tier Internet-Based Library System", *International Journal of Library Science* 2(4): 69-79, 2013.

Kelly, Kevin (2007). "Scan This Book!". New York Times Magazine. http://www.nytimes.com/2006/05/14/magazine/14publishing.html?_r=1&oref=slogin&pagewanted=all. Retrieved 7th April, 2007.

L. Candela et al (2008). "The DELOS Digital library Reference Model - Foundations for Digital Libraries," Version 0.98, (PDF) February 2008.

Meyyappan, N., Chowdhury, G.G., & Foo, S. (2017). "Design and development of a user-centred digital library system: Some basic guidelines" *Proc 4th International Conference of Asian Digital Libraries (I*CADL-2001), Bangalore, India,135-148.Accessed 29th March, 2017.

Parida Baman (2004). "Emergence of Digital library Services in India," *2nd International CALIBER-2004*, INFLIBNET Centre, New Delhi, 2004.

Raji, A. K, Agboola O. M, Abiodun E. T & Abdulrahman T. A (2013). *Developing Digital Library: A Model of Kwara State Polytechnic Digital Library.* International Journal of Advanced Research in Computer Science. Volume 4, No. 2, January-February 2013, Pp 65 - 69. Available Online at www.ijarcs.info.

Rosenberg Diana (2005). "Towards the Digital Library: Findings of an investigation to establish the current status of University libraries in Africa," International Network for Availability of Scientific publication, U.K, 2005.

Withen I. H and Bainbridge D. (2003). How to Build Digital library, Morgan Kaufmann Publishers, San Francisco, 2003.

ICT SKILLS AND USE OF ELECTRONIC INFORMATION RESOURCES BY NATIONAL OPEN UNIVERSITY STUDENTS IN SOUTH-WEST NIGERIA

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ABSTRACT

The study was carried out among 8.812 undergraduates of the National Open University of Nigeria in South-West, Nigeria to ascertain the influence of ICT skills on the use of electronic information resources (EIRs). The survey research design was adopted for the study. Stratified sampling technique was used to select 802 participants. Data was collected with a self-structured questionnaire and analyzed using descriptive statistics, correlation and simple regression analysis. Findings showed that majority of the students had the requisite ICT skills to effectively use electronic information resources. There was a significant relationship between the use of EIRs and ICT skills ($r=0.389$; $p<.05$) and ICT skills had a significant influence on the use of EIRs (Adj. $R^2=.50$, $t=6.479$, $p<.05$). The study recommended that the management of NOUN should make efforts to remove the impediments to optimum use of EIRs by NOUN students such as erratic power supply, and poor Internet access. Also, the library should engage provide periodic training to sharpen the ICT skills of students.

Keywords: *Electronic information resources, ICT skills, Lifelong learning, National development, National Open University of Nigeria, South-West Nigeria.*

1. INTRODUCTION

The emergence of electronic information resources (EIRs) has greatly transformed information sourcing and use in the academia. Electronic information resources (EIRs) or simply e-resources are information stored in electronic format, in computer or computer related facilities such as CD-ROMs, flash drives, digital libraries or the Internet. Information is vital to the success and achievement of every student and most importantly, higher education students. Effective use of electronic information resources depend on ICT skills hence, undergraduates, especially distance learning students must be ICT literate.

Distance learning is the type of education where students seldom come in physical contact with teachers. The need to provide access to quality education and equity in educational opportunities, to meet special needs of employers by mounting special certificate courses for their employees and to encourage internationalization of tertiary education curricula led to the establishment of the National Open University of Nigeria (NOUN) (Federal Republic of Nigeria, 2004). Open distance education involves open admissions and freedom of students to select what, where and when to learn. It is a flexible

educational system in terms of organizational structures, delivery and communication patterns (Okebukola, 2014).

In order to achieve her stated objectives, the National Open University of Nigeria has invested heavily in EIRs and the enabling ICT infrastructure for use by staff and students. Unfortunately, Omoike (2013) observed that EIRs are grossly underutilized among NOUN students. Perhaps, inadequate or lack of ICT skills by students in tertiary institutions is responsible for this situation. The huge financial commitment required to sustain access to electronic information resources as well as the importance of the resources for academic success of NOUN students makes it necessary to find out the factors affecting the limited use of EIRs among this student group. Therefore, this study examined the influence of ICT skills on the use of EIRs by the undergraduates of NOUN in South-West, Nigeria. The study was guided by the following research questions:

- What are the ICT skills possessed by the students of the National Open University in South-West, Nigeria?
- To what extent do the students of the National Open University of Nigeria in South-West, Nigeria use electronic information resources?
- What are the constraints to effective use of EIRs by the students of National Open University in South-West, Nigeria?
- Is there any significant relationship between ICT skills and use of electronic information resources by students of the National Open University in South-West, Nigeria?
- How do ICT skills influence the use of electronic information resources by the students of the National Open University in South-West, Nigeria?

The following null hypotheses were tested at $\alpha = 0.05$ level of significance.

$H0_1$: There is no significant relationship between ICT skills and use of electronic information resources by the students of National Open University of Nigeria in South-West, Nigeria.

$H0_2$: ICT skills have no significant influence on the use of electronic information resources by the students of National Open University of Nigeria in South-West, Nigeria.

2. REVIEW OF RELATED LITERATURE

Sarkar (2012) described ICTs as the hardware, software, network and media for collecting, storing, processing, transmitting and presenting information; which comprises electronic devices such as computer, radio, television, telephone, satellite, and the Internet. The use of ICTs in education is believed to increase access to learning opportunities and enhance the quality of education (Omoike, 2013). ICT connects students and teachers with remote information resources and to research experts globally (Omotosho, Lateef, Amusa & Bello, 2015). Mikre (2011) posited that ICT use enables constructivist learning approaches including active learning, collaborative learning, creative learning, integrative learning and evaluative learning. With the use of ICTs, students become more independent and take responsibility for their learning.

There have been conflicting reports on the ICT skills of undergraduate students in the literature. Omotosho, et al. (2015) revealed that majority of the students are highly skilled in the use of ICT and its applications such as the Internet and e-mail and recommended

compulsory training and re-training session for newly admitted students in order to improve their ICT skills. Quadri, Adetimirin and Idowu (2014) carried out a study on availability and utilization of library e-resources in private universities in Ogun state, Nigeria. The study revealed that Internet use was high in the selected universities. However, a study conducted by Hamutunwa (2013) among distance learners at University of Namibia established the fact that most learners lacked computer skills, searching skills, and sufficient training in the use of ICT and electronic resources. Adetimirin (2012) studied the ICT literacy of undergraduates in Nigerian universities and found that undergraduates in state universities had low ICT skills while those in federal universities' ICT skills were rated average. A similar finding was reported by Ojeniyi and Adetimirin (2013). In a survey of sandwich students of University of Ado Ekiti, Nigeria, Akande (2011) revealed that less than half of the respondents were computer literate and that very few used Internet facilities.

Studies within and outside Nigeria have reported low usage of EIRs by undergraduates. Gakibayo, Ikoja-Odongo, and Okello-Obura (2013) in their study on electronic information resources utilization by students in Mbarara University library, Kenya revealed that the students had inadequate computer skills which resulted in low usage of electronic information resources in the University library. Similarly, Omoike (2013) reported low level of use of EIRs by NOUN students in Lagos and Ibadan study centers. Omosekejimi, Eghworo and Ogo (2015) found low usage of EIRs by the students of the Federal University of Petroleum Resources, Effurun (FUPRE) which they linked to lack of skills required to navigate the modern technology. Abubakar and Adetimirin (2015) reported a positive relationship between computer literacy and the use of electronic information resources. This implies that low level of computer literacy will limit people's ability to use EIRs.

As important and beneficial as the use of ICT in education is, there are factors that hinder its effective use. Khan, Hassan and Clement (2014) observed that despite the potential of ICTs to advance the educational system, developing countries are not giving the desired benefits due to barriers like erratic power supply (Adetimirin, 2012), frequent breakdown of ICT facilities and inadequate internet bandwidth (Omotosho et al, 2015), incompetence of students in the use of ICT and lack of regular training (Bingimlas, 2009). Emwata and Nwalo (2013) found out that inadequate ICT skills of the students constitute the major challenge to the use of EIRs. The need to address these issues so distance learners can harness the opportunities of ICTs students and be empowered to compete favourably with their counterparts globally is therefore obvious.

3. METHODOLOGY

The research design adopted for the study was descriptive survey in which the students self-reported their ICT skills and use of EIRs. The population of the study was 8,812 undergraduate students of National Open University of Nigeria (NOUN) in South-West, Nigeria. Stratified proportionate sampling procedure was used to select a sample of 812 participants from Akure, Ikeja-Lagos and Ibadan study centers in South-West, Nigeria. Data was collected using a self-structured questionnaire which had a Cronbach reliability coefficient of 0.91. There was a 73.1% return rate of the questionnaires distributed. Data

collected were analyzed using descriptive statistics, correlation and simple regression analysis. SPSS version 21 was deployed to analyze the data.

Research Question 1: What ICT skills do the students of the National Open University of Nigeria in South-West, Nigeria possess?

Table 1: Percentage Distribution of Respondents' ICT skills

SA=Strongly Agree, A=Agree, D= Disagree, SD= Strongly Disagree

	ICT Skills	SA (%)	A (%)	D (%)	SD (%)	$\bar{x}$	Std. Dev.
	Basic computer skills I understand the concepts and basic functions of computer operating systems (e.g. DOS, Windows)	66.0	28.2	2.5	3.3	3.57	.703
	I can download and install software on a computer hard disk	55.7	31.5	7.4	5.4	3.37	.842
	I can copy files from hard disk to storage devices and vice versa **Group mean = 3.49**	61.6	29.2	4.9	4.2	3.48	.775
	Proficiency in using Productivity Software I can type a document using Word processing software	72.2	21.5	4.4	1.9	3.64	.659
	I can use Excel spreadsheet software to organize information	42.4	37.1	13.8	6.7	3.15	.898
	I can use Power point software to present information **Group Mean = 3.26**	38.0	33.8	18.2	10.0	3.00	.981
	Electronic Communication skills I can handle e-mail program and compose email messages using MS Outlook, Gmail or Yahoo	66.0	22.8	6.3	4.9	3.50	.819
	I can attach files and open file attachments from an e-mail message	62.0	24.9	7.9	5.2	3.44	.849
	I can organize email folders **Group Mean = 3.38**	50.3	27.7	13.5	8.5	3.20	.972
	Internet skills I can set up an internet connection and connect to the internet	63.7	23.6	7.9	4.7	3.46	.831
	I can use web browsers and search engines (e.g. Firefox, Google) to find information on the Web effectively.	70.1	19.6	6.3	4.0	3.56	.785
	I can participate in electronic conferencing.	37.8	35.9	17.3	8.9	3.03	.954

	Group Mean = 3.35						
	Grand mean = 3.38						

N = 571 Source: Field survey, 2017

The result on Table 1 reveal that the students' ICT skills were high with a grand mean of 3.38 on a 4 point scale.The students' basic computer skills ($\bar{x}$= 3.49), electronic communication skills ($\bar{x}$= 3.38), Internet skills ($\bar{x}$= 3.35) and proficiency in using productivity software ($\bar{x}$=3.26). The students' ability to use Power point software had the lowest mean of 3.00. This is an indication that the students even though fared well in using productivity software, there is still room for improvement in ICT skills of undergraduates through training and retraining.

Research Question 2: To what extent do the students of the National Open University of Nigeria in South-West, Nigeria use EIRs?

Table 2: Extent of use of EIRs

Use of EIR	**A great extent (%)**	**Some extent (%)**	**Little extent (%)**	**Never (%)**	**$\bar{x}$**	**Std. Dev**
World Wide Web	67.1	20.0	4.7	8.2	3.46	.916
Electronic mail	58.5	24.7	7.9	8.9	3.33	.957
E-news	44.5	34.0	10.2	11.4	3.12	.995
E-book	42.4	33.6	12.8	11.2	3.07	.998
E-reference	30.8	35.9	16.6	16.6	2.81	1.051
E-journal	27.7	36.1	20.5	15.8	2.76	1.027
E-Archives	28.9	35.7	16.6	18.7	2.75	1.069
CD-ROM	27.3	35.6	19.8	17.3	2.73	1.045
Library OPAC	29.1	29.9	22.1	18.9	2.69	1.048
Online databases	22.8	32.6	20.5	24.1	2.54	1.091
Grand Mean	**2.93**					

*** N= 571 Source: Field survey, 2017**

The results on Table 2 show the distribution of the responses of the students of NOUN on the extent to which they use EIRs. The results show that the means of EIRs like the World Wide Web, Electronic mail, electronic news and E books were greater than 3 on a scale of 4 while the mean value for all other EIRs as well as the grand mean were below 3.0. This suggests moderate use of electronic information resources by the respondents.

Research Question 3: What factors constrain the use of EIRs by the students of the National Open University of Nigeria in South-West, Nigeria?

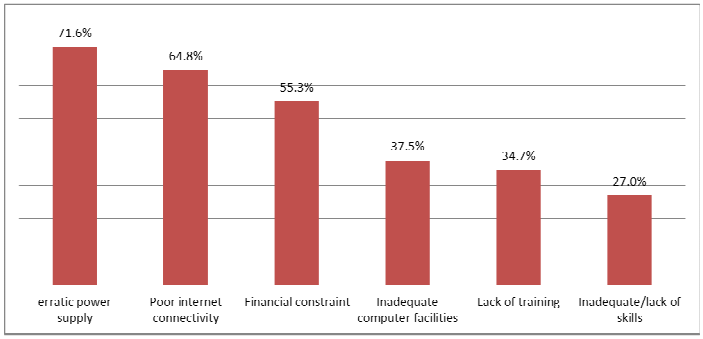


Figure 1: Constraints to the use of EIRs

Figure 1 shows that the most common constraint to the use of electronic information resources identified by the students is erratic power supply (71.6%). This is followed by poor Internet connectivity (64.8%) and financial constraints (55.3%). Most of the students did not perceive inadequate/lack of skills as a constraint which confirms the result on Table 1 that they have high level of ICT skills. It is obvious from the results that erratic power supply and poor Internet connectivity pose serious limitation to the use of EIRs by the undergraduates of NOUN in South-West Nigeria. This is a reflection of the situation in Nigeria which demands urgent attention.

Hypothesis 1: There is no significant relationship between ICT skills and the use of EIRs by the students of National Open University of Nigeria in South-West, Nigeria.

Table 3: Relationship between ICT skills and use of electronic information resources

Variables	$\bar{x}$	SD	N	R	P	Remark
ICT Skills	40.3958	6.4346				
Use of Electronic Information Resources	29.2469	7.2531	571	.389	.000	Sig.

A Pearson Product-Moment Correlation was run to determine the relationship between ICT skills and use of electronic information resources. Table 3 shows that there is a significant, positive correlation between ICT skills and use of electronic information resources (r=.389, $p < .05$). This implies that as students' ICT skills increase, the use of EIRs also increases. The hypothesis is therefore rejected.

Hypothesis 2: ICT skills will not significantly influence the use of EIRs.

Table 4: Influence of ICT skills on Use of electronic information resources

Model	R	R^2	Adjusted R^2	Std. Error of Est.	Df	F	T	Sig.
(Constant)			150	6.6879	1		6.479	.000
ICT skills					569	101.40	10.070	

Dependent variable: Use of electronic information resources

The result of simple linear regression analysis carried out to determine the influence of ICT skills on the use of EIRs by the students shows that ICT skills accounted for 15.0% of the variance in the use of electronic information resources (*Adj*. R^2=0.15, F(1,569) =101.40, $p < .05$). ICT skills had a significant influence on the use of EIRs hence, the null hypothesis was rejected.

4. DISCUSSION OF FINDINGS

The findings on ICT skills of the NOUN undergraduates revealed that the respondents are highly skilled as they rated themselves high in all the levels of ICT skills. The finding corroborates those of Omotosho, et al. (2015) which revealed that students have the basic computer skills and possess Internet searching skills. The findings also agree with the study by Ojeniyi and Adetimirin (2013) and Odede and Odede (2016) which revealed that majority of the undergraduate students are highly skilled in the use of ICT and its applications such as the Internet and e-mail. The finding is however inconsistent with those of Gakibayo, Ikoja-Odongo and Okello-Obura (2013) who revealed inadequate ICT skills by undergraduate students.

Finding on the extent of use of EIRs revealed a moderate use of electronic information resources by the students of NOUN in South-West, Nigeria. The World Wide Web, electronic mail, e-news and e-books were mostly used. The findings concurred with the findings by Quadri, Adetimirin and Idowu (2014) which revealed that the students in Nigerian universities use e-books, e-journals and e-news mostly and that they often utilize electronic information resources but contradicts those of Emwata and Nwalo (2013), Omoike (2013) and Abubakar and Adetimirin (2015) who found out low usage of electronic information resources by undergraduate students.

The finding also confirms that of Abubakar and Adetimirin (2015) that a strong positive relationship exists between ICT skills and use of EIRs. With regard to the challenges militating against the use of EIRs by the Polytechnic faculty, finding showed revealed that the greatest impediment was erratic power supply as indicated by majority (71.8%) of the students. This is in line with the findings of Omoike (2013) Abubakar and Adetimirin (2015) who found that erratic power supply constitute a major hindrance to effective use of e-resources in Nigeria. The findings also agree with (Quadri, Adetimirin & Idowu, 2014)

that poor Internet connectivity is a factor that affects access to and usage of electronic information resources. This finding is inconsistent with the finding by Omosekejimi et al. (2015) who revealed low usage of electronic information resources by the students of Federal University of Petroleum Resources, Effurun (FUPRE) due to lack of skills required to navigate the modern technology. By implication, regular power supply, stable Internet connection and adequate finance are facilitating conditions that enhance the use of e-resources.

5. CONCLUSION

The use of ICT is inevitable and calls for the development requisite skills among higher education students. ICT skills are fundamental to effective use of EIRs and learning. This study has revealed that undergraduates in NOUN, South-West Nigeria are highly skilled in the use of ICT which reflects in their use of electronic information resources (EIRs). The electronic information resources mostly used by the students are the World Wide Web, E-mail and e-book. In spite of the great benefits electronic information resources hold for students and researchers, erratic power supply, poor Internet connectivity and financial constraint are impediments to their effective use for learning and research.

6. RECOMMENDATIONS

Based on the findings of this study, it is recommended that:

1. The management of the NOUN should invest in alternative source of power to ensure maximum use of electronic information resources by the students.
2. The library of the NOUN should periodically organize training and training to sharpen the ICT skills students increase the use of electronic information resources.
3. Also, the management of NOUN should make adequate investments in ICT infrastructural facilities such as the computers, the Internet, virtual/e-library, mobile technologies to match the trends in the globalization of education.

7. REFERENCES

Abubakar, D. & Adetimirin, A. (2015). Influence of computer literacy on postgraduates' use of e-resources in Nigerian university library. *Library Philosophy and Practice (e-journal)*. Retrieved from http://digitalcommons.unl.edu/libphilprac/1207

Adetimirin, A. E. (2012). ICT literacy among undergraduates in Nigerian universities. *Journal of Education and Information Technologies 17*(4), 381-397.

Akande, S. O. (2011). Computer and Internet facilities use in distance education: A survey of sandwich students of University of Ado Ekiti, Nigeria. *Library Philosophy and Practice*

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: a review of the literature. *Eurasia Journal of Mathematics, Science & Technology Education, 5*(3), 235-245.

Emwata, M. & Nwalo, K. I. N. (2013). Influence of computer literacy and subject background on use of electronic resources by undergraduate students in universities in South-western Nigeria. *International Journal of Library and information Science, 5*(2), 29-42. Retrieved from http://www.academicjournals.org/IJLIS

Hamutumwa, M. U. N. (2013). Electronic resources use by distance learners at University of Namibia. Ph. D. Thesis University of KwaZulu-Natal, Pietermaritzburg.

Ikoja-Odongo, J. R. & Okello-Obura, C. (2013). Electronic information resources utilization by students in Mbarara University Library. *Library Philosophy and Practice (e-journal)* Paper 869.

Mikre, F. (2011). The roles of Information Communication Technologies in education review article with emphasis to the computer and Internet. *Ethiopia Journal of Education & Science, 6* (2): 1-16.

Odede, I. & Odede, E. (2016). Undergraduates' computer skills and the use of online information resources: a case study of library and information science students of Delta State University, Nigeria. *International Journal of Academic Library and Information Science, 4*(3), 87-93.

Ojeniyi, A. & Adetimirin, A. (2013). Gender influence on ICT use by undergraduates in two University libraries in Nigeria. *Computer Communication and Collaboration,* 62-71.

Okebukola, P. A. (2014). Open and Distance Education: A catalyst for production of quality teachers and the transformation of Nigeria. Paper presented at the 4th National Teachers Summit, National Teachers Institute, Kaduna November 13-14, 2014.

Omoike, A. D. (2013). Use of electronic resources by distance students in Nigeria: the case of the National Open University, Lagos and Ibadan Study Centers. *Library Philosophy and Practice (e-journal)* Retrieved from http://digitalcommons.unl.edu/libphilprac on15/7/2014.

Omosekejimi, A. F., Eghworo, O. R. & Ogo, E. P. (2015). Usage of electronic information resources (EIRs) by undergraduate students of Federal University of Petroleum Resources, Effurun. *Information and Knowledge Management*, *5*(4), 94-103.

Omotosho, A. O., Lateef, E. B., Amusa, O. I. & Bello, T. O. (2015). ICT adoption and use among students of a Nigerian University for distance learning. *Library Philosophy and Practice (e-journal),* Paper 1246.

Quadri, G. O., Adetimirin, A. E. & Idowu, O. A. (2014). A study of availability and utilization of library electronic resources by undergraduate students in private universities in Ogun state, Nigeria. *International Journal of Library and Information Science, 6*(3), 28-34.

Sarkar, S. (2012). The role of information and communication technology (ICT) in higher education for the 21st century. *The Science Probe*, *1*(1), 30-41.

SCRUM PROCESS MODEL FOR THE DEVELOPMENT OF SMART PAYROLL INTEGRATED WITH TASK MANAGER

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ABSTRACT

This study proposes a smart payroll integrated with a task manager based on scrum process model. Requirement engineering was thoroughly conducted to ascertain functional, non-function, expected, exciting and normal requirements. Uniform Modelling Language was used for the modelling of the software architecture, deployment diagram, Swimlanes, sequence diagram and use case for the smart payroll integrated with task manager. Scrum is the adopted methodology for the software development. The smart payroll integrated with task manager extended a previous work where reports for employee time and attendance was developed based on scrum without payroll and task manager. The study has the potential to promote local content software development based on the state of the art software development process model with capability to compete with foreign software in the Nigeria software market and beyond.

Keyword: *Payroll, Scrum, Task Manager, Software Architecture.*

1. INTRODUCTION

The proliferation of Information and Communication Technology (ICT) in the 21st century has revolutionized the way businesses are conducted. It is widely accepted that ICT enables organizations to decrease costs and increase capabilities. Hence, shape inter-organizational coordination (Hengts & Sol, 2001). Information and database system projects has been used to enhance performance (Gautam, Ragumani & Sharma, 2010).

Jagli, Solanki and Chandarana (2013) argued that processing the salary of an employee is a very difficult job especially if not automated. Payroll Application is designed purposely to maintain details of various allowances and deductions that need to be given to the employees of the organization and provides records of employees in the database to enable easy and faster retrieval of data (Madavarapu, 2014). Payroll is very critical

operation and paramount for every company to recompense employees accurate salary and enrolments on time (Mahajan, Shukla & Soni, 2015; Singh, Chaphekar & Sawant, 2016).

There are attempts made by researchers on the automation of payrolls: desktop and online. For example, Chebolu (2016) developed web-based reports for employee time and attendance based on SCRUM. Singh et al. (2016) developed a desktop based payroll application for a college. The automated payroll application was able to computes, maintains and records the payroll information of the faculties and has biometric feature for tracking attendance. Singh *et al*. (n.d) observed that in most of the organizations payroll management are paper work. As a result, the study developed a web-portal that will provide the employees of the organization with an online platform to view their leave history and apply for leave. It also has a subsystem for managing the tasks related to payroll and income tax deductions. Similarly, Mahajan *et al*. (2015) built a web based payroll application. The payroll application is accessible on the internet. Jagli *et al*. (2013) proposed a payroll management system (PMS) to cope the manual and time consuming task of processing the salary of an employee. The payroll application was developed to be software as a service (SaaS) on the cloud. Prassanna and Senthilkumar (2012) designed and implemented a reliable, scalable and cost effective biometric attendance payroll application over cluster based cloud technology. The cloud based biometric attendance manager (BAM) collects data from different biometric terminals (BT) and process those data before storing in the cloud based enterprise biometric information server (EBIS) to generate payroll.

Despite the progress made by researchers to automate payroll system as discussed in the preceding paragraph, the major issue with the previous approaches is the limited attempts made by previous studies to integrate SCRUM process model in their methodology. To the best of the authors knowledge, only Chebolu (2016) was found to apply scrum for the development of web-based reports for employee time and attendance. However, the study didn't consider payroll and task management.

In this study, we proposed a smart payroll based on scrum agile process model that integrate task management to demonstrate its applicability within the context of Nigeria organization.

2. METHODOLOGY

2.1 Scrum Agile Process Model

Scrum model was proposed by Jeff Sutherland and his team in the early 1990s. Scrum agile process model or simply Scrum is one of the popular agile software development frameworks. Scrum is primarily for developing complex projects (Anand & Dinakaran, 2016). Other agile development frameworks include; Extreme Programming, Adaptive Software Development, Feature Driven Development, Dynamic System Development Method, Lean Software Development etc. There are key assumptions about most of the software projects that any agile process model seeks to address (Pressman, 2010)

2.2 Scrum Process Flow

Scrum has mainly three roles (Anand & Dinakaran, 2016):

- The product owner
- Scrum Master
- Project Team or Scrum team

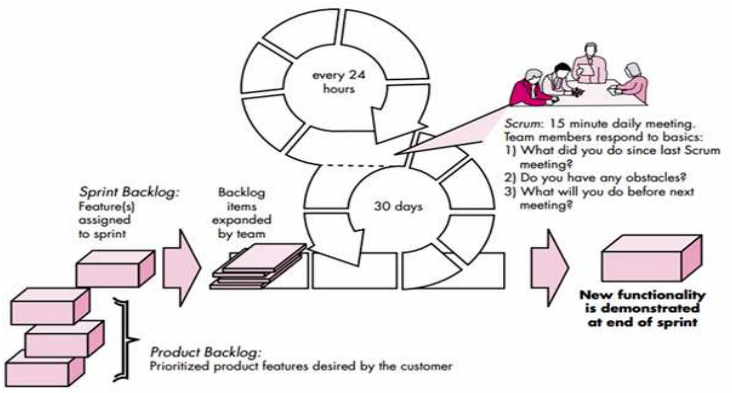


Figure 1: Scrum Process (Pressman, 2010)

From the Figure 1, the client (product owner) gets the input from end-users, customers, stakeholders etc and come up with the product backlog/list of features (backlog are prioritized list of project requirements or features that provide business value for the customer). The product owner assesses the backlog and prioritised them in the sequence of business requirements. The scrum team pull from the product backlog what is called Sprint backlog and work on within a fixed period of time that the team commits to work in a course of developing the product (called sprint). Once the team starts working on the sprint backlog, no change of requirement is accommodated. The length of the sprint is determine by the team and product owner and the size of the sprint backlog (typically 30 days). Each day the team has a short meeting (also called scrum meetings) to update each other on progress and blocks. It is usually, a casual and informal meeting of about 15 minutes where everyone stand up to keep it fast and report just 3 things (Pressman, 2010).

A team leader (scrum master) acts as a supervisor, assesses the responses from each scrum team member. The Scrum meeting helps the team to uncover potential problems as early as possible. At the end of every sprint, a demo (deliverable feature or the software increment or prototype) is delivered to the customer so that functionality that has been implemented can be demonstrated and evaluated by the customer. There are two reviews that takes place. First one called "Sprint review meeting" where product owner, team, scrum master, stakeholder, etc. come together and see the demo of working software and feedback is taken. The other one called "Retrospective meeting" primarily only for the team, product owner and scrum master. They meet to improve their effectiveness by reviewing their way of working. Sprint review is a "product review" and Retrospective is a "process review" (Pressman, 2010; Anand & Dinakaran, 2016).

2.3 Requirement Engineering

Case Study: To demonstrate the applicability of the Scrum agile process model, SKY B Dynamics, Jos, Plateau state was chosen as the case study.

2.3.1 Elicitation of User Requirement

Following the processes in the scrum methodology, the development team visited SKY B Dynamics and had a face-to-face interaction with the product owner (manager). The purpose of meeting the client was to find out the requirement of the propose computer based system. Here are the user stories (product backlog) that were captured from the client:

i. The program should compute net pay.
ii. The program should accept employee hours worked.
iii. The program should prepare and able to print a payroll slip.
iv. Non-statutory deductions such as tax, loans and pension plans should be made.
v. The program should have task management environment for every employee in the company.
vi. The program should enable communication between the manager and the employee.

After the meeting with the product owner, the development team came up with the sprint backlog to be delivered at the end of the sprint.

2.3.2 System Function

In this project administrator adds Branch manager records and upload tasks to each branch. Branch manager create a team to assign tasks to the employees and set time frame for the project. Daily employee submits attendance by Login Time and Logout time.

After completion of project work, employee sends documentation of project work to branch manager. Chat and message option is implemented to enhance communication among co-workers, branch managers, and administrators.

2.3.3 Actors

Based on the requirement gathered from SKY B Dynamics, the actors involved:

- **Administrator:** The administrator is a super user and has complete control over all activities that can be performed on the system. The administrator can view branch details, employee details, task details, salary details, etc.
- **Brach Manager:** The branch manager handles employees and is responsible for assigning tasks to the employees.
- **Employee:** Employees are the co-workers whose responsibilities are to complete the task given by the branch manager.

2.3.4 Functional Requirement

The major deliverables that the system will be performing base on the requirement gathered are as follows:

Home page: Home page is the first page of the website. Home page contains the information of the company and Login page. The Administrator or Employee can login to the site by entering Login ID and Password.

Employees Module: In this page Administrator adds employee record by entering employee profile, experience details, and payroll details. Once the system creates employee record, admin can send login information to the employees.

Projects and Task Module: In this page, admin adds different projects and scheduled time frame, start time and end time for those projects. The admin creates team and assign task to the team members. In this module, administrator can send project documents, requirements and communicate with the employees.

Attendance Module: In this module, employees submit attendance. Admin or Branch manager track employee's attendance report i.e.; Login time, logout time, Number of days present at work.

Payroll Module: In this module, administrator or Branch manager generates monthly salary to its employees. Generate basic salary, deduction, PF, bonus, Loss of Pay (LOP) are the main features of this module.

2.3.5 Non-Functional Requirement

These are requirements whose absence does not necessarily affect the co-functionality of the system but enhance the entire system performance.

Performance

- Performance requirements define acceptable response times for system functionality.
- The load time for user interface screens shall take no longer than five seconds.
- The log in information shall be verified within five seconds.
- Queries shall return results within five seconds.

Reliability

- Good validations for user inputs.
- Avoid incorrect storage of records.

Security

- Encrypted Password.
- Administrator has more rights than the sub user.

Portability: This Website opens in any personal computer supporting windows, Linux and UNIX operating system.

Flexibility: The system keeps on updating the data according to the transactions that takes place.

Maintainability: During maintenance stage, the SRS can be referred for the validation.

Timeliness: The system carries out all the operations with short time.

2.4 Modelling

The smart payroll integrated with task manager is modelled using UML based on the requirement engineering presented in Section 2.3. This section presents the modelling of the propose smart payroll integrated with task manager. The models presented in the section are as follows: use cases for the employee (Figure 2), manager (Figure 3) and administrator (Figure 4). Activity diagram for the smart payroll integrated with task manager and Swimlanes for the smart payroll integrated with task manager are presented in Figures 5 and 6, respectively. Figures 7 and 8 are the sequence diagram.

USE CASE

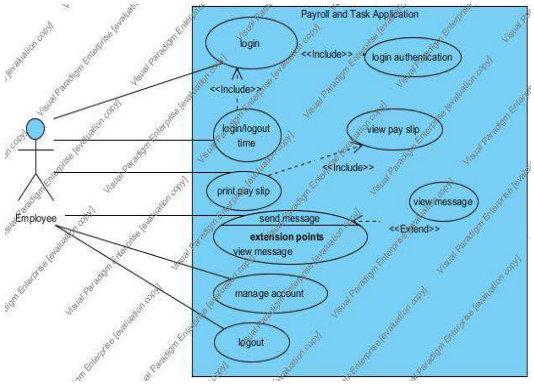


Figure 2: Use case diagram for the employee

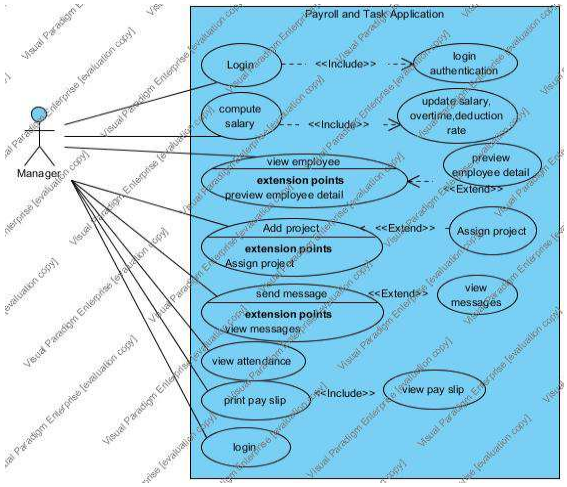


Figure 3: Use case diagram for the manager

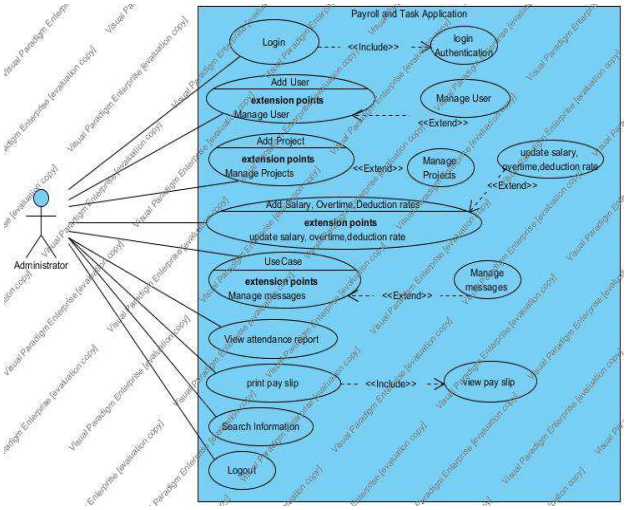


Figure 4: Use case diagram for the administrator

ACTIVITY DIAGRAM

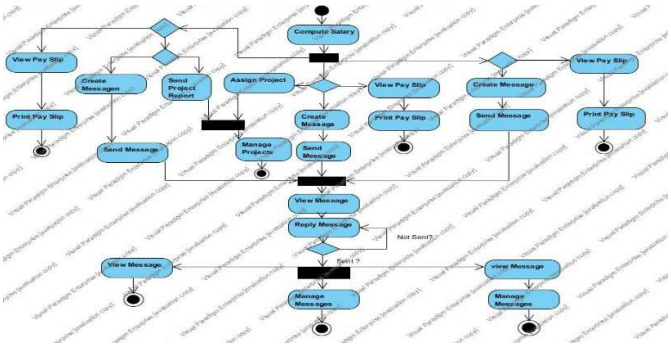


Figure 5: Activity diagram for the Smart Payroll Integrated with Task Manager

SWIMLANES

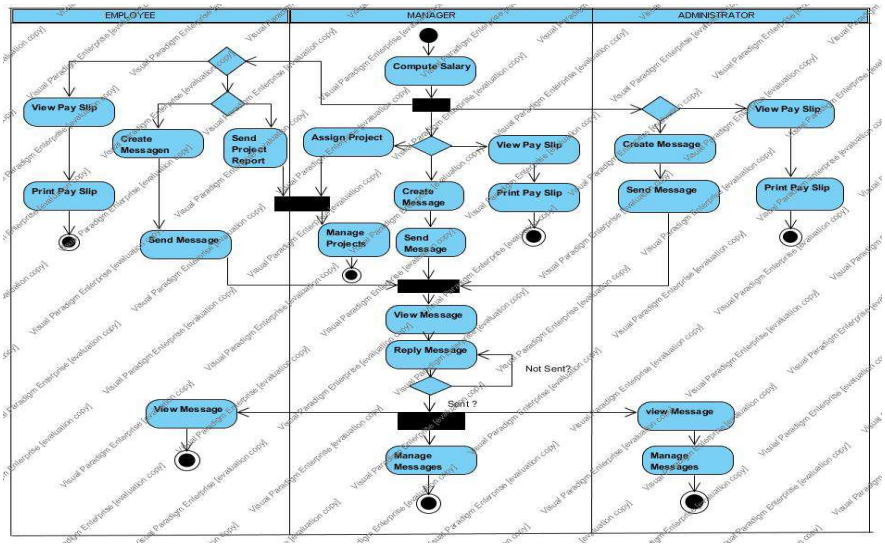


Figure 6: Swimlanes for the Smart Payroll Integrated with Task Manager

SEQUENCE DIAGRAM

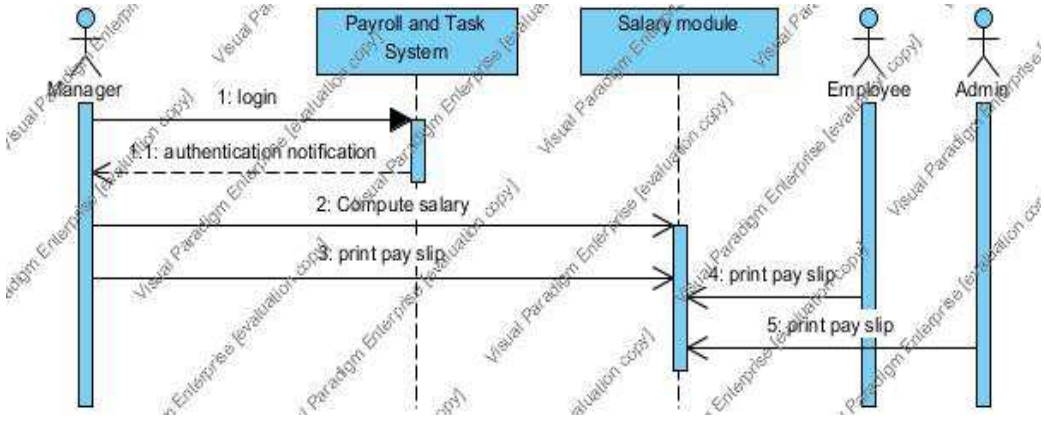


Figure 7: Sequence Diagram for the Smart Payroll Integrated with Task Manager

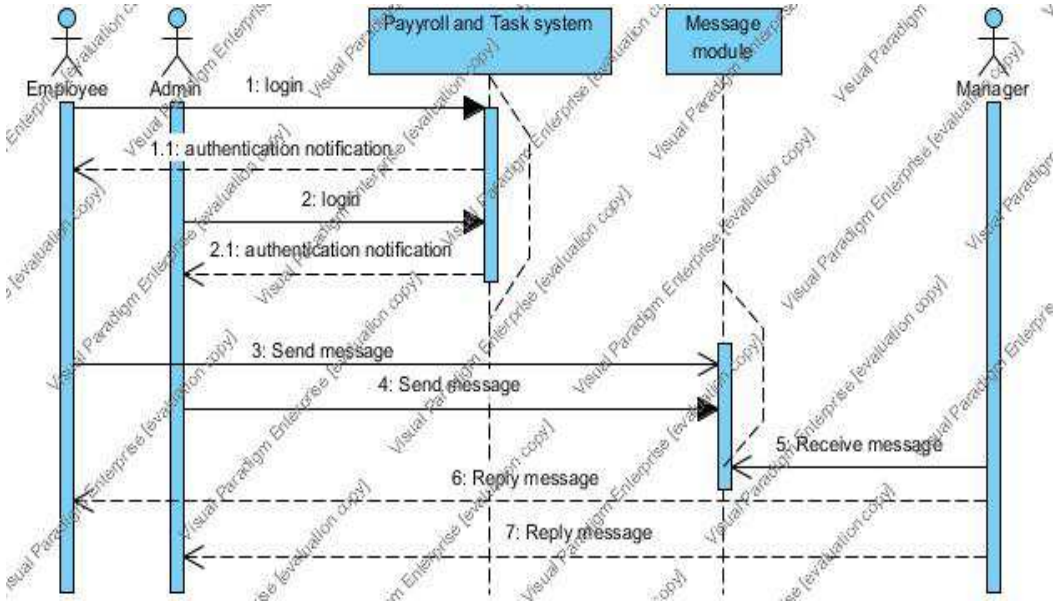


Figure 8: Sequence diagram for the Smart Payroll Integrated with Task Manager

2.5 Software Architecture

Architecture of the software gives a very high level view of the various components of the system and how they relate to form the entire system (Jalote, 2008). In this section, the software architecture of the smart payroll integrated with task manager is depicted in Figure 9, showing the programs that manipulate the modules, visible features and their relationship. This comprises of the database, modules, layers, servers and the client.

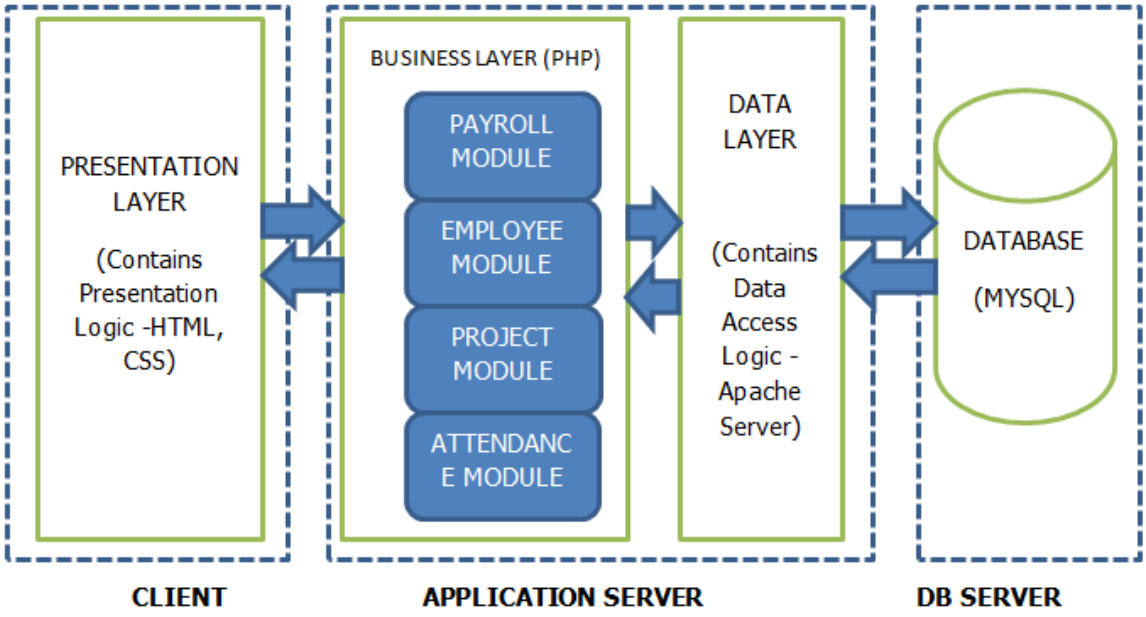


Figure 9: Software Architecture of the Smart Payroll Integrated with Task Manager

2.6 Deployment Diagram

This section presents the deployment diagram of the smart payroll integrated with task manager as shown in Figure 10. The diagram shows the hardware, deployment environment and the software for the entire smart payroll integrated with task manager system.

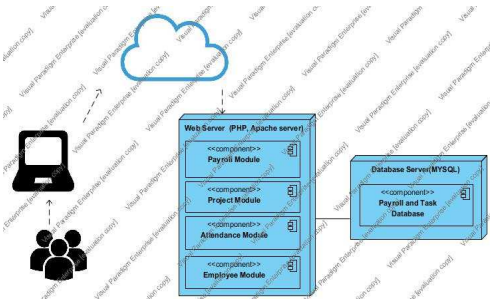


Figure 10: Deployment diagram of the Smart Payroll Integrated with Task Manager

2. CONSTRUCTION AND DISCUSSION

In this section, we present the construction of the smart payroll integrated with task manager. The technology applied for the construction of the system are outlined. The interface of the system and sample results generated are shown. The system was constructed using HTML5, CSS, and JavaScript (for the front end), PHP, Appache Server and MYSQL (for the back end). The system was tested with a local host, using XAMP package. The application was tested to be fully functional and meets the requirements of the clients. Below are the interface screen shots of the application.

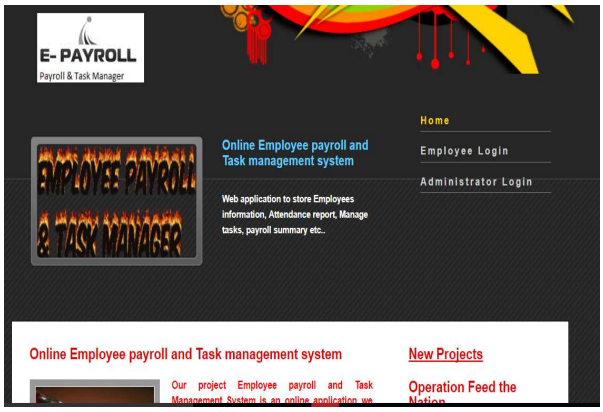


Figure 11: Administrator login

Figure 11 is the home page of the application showing the login options (Employee and Administrator). The manager is also an employee but with higher privileges than the other employees

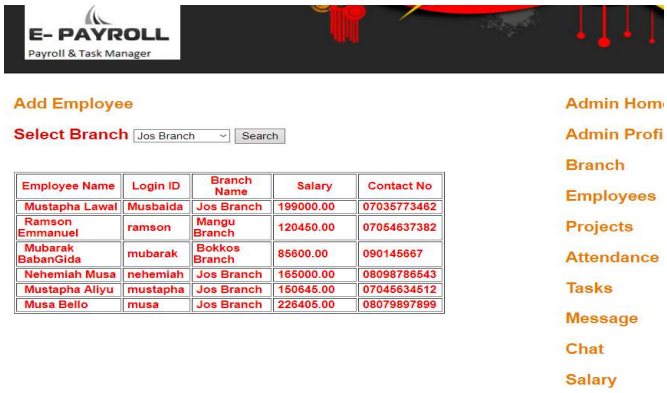


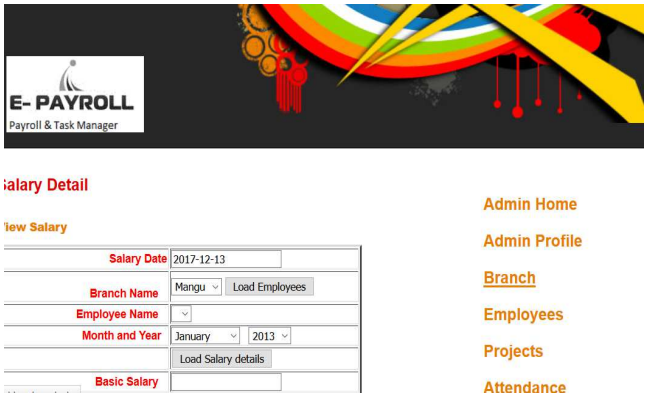
Figure 12: Add employee

Figure 12 is the add employee page where the admin adds the employees across the organization branches (Managers can also add employees). It gives the managers and other employees login ID to enable them access their page.



Figure 13: Employee Attendance Report

Figure 13 is the employee attendance records showing their names, login and logout times. This will help determine the working hours by each employee to be used to computes the salary automatically. The login time is captured from the first login of the employee every day and the system keeps track of the time until the employee logout at the end of each day.



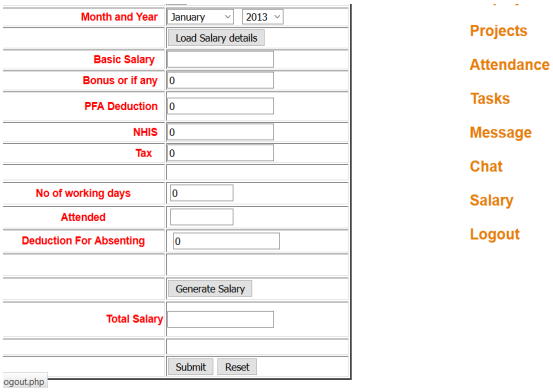


Figure 14: Salary Details on the smart payroll integrated with task manager

Figure 14 is the salary details page where the admin/manager can compute the salary of an employee. Once the name of the employee is selected, the load salary detail is click, and the basic salary, bonus (if any exist, else, the bonus is zero by default), PFA deductions, NHIS, tax, No of working days (this is all the days in the month excluding non-working days) and the number of working days attended by the employee (this will be determined automatically from working hours by the system). Subsequently, generate salary button is click to compute the salary.

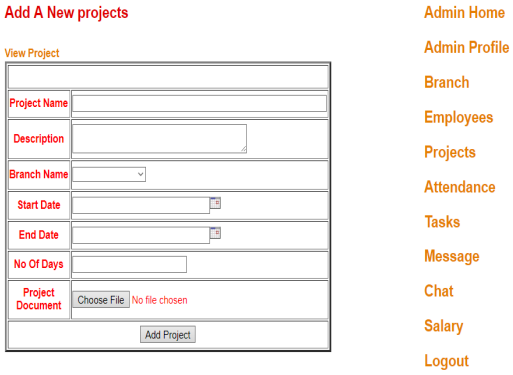


Figure 15: Add New Projects

Figure 15 is the page of the admin/manager that adds and assign project to the employees. Given the description, start date, end date and project document. The employee will work base on these information and report back to the manager.

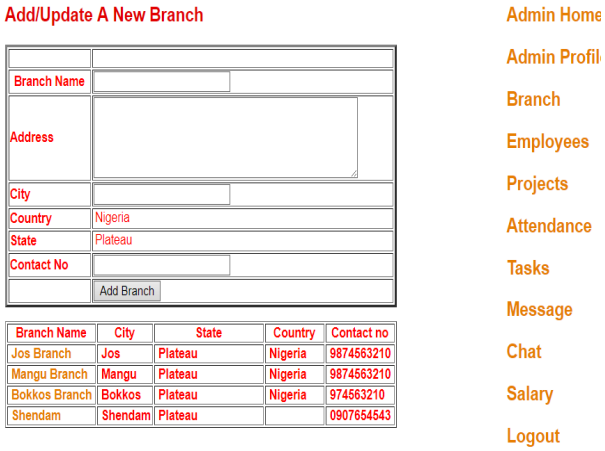


Figure 16: Add/Update New Branch

Figure 16 is a page where the admin can add or updates branch information

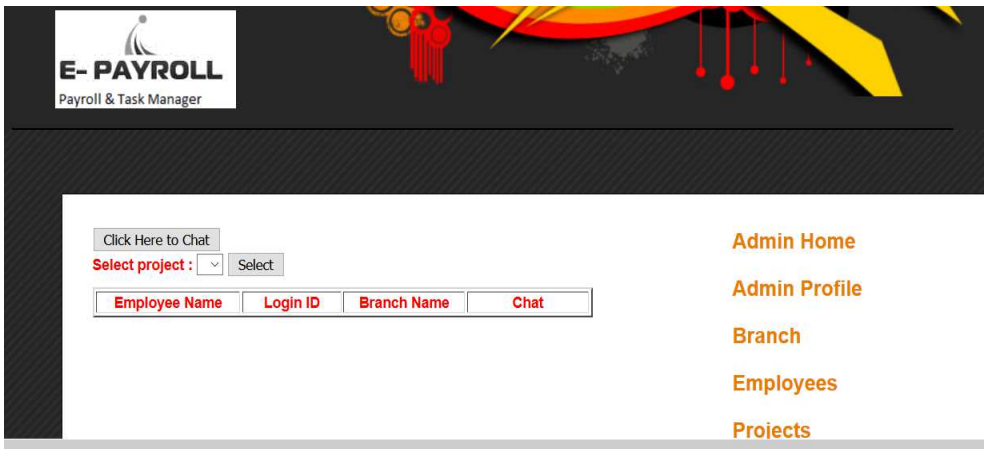


Figure 17: Chat page

Figure 17 enables the system users to chat among themselves (showing from the admin end)

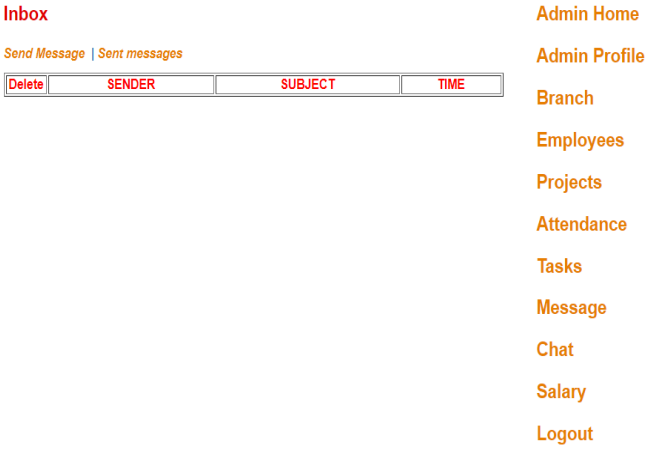


Figure 18**:** Message page

Figure 18 enables the system users send and reply messages. This is a bit different from chat, the user can select who to send a message. Unlike the chat where it is public, every user can see the chat sent.

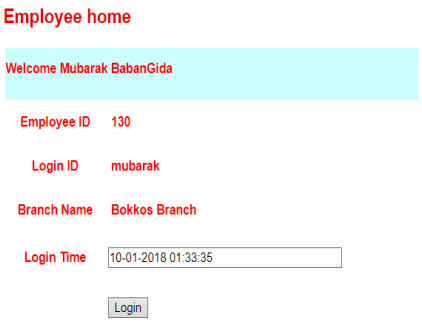


Figure 19**:** Employee home page

Figure 19 shows the time the employee login and the login time is captured. The time starts tracking as the user proceeds to login to their main pages.

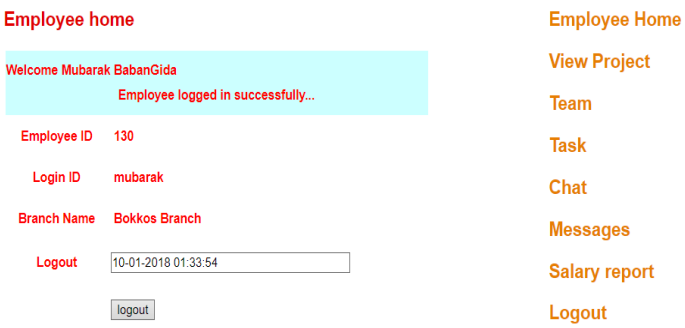


Figure 20: Employee logout page

Figure 20 shows the employee's logout page. Once the user clicks the logout time, the records is kept in the database automatically. Also, the login time to generate the hours worked for that day is generated by the system. This smart payroll integrated with task manager is develop based on the Scrum agile process model unlike the commonly developed payrolls. It is common in Nigeria for workers to come to work late and close earlier than the closing hour especially workers of the local government. Putting this kind of system in place, it will force the workers to be punctual to their duty post. The smart payroll Integrated with task manager has the capability to track the activity of a worker in an organization including number of days presents and the number of days absent without proper permission from the organization authorities. At the end of the month the smart payroll integrated with task manager generate the pay slip of the employee including deductions of money for days been absent by the employee without a permission.

3. Conclusions

This study modelled and constructed a smart payroll and task manager for an organization using scrum agile process model. The application can efficiently manage the employees' records, employees' tasks, attendance and track the activities/movement of the employee. This paper has shown that scrum process model can effectively be used by the software industry in Nigeria to develop software for both home and foreign consumption. As such, promote the use of agile software development in the context of Nigeria. The authors intend to further the research by re-modelling and deploying the application on the cloud to reduce cost of hosting by organizations.

REFERENCES

Anand, R.V., & Dinakaran, M. (2016).Popular Agile Methods in Software Development: Review and Analysis. *International Journal of Applied Engineering Research,* 11(5), 3433-3437

Beck et al. (2001). Manifesto for Agile Software Development. Retrieved from http://agilemanifesto.org

Chebolu, V. V. (2016). Development of Web Based Reports for Time and Attendance in Agile Environment. Culminating Projects in Mechanical and Manufacturing Engineering. Paper 45

Gautam, P. R., Ragumani, S., & Sharma, Y.K. (2010). A System for Payroll Management. *Journal of*

Computer Science, 6 (12),1531-1534

Hengst, M, & Sol, H. G. (2001). The Impact of Information and Communication Technology on Interorganizational Coordination: Guidelines from Theory. *Special Series on Information Exchange in Electronic Markets,* 4(3), 129-138

Jagli, D., Solanki, R., & Chandarana, R. (2013). Payroll Management System as SaaS. *Proceedings of*

National Conference on New Horizons in IT – NCNHIT, 90-94

Jalote, P. (2008). A Concise Introduction to Software Engineering. Verlag, London: Springer

Madavarapu, J. B. (2014). P ayroll Management S ystem. All Capstone Projects. 82. http://opus.govst.edu/capstones/82

Mahajan, K., Shukla, S., & Soni, N. (2015). A Review of Computerized Payroll System. *International*

Journal of Advanced Research in Computer and Communication Engineering, 4(1), 67-70

Prassanna. J, Senthilkumar. M.K.S. (2012). Implementation of Biometric Attendance Management System on Cloud Environment. *International Journal of Modern Engineering Research (IJMER).* 2(3),1052-1054

Pressman, S., R. (2010). Software Engineering: Practitioner's Approach. America, New Yock: McGrawHill

Singh, A. V., Chaphekar, S. V., & Sawant, Y. S. (2016). Automated Payroll System (A-PAY). *International*

Journal of Modern Trends in Engineering and Research (IJMTER), 3(2), 548-553

Singh, M., Singh, P., Singh, R., Singh, S., & Gupta, S. (n.d). Leave and Payroll Management System. *IOSR*

Journal of Computer Engineering (IOSR-JCE), 62-66

ASSESSMENT OF PATIENTS' KNOWLEDGE AND PERCEPTION TOWARDS CONVENTIONAL AND DIGITAL RADIOGRAPH IN DENTAL IMAGING.

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ABSTRACT

Objective: This study aimed at assessing patients' knowledge and perception towards conventional and digital radiograph in dental imaging and also to determine the reasons why patients prefer one to the other.

Materials and Methods: A 12 item questionnaire, covering socio-demographics, familiarity, preferences, knowledge and attitude of respondents towards conventional and digital radiograph was applied. Questionnaires were only given to participants above the age of 18 years. Participants were given maximum of one week to fill the questionnaires.

Results: There are 222 questionnaires distributed to patients attending the dental clinic, only 180 (81.08%) surveys returned for collection. Most patients displayed a low level of knowledge, but preferred digital radiographs due to clearer images obtained. About 30% of patients also preferred digital radiographs due to clearer images obtained (better resolution). About 10% had no knowledge about digital and conventional X-ray, while 10 % has knowledge on digital, 80% has knowledge on conventional and 10% has knowledge on both.

1. INTRODUCTION

Science is dynamic and innovation is highly welcome in science.[1]

The history of digital radiography can be dated back to Nov 8th 1895, when a Professor of experimental Physics in Germany, Wilhelm Conrad Roentgen, was working in his laboratory using Crooke's tubes. In the darkened laboratory, he noticed that a sheet of cardboard, placed several feet away, was glowing in the shape of the letter A that a student had painted in liquid barium platinocyanide. Roentgen was intrigued by glowing cathode tubes and decided to see what they could do. He found that the rays emitted could pass through body parts, such as his hand, the bones beneath the skin became clearly visible on the screen. [2-4]

Because he didn't know exactly what was causing this interesting phenomenon, he labeled the rays, "X", which is the mathematical symbol for anything that is unknown. Within two weeks after Roentgen made his important discovery, Dr. Otto Walkhoff developed the first original dental "roentgenogram" from a portion of a glass imaging plate. The image required 25 minutes of exposure. The dawn of the digital era in dental radiography came in 1987 when the first digital radiography system called RadiovisioGraphy, was launched in Europe by the French company Trophy Radiologie. The inventor of this system was Dr. Francis Mouyen. He invented a way to empty fiber optics to narrow down a large X-ray image onto a smaller size that could be sensed by a charge Coupled Device (CCD) image sensor chip. Two decades after, today's digital radiographic systems have developed a great superiority and have many benefits.

In digital radiography, images are scanned, displayed and stored on computer system while conventional radiography displays images on radiographic films; both digital and conventional radiographs have been highly valuable diagnostic tools in orthodontic treatment.[6]

The concept of digital radiographic image refers to the image obtained from X-rays and displayed on computer.[5]

There are two methods of digital radiography: Direct and Indirect. In the direct method, the image is captured directly through a charged Coupled Device (CCD) eliminating the use of radiographic film and darkroom.[7]

In the indirect, also known as hybrid system, a conventional radiography is recorded by a video camera or scanner and converted into digital format in a computer through a software program.[7-9]

Radiographs and other imaging modalities such as computed tomography, ultrasound, Magnetic resonance imaging and radionucleide studies are used to diagnose and monitor oral diseases as well as to monitor dental development and the progress or prognosis of therapy.[10]

Radiographic examinations can be performed using digital imaging or conventional films, both serves as important supplement to clinical examination of the teeth for detecting carious lesions.[11]

Digital imaging, however offers reduced radiation exposure and the advantage of image analyses that may enhance sensitivity and reduce error introduced by subjective analysis.

X-ray units recommended for use in digital radiography should have the following characteristics, the smallest focal spot possible, an accurate timer capable of producing very short exposures, direct current with 70kv setting or below and 5mA or less rectangular collimation.[12]

The optimal application of digital technology in the dental practice setting is to have a networked office system that is paperless and integrates all aspects of the patient record, including medical and dental history.[13]

Digital radiography has better resolution and also reduces patient radiation exposure, these make it highly attractive when compared to conventional radiograph. however the potential benefit must be weighed against potential risk when using either of them.[14-15]

Other benefits are; immediate image production with solid state devices, interactive display on a monitor with the ability to enhance image features and make direct measurements, integrated storage, elimination of darkroom and making image duplications for referral to other practitioners.[16-18]

2. MATERIALS AND METHODS

This was a cross-sectional study in which a questionnaire was designed to collect a data from patients attending the dental clinic. Convenient sampling technique was used for recruitement over the period of 6 months. A 12 item questionnaire, covering socio-demographics, familiarity, preferences, knowledge and attitude of respondents towards conventional and digital radiographs in dental imaging. Questions also captured similarities and differences between conventional and digital radiographs. In addition, advantages and disadvantages of conventional and digital radiographs were also featured in the questionnaire. Questionnaires were only given to participants above the age of 18 years.

Participants were given maximum of one week to fill the questionnaires. Participation in the study was voluntary and no incentives were offered. Figures 1 and 2 show images of conventional and digital radiographs respectively.

The questionnaire used took a multiple format, i.e it comprises closed- and open-ended questions. The information collected was based on self-reporting by the participant. Occasionally, patient requested for clarifications of questions from the dentists. Collected data was handled with confidentiality.

Sliding scales were used to assess attitude towards dental radiographs. Statistical analyses were performed using descriptive and non-parametric tests.



Figure 10 ; showing a conventional radiograph

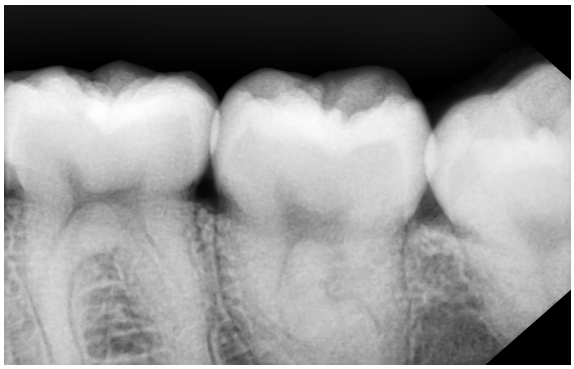


Figure 2 ; showing a digital radiograph

RESULTS

AGE DISTRIBUTION OF THE RESPONDENTS

AGE DISTRIBUTION	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS %
18 – 25	23	12.8
26 – 33	81	45
34 – 41	54	30

42 -49	18	10
50 >	4	2.2

The mean age is 36 and the standard deviation is 31.09

SEX DISTRIBUTION OF THE RESPONDENTS

SEX DISTRIBUTION	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS (%)
M	76	42.2
F	104	57.8

KNOWLEDGE ON DIGITAL AND CONVENTIONAL X-RAY DISTRIBUTION OF THE RESPONDENTS

KNOWLEDGE DISTRIBUTION	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENTS (%)
DIGITAL	18	10
CONVENTIONAL	144	80
KNOWLEDGE ON BOTH	18	10
NO KNOWLEDGE	18	10

FAMILIARITY ON DIGITAL AND CONVENTIONAL X-RAY

YEAR OF FAMILIARITY	CONVENTIONAL	DIGITAL
LESS THAN 1 YEAR	25(13.89%)	15(8.33%)
MORE THAN 1 YEAR	119(66.11%)	3(1.67%)
ABSTAINANCE	36(20%)	162(90%)
TOTAL	180(100%)	180(100%)

PREFERENCE FOR CONVENTIONAL AND DIGITAL X-RAY

PREFERENCE	CONVENTIONAL (%)	DIGITAL (%)
YES	12(6.7%)	150(83.3%)
NO	168(93.3%)	30(16.7%)

TOTAL	180(100%)	180(100 %)

EDUCATIONAL STATUS AMONG THE RESPONDENTS

EDUCATIONAL STATUS	NUMBER OF RESPONDENTS	PERCENTAGE OF RESPONDENT
PRIMARY	72	40%
SECONDARY	40	22.2%
TERTIARY	68	37.8%

RESULTS

222 questionnaires were distributed to patients attending the dental clinic, only 180, 81.08% surveys returned for collection. The possible reasons for poor response could be lack of incentive and lack of active follow-up. Despite the poor response by some patients, the data collected provided useful information for statistical analysis of this work.

60% of participants had educational level above secondary schools.

90% of patients who attended the dental clinic were not aware of digital X-ray. 10% of the patients had knowledge on both conventional and digital X-ray.

About 30% of patients also preferred digital radiographs due to clearer images obtained (better resolution).

About 10% had no knowledge about digital and conventional X-ray, while 10 % has knowledge on digital, 80% has knowledge on conventional and 10% has knowledge on both.

57.8% of the respondents were females.

66.11% and 1.67% are familiar with conventional and digital X-ray respectively for more than a year.

6.7% of the respondents prefer conventional x-ray to Digital X-ray while 83.3% of the respondent prefers digital X-ray to conventional X-ray.

4. DISCUSSION

Nowadays, digital x-ray units are ubiquitous in most radiology departments.[19]

Digital radiography plays an important role in the detection, management and prognosticating oral diseases. [20-21]

Radiographs often add critical information to the clinical examination[22], revealing tooth development and eruption problems, in addition to dental caries, pulp and periapical pathologies.[23-25]

Conventional radiography is the most economical and accessible method when compared to digital radiography, however digital radiography eliminates the use of darkroom, reduce patient exposure and gives better resolution.

A good number of studies has been done previously to compare digital and conventional radiograph in dental imaging, however, there is paucity of similar work in this environment [26]

Radiation dose reduction, reduced time between the exposure and image generation and image enhancement are the advantages of digital radiograph over conventional radiograph mentioned on previous similar works .[27]

Although, the design of the study slightly differs from previous studies, however, similar reasons was derived for preference of digital radiography over conventional radiography.[28]

In a study done by Berkhout et al, no significant differences was found in gender and other demographic data between users of digital and conventional radiographs, this result is however similar to our findings.[29]

Further, it would be useful for further research studies to investigate items that are not included in this work and create awareness to people that varying radiation are emitted from different types of radiographic procedures.

Ludwig and Turner suggested in their study that most participants were aware of the usefulness of dental radiography; however, the knowledge of the effect of radiation was limited in most of them.[30]

The 2007 international commission on radiological protection (ICRP) guidelines suggest that the cancer risk associated with dental radiography is 32% to 42% higher than previously estimated in the 1990 ICRP guidelines[25-26], it is therefore, recommended that users of x-rays (either conventional or digital) should avoid the unnecessary pursuit of beautiful radiographic images or over expose patient.

In our own study, a good percentage of participants prefer digital radiograph to convectional radiograph due to the lesser number of exposure, reduced waiting time and clearer images obtained from digital radiographs, however most patients complain of the cost. However, most participant lack knowledge involving risk associated with radiation.

Radiographic guidelines exist to avoid unnecessary exposure, as well as to identify individuals for whom radiographic examination will be beneficial.

The relevant of digital X-ray to modern day technology include the better archiving of images, pictures and real time images can be sent to colleagues for additional information and the ability to take several exposures.

It is highly recommended that radiologist, radiographers and dentist should adopt the comprehensive national or international protocols and use machines and equipment that will reduce patients' dose during the process of exposing patients to radiation[31].

5. CONCLUSION

A good percentage of participants prefer digital radiograph to conventional radiograph due to the lesser number of exposures, reduced waiting time and clearer images obtained in digital radiographs.

Physicians and dentist should always consider the benefits, limitations and risks involved when requesting for either conventional or digital radiographs.

The turning point from conventional radiography to digital radiography is an is an excellent advancement of better dental radiographic imaging system.

REFFERENCES

1.Silva JMG, Castilho JCM, Matsui RH, Matsui MY, Gomes MF. Comparative study between conventional and digital radiography in cephadelomatric analysis. J Health Sci Inst. 2011; 29(1): 19-22.

2. Parks ET, Williamson GF. Digital Radiography: An over view. The journal of Contemporary Dental Practice 2002; 3:1-13

3. Van der Stelt PF. Better imaging: The advantages of Digital Radiography. J Am Dent Assoc 2008; 139: 7-13.

4. Bremnan J. An introducting digital radiography in dentistry. Journal of orthodontics 2002; 29: 66-69.

5. Frommer HH. The history of dental radiology. Tex Dent J 2002; 119: 416-421.

6. Hodges RJ, Atchison KA, White SC. Impact of cone- beam computed tomography on orthodontic diagnosis and treatment planning. Am J orthod Dentofacial orthop 2013; 143; 665-674.

7. Watanabe PCA, Tanaka EE, Fenyo Pereira M, Panella J. Estado atual da arte da imagem digital emOdontologia. Rev Assoc Paul Cir Dent. 1999; 53(4): 320-325.

8.Attaelmanan A, Borg E, Grondahl H.G. Digitalization and display of intra-oral films DentomaxillofacRadiol. 2000; 29(2): 97-102.

9 .Sewell CMD, Pereira MF, Varoli OJ. Principios de producao da imagemdigitalizada. RPG Rev Pos-Grad. 1997; 4(1): 55-58.

10. White SC, Pharoah MJ. Oral Radiology principles and interpretation. 6th Edition St.Loius, Mosby 2009:37

11. Masoomah A, Asma Z, Ghader Z, Estimation of remnant Dentin Thickness under Proximal caries Using Digital Bitewing Radiography: An Iintro study. JDMT : 2016 ; 5 (1);49-52

12.Bushong S. Radiologic Science for Technologists: Physics, Biology and Protection. 9th ed. St Louis, MO: Elsevier / Mosby; 2008:80-108.

13.Dental radiographic examinations: Recommendations for patient selection and limiting radiation exposure. American Dental Association Council on Scientific Affairs and US Department of Health and Human Services Public Health and Food and Drug Administration, revised 2012.

14. Shahidi S, Zamiri B, Danaei SM, Salahi S, Hamedani S. Evaluation of Anatomic variations in maxillary Sinus with the aid of Core Beam Computed Tomography(CBCT) in a population in south of Iran. Dent (Shiraz) 2016; 17: 7-15.

15. Signorelli L, Patcas R, Peltomaki T, Schatzle M. Radiation dose of Core Beam Computed Tomography compared to conventional radiographs in orthodontic. J Orofac Orthop 2016; 77:9-15.

16.Wenzel A, Moystad A. Work flow with digital intraoral radiography: A systemic review. ActaOdontol Scand. 2010 March ; 68(2) : 106-114.

17. Ludlow JB, Mol A. Digital imaging. In white SC, Pharaoh MJ.Oral radiology principles and interpretation 6th edition. St. Loius, Mosby, 2009: 78-99.

18. Button TM, Moore WC, Goren AD. Causes of excessive results of a survey regarding radiographic equipment in New York.Oral Surg Oral Med Oral Pathol Oral RadiolEndod. 1999 April; 87(4): 513-517.

19. Marshall NW. An examination of automatic exposure control regimes for two digital radiography systems. Phys Med Biol 2009; 54(15): 4645-4670.

20. Turpin D L. British orthodontic society revises guidelines for clinical radiograph. Am J orthodDentofacialOrthop 2008; 1: 1-2.

21. Abbott P. Are dental radiographs safe? Aust Dent J 2000; 45: 208-213.

22. Espelid I, Mejare I. Weerheijm K. EAPD guidelines for use of radiographic in children. Eur J Paediatr Dent 2003; 1: 40-48.

23. American Dental Association. Dental radiographs : A diagnostic tool. J Am Dent Assoc 2006; 137-1472.

24. Ludwig RL, Turner LW. Effective patient education in medical Imaging: Public perceptions of radiation exposure. J Allied Health 2002; 31: 159-164.

25. Kim HI, Mupparapu M. Dental radiographic guidelines: A review. QuitessenceInt 2009; 40:389-398.

26. Pathi R, Langlois S. Evaluation of the effectiveness of digital radiograph in emergency situations. Australas Radiol 2002; 46: 167-169.

27. Wenzel A, Moystad A. Experience of Norwegian general dental practitioners with solid state and storage phosphor detectors. Dentomaxillac Radiol 2001; 30: 203-208.

28. Wenzel A, Moystad A . Decision criteria and characteristics of Norwengian general dental practitioners selecting digital radiography. Dentomaxillac Radiol 2001; 30: 197-202.

29. Berkhout WER, Sandrink GCH, Van der Stelt PF. A comparison of digital and film radiography in Dutch dental practise assessed by questionnaire. Dentomaxillac Rdiology 2002; 31:93-99.

30. Ludlow J, Davies – Ludlow L, White S. Patient risk related to common dental radiographic examinations: the impact of 2007 international commission on radiological protection recommendation regarding dise calculation. J Am Dent Assoc 2008; 139: 1237-1243.

31. Practice guidelines for digital radiography in practice guidelines and technical standards Reston, Va : American College of Radiology, 2007: 39-72.

QUESTIONNAIRE

1. Demographic and other basic information

Serial number_____

Date_____

Age_____ yrs

Occupation_____

Education (indicate highest level attained)_____

2. Is this your first visit to the dental clinic

Yes ☐ No ☐

If yes, who is the referring physician _____

3. How did you hear about the centre

Advertisement ☐ Friend ☐ Family ☐ Internet ☐ Referral ☐

4. Have you heard about dental x-ray? Yes ☐ No ☐

If Yes, Conventional ☐ Digital X-ray ☐ Both ☐

If Conventional X-ray, for how long? <1yr ☐ 1yr ☐

2yrs ☐ >2yrs ☐

If Digital X-ray, for how long? <1yr ☐ 1yr ☐

2yrs> ☐ 2yrs ☐

Which one do you prefer? Conventional ☐ or Digital ☐

5. Have you been exposed to conventional x-ray before? Yes ☐ No ☐

If yes, how long does it take you to get the result? _____

How many exposure were taken before the desired result? _____

6. Have you been exposed to digital x-ray before? Yes ☐ No ☐

If yes, how long does it take you to get the result? _____

How many exposure were taken before the desired result? _____

7. Which image was clearer? Digital X-ray ☐ onventional X-ray ☐ on't know ☐

If yes, how long does it take you to get the result? _____

How many exposure were taken before the desired result? _____

8. Have you heard about risk involving radiation? Yes ☐ No ☐

If yes, state them.....

9. Indicate the level of satisfaction that best reflects your experience with the centre.

Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Poor ☐

10. Indicate the level of satisfaction of general appearance and comfort of our facility.

    Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Poor ☐

11. Indicate the level of hospitality you received at our centre.

    Excellent ☐ Very Good ☐ Good ☐ Fair ☐ Poor ☐

12. Would you recommend the radiology centre to others? Yes ☐ No ☐

THE PROSPECT OF ADDRESSING PROPERTY MANAGEMENT CHALLENGES WITH INFORMATION AND COMMUNICATION TECHNOLOGY (ICT): A SURVEY OF MINNA METROPOLIS, NIGER STATE

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ABSTRACT

Amongst all basic human needs, shelter happens to be one of the most essentials, hence acquisition and management of rental property by individuals become very important. Often, the process of advertising and securing rental housing is cofounded by some challenges on prospective tenants and property managers. Nevertheless, with current paradigm shifts in the World towards technology, the housing sector is presented with a new strategy to facilitate easy management of rental houses. In line with this, this study investigated the challenges faced by stakeholders in rental housing within Minna metropolis of Niger State and adoption of information and communication technology (ICT) by the stakeholders. Thus, the study adopted simple random sampling technique and data were collected through structured questionnaires. Based on our findings, the process of advertising and securing accommodation is not convenient for tenants. Likewise, agents are grappling with impersonation, financial crime etc. Again, ICT is underutilized for rental housing by stakeholders despite its availability. Therefore, this study craved for development of ICT platforms to ease the issues surrounding property management.

Keywords*: Property management, Rental housing, Rental Properties, Information and Communication Technology (ICT).*

1. INTRODUCTION

Shelter as one of the indispensable human wants, which gives protection to its occupants or against intruders and unwanted elements (Babalakin, 2004; Onu & Onu, 2011). Due to its relative immobile nature, it is therefore imperative for individuals to acquire one either by way of rent or purchase depending on one's purchasing power. Consequently, this leads to emergence of two classes of urban residents; the owner-occupier resident and the rented resident. In the latter, the property owner is referred to as the landlord while the occupant is referred to as the tenant. Under this arrangement, the tenant pays rent to the landlord for usage of rented apartment. The amount paid as rent depends on available facilities on the apartment.

In recent times, landlords have resulted to employing the expertise of property managers who serve as middlemen (popularly known as agents) between them and the tenants for effective management of their properties. Also, various tasks are involved in property management among which are: to achieve the set-out objectives of the property owner; to

maintain the investments in the property and to maintain the physical aspects of the property (Gilbert, 2016).

When managed by the agent, a lease or tenancy agreement is normally invoked. It is an agreement between a landlord and tenant which contains the terms and conditions of the rental (Akogun & Olatoye, 2013). It offers security to its stakeholders just on paper (Daniel, Okorie & Ojo, 2012).

With continuous demands for urban rental housing in Nigeria, the process of sourcing and securing a suitable rented apartment are under threats by actions quack agents and lack concerted drive to leverage the potentials of information and communication technology (digital divide) among stakeholders (Ibisola, Oni & Peter, 2015).

Basically, information and communication technology (ICT) provides the housing sector with novel strategy to facilitate easy management of rental housing (Gommans, Owange & Njiru, 2014). In view of this, the success of ICT implementation depends on well informed stakeholders. However, based on literature review conducted in this study, an empirical evaluation of the use of ICT in housing rental services in Minna metropolis is still limited.

Therefore, this study aims to probe the possibility of deploying ICT to problems of managing rental units in Minna metropolis. Therefore, to achieve this aim, the following objectives were formulated:

i. To establish how tenants, housing agents and landlords managed information about rental property.
ii. To determine the challenges of rental housing in Minna metropolis of Niger State.
iii. To determine ICT access level of tenants, housing agents and landlords.
iv. To evaluate ICT utilisation for advertising and securing property by tenants, housing agents and landlords.

In order to actualise the stated objectives, the following research questions were formulated:

i. How do tenants, housing agents and landlords managed information about rental property?
ii. What are the problems affecting rental housing business in Minna metropolis of Niger State?
iii. Do tenants, housing agents and landlords have access to ICT facilities?
iv. How do tenants, housing agents and landlords utilise ICT for advertising and securing apartments?

The remaining sections of this paper are arranged as follow: section two reviews related works, section three details the research setting, section four explains the research methodology and empirical analysis. Finally, section five summarises the findings and recommendations of this paper.

4. REVIEW OF RELATED LITERATURE

The operation of rental property market varies among regions and nations (Sani & Gbadegesin 2015). Majority of the researches conducted in the past focused on factors affecting rental housing. For example, Sani and Gbadegesin (2015) researched private rental housing business in Nigeria. The researchers observed that more males, more married people, more civil servants, more Christians and families with size range between 3-4 patronize the urban rental housing. Similarly, Eni and Danson (2014) studied the

private sector participation in urban housing supply in Calabar metropolis. The authors stated that housing supply by private sector are unaffordable to the low-income earners residing in the metropolis.

In addition, Oni (2010) examined the means of harnessing real estate investments through decision process for selecting tenants in Lagos metropolis. The study showed that amongst others, income of prospective tenants is most important criteria used by estate agents in selecting renters. In Akogun and Olatoye (2013), the causes and methods of tenant eviction in property management practice in Ilorin metropolis were examined. The study revealed that rent default constituted the major reason for tenants' evictions. Likewise, Yusuff (2011) found that the challenges associated with the sourcing and securing of accommodation among the students of Lagos State University influences negatively on their academic performances.

Likewise, Ibisola et al., (2015) investigated the relevance and application of ICT in estate surveying and valuation in Ogun State. Their study revealed that the stakeholders in estate management acknowledge the existence of ICT, but they are not utilising it in professional practices due to poor training. Similarly, Razali and Martin (2006) examined the implementation of ICT by property management company in Malaysia. The authors, confirmed that property managers in Malaysia are lagging behind in ICT adoption for property management. Again, a recent work by Gilbert (2016) examined rental housing from an international perspective. The author opined that there are no universal remedies to the problems facing rental housing in the world.

Therefore, the foregoing opinion presented by Gilbert (2016) and the findings made by Razali and Martin (2006) indicated the need for recent empirical researches to assess the level of ICT penetration in property management, especially in rental housing. Unfortunately, research in this direction is not receiving enough attention.

5. RESEARCH SETTING

In line with the aim of this paper, our focus is on Minna metropolis, the capital of Niger State in North-central Nigeria. The metropolis comprises of Bosso and Chanchaga Local Government Areas (LGAs). According to 2006 National Population Census, the population of people who are 15 years and above in Bosso and Chanchaga are 80,440 and 116,492 respectively (National Population Commission, 2010). Thus, considering this age group, the population of this study is 196,932.

Generally, majority of the populace in the State (85%) are farmers while the remaining 15% are involved in other vocations such as white-collar jobs, business, craft and arts (Niger State Bureau of Statistics, 2012). Interestingly, Minna being the State Capital is home to elites doing white collar jobs in private companies, as well as State and Federal Government Organisations. Thus, being largely an agrarian state, the property market in Niger is still growing. The high cost of erecting individual personal houses has triggered the need for rental housing.

6. RESEARCH METHODOLOGY AND EMPIRICAL ANALYSIS

This study adopted survey research design, it sought opinions of respondents on problems relating to rental housing and their ICT utilisation for rental needs. The population of the study is 196,932 and the sample size is 80. Based on the population, sample size and

confidence level of 95%, the sample size calculator (National Statistical Service, n.d.) estimated the standard error of the sample size against the population as 0.05625. Also, simple random sampling was used as sampling technique to administer structured questionnaire which served as research instrument. The instrument was administered on 80 respondents after initial validation by two experts. The sample comprised of 35 tenants, 30 housing agents and 15 landlords. Out of the administered questionnaires, 68 were returned, which represent 85% response rate.

Precisely, 33 respondents which represents 48.52% of the returned questionnaire were tenants, while 28 respondents representing 41.17% respondents were housing agents and 7 respondents representing 10.29% were landlords.

4.1 Demography of Respondents

Table 1 presents the demographic information of respondents. As shown in the table, majority of the respondents (64.70%) were males, on the other hand, 35.29% of the respondents were female. Also, respondents' age indicates that most of the respondents (52.94%) were in the age bracket of 18–25. This group was followed by 17.64% representing respondents who were in the age category of both 36 – 45 and 26 – 35 years. Similarly, respondents in the age bracket of 46 – 55 years were accounted for 8.82%, whereas, 2.94% of the respondents were 56 years and above. Again, majority of the respondents (52.94%) had Bachelor degree as their highest qualification. Meanwhile, other respondents had one educational qualification or the other. This implies that they were all literates and should be able to appreciate the use of ICT in their daily activities.

Table 1: Demographic of respondents

Characteristics	Frequency	Percentage
Gender		
Male	44	64.70%
Female	24	35.29%
Age		
18 – 25	36	52.94%
26 – 35	12	17.64%
36 – 45	12	17.64%
46 – 55	6	8.82%
56 and above	2	2.94%
Educational qualification		
No Formal Education	0	0%
Primary School Certificate	0	0%
SSCE or GCE	23	33.82%
Diploma	9	13.23%

Degree	36	52.94%
Others	0	0%
Total	**68**	**100%**

4. 2 Availability and Utilisation of ICT

Table 2 shows that most of the respondents (57.35%) agree that they have frequent access to internet services and most (58.8%) use mobile phones to access these services.

Table 2: Availability and Utilization of Information and Communication Technology

Questions	Frequency	Percentage
How often do you use the Internet services to get information?		
Do not utilise it	0	0%
Occasionally	12	17.64%
Frequently	39	57.35%
Very Frequently	17	25%
Which device do you use to access these services?		
Mobile phone	40	58.82%
Computer	16	23.52%
Others	12	17.64%
Total	**68**	**100%**

4.3 Analysis of Data from Tenant Respondents

Table 3 presents response provided by tenants that acquired rented apartments. As shown in the table, most tenants (73%) secured their current accommodation through housing agents. However, 55% of the tenants agreed that it wasn't an easy task to locate a legal housing agent. Almost half of the tenants (46%) agreed that they encountered some forms of difficulty during the process of securing the accommodation. Also, 73% of the responding tenants expressed general dissatisfaction with current system of securing and acquiring rental housing. Also, banners and posters (55%) are seen to be the major source of getting information about vacant apartments.

In the overall, most respondents expressed dissatisfactions with the present practice of acquiring rental housing information. This however, implies that they should be able to appreciate a more convenient process of acquiring such information.

Table 3: Tenant Responses

Questions	Frequency	Percentage
How did you secure your current accommodation?		

Landlord/Landlady	6	11%
Agent	24	73%
Transfer	3	6%
Others	0	0%
Through what means did you get information about available apartments?		
Website	0	0%
Friend	6	18%
Posters/Banners	18	55%
Others	9	27%
How easy was it locating an agent?		
Very easy	6	18%
Easy	9	27%
Difficult	15	46%
Very difficult	3	9%
How convenient was the process of securing the accommodation?		
Very inconvenient	3	9%
Convenient	6	18%
Very convenient	6	18%
Inconvenient	18	55%
Were you satisfied with the process?		
Yes	9	27%
No	24	73%
Total	**33**	**100%**

4.4 Analysis of Data from Agent Respondents

The data presented in Table 4a shows that most housing agents (89%) are estate surveyors and managers, but only 20% of them registered with relevant regulating bodies. Again, as Table 4b depicts, majority of the registered agents have less than ten years working experience. Still, while Table 4a shows that only 6 agents (21%) have functioning websites, Table 4c reveals that they less often got tenants from their websites and most of such agents (66%) used their websites for personal purpose aside property management. As depicted in Table 4a, most agents (71%) agreed that some problems exist with their current modulus operandi. Accordingly, these problems include scamming, transporting prospective tenants to inspect property and high cost of apartment as reflected in Table 4d. It is also pertinent to note that, financial capability (54%) was the major factor the agents consider in tenants' selection as shown in Table 4a.

Table 4a: Agent Responses

Questions	Frequency	Percentage
Are you an Estate Surveyor and manager?		
Yes	25	89%
No	3	11%
Are you registered?		
Yes	8	20%
No	20	80%
Do you have a website?		
Yes	6	21%
No	22	79%
Do you think there are problems encountered in the process of securing rental residential properties?		
Yes	20	71%
No	8	29%
What factors do you consider in selection of tenants?		
Financial capability	15	54%
Family size	6	20%
Religious background	1	4%
Employment status	5	18%
Social background	1	4%
Total	**28**	**100%**

Table 5b: Registered Agent Responses

How long have you been in practice?		
Below 10 years	6	75%
10 – 20 years	2	25%
30 years and above	0	0%
Total	**8**	**100%**

Table 4c: Agent having Website Responses

How often do you get prospective tenants from your website?		
Rarely	2	33%
Often	3	50%
Very Often	1	17%
What do you use the website for?		
Apartment advertisement	1	17%
Leasing out apartment	1	17%
Personal	4	66%
Others	0	0%
Total	**6**	**100%**

Table 4d: Problems Encountered by Agent Responses

What are they?		
Impersonation	3	15%
Scam	5	25%
Mobility	5	25%
Rental value (price)	6	30%
Others	1	5%
Total	**20**	**100%**

4.5 Analysis of Data from Landlord Respondents

Table 5 reveals that most of the landlords (57.14%) built their properties less than 10 years ago. Also, majority of the landlords (85.71%) prefer to lease their properties to managing firms for effective management. Thus, it implies that they should be able to appreciate a system that informs them of how effectively their properties are being managed.

Table 5: Landlord Responses

Questions	**Frequency**	**Percentage**
How long has your property been in existence?		

Under 10 years	4	57.14%
11 – 20 years	2	28.57%
Over 20 years	1	14.28%
Who is in charge of the management and maintenance of the property?		
Landlord	1	14.28%
Managing firm	6	85.71%
Other Tenants	0	0%
Total	**7**	**100%**

5. DISCUSSION OF FINDINGS

The result of this study revealed that majority of tenants and landlords still engaged in conventional approach of seeking apartment by going through posters prepared by agents. Furthermore, agents remained the main source of advertising and securing rental housing, not only because tenants lack capacity to directly approach landlords to secure rented apartments, but landlords equally preferred to engage agents for proper management of their properties. Consequently, as most of the residential apartments were built less than 10 years ago, landlords will opt for services of property managers to assist in realising their investments in good time, couple with proper maintenance of their properties. Thus, Minna metropolis is a worthwhile location for property managers and investors.

Though, most of the agents are property managers by doing, but locating the few legitimate agents is an issue, because only few among them actually register with professional body regulating property management in Minna metropolis. Therefore, they are not adequately prepared to tackle problems like impersonation, scamming, tenants defaulting in paying rents etc, which are associated with tenants. In addition, transporting prospective tenant to inspect apartment is often additional challenge to agents. Relatedly, most tenants agreed that searching for accommodation under current method, causes some inconveniences and left them with unsatisfied experience. Probably, these challenges could be one of the reasons that make landlords to engage the service of agents.

Interestingly, majority of the respondents have regular access to internet and internet-enabled devices. Mostly, the mobile device is the prevalent devices through which they access internet. The possible reason for this level of ICT utilization, is that the metropolis is host to two higher institutions of learning (Federal University of Technology Minna, and Niger State College of Education). Also, this assumption is corroborated by the highest number of respondents who were within the age bracket of 18-25 years and about 34% of the respondents have secondary school certificates as their highest degree.

Despite the impressive ICT utilization among the respondents, tenants still preferred posters over ICT platforms as source of getting information about vacant apartments. This could be as a result of few websites dedicated to property management in Minna metropolis. Even, most of the websites owned by agents are used for personal activities. Hence, the agents do not get patronage through their websites often. This attitude of possessing ICT, but not it for professional practices is similar to conclusion drawn by Ibisola et al., (2015).

6. CONCLUSION AND RECOMMENDATION

Currently, stakeholders in property management within Minna metropolis still engaged in conventional practice. Exclusively, advertising and securing rental accommodation within Minna metropolis is a viable business, though, with some problems relating to scamming, impersonation, mobility of tenants to property location amongst others. Actually, tenants and agents are yet to take advantages of ICT to alleviate these challenges despite its commendable adoption by these stakeholders. Again, housing agents who are mostly unregistered remain the link between house owners and prospective tenants have not pay enough attention to contributions of ICT to property management.

Consequently, there is need for synergy between ICT professionals and property managers to evolve viable ICT platforms that would improve tenant's search experience for rental housing. As an example, web or mobile application could be introduced to assist prospective tenants with detailed textual and 3-dimensional pictographic information about rental housing units thereby reducing cost of transportation for inspection of apartment. In addition, these platforms would assist in electronic management of such properties in terms of finance, maintenance, monitoring and reporting scandalous tenants etc. Also, such platforms could integrate a module that provides statutorily recognized property managers in the metropolis, thereby, eliminating the activities of fraudulent agents.

REFERENCES

Akogun, I. T., & Olatoye, O. (2013). Tenant eviction in property management practice. *Journal of Economics and International Finance*, 5(4), 139–145. http://doi.org/10.5897/JEIF12.088

Babalakin, W. (2004). Key constraints to real estate development in Nigeria. *Babalakin & co*.

Daniel, D. I., Okorie, A., & Ojo, O. (2012). An Examination of the Tenancy Agreement as a Shield in Property Management in Nigeria. *International Journal of Business Administration*, 3(4), 54–66. http://doi.org/10.5430/ijba.v3n4p54

Eni, D. D., & Danson, T. P. K. (2014). Private Sector Participation in Urban Housing Supply in Calabar, Nigeria. *American International Journal of Contemporary Research*, 4(8), 130–141.

Gilbert, A. (2016). Rental housing: The international experience. *Habitat International*, 54, 173–181. http://doi.org/10.1016/j.habitatint.2015.11.025

Gommans, H. P., Njiru, G. M., & Owange, A. N. (2014). Rental House Management System. *International Journal of Scientific and Research Publications*, 4(11), 1-24.

Ibisola, A.S., Oni, A.B. & Peter, J.N. (2015). The relevance and Application of ICT in Estate Surveying and Valuation in Ogun State. *International Conference on African Development Issues (CU-ICADI) 2015: Information and Communication Technology Track*, 112-120.

National Population Commission. (2010). 2006 Population and Housing Census. Priority Table Volume IV (Population Distribution by Age & Sex). Available online: http://population.gov.ng/wp-content/themes/expo18/documents/Pr%20Vol%204%20Age%20Sex.zip

National Statistical Service (n.d.). Sample size calculator. Available online: http://www.nss.gov.au/nss/home.nsf/pages/Sample+size+calculator.

Niger State Bureau of Statistics (2012). *Fact and Figures about Niger State*. Available online: http://www.nigerianstat.gov.ng/pdfuploads/NIger%20State%20Statistical%20Year%20Book%202011.pdf

Oni, A. O. (2010). Harnessing Real Estate Investment through Decision Process for Selecting Tenants in Nigeria. *10th African Real Estate Society Conference*, Kenya, 1–19.

Razali, M.N. & Martin, D. (2006). Assessing Implementation of ICT among Property Management Companies in Malaysia. *International Business Information Management Conference (7th IBIMA)*, Brescia, Italy.

Sani, K. S., & Gbadegesin, T. J. (2015). A Study of Private Rental Housing Market in Kaduna Metropolis, Nigeria. *Journal of Resources Development and Management*, 11(Stone 1993), 1–12.

Yusuff, O. S. (2011). Students Access to Housing: A Case of Lagos State University Students – Nigeria. *Journal of Sustainable Development*, 4(2), 107–122. http://doi.org/10.5539/jsd.v4n2p107

PROMOTING LOCAL CONTENT SOFTWARE PRODUCTS THROUGH AGILE PROCESS MODELS

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ABSTRACT

Agile software methodology has received considerable attention in recent decades and is being adopted as a better alternative to the traditional methodologies. In this study*, we propose to propagate the adoption of agile process models for software development projects in Nigeria by presenting recent progress in agile process models. Concise summary of the state of the art issues, recent progress, suggestion for future studies on agile software development methodology are presented in the paper. If software products produce in Nigeria are tailored towards agile software methodology they can compete with their foreign counterpart in the international software market. This* study *can motivate software developers, researchers and practitioners in Nigeria to rigorously invest in agile software development methodology. In turn, promote local content and subsequently open thousands of job opportunities in Nigeria.*

Keywords: *Agility, Scrum, Agile process Models, Adoption*

1. INTRODUCTION

In the recent years of the twentieth century, software development witnessed a considerable change in its principles and practices (Fernandes, Alencar, Schmitz, Silva & Stefaneas, 2016). A software development methodology is a way of managing a software development project (Young, 2013). The agile manifesto Beck et al. (2001) introduced a software process model referred to as Agile Software Development. Agile software development is a group of software development methods based on iterative and incremental development. In the agile development process, requirement and solutions are develop through collaboration between self-organizing, cross functional teams, working closer with customers and faster response to requirement change. It is an iterative and incremental approach to keep action with dynamic development environments (Chang & C-Y. Lu, 2013; Shelly,2015; Karambir & Sharma, 2016).

The agile approach uses continuous delivery instead of distinct procedure to work closely with customers (Chang & C-Y. Lu, 2013). Agility means able to move quickly and easily and the ability and flexibility of a company or organization to adapt to changes within a new context (Karambir & Sharma, 2016; Obrutsky & Erturk, 2017). Highsmith (2002) argued that agility is not only responding to change but also creating the

change. Agility does not only react but also act. Organizations can create change to gain competitive advantage over their competitors by creating new knowledge that brings business value to them and satisfies their customers.

Many software projects were carried out based on the traditional software development methodologies such as the waterfall, spiral, V-Model, rapid prototyping, incremental etc. The oldest of these, and the best known is the waterfall model (Balaji & Murugaiyan, 2012). These methods are also called prescriptive or traditional or heavyweight methods (Awad , 2005; Pressman, 2010; Popli, Anita & Chauhan, 2013). The agile methodology is called lightweight methods (Awad, 2005; Jain & Dubey,2014).

To deviate from the limitations of the traditional methods, agile methods are response to the inflexibility of traditional methods to embrace change in a turbulent business environment that demands software to meet its needs quickly (Jain & Dubey,2014). The traditional methods such as waterfall, are prescriptive in its processes and strict procedural which is its major strength, and at the same time happened to be its major weakness (Saxena & Upadhyay, 2016). Though, no one methodology is best for all situations and projects (Young, 2013; Shaydulin & Sybrandt, 2017). However, Ruël, Bondarouk, and Smink (2010); Stoica, Ghilic-Micu, Mircea, & Uscatu (2016) and Shaydulin & Sybrandt (2017) argued that in spite of the increasing popularity of the agile development methodologies, waterfall method remains the most popular software development life cycle. They dwelled on its main advantages which easily overcome the its drawbacks. Also, it is suitability for large projects over agile methods. However, traditional methods have been criticized of their inflexibility to accommodate changing requirements during the development process (Munassar & Govardhan, 2010; Balaji & Murugaiyan, 2012; Chang & C-Y. Lu, 2013; Javanmard & Alian, 2015; Saxena & Upadhyay, 2016).

Despite the criticism of the agile models, currently, the agile process models dominate the software development market over other process models. The agile process models have been accepted by the IT professionals for software development projects. Obrutsky and Erturk (2017) investigated the most common barrier militating the adoption of agile approaches to project management. The survey showed that more than 70% of IT professionals are currently using agile process models for software project management. Choudhary and Rakesh(2016) organize, analyse and make sense out of the dispersed field of agile software development methods. This is to sensitize practitioners to understand the various properties of each of the method and make their judgment in a more informed manner. Sharma and Bawa (2017) reviewed agile software process to help software engineers understand the key characteristics of these processes. The recent progress present by Sharma and Bawa (2017) has the potential to help software developers select the most suitable agile process model based on the type of software project. Barlow et al. (2011) proposes theories and agile processes for handling large scale software project in large organizations.

For the software development industries in Nigeria to compete in the global software market, they must adopt the agile process models for developing software products. Adopting the agile process models in Nigerian software industries can put the software industries in Nigeria in a better position to compete with the foreign software products. Presently, the agile process model has penetrated different aspect of the society and industry. For example, agile process models have penetrated different domain of

applications such as but not limited to telecommunications, mobile computing, business, pharmaceuticals and automobile industries.

In this paper, we propose to propagate the adoption of agile process models for software development projects in Nigeria by presenting recent progress in agile process models. This can make software products produce in Nigeria compete with their foreign counterpart.

2. AGILE SOFTWARE DEVELOPMENT

In February, 2001, several software engineering consultants also refers to as the "Agile Alliance" signed a manifesto Agile Software Development (Beck et al., 2001):

- Individuals and interactions over processes and tools: Communication and collaboration among the team of developers and the individual competence is valued over processes and tools.
- Working software over comprehensive documentation: Functional working software is valued over a well detailed documentation of requirements and designs.
- Customer collaboration over contract negotiation: The involvement of the customer in the software development cycle, to provide requirement progressively as the software is being developed is valued more than the contract negotiation.
- Responding to change over following a plan: Change is welcomed and accommodated, providing quick responses to change and progressive development, rather than following plan strictly.

There are twelve principles that guide agile project development team during software development processes. It is pertinent to stress that not every agile process model employs all the 12 principles with the same impact, some models downplay the importance of one or more principles, nevertheless, the principles states the motivation behind agile process models (Pressman, 2010). The twelve principles of the agile process models can be found in (Pressman, 2010).

2.1 Agile Process?

There are key assumptions about most of the software projects that any agile process model seeks to address:

3.1.1 It is hard to determine beforehand, which among the software requirements will persevere and the one that will change. Software requirement predictability is hard. And it is hard to predict the change in customer priorities as the project move on.

3.1.2 Design and construction are often interwoven in many types of software, that is, they should be done simultaneously so that the design models can be attested before they are built. It is hard to determine how much design is required before construction is employed to validate the design.

3.1.3 Analysis, design, construction and testing are not foreseeable easily.

To address the aforementioned assumptions, a process model has to be adaptable in order to address the question of creating a process that handles unpredictability. Also, agile process model has to be adapted incrementally in order to achieve progress, and to obtain incremental adaptation, customer feedback is needed to implement appropriate adaptation (Pressman, 2010)

2.2 Human Factors in Agile Software Development

The influence of human factor is worth noting in agile software development. Cockburn and Highsmith (2001) expressed that emphasis is place on people factors in the project. Human factors such as amicability, competence, skills and communication as implication of managers working in the agile manner.

i. Individual and team Competence: Competence determines the level of understanding the team has over what they are working on. New knowledge should be taught to team members. Individual competence is a critical factor in the agile development team success in projects. If the agile team have enough competence, they can use almost any process to get their work done (Cockburn & Highsmith, 2001).
ii. Common focus: Agile development team must have a specific goal they want to achieve after everything has been done. Tasks may be shared among team members but all work together to accomplish a common goal.
iii. Collaboration: This characteristic is needed among the team members in order to access, analyse and use information that is communicated to the software team. Chagas and Santos (2015) concluded that communication is the most important factor.
iv. Decision making ability: The project team should be given liberty to decide its destiny.
v. Fuzzy problem solving ability: the software developers should understand that the agile team have to deal with uncertainties and constantly being bombarded by change. Agile team must be careful to learn from their experiences.
vi. Mutual trust and respect must be practiced and respected among agile team
vii. Self-organization: This entails the agile team to put themselves together, the team organizes the process in favour of the local environment and the schedule of activities to best deliver software increment.

2.3 Agile Process Models

Agile Software Development is a philosophy of software development methodology while methodologies under this philosophy exists (Beck *et al*., 2001; Pressman, 2010; Stoica *et al*., 2016) referred to as agile software process models. Several methodologies have been created: extreme programming (XP), Scrum, Feature Driven Development (FDD), Dynamic System Development Method (DSDM), Adaptive Software Development (ASD), Crystal, Kanban, Agile Model (AM), Rational Unified Process (RUP), etc. The two most popular methods are explained as follows:

2.3.1 Extreme Programing

XP is one of the most popular agile development methodologies that used agile practices for developing a high quality software (Liu, 2009; Anand & Dinakaran, 2016). It focuses on customer satisfaction, it delivers software product incrementally and allows change of requirements even at the late stage of the development cycle. XP encourages team work, where project manager, customers and developers collaborate and communicate and are consider as team members (Wells, 2017).

2.3.2 XP Values

Beck (as cited by Pressman, 2010) outlined five values that provide the bed framework for all activities performed in XP. Each of these values is used as a motivator for a particular XP process, actions and task. These values are;

- **Communication**: In order to provide a required software feature or functionality, XP encourages effective (informal or verbal) communication and collaboration among software engineers and other stakeholders. Customers and developers should have common stories (metaphors) for communicating concept, obtaining feedback and preventing bulky documentation as a way of communication.
- **Simplicity:** XP ensures that only the needed functionality is tackled which required immediate implementation. The aim is to provide a simple design that can be coded easily and if there is any need for improvement at later time, refactoring is employed.
- **Feedback**: XP uses unit test as the fundamental testing strategy. As each increment of the software is being developed, unit testing is followed to verify the functionality and validate the business requirement. The level at which the software implements the output, functionality and customer specification is a form of feedback. Feedback is drawn from three sources; the working software, the customer, and other software stakeholders.
- **Courage**: Also better referred to as discipline, is required from the agile team to resist the temptation of designing for the future. XP encourages designing for immediate utilization incrementally, based on customer requirement priority. Designing for the future could cause cost and development overhead because it can change.
- **Respect:** By adhering to all of these values, agile team indoctrinate respect as a value among the software development team and consequently, for the software itself. As they record success in the delivery of software increments, the agile team instil respect for the process of extreme programming.

2.3.3 The XP Process

The XP process employ the object oriented method as the model for development and compose of four framework activities; planning, design, coding and testing as depicted in Figure 1 (Pressman, 2010).

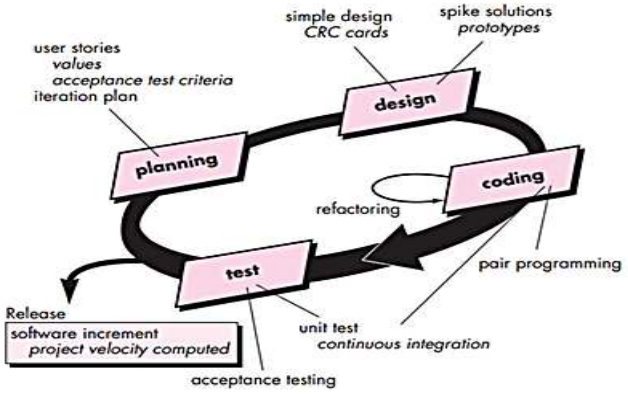


Figure 1: XP Process (Pressman, 2010)

- **Planning:** Also known as planning game, it starts with listening. Through listening, the technical members of the XP team get to know the business context for the product and to identity broadly the output and main functionality. Listening enable the customer to create user stories that defines the output, features and functionality required of the software under development, and place on an index card. Priorities are assigned on the stories by the customer based on the need of the customer. The XP team then determine the cost of development and if it exceeds three development weeks, the customer is asked to fragment the story. The customers and developers come together to agree on how to group the stories into the next software increment. The customers can modify stories, add stories as the development proceeds and the XP team readjust to accommodate this changes.
- **Design:** XP designed is strictly based on keep it simple (KIS) principle rule. Whereby, a simple design is develop and followed by a well guided implementation. It strongly shuns the concept of designing for the future. The XP team encourages the use of CRC (class-responsibility collaborator) cards as an efficient mechanism for thinking about the software in an object-oriented context. CRC cards identify and organize the object-oriented classes that are relevant to the current software increment. If designed problem is encountered, an immediate release of an operational prototype is recommended also known as spike solution. The intention is to reduce the bottlenecks during the actual implementation. Refactoring—a construction technique that is also a method for design optimization, is employed to changing a software system in such a way that it does not alter the external behaviour of the code yet improves the internal structure.
- **Coding:** After the previous steps are implemented, the user stories, which will be included in the next increment, are tested first. When the coding is completed, a unit test is employed to provide feedback by validating the functionality. Pair programming is often employed during the coding stage and the results of the pair programing are amalgamated with other pair programmers of the XP team.
- **Testing:** Testing is considered very important in XP process. The unit testing from the coding stage are performed daily to ensure proper and immediate feedback to the customer for their perusal. Acceptance test is also provided by the customer which are drawn from the user stories implemented as part of the incremental software release. The acceptance test centre on the functionality that are see able and modifiable by the customer.

2.4 Scrum Method

Scrum was proposed by Jeff Sutherland and his team in the early 1990s. Scrum principles conform to the agile manifesto and it has the following processes: requirements, analysis, design, evolution, and delivery (Pressman, 2010). Scrum is one of the popular agile software development framework. Scrum is primarily for developing complex products and system (Anand & Dinakaran, 2016).

Scrum has mainly three roles or people involved: The product owner, scrum master, and project team or scrum team (Anand & Dinakaran, 2016).

- **Product owner**: The product owner should have the quality of a leader, a person with vision, authority, and availability. Product owner is responsible to convey the vision and priorities to the development team. Product owners have to avail themselves to answer questions from the development team.

- **Scrum Master**: The scrum master act as the middle man between the product owner and the team. The scrum master is responsible to do away with any hurdle that can obstruct the team from achieving their goal (sprint goal). Scrum master provide advisory service to product owner where necessary.
- **Team**: The team ensure self-organizing to complete work. They are usually, a group of 3 to 9 consist of mix of software engineers, architects, programmers, analyst, QA expert, testers, UI designers etc. the team ensure how each sprint accomplish it work to be completed. They are totally responsible to the goals of sprint.

2.4.1 Scrum Process Flow

Product Backlog refers to a prioritised list of requirement that give customer business value. At any time, items can be added to the backlog. The product manager updates priorities in the backlog.

Backlog Sprint refers to the work unit required to accomplish a requirement stated in the backlog that fits into the time assigned to accomplish the task (time box). The length of the sprint is set by the team and product owner and also by the size of the sprint backlog (typically 30 days). The work conducted within a sprint (the number of sprints required for each framework activity will vary depending on product complexity and size) is adapted to the problem at hand and is defined and often modified in real time by the Scrum team.

Scrum meetings, usually 15 minutes, are held daily where certain questions are asked and the scrum master examines the response from each team member. This meeting helps to uncover problems as early as possible. A demo is usually delivered (this happens during a Sprint review meeting) to be evaluated by the customer and feedback is taken, this demo only implements functionality defined within the time box given. Another meeting called "Retrospective meeting" is primarily only for the team, product owner and scrum master. They meet at the end of every sprint to improve their effectiveness by reviewing their way of working. Sprint review is a "product review" and Retrospective is a "process review" (Pressman, 2010; Anand & Dinakaran, 2016). The scrum overall flow of process is given in the figure below.

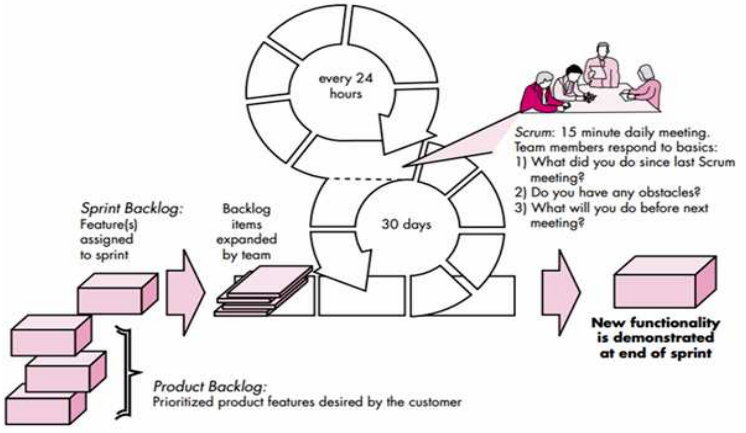


Figure: Scrum Process Flow (Pressman, 2010)

2.5 Agility and Cost of Change

Pressman (2010) argued that one of the core issues in agile approach is the ability to decrease the cost of change during the development process. Change could be very expensive, more especially if it is poorly managed and controlled.

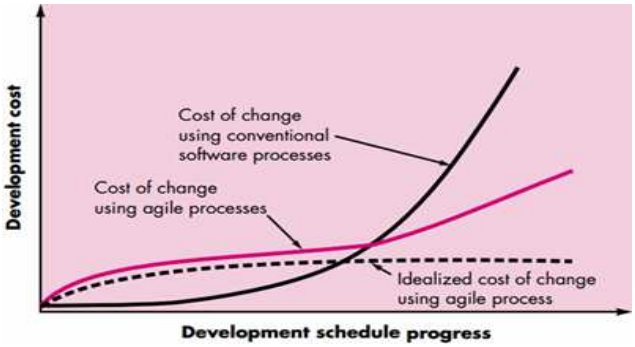


Figure 2: Cost of Software Development change over Time (Pressman, 2010)

The conventional cost of change graph is depicted (the solid black curve) in Figure 2. It indicates the relative cost of handling a changed requirement that was possibly missed or misunderstood during the development life cycle. For instance, a bug detected at the early stage of requirement gathering will be very easy to debug with less cost to address. However, if the error was detected in the design stage, it will be more expensive to fix, which could lead to change of design and change of analysis. If the error is detected only until the programing (coding) stage, software analysis, design and even some portions of the code has to be jettison or modified which pose a serious cost on the development. The cost will be worse if the bug were to be detected at the testing stage and finally, it will be highly expensive, if the error manifest during production stage, the whole development may be edited, updated and other portions jettison as a result. The curve (the shaded blacken curve) is seen to grow exponentially over the time (Ambler, 2014). Beck and Ambler (as cited by Pressman, 2010) argued that using agile approach, the curve is flattens. This is achieved through a well-designed agile process which allows software development team to welcome changes lately without high impact of cost and time. If agile practices such as incremental unit test and pair programming are employed, the cost of implementing change will be reduced. This is depicted in Figure 2 with a coloured flatten curve. The dotted line shows the idealized cost of change using agile process.

5. RECENT PROGRESS ON AGILE SOFTWARE DEVELOPMENT

Agile software methodology has received considerable attention in recent decades. Many researchers are working intensively on it, adding knowledge and exploring new possibilities of agile methods.

Due to the dynamic nature in organizational operation and processes to meet the need and changing requirement of the customers, organizations are in constant need of changing their way of doing things. This can give them competitive advantage over their competitors. As a result, it has caused serious pressure to software developers to develop software methods that will deliver software product as quick as possible while maintaining high quality. Agile software development was developed to tackle this demand by providing timely and economical software with high quality at the time of delivery (Turk et al., 2005).

Following the recent developments of agile software methodology, a lot of literatures have described the present state of agile software methodology, emerging trend and suggestion for possible future directions. Some recent developments published in the literature are the applicability of the agile software methodology whereas others present enhancement to the practice of agile software methodology. Few recent developments from different domain of disciplines as examples are described as follows:

3.1 Non-Software Development Context

Gustavsson (2016) presented a systematic review to identify the benefits of projects that adopted agile methods in non-software development contexts. Out of the 21 case studies analysed, most reported projects were from manufacturing companies including library management and strategic management. The frequently reported benefits were attributed to team work, customer interaction, productivity and flexibility. These benefits conforms to the first value of the Agile Manifesto: Individuals and interactions over processes and tools.

3.1.1 Business Intelligence and Big Data

Organizations require better use of data and analytics to support their business decisions (Kisielnicki and Misiak, 2017). Business intelligence plays the role of enabler in a business. It enables the organization to be smarter and make better decision via the use of information. Business intelligence centred on data processing. It is a way of combining data storage with knowledge management to provide input into the business decision making process. Business Intelligence enables the organization to make better decisions (Larson & Chang, 2016). Big data on the other hand, is a term used when data sets become very large enough that they need complex and special tools and techniques to process (Kepez, 2014). Big data has impacted business intelligence and the use of information because the amount of data generated via the internet and smart devices has greatly increase and has change the way organizations use information (Larson & Chang, 2016; Kisielnicki, Misiak, 2017). The iterative nature of business intelligence delivery has made agile methodology the best methodology as it is also iterative in nature. By using agile process, common problems found in business intelligence projects can been addressed by promoting interaction and collaboration between stakeholders. Close collaboration between parties ensures clear requirements, an understanding of data, joint accountability, and higher quality results (Larson & Chang, 2016).

3.1.2 Automobile Industry

Automobile industries are going adaptive due changing nature of market. Most of the functionalities of modern cars are handled by software. The level of sophistications and functionalities of these software are increasing with each generation (Katumba & Knauss, 2014). For automobile manufacturing industry to remain relevant and competitive they must devise a way of deploying new features and functionalities quickly and fast to meet the need of the market and that bring business value to customers and remain competitive (Eliasson & Burden, n.d). The key solution to these problems is application of agile methodology to deliver functionalities incrementally and within small time frame and with greater quality to the customer and getting feedback from customers for further development cycle. Katumba & Knauss (2014) carried out a study to determine the extent at which agile methods are applicable to the software development at Volvo Car Corporation (VCC). In their study, they found out challenges with the automotive software

process and discussed applicability of agile methods to these challenges. In California and Nevada, semi-autonomous are being made by Google, Audi and Daimler and are now on the high ways and soon they will be on the streets. All these technological giants like Google, Telsa, etc are proving to the automotive industry that with time, autonomous cars will be ready to move on the streets (Binder, Hemmer, Kuhn & Mies, 2015). This fact will cause these companies to employ the best methodology that will give them competitive advantage over their competitors, and agile methods will prove applicable.

3.1.3 Telecommunication Industry

Telecommunication is one of the dynamic industries across the globe where product and services are adaptive in nature. The telecommunication industry is faced with a challenge of rapid introduction of new services because of high competition between the telecommunication industries. Difficulty of integration into the existing information infrastructure and the large scale and volume of services provided introduces high cost of errors. For an industry to remain competitive with other industries, it must have to be adaptive to changing market demands (Balashola & Gromova, 2017). Balashola and Gromova (2017) outlined examples of telecommunications that have successfully implemented agile project philosophy as follows: TechCore Inc., implemented Scrum as an agile solution. The company realized that by creating a product backlog, it allowed them to see that revenue could be generated by concentrating on product development. TelecomAustralia, a large telecom provider engaged on a journey to develop next generation telecom billing and ordering capabilities using agile process. They employ the principles in Scrum process by enabling the highly skilled teams to work in a highly coordinated way to refine the features for next cycle and openness of the work at all levels. In 2004, Vodafone Turkey, the second largest telecom provider in Turkey, embarked into agile transformation. It was done in 3 stages, first, a pilot team was established and it progress was tracked for several spints and was found to triple productivity within the first three months. Subsequently, it move to the 2nd step, scaling step, by establishing new scrum teams. Five months later, the scrum's team throughput was found to be double more than ever before. Furthermore, a great reduction was achieved in defect rate and customer complaints inside these scrum teams. The last step was enterprise adopting with the objective to grow agile culture.

3.2 Global Software Development

Global software development (GSD) has emerged recently, it makes the best use of software development resources available elsewhere in the world with geographically separated as a barrier. This type of development is now known to researchers and practitioners a GSD (Alsahli, Khan & Alyahya, 2017). Alsahli, Khan and Alyahya (2017) studied the applicability of agile practices on global software development. They reviewed 24 papers that revealed how agile practices can be used to mitigate the known GSD challenges. Gonçalves et al. (2017) analyzed the use of agile methods in a distributed software development (DSD) environments. The study indicated that 94.3% of participants agreed that the use of agile practices aggregates value to the DSD projects.

3.2.1 Pharmaceutical Companies

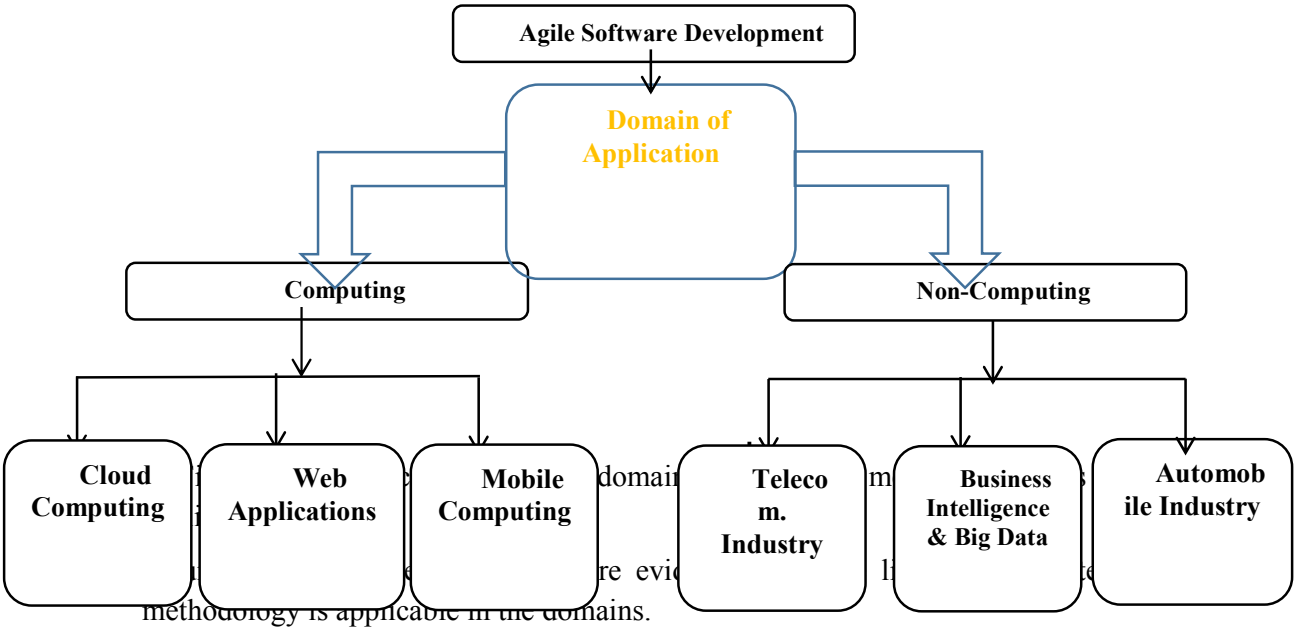
Priyal (2017) observed that the agile development model is increasingly being adopted by the pharmaceutical industry for software development. It was found that the software

development based on agile process in the pharmaceutical industry for drug development is very unique and has many components that are transforming the biomedical industry.

3.2.2 Cloud Computing

With the cloud computing, organization need not bother over the cost of acquiring hardware infrastructures and locations of their branches. This is because the hardware and software are housed in a cloud datacentre and made available to be accessed over the internet (Huth and Cebula, 2011).

The ubiquitous nature of cloud computing has been used to enhance the development of agile projects (Nazir, Raana & Khan, 2013; Jain & Dubey, 2014; Singhal, Sonia & Singhal, 2016) and Jyothi & Rao (2014) described the use of cloud computing to cope issues such as delivering product very fast, geographical barrier that exist between development team working from different environment, regular and timely customer feedbacks, continuous integration and testing with fast development sprints. The cloud services can be used to achieve all these in an efficient and effective manner. In a similar study, Haig-Smith & Tanner (2016) found the use of cloud computing to solve the issues in applying agile global software development (AGSD) in organizations. The distributed nature of AGSD creates geographic barrier and socio-cultural distance and so made collaboration among stakeholders difficult. This is a great challenge to agile development as communication and collaboration among the stakeholders is vital during the development process. The researchers were able to established that the use of cloud computing has help eliminate the challenges of applying agile principles in AGSD.



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methodology is applicable in the domains.

3.2.3 Mobile Computing

The emergence of mobile phones has gained acceptance and popularity in the world. Two to three decades back, only a few number of people had mobile phones. At that time there was no high demand of mobile applications. However, recent decades witnessed the birth of different kinds of mobile brand from different manufacturers and companies. This has really increased the demand of mobile applications and consequently, a significant increase of the mobile application development projects (Flora, Chande & Wang, 2014). Flora et al. (2014) carried out a study on how adopting agile process for mobile application development is the best. The agile development process was found to have greatly

improved the mobile application developments. Corral, Sillitti and Succi (2013) studied the accomplishments, evidence and evolution of agile software development in mobile computing, with the aim to access the contribution of agile models to the mobile software in the practical and real production environment. They found out in their study that the use of agile methods best fit to conduct a software project in the context of mobile computing.

3.2.4 Web Application

Agile software development is being used to develop web applications that accommodate new requirements at the course of development. Kumar and Sowmyavani (2012) developed an application called "A State Level Women Development Support". This web application was to satisfy the different bulk of requirements needed by the women in Andhra Pradesh, such as legal issues, health issues, educational issues etc. It was demonstrated that the application can be achieved using agile methodologies (XP and Scrum). Alpaslan and Kalipsiz (2016) proposed an agile model based approached for web applications, which combines a model driven development with agile practices to develop the web applications.

6. EMERGING TREND AND GENERAL DISCUSSION

The applicability of agile methods in different domain and processes cannot be over emphasized and this suggests that agile software development is attracting attention from the software development community. This emerging trend is expected to grow into the future with novel innovation and ideas from the software development community. The studies have indicated that agile process models have been adopted in education, healthcare, critical systems, e-governance, manufacturing industries, medical sector, etc. for adaptive developing. It can be stated that research on agile software development is still on going and many disciplines are embracing and taking the advantage of these methods to enhance their operations and activities.

7. FURTHER RESEARCH

Literatures have shown that agile software development methodology is still facing challenges that require more rigorous research. To promote agile software development methodology in the Nigeria software industries, researches should be conducted on agile software development within the context of Nigeria. We therefore, suggest that Nigerian software developers and companies should adopt agile software development to meet the state of art and join the global trend in software development. Further research should be explored in more areas of agile software development applications to further convince the software community on the acceptability of agile methodologies.

8. CONCLUSIONS

This study described the agile software development methodologies, advantages and suitability over the traditional methodologies. The paper presents state of the art materials and recent development on agile methodology. It was revealed from the literature that the agile methodology has penetrated different domain of applications such as automobile industries, telecommunication, pharmaceuticals, business, etc. The application of the agile methodology has proven that if properly adopted for software development it gives competitive edge over rivals that concentrated on the traditional software development methodology. Researchers have given a glimpse of hope on any individual, software engineers or practitioners, companies or organizations who will like to adopt agile software

methods that agile software process models are good enough and provide a better alternative over other software methods. The paper is a very useful resources especially to the software practitioners in Nigeria that want to compete in the software global market and promote local content in the context of Nigeria.

REFERENCES

Alpaslan, G., & Kalıpsız, O. (2016). Model Driven Web Application Development with Agile Practices. *International Journal of Software Engineering & Applications (IJSEA)*, 7(5),1-11

Alsahli, A., Khan, H., & Alyahya, S. (2017). Agile Development Overcomes GSD Challenges: A Systematic Literature Review. *International Journal of Computer Science and Software Engineering (IJCSSE)*, 6(1), 7-18.

Ambler, S. W. (2014). Examining the Agile Cost of Change Curve. Retrieved from http://www.agilemodel.com/essays/CostOfChange

Anand, R. J., & Dinakaran, M. (2016). Popular Agile Methods inSoftware Development: Review and Analysis. *International Journal of Applied Engineering Research*, 11(5), 3433-3437.

Awad, M. A. (2005). A Comparison between Agile and Traditional Software Development Methodologies (Unpublished mater's thesis). School of Computer Science and software Engineering, University of Western Australia.

Balaji, S., & Murugaiyan, M. S. (2012). Waterfall vs V-Model Vs Agile: A Comparative Study On SDLC. *International Journal of Information Technology and Business Management*, 2(1),26-30.

Balashova, E. S., & Gromova, E. A. (2017). Agile project management in telecommunications Industry. Revista Espacious, 38(41).

Barlow, J. B. et al. (2011). Over view and Guidance on Agile Development in Large Organizations. *Information Systems and Quantitative Analysis Faculty Publications. 31.* http://digitalcommons.unomaha.edu/isqafacpub/31

Beck, et al. (2001). Manifestor for Agile Software Development. Retrieved from http://agilemanifesto.org/

Binder, C., Hemmer, T., Kuhn, S., & Mies, C. (2015). Adaptive Automotive Development: Faster and more targeted innovations through agile methods. *Adaptive Automotive Development*, 1-16.

Bhargava, P. (2017) The Agile Approach in Pharmaceutical Software Development. (Unpublished Master's thesis). http://digitalcommons. uconn.edu/srhonors_theses/523

Cockburn, A., & Highsmith, J. (2001). Agile Software Development: The People Factor. *Software Management*, 131-133.

Corral, L., Sillitti, A. & Succi, G. (2013) Agile Software Development Processes for Mobile

Systems: Accomplishment, Evidence and Evolution, 90-106

Chagas, A., & Santos, J. M. (2015, August 3-7). The impact of Human Factors on Agile project.
Retrieved from http://ieeexplore.ieee.org/document/728403/

Chang, H., & C-Y. Lu, S. (2013). Toward the Integration of Traditional and Agile Approaches. *(IJACSA) International Journal of Advanced Computer Science and Applications*, 4(2), 1-6.

Choudhary, B., & Rakesh, S.K, (2016). An Approach using Agile Method for Software Development. *2016 1st International Conference on Innovation and Challenges in Cyber Security (ICICCS 2016*), 155-158.

Eliasson, U., & Burden, H. (n.d). Extending Agile Practices in Automotive MDE

Fernandes, M. C., Alencar, A. J., Schmitz, E. A., Silva, M. F., & Stefaneas, P. S. (2016). Evaluation of Agile Software Projects in the Public Sector: A Literature Review. *Journal of Software*, 11(3), 312-325.

Flora, H. K., Chande, S. V. & Wang, X. (2014). Adopting an Agile Approach for the Development of Mobile Applications. *International Journal of Computer Applications (0975 – 8887),* 94(17), 43-50

Gonçalves, W.F. et al.(2017). Using Agile Methods in Distributed Software Development Environments. *Springer International Publishing* AG, 16-27.

Gustavsson, T. (2016). Benefits of Agile Project Management in a Non-software Development Context – a Literature Review. *PM World Journal*, 5(8), 1-12.

Haig-Smith, T., & Tanner, M. (2016). Cloud computing as an enabler of agile global software
development. *Issues in Informing Science and Information Technology,* 13, 121-144. Retrieved from http://www.informingscience.org/Publications/3476

Highsmith, J. (2002). Agile in Software Development. Retrieved from http://www.informit.com/articles/article.aspx?p=25980

Huth, A., & Cebula, J. (2011). The Basics of Cloud Computing

Jain, N., & Dubey, S. (2014).Agile Development Methodology with cloud computing. *International Journal Of Engineering And Computer Science*,3(4), 5373-5378.

Javanmard, M., & Allian, M. (2015). Comparison between Agile and Traditional Software Development Methodologies. Cumhuriyet University Faculty of Science *Science Journal (CSJ),*36(3), 1386-1394.

Jyothi, V. E., Rao K. N. (2014).Effective Implementation of Agile Practices – In Collaboration
with Cloud Computing. *International Journal of Current Engineering and Technology,* 4(2), 1690-1693.

Karambir, & Sharma, A. (2016). A Review of Agile Methodology in Software Development.
International Research Journal of Engineering and Technology (IRJET), 3(3),1325-1329.

Katumba, B., & Knauss, E. (2014). Agile Development in Automotive Software Development:
Challenges and Opportunities.

Kepez, B. (2014).How to utilize cloud computing, big data, and crowdsourcing for an agile enterprise. Gigaom Research Cloud Report.

Kisielnicki, J., Misiak, A. M. (2017). Effectiveness of Agile Compared To waterfall Implementation Methods in it Projects: Analysis Based on Business Intelligence Projects. *Foundations of Management*, 9,273-286.

Kumar, D. T. T. V., & Sowmyavani, M. (2012). AgileSoftware Development: A Case Study of Web Application. *Global Journal of Computer Science and Technology Software & Data Engineering*, 12(14).

Ladokun,I.O, Osunwole, O.O, & Olaoye, B.O. (2013). Information and Communication Technology in Small and Medium Enterprises: Factors affecting the Adoption and use of ICT in Nigeria. *International Journal of Academic Research in Economics and Management Sciences*, 2(6), 74-84.

Larson, D., & Chang, V. (2016). A Review and Future Direction of Agile, Business Intelligence, Analytics and Data Science, 1-25.

Liu, H.H. (2009). *Software Performance and Scalability: A Quantitative Approach*. Hoboken, New Jersey: John Wiley & Sons, Inc

Munassar, N. M. A., & Govardhan, A. (2010). A Comparison Between Five Models Of Software Engineering. *IJCSI International Journal of Computer Science Issues*, 7(5), 94-101.

Nazir, A., Raana, A., & Khan, M. F. (2013). Cloud Computing ensembles Agile Development Methodologies for Successful Project Development. *I.J.Modern Education and Computer Science*, 28-35.

Obrutsky, S., & Erturk, E. (2017). The Agile Transition in Software Development Companies: The Most Common Barriers and How to Overcome Them. *Business and Management Research*, 6(4), 40-53.

Popli, R., Anita, & Chauhan, N. (2013). Mapping of traditional software Development methods to agile Methodology. *Computer Science & Information Technology (CS & IT)*, 117–123.

Pressman, S. R. (2010). *Software Engineering: Practitioner's Approach*. America, New Yock: McGraw-Hill

Saxena, A., & Upadhyay, P. (2016). Waterfall vs. Prototype: Comparative Study of SDLC. *Imperial Journal of Interdisciplinary Research (IJIR)*, 2(6),1012-1015.

Singhal, R., Sonia, & Singhal, A. (2016). Rising future of Agile Software Development using Cloud Computing: A study using Cloud Computing in different phases of an Agile method-SCRUM. *Int.J.Computer Technology & Applications*, 7(2), 240-246

Sharma, A., & Bawa, R. A. (2017). A Critical Review of Agile Development Methods. *InternatIonal Journal of Computer SCIenCe and teChnology (IJCST)*, 8(2),103-107.

Shaydulin, R., & Sybrandt, J. (2017). To Agile, or not to Agile: A Comparison of Software Development Methodologies, 1-11.

Stoica, M., Ghilic-Micu, B., Mircea, M., & Uscatu, C. (2016). Analyzing Agile Development –
from Waterfall Style to Scrumban. *Informatica Economică*, 20(4), 5-14.

Turk, D., France, R., & Rumpe, B.(2005). Assumptions Under lying Agile Software Development Processes. *Journal of Database Management*, 16(4), 62-87

Wells, D. (2017). Extreme Programming: A agile Introduction. Retrieved from http://www.extremeprogramming.org/

Young, D. (2013). Software Development Methodologies.
Shelly (2015). Comparative Analysis of Different Methodologies. *Internal Journal of Computer Science and Information Technology Research,* 7(1), 199-203.

APPRAISING THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) AS A CHANGE AGENT FOR UNIVERSITY LIBRARIES IN NIGERIA

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ABSTRACT

This study reviewed the role of Information and Communication Technology (ICT) as a change agent for university libraries in Nigeria. As such, several literature were consulted and revealed that ICT is changing the roles of university libraries. It was recommended in this study *that The Federal and State government including proprietors of private universities and other stakeholders should ensure adequate funding of university libraries in the light of active investment rather than a passive obligation, There is urgent need for the improvement of power supply in university libraries in order to enhance maximum use of the ICT facilities because they depend on light (electricity) to function. Librarians in Nigeria should realize that ICT is now the tool needed to move university libraries forward and also to meet client need, thereby making their library relevant, if not they face obsolescence.*

1. INTRODUCTION

Universities are established to promote scholarship, research and learning in the various fields of learning. Behind the mission and vision of the university education is the university library, which is the academic library serving the university community (Eze & Uzoigwe, 2013). University libraries are at the forefront of providing information services to their respective communities which comprises of students, lecturers, and researchers in order to support their teaching, learning and research needs. Scholars have emphasized on the crucial role of university libraries in research and scholarship in universities. Many a times, university libraries are referred to as the heart or nerve centres of universities where all academic activities revolved (Abubakar, 2011). University libraries, as Yusuf and Iwu (2010) put it, is the nerve centre or the hub around which scholarship revolves. It is an indispensable instrument for intellectual development, being a store house of information to which user (students as well as lecturers) may turn to for accessing information. According to Nwezeh and Shabi (2011), librarians have information dissemination as their predominant function. The library has a unique position as a potential educational force in the university community of staff and students of different levels especially in this era of information and communication technology which can facilitate the libraries' capability to reach out to direct users as well as remote access users.

Information and communication technology (ICT) is an indispensable part of the contemporary world. In fact, culture and society have to be adjusted to meet the challenges of the information age. Information and communication technology (ICT) is a force that has changed many aspects of people's ways of life. Considering such fields as medicine, tourism, travel, business, law, librarianship, banking, engineering and architecture, the impact of ICT in the past two or three decades has been enormous. The way the fields operate today is vastly different from the way they operated in the past (Yusuf, Afolabi and Loto, 2013).

Over the past few decades, the library environment has changed considerably in terms of collection, organization and services. The e-resources (both online and offline) have occupied a considerable space in the library collection, the transaction of library materials are fully automated, new web based services are offered by libraries to attract users participation in redesigning the library system and services and so on. These changes are mainly due to the development and impact of information and communication technology (ICT) in libraries which have also made changes in all walks of life. The ICT tools and services are being used in libraries to manage libraries more efficiently and to cater users demand properly (Satpathy & Maharana, 2011).

Information and communication technology (ICT) has changed the landscape of libraries and librarianship. Libraries are being transitioned from the four walls to the cyber environment. Library resources are being transformed from print to digital and web resources. Information has been disseminated speedily around the globe due to advanced means of telecommunication. Therefore, it is being used extensively and has resulted in tremendous growth of information (Ansari, 2013).

2. INFORMATION AND COMMUNICATION TECHNOLOGY FACILITIES USED IN UNIVERSITY LIBRARIES

The conception of the library as a store house of knowledge by some writers has greatly been altered by trends in the information and communication technology (ICT) fields; much emphasis is placed on access. There are wide ranges of technologies available in university libraries today. Oketunji (2001) stated that the ICT facilities available for library use include: personal computers, CD-ROMs, telefascimile, (fax), network, electro-copying (scanning), and the internet. Combining the technology and services, Daniel and Matthew (2000) described the new development as tools for information delivery in the new millennium. A computer is an electronic device that: accept data and instruction (input); processes data according to instructions given (processing); stores the processed data (storage); and display the result of the processed data (output). The use of computer has permeated all aspects of human life such that no aspect is left unturned by computer revolution. It is a technology that is affecting the sectors of education, economy, health, manufacturing industries and libraries inclusive. In education, computers are used in teaching large number of students thereby solving the problem of distance learning programme through the application of computer technology, (Mabawonku, 2003).

The internet is a global collection of many different types of computers and computer networks that are linked together. It enables individuals, organizations, companies, libraries and government to share information across the world. Ehikhamenor (2003) described the internet as an information superhighway of information infrastructure to emphasize the expectation that it would transform the way information is created,

manipulated, stored, retrieved, transferred and utilized. The internet is the fastest growing computer network with millions of users worldwide and has been found to assist users to easily obtain and share information available worldwide. Network is a type of information and communication technology that allows the link of separate computers to share their resources together. Oni (2004) described network as a way of connecting computers so that they can communicate with each other and share resources like printers and storage spaces. Aina (2004), extensively discussed ICTs applied in libraries to include personal computer application, CDROM searching, telefascmile, networks, electro copying, electronic mail, online-searching and the internet. ICT application in libraries all over the world have brought about more efficient technical services and improved reader's services. In fact, ICT application in libraries has enhanced the library services than ever been known.

Anunobi and Edoka (2010) examined the use of ICT facilities in Nigeria university libraries and discovered that personal computers, photocopiers and CD-ROM were the ICT facilities mostly used in serial units of the universities. Other facilities identified were printers, LAN, scanner, fax machine and the internet. Similarly, Omekwu and Eruvwe (2014) examined the Application of information and communication technology (ICT) in Delta State Polytechnic Library, Nigeria. The data analysis shows that different ICT facilities are available in the library. The facilities included connected computers, stand-alone computers, telephone, network facilities, online databases, photocopiers, printers, scanners, internet facilities, e-mails, CD-ROM, DVDROM, projectors, library based software eg Xlib, local area network LAN, wide area network WAN, and wireless internet access. Ajayi and Ekundayo (2009) listed information technologies to include:

i. Computers that are used to process, organize, store and access information in the library;
ii. Radios (tape recorders) that are used for listening to recorded audio information;
iii. Projectors that are used in teaching and learning during presentation to viewing audience;
iv. Television sets and videos and disc players that are used in viewing audio visual contents;
v. Slides and film trips that are used in viewing visual contents;
vi. Bulletin boards and electronic notice boards for announcement like new arrival and other information the library want the public to know; and
vii. Internet for accessing and retrieval of online information

Also, Olatokun (2007) found from a study that ICT facilities available in academic libraries included:

i. Computers which include personal computer (PC), laptops etc.;
ii. Printers for printing document in the library;
iii. Internet for uploading and downloading information;
iv. Scanners for electronic conversion of document;
v. Facsimile for sending and receiving document like book order and quotation;
vi. Telephone for enquiry and reference services as well as mobile phone;
vii. Photocopiers for reprographic services; as well as
viii. Videoconferencing and teleconference technologies for online chatting and meetings.

3. INFORMATION AND COMMUNICATION TECHNOLOGY AS A CHANGE AGENT IN UNIVERSITY LIBRARIES IN NIGERIA

The functions of university libraries are to collect, process, disseminate, store and utilize information to provide services to the university community (Olayemi, Umar, Yemi-Peters, Sokari, & Haliru, 2017). However, the constantly increasing amount of information been generated and published, the expanding formats of information storage and retrieval, and ever changing education and research needs of library users make it difficult for any library to be an effective learning resource center (Afolabi & Abidoye, 2011). Since the ultimate goal of the library is to provide services in a manner most useful to the library's users, efforts are made constantly towards rendering effective and efficient services. The development in ICT applications came as a savior to this predicament by providing speedy and easy access to information from different sources and facilitates the reformatting and combination of data from different sources (Saleem, Tabusum and Batcha, 2013). Many libraries have therefore, embraced the use of information technology to help them for effective library services (Afolabi and Abidoye, 2011). Such services include: reference service, document service, serial service, technical service, and e-library service also in the form of the library collection development strategies, library building and consortia (Krubu and Osawaru, 2011).

According to Nwezeh and Shabi (2011), librarians have information dissemination as their predominant function. The library has a unique position as a potential educational force in the university community of staff and students of different levels especially in this era of information and communication technology which can facilitate the libraries' capability to reach out to direct users as well as remote access users. Agboola and Bamigboye (2011) maintained that the quality and strength of any educational programme depends on the library; not the library as a magnificent building but the use of it. University libraries are at the forefront of providing information services to the different categories of user –students, lecturers and researchers in order to support their teaching, learning and research needs. Singh and Kaur (2009) noted that preservation and access to knowledge and information is the main mandate of academic libraries alongside supporting the mission of their parent institution. The university libraries are playing their supportive role to the university education by providing necessary resources and services more so in this information era. These enable the libraries to meet up the needs of their teaming patrons. Such resources range from print to non-print and electronic materials in line with what Yusuf and Iwu (2010) asserted that different users of academic libraries utilize different materials provided by these libraries; such materials as reference materials, textbooks, journals, newspapers, past projects, electronic journals etc. (Nwezeh and Shabi, 2011); also resources like books, journals, newspapers, government publications, indexes and abstracts as common information materials provided and utilized by academic libraries.

According to Aina (2004), the evolution of information and communication technology

(ICT) has brought about new changes and services in modern libraries. ICT is heavily utilized in storage, processing and dissemination of information. It has made organization of information very efficient, the delivery of basic information more effective and dissemination of information faster. ICT has also eliminated the conventional time and

space that are familiar with the traditional library system. With ICT, libraries are now positioned to play active role in information services delivery for national development.

The emergence of ICT has affected the role and services of the academic libraries. As Etim (2004) noted, the rapid pace of development in the field of IT and the emergence of networked information services have prompted a comprehensive review of the library and information science profession. There is a clear paradigm shift from manual ways of carrying out information services powered by analog data to electronic ways of accessing and retrieving information powered by electronic gadgets. ICT according to Abubakar (2011) is being introduced and included into all aspects of library services. E-library and e-resources are becoming the order of the day in library and information practice. In a nutshell, the libraries especially the university libraries have to adapt to the e-environment in line with the indications of Kumar (2009). For the university library to be where their users are, they have to fully recognize the fact that the world is living in virtual realities as was indicated by Omekwu and Echezona (2008) where library services are in cyberspace and are not affected by opening and closing hours. Users of university libraries now expect to be given what they need, when they need it and from which ever location they may be (Ajogboye, 2010). Anaeme (2006), highlighted that the emerging and fast growing ICT application in libraries especially university libraries have continued to revolutionaries the pattern and scope of library services. University libraries are now expected to provide to users a range of information and communication technologies and e-resources necessary for retrieving information quickly from both immediate and remote databases, as well as creating a need for library cooperation and consortium initiatives (Okiy, 2005). Achieving 'education for all initiative' in Nigeria will be much more attainable when sound library and information services are provided in different institutions especially electronically. Through e-resources, education can get to people from physical as well as remote locations.

The information environment has changed rapidly with technological developments to facilitate easy accessibility to information by different users. The developments in Information and Communication Technology (ICT) have revolutionized changes in information processing, storage, dissemination, distribution and access. ICT in the library involves the Information and Communication Technology facilities use in libraries to perform library operations. This has resulted to a paradigm shift from the traditional library system of handling information packaged in printed format to a technological system. ICT in the library operations has changed the format of library operations and services; much emphasis is placed on access as against ownership of the collection. The easy and speed of access to information resources has increased tremendously (Omekwu & Eruvwe, 2014).

According to Akanni (2007), globalization of library services engendered by the advances in ICT and the emergence of virtual libraries is perhaps the greatest development of our time. Traditionally, the library has its role as the place for collection, organization, preservation and dissemination of information materials gathered in a place. This has however changed as libraries now lay more emphasis on dissemination of information that has been collected, organized and stored not only in a given library but from one library to another or between libraries. Consequently, this is the birth of virtual library using modern technology to facilitate dissemination of information to information seekers (Madu, 2006).The present day library services in the 21st century focus more on digital, virtual or

libraries without borders. The transformation and transition, according to Abubakar (2011), are accompanied with sophistication in the changing pattern as the information needs of users continue to grow rapidly. One of the beauties of the concept of the virtual library system lies in its ability to provide access to a wide range of services to users or members of a virtual library community irrespective of their locations.

The development of ICT has provided opportunity for online reference services based on the questions and answer type of assistance provided in the traditional inter-personal reference. Asynchronous tools such as e-mail, subject gateways and interactive social media tools like chat rooms (whatsApp, 2go, facebook etc), virtual reference desk and 'ask- me' are rapidly replacing the conventional means of post, or in-person reference enquiries. Ask-a-Librarian allows the user to click on ask a librarian link to send a formatted enquiry to the reference librarian (Ndukwe, 2012). The reference librarian either provides an answer, links to resources or a link to a subject specialist. Interactive tools now allow reference interviews online thereby improving access to information

The advent of virtual library has begun to transform the collection development of libraries. Akanni (2007) opines that a lot of electronic publications abound to which library can subscribe to, in addition to converting its texts into digital formats. Such electronic information resources include e-journals, ebooks, e-databases (EBSCOHOST, HINARI, JSTOR, OARE, MIT, AGORA, Science direct, IEE etc) OPAC, e-thesis and dissertations. This can empower libraries to develop blended and hybrid collections towards meeting the information needs of their clientele.

Current Awareness Services (CAS) has been an important means for keeping users updated in their areas of interest. According to Ndukwe (2012), a current awareness service may be as simple as a copy of table of contents or a bulletin containing bibliographic records of articles selected from the current issues of journals and other materials, and usually organized by subjects. Libraries now compile current awareness bulletins using predefined search strategy and running on the database either on CD-ROM or online periodically and getting the desired output. Subject to copyrights, the output can also be stored on a local system, and disseminated online (internet, intranet) and offline (print, CD-ROM, mail). With CAS powered by ICT, library users, especially researchers are kept abreast with latest development thus opening up the frontiers of research for nation building.

The terms library co-operation, library networking, library collaboration, library consortia, inter library loan and document delivery and access services are some of the terms used interchangeably to describe formal and informal cooperation, partnership and resource sharing activities among libraries. Rydling (2007) cited in Muhammad (2014), defines library resource sharing as the process whereby resources of a group or network of libraries are made available to the sum total of persons (users) entitled to use one of the libraries. The necessity of resource sharing was born out of the fact that no single library, irrespective of its level of funding can acquire all information resources needed to satisfy the information needs of its clients. With the advent of ICTs, resource sharing among libraries such as library co-operation, inter library loans, co-operative acquisition, co-operative storage like National Union Catalogue (NUC), bibliography of bibliographies and reference services have adequately made available library resources to users with ease, irrespective of their needs and proximities. Advances in ICTs have enabled sharing and exchange of information for various purposes worldwide. This development has placed

libraries in most advantageous position that will enable them to serve the information needs of the global village. It has become imperative for Nigerian libraries to make their intellectual collections available for global access via the internet in order to fit into the new direction (Nkanu and Okon, 2010).

Saleem, Tabusum and Batcha (2014) revealed that the use of ICT in libraries enhances users' satisfaction. It provides numerous benefits to library users. Some of the benefits are:

i. Provide speedy and easy access to information
ii. Provides remote access to users
iii. Provides round the clock access to users
iv. Provides access to unlimited information from different sources
v. Provides information flexibility to be used by any individual according to his/her requirements
vi. Provides increased flexibility
vii. Facilitates the reformatting and combining of data from different sources
viii. Provision of Web access to OPACs
ix. Electronic document delivery
x. Networked information resources
xi. Delivery of information to user desktops
xii. Online instructions
xiii. Online readers advisory services

Vijayakumar and Vijayan (2011) argued that ICT has wide ranging impact on library and information works. They summarized the impact on a table as shown below:

	Information Activity	**Conventional Method**	**New Technology**
	Generate, Originate	Writing, Typing	Word Processing, Text editing, Character Recognition, voice Recognition
	Preserve, Store	Manuscript, Paper-Print Media	Electronic Publishing, Magnetic Storage, Videotext, Tele-text. Computer disk, ROM
	Process	Classification, Cataloguing, Indexing	Electronic data processing, Artificial intelligence/ Expert systems.
	Retrieval	Catalogues, Indexes	Database management system, Information retrieval off-line, On-line.
	Disseminate/ Communicate	Lists, Bibliographies, Abstracts, Hard Copies	Electronic mail, Electronic document delivery, Computer conferencing

	Destroy	Physical weeding	Magnetic erasers, Optical erasers, re-use the medium

4. ISSUES IN ICT APPLICATION IN NIGERIAN UNIVERSITY LIBRARIES

A good number of factors hinder the adequate provision of library and information services and resources by university libraries in Nigeria. Government-owned university libraries according to Ifijeh (2011) are suffering from a low budgetary allocation for education. Akin and Ajayi (2008) also noted that the Nigerian education sector and in particular Nigerian university libraries are yet to recover from the economic down turn of the 1980s and the subsequent impact of this is the under-funding of the university libraries. Ojuade and Ochai (2000) earlier on took note of funding as the crisis facing the Nigerian university libraries and the book industry. If the university libraries want to meet the expectations of their clientele and the current wave of technological developments in the library and information services which will even facilitate their contribution to achieving education for all, improved funding is needed (Akin and Ajayi, 2008). Many other improvement strategies emanate from this; like automation, acquisition, installation and utilization of electronic resources and facilities including the internet, subscribing to and maintenance of access to databases in different disciplines as well as training and re-training of staff will all be facilitated when fund is adequately available. Nwezeh and Shabi (2011) recommended that in order to serve the patrons better, the university libraries should re-address the issue of library orientation for fresh men, aggressive and large scale user education, providing functional library building and making library environment pleasant and comfortable amongst other things.

Fagbe, Amanze, Oladipo, Oyenuga and Adetunji (2015) identified the following constraints to effective ICT availability and application in academic libraries in Nigeria:

i. Lack of trained ICT manpower
ii. Peoples negative attitude to changes in ICT
iii. Technical problems in the course of using ICT
iv. The conversion of analogue information into digital format and its storage capacity place a high demand on the bandwidth of the University
v. Crashing of a computer due to virus, malware, hackers etc can have a large negative effect of loss of data and exposure of information to non-users
vi. Non availability of funds
vii. Poor maintenance culture

Philip, Oluwagbemi and Oluwaranti (2010) observed that tertiary institutions in Nigeria lack adequate ICT infrastructure to effectively tap into the opportunities offered by the cyberspace. He stated that personal computers are available in most Nigeria tertiary institutions, but they are not readily accessible to students because of the low computer to student ratio, put at about 1 to 40. In addition, the basic software needed for practical works are not available and where they are available, they are not accessible because of the low ratio. It was remarked that for internet connectivity in most tertiary institutions in Nigeria, the bandwidth subscribed is too small to support any meaningful activity during peak

period. He also noted that, where ICT infrastructures like multimedia projectors are available, other infrastructures like interactive whiteboards are lacking.

Akomolafe (2009) investigated the strategies and challenges of ICT infrastructure development for university education in Nigeria. He stated that available infrastructure for ICT in most Nigeria universities were grossly inadequate. He identified that most university students still visit the internet off campus because of too much demand on the internet on-campus. Respondents indicated that computers available for internet browsing were inadequate to meet the demand for its usage. He observed that much attention was given to computers and the internet while other ICT infrastructures such as CD-ROM, radio, tape, television, mobile phones and others were lacking and that the level of awareness on the extent to which ICT could be useful in education was still low, noting that many lecturers were not conversant with ICT usage in classroom situations.

5. CONCLUSION

It is concluded in this paper that Information and Communication Technology has changed the face of university libraries in Nigeria. Nigerian university libraries are making serious effort to meet user's information need in this era by making ICTs available and applied to university library's services.

6. RECOMMENDATIONS

The Federal and State government including proprietors of private universities and other stakeholders should ensure adequate funding of university libraries in the light of active investment rather than a passive obligation. Adequate funding will help libraries in the provision of necessary ICT infrastructures and facilities;

i. There is urgent need for the improvement of power supply in university libraries in order to enhance maximum use of the ICT facilities because they depend on light (electricity) to function. The current efforts of the Federal Government of Nigeria aimed at providing stable energy to federal universities should be implemented and sustained.
ii. Librarians in Nigeria should now realize that ICT is now the tool needed to move university library forward and also to meet client need, thereby making their library relevant, if not they face obsolescence.
iii. The following ICT facilities should be made available in university libraries in Nigeria which are formed into a library network where possible, they include:
    a. . Computers with library management software (LMS) that are used to process, organize, store and access information in the library.
    b. Radios (tape recorders) that are used for listening to recorded audio information.
    c. Projectors that are used in teaching and learning during presentation to viewing audience.
    d. Television sets and videos and disc players that are used in viewing audio visual contents
    e. Slides and film trips that are used in viewing visual contents
    f. Bulletin boards and electronic notice boards for announcement like new arrival and other information the library want the public to know.
    g. Internet for accessing and retrieval of online information

viii. Subscription to online Databases and purchase of E-Resources

ix. Printers for printing document in the library

x. Scanners for electronic conversion of document

xi. Telephone for enquiry and reference services as well as mobile phone

xii. Photocopiers for reprographic services, as well as

xiii. Videoconferencing and teleconference technologies for online chatting and meetings.

xiv. Barcode readers, Circuit cameras, Radio Frequency Identifiers (RFID) for library security etc.

REFERENCES

Abubakar, B. M. (2011). Academic libraries in Nigeria in the 21st Century. *Library Philosophy and Practice, 3*(5), 15-23. Retrieved from http://digitalcommons.unl.edu.

Afolabi, A. F. and Abidoye, J. A. (2011). Integration of information and communication technology in Lib. operations towards effective Lib. services. *J. Edu. and Soc. Res*.. Retrieved from http://www.hrmars.com

Aina, L. O. (2004). *Coping with the challenges of library and information services delivery: The need for institutionalized professional development*. A paper delivered at the 42nd National Conference of the Nigerian Library Association. Akure 20th-25th June.

Ajayi, I. A. and Ekundayo, H. T. (2009). The application of information and communication technology in Nigerian secondary schools. *International NGO Journal, 4* (5), 281-286.

Ajogboye, S. (2010). *Mobile learning: Exploring partnership between education and Communication platforms*. Being a paper delivered at the 2nd Professional Summit on Information and Technology held at the Nnamdi Azikwe Library, University of Nigeria Nsukka 3rd -7th May, 2010. Pp. 49.

Akanni, S. B. (2007). The virtual library: issues, prospects and challenges. *Niger Biblios, 18*(1&2), 116-131.

Aki, A. O. and Ajayi, P. O. (2008). Students' utilization of academic libraries in Nigeria: A case of Federal University of Technology, Akure between year 2001-2005. *Asian Jnl. of Infor. Tech., 7* (5), 172-174.

Akomolafe, C. O. (2008). Strategies and challenges of information and communication technology infrastructure for university education in Nigeria, Revitalization of African higher education. *Journal of Educational Research, 2* (2)

Anaeme, F. O. (2006). Information Communication Technology (ICT) intervention in library and information services. *Nigerian Library and Information Science Trend, 4*(1&2), 27-36.

Ansari, M. N. (2013). ICT skills proficiency of library professionals: A case study of universities in Karachi, Pakistan. *Chinese Librarianship: An International Electronic Journal, 36* (1). Retrieved from http://www.iclc.us.

Anunobi, C. V. and Edoka, B. E. (2010). Use of ICT facilities for serials functions in southern Nigeria federal university libraries. Library *Philosophy and Practice* (April) pp. 1-10, retrieved from http://digitalcommons.unl.edu.

Bamigboye, O. B. and Agboola, I. O. (2011). Availability and accessibility of internet facilities in Nigerian university libraries: A case study of two federal universities in South West Nigeria. *Library Philosophy and Practice.* Retrieved from http://unllib.unl.edu/LPP/

Daniel, J. O. (2000). Virtual library for Nigerian libraries. *Nigerian Libraries,* 36 (2), 56.

Daniels, J. O and Matthew, O. G (2000). *Strategies and new tools for information delivering in the research and academic libraries ion the new millennium*. Paper presented at the national conference of the Nigerian Library Association, Abuja, 20-27.

Ehikhamenor, F. A. (2003). Information technology in Nigerian banks: The limits of expectations. ***Information Technology for Development*** *10* (1). DOI: 10.1002/itdj.1590100103.

Etim, F. E. (2004). Resource sharing in the digital age: Prospects and problems in African Universities. *Library Philosophy and Practice, 9* (1). Retrieved from http://unllib.unl.edu/LPP/

Eze, J. U. and Uzoigwe, C. U. (2013). The place of academic libraries in Nigerian university education: Contribution to the education for all initiative. *International Journal of Library and Information Science, 5*(10), 432-438. Doi:10.5897/IJLIS2013.0397

Fagbe, A. O., Amanze, R. C., Oladipo, S., Oyenuga, E. and Adetunji, O. O. (2015). *The roles of information technology (it) in the academic library*. Paper presented at the 3rd school of education and humanities international conference on the future of higher education in Africa held at Babcock University August 24-26, 2015.

Ifijeh, G. S. (2011). Assessing faculty use of university library collection and services in Nigeria: A case study of Covenant University Ota. [online] *Library Philosophy and Practice.* Retrieved from http://www.uidaho.edu.

Kumar M. (2009). *Academic Libraries in electronic environment: Paradigm shift.* A paper presented at the International Conference on Academic Libraries (ICAL) held at the University of Delhi, India. p. 105.

Krubu, E. D. & Osawaru E. K. (2011). The impact of information and communication technology (ICT) in Nigerian university libraries. *Library Philosophy and Practice.* Retrieved from http://unllib.unl.edu/LPP/

Madu, E. C. (2006). *Information technology: uses and preservation of resources in libraries and information centers*. Ibadan. Evi-Coleman Publications.

Mabawonku, I. (2003).*The Application of Information Technology Distance Learning* in: Case Study of three Nigerian Universities Nigeria Libraries. *Nigerian Libraries, 37*(2), 34-45.

Ndukwe, C. (2012). *Information and communication technology (ICT) and information service delivery in libraries*. A seminar paper presented in the Department of Educational Technology/ Library and Information, Faculty of Education, University of Uyo, Akwa Ibom State.

Nkanu, W. O. and Okon, H. I. (2010). Bridging the gap through ICT in Nigerian libraries. *Library philosophy and practice* 10(5), 123-131. Retrieved from http://unllib.unl.edu/LPP/.

Nwezeh, C. M. T. and Shabi, I. N. (2011). Students use of academic libraries in Nigeria: a case of Obafemi Awolowo University library, Ile Ife. *Library philosophy and practice*. Retrieved from http://unllib.unl.edu/LPP/.

Ojuade, A.B. and Ochai, O. (2000). Income generation as alternative source of funding libraries in Nigeria: Myth or reality. Nig. Libs. 34 (1).

Oketunji, I. (2001). Libraries and the internet connectivity: What benefits? In Lasis J., Odunsanya, O.K., Sonaike, S.E.A., and Osinulu L.F. (Eds.), *Automation of cataloguing Practices In Nigerian Libraries* (pp.32-40), Ijebu-Ode: Nigerian Lib. Association, Cataloguing, Classification and Indexing Section.

Okiy, R. B. (2005). Strengthening information provision in Nigerian university libraries through information communication technologies. *The Electronic Library* 23.3, 311-318.

Olatokun, W. M. (2007). Availability, accessibility and use of ICTs by Nigerian women academics. *Malaysian Journal of Library & Information Science, 12,* (2), 13-33. Retrived from http://www.myjurnal.my

Olayemi, K. J., Umar, G. G., Yemi-Peters, O. E., Sokari, V., and Haliru, Z. A. The application of information and communicationtechnology for service delivery in the serial unit of Bayero University Kano. *Educational Research, 8*(3), 027-033. DOI: http:/dx.doi.org/10.14303/er.2017.026

Omekwu C, Echezona RI (2008). *Emerging challenges and opportunities for Nigerian libraries in a global service*. Paper delivered at the Nigerian Library Association 46th Annual National Conference and AGM held at Arewa House Conference Centre Kaduna 1-6 June: HEBN Publishers PLC, Ibadan: Pp.63-76

Omekwu, C and Eruvwe, U (2014). Application of information and communication technology (ICT) in Delta State Polytechnic Libraries, Nigeria. *Journal of Applied Information Science and Technology, 7* (1). 46-60.

Oni, F. A. (2004) *Enhancing the Performance of Library Operations through appropriate Information Technology*. In Technology for Information Management and Service in Modern Libraries and Information Centers in Developing Countries. Madu, E.C. (ed) Ibadan: EviColeman Publications

Philip A., Oluwagbemi O., Oluwaranti A. (2010). An Evaluation of the Impact of Information and Communication Technologies Diffusion in Nigeria's Higher Educational *Institutions, Journal of Information Technology Impact, 10* (1), 25-34.

Saleem A, Tabusum SZ, Batcha M. S. (2013). Application and uses of information communication technol. (ICT) in Academic Libraries: An Overview. *Intl. J. Library Sci.*, *2*(3). Doi:10.5923/j.library.20130203.01

Satpathy, S. K. and Maharana (2011). ICT skills of LIS professionals in engineering institutions of Orissa, India: A case study. Library Philosophy and Practice. Retrieved from http://digitalcommons.unl.edu.

Singh, J. and Kaur, T. (2009). *Future of Academic Libraries in India: challenges and opportunities*. A paper presented at the International Conference on Academic Libraries (ICAL) held at the University of Delhi, India. p. 52.

Vijayakumar, A. and Vijayan, S. S. (2011). Application of information technology in libraries: an overview. *International Journal of Digital Library Services, 1*(2), 114-152. Retrieved from http//www.ijodis.in

Yusuf, M. A., Afolabi, F. O. and Loto, A. B. (2013). Appraising the role of information communication technology (ICT) as a change agent for higher education in Nigeria. *International Journal of Educational Administration and Policy Studies, 5*(8), 177 –183.

Yusuf, F. and Iwu, J. (2010). Use of academic library: A case study of Covenant University, Nigeria. Chinese Librarianship: An International Electronic. Journal, 30(1). Retrieved from http://www.iclc.us/cliej/c130Y1.pdf.

SQL INJECTION ATTACK: A SYSTEMATIC LITERATURE REVIEW ON DETECTION, PREVENTION AND CLASSIFICATION WITH MACHINE LEARNING APPROACH

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ABSTRACT

When it comes to web application, confidentiality, availability and integrity of individuals and organizations data are not assured. Open Web Application Security Project (OWASP) has identified SQL injection attacks as common threat to the web application. Consequently, many researchers have proposed different approaches for either detection, prevention or classification/categorization of SQL injection attack. Machine learning approach is one of the approaches existing in the literature, though not very much research outputs with this approach are available in the literature. This implies that, future researchers can still apply machine learning approach in addressing SQL injection attack problem. For this reason, this study presents a systematic literature review on SQL injection attack detection, prevention and classification based on machine learning approach. In order to obtain SQL injection attack related articles, various search engines and scholar databases were visited. The authors review analysis revealed that most of the proposed machine leaning approaches were proposed to only detect whether an application is vulnerable to SQL injection attack or not. Very few were proposed to prevent and classify the injection based on the attack type. It is our hope that this review will provide a theoretical background for future research and enable future researches to identify how and where machine learning approaches have been used to address SQL injection attack.

Index Terms - *Categorization, Detection, Prevention, SQL injection Attack, Machine learning.*

1. INTRODUCTION

Technology has burgeoned to the degree that individuals, groups and organizations keep save of vital and confidential information such as date of birth, password, username, credit card information, email address, mobile phone, student and staff identification number, last and first name, staff identification number and work address number that relates to individuals, groups organizations and partners (customers) on the World Wide Web (WWW). When a particular database is attacked, information in the database can be revealed to illicit users, even modified by the hackers or totally moped out from the database through various web application vulnerabilities such Denial of Service (DoS), Cross Script (CSS) and Structural Query Language Injection Attacks (SQLI) [1].

The SQL Injection Attack (SQLIA) is a type of attack that injects malicious codes into the original query structure of a web application with the motive of modifying, deleting, retrieving/manipulating sensitive data that target databases connected web applications [2]. This vulnerability subsists when there is no proper input validation, standard error reporting and poor website administration [3]. Malicious code can be injected into a web application that is poorly designed in other to get access to the back end database. There are scores of location where users can input data in web applications such as URLs and login form, each leading to SQL injection attack opportunity resulting to loss of integrity, market value and confidentiality of an organization [4]. Various methods have been proposed to detect, prevent and even classify SQLI such as static, dynamic and machine learning based approach [2].

Machine learning is defined as a type of Artificial Intelligence (AI) that gives computers the ability to learn without being explicitly programmed. Machine learning focuses on the development of computer programs that can change when exposed to new data [5]. Addendum, machine learning has become one of the bases of information technology in which knowledge is discovered using different algorithms from a specified form of data over two decades [6]. The intrinsic ability to learn knowledge from data, technique of machine learning is believed to attract better attention in information retrieval, data mining and pattern recognition because data plays indispensable role in machine learning and learning algorithm that are used to learn knowledge and discover properties from the data [7]. There are various types of model in machine learning such as Neural Network (NN), Support Vector Machine (SMV) and Naive Bayes (NB) to mention but a few [8]. This study presents a systematic literature review on Detection, Prevention and Classification of SQL Injection Attacks using machine learning approach. The seven (7) most popular attack types of SQL injection [10] were considered in the review. The Table 1 below illustrates the seven (7) most SQL injection attack types.

Table 1: Seven (7) most SQL injection attack types

Types Number	SQL injection Type
Type 1	Tautology
Type 2	Illegal/logically incorrect queries
Type 3	Union query

Objectives of the Study

The following are the objectives of the study.

i. To identify the SQL injection causes, motives, and consequences.
ii. To identify the various ways of carrying out SQL injection.
iii. To identify SQL injection attack types and patterns/signatures widely used.
iv. To identify the proposed machine learning approaches that has been used for detection, prevention and classification of SQL injection.
v. To examine the effectiveness of the approaches in (iv).

2. RESEARCH METHODS

Research Questions

The following are the research questions formulated to guide his study

I. What are the major SQL injection causes, motives, and consequences?
II. What are the various ways of carrying out SQL injection?
III. What are the SQL injection types and patterns/signatures that are widely used?
IV. What are the proposed machine learning approaches that have been used for detection, prevention and classification of SQL injection?
V. How effective are these approaches in research question IV?

In responding to research question I, a comprehensive review was carried out with a view to identify the root causes, various motives of SQL injection attackers and consequences of SQL injection attack to the web applications security. To answer research question II, the study identified various ways/mechanism in which SQL injection is performed from sundry sources. Regarding the research question III, the study sorted out the widely used attack types and patterns/signatures which gave an insight into the nature of the attack. To address research question IV, various machine learning approaches that have been proposed was sorted with the view to identify approaches that were proposed for detection, prevention or classification of SQL injection attacks. Lastly, research question V was addressed by finding out the effectiveness of the proposed machine learning approaches in detecting, preventing and classifying different SQL injection attack types.

2.1 Procedures Used for the Research

In order to gather SQL injection attack related articles for this study, various search engines and scholar databases such as www.google.com, googlesclolar.com, ieeexplore.ieee.org, www.researchgate.net,academia.edu and www.sci-hub.com were used. The following terms were considered while searching for articles related to SQL injection attack:

i. SQL injection
ii. SQL injection detection and prevention
iii. Machine learning approaches for SQL injection
iv. Types of SQL Injection
v. SQL injection patterns/signatures
vi. SQL injection motives
vii. Effects of SQL injection
viii. SQL injection mechanism

Standard Adopted for Including a Paper

i. Conference and journals related SQL injection attack detection and prevention

ii. Articles that discuss SQL injection attacks
iii. Systematic literature review on SQL injection which was used as a guide
iv. Surveys that are in line with SQL injection
v. Surveys that are related to prevention, classification and prevention of SQL injection
vi. Books that are related to SQL injection

Data Collection

In order to collect research works that are relevant and related to this systematic review, online scholar databases and search engines were explored. Roughly 90 articles were downloaded including conference and journal articles. It is important to note that only 34 research works were useful for the review.

The following information was obtained from the research of all the studies.

i. Title, Author and Year
ii. Proposed approach
iii. Type of SQL injection attack (tautology, Illegal/Logically incorrect queries, union query, piggy-backed queries, stored procedures, inference and alternate encodings**)** tackled.
iv. Machine leaning area of focus (detection, classification and prevention) and the accuracy of the models

Various researchers such as [14], [16], [25], [26] and [27] have used different approaches in detection, prevention or classification of SQL injection attack. For the purpose of this systematic review, only machine learning approaches were reviewed. Table 2 below shows summary of SQL injection attacks researches based on machine learning approach.

Table 2: Summary of SQL Injection Attacks Researches Based on Machine Learning Approach

References	Research approach	Area of focus
[9]	Proposed a Support Vector Machine (SVM) for classification and prediction of SQL-Injection attack	Classification and prediction
[10]	Pattern recognition neural network model for detection and classification of SQL injection attacks was proposed	Detection and classification
[11]	This model enables detection of unknown attacks with reduced false positives and partial overhead and reduces the chance of implementing SQL-based imitation attacks.	Detection
[12]	SVM classification and Fisher score were proposed to detect SQL injection attacks. According to the query submitted by the users, the approach can classify them into either normal users or attackers	Detection
[14]	Proposes a genetic fuzzy system for detection of SQLI. In this research, accuracy is not the only priority, but also the learning and flexibility of the rules obtained. The algorithm was built on parameters, initial rules, enhancing function and data-dependent	Detection
[15]	A novel approach was introduced to dissect the HTTP traffic and inspect complex SQL injection attacks. A hybrid HIPS and a web application firewall architecture were used.	Dissect and inspection
[16]	Proposed Bayes classification for detection of SQL injection. The paper uses keywords rather than a statement of SQL query. Bayes theorem is applied on the keyword which improves the accuracy and performance of the detection.	Detection

3. RESULT AND DISCUSSION

Research Question I: What are the SQL injection causes, motives, and consequences?

The major root causes of SQL injection attacks as stated by [3] include the following:

i. Poor website administration
ii. Weak Input validation techniques
iii. Nonstandard error reporting.

For every invader to infiltrate any system there must be a motive behind the action, so do SQL injection attackers. The authors in [4], [3], [28], [29] and [35] stated the following as the motive behind SQL injection.

i. **Database finger printing (collected metadata information):** The main aim of attacking database is to collect certain technical information that is important and specific to the database.
ii. **Retrieving sensitive or regular data:** The aim of this, is to extract and have access to back-end database
iii. **Performing data manipulation:** The motive of the invader here is to have access to the database so to append, remove, insert, delete and update values of the data in the database.
iv. **Performing a Denial of Service:** The activities and processes of a web application is interrupted through performing some command in the database leading to denial of service.
v. **Bypassing Authentication:** The invader here bypasses the authentication of web application and gaining access to the database. This gives the invader some privileges and right as a legitimate user in the web application.
vi. **Executing Remote Commands**: This is done by executing illegal commands which give invaders total control of the whole system.
vii. **Performing Privilege Escalation**: These attacks centered on exploiting the database user privileges taking the advantage of implementation mistakes or logical errors in the database.

SQL injection can be very overwhelming if it successful, the damage an invader can cause has no limit. The following are consequences of SQL injection attack as stated by [28] and [29].

i. **Loss of Data**: When illicit user get access to the web application, user privilege can be changed and how to carry out a certain operation in the database can also be altered. If an unintended user gets access to the SQL database of the web application through the weakness, important information stored on this database is gained and modified leading to the loss of data.

ii. **Data Secrecy:** The secrecy of data is lost if the unauthorized user gets access to the information that is vital to individuals, group and organization.
iii. **Data Tempore**
iv. **Loss of Customer Trust and Loyalty:** Customers loyalty and trust is loss when they found out that the vital information their provided is been accessed/miss handled by someone without their permission.

Research Question II: What are the various ways of carrying out SQL injection?

There are various ways in which attackers used SQL injection to compromise the security of web application. [30], [31] highlighted the following as the most common mechanism used.

i. **User Input**: This is one of the media used by invaders to inject SQL command which is sent when forms are submitted to the web application.
ii. **Cookies:** This stores the state of information of a web page, when the content of the stored information is used to construct SQL queries, the invader can easily embed the attack in the cookies.
iii. **Server Variables**: These are variables that contain environmental, HTTP and network headers variables that are used in many ways web applications such as identifying browsing trends and logging usage statistics among others. The vulnerabilities are created when these variables are logged to a database without sanitization which paves a way to invaders to forge SQL commands into the headers.
iv. **Second Order Injection:** In the second-order injections, attackers send malicious inputs into a system or database to indirectly trigger SQLIA when that input is used at a later time

Research Question III: What are the SQL injection attack types and patterns/signatures that are widely used?

There are seven (7) most common SQL injection attack type each associated with its own attack patterns/signatures. Below are the SQL injection attack types with their attack signatures/patterns respectively by [10] [18], [28], [32] and [34].

i. **Tautology**: In this attack type, codes are injected into one or more conditional statement so that they always assess to true. Attackers made use of this technique to extract data and bypass authentication pages. The following are the patterns/signatures associated with this attack “‘”, “OR”, ”LIKE” and ”SELECT ”.
ii. **Stored Procedures**: As the name implies, they are set of operations that are stored which are mainly written in SQL and are stored in server side. These procedures can be modified by the client leading to denial of service and privilege escalation because they are available to the client and automatically obtain the new version. The following are the patterns/signatures associated

with this attack; “SHUTDOWN”, ”EXEC”, “XP_CMSHELL()”

iii. **Alternate Encodings**: Alternate encodings are employed to use vulnerabilities that might not otherwise be usable, evade prevention and detection schemes. The attack string unicode character, ASCII and hexadecimal are been concealed using alternate encodings. “EXEC ()”, “CHAR ()”, “ASCII ()”, “BIN ()”, “HEX ()”, “UNHEX ()”, “BASE64 () », « DEC () », and « ROT13 () among others » are the attack signatures/patterns

iv. **Union Query**: this is the type of attack in which invaders strive to extract data from a back-end database and bypass authentication by combining two separate SQL SELECT queries, which have nothing in common, using UNION SELECT statement. The attack pattern/signatures are “UNION” and “UNION SELECT”

v. **Illegal/Logically Incorrect Queries**: This is an attack in which invaders try obtaining information about the backend database from the malicious login page. Through this attack, data are extracted from the database, injectable parameters are discovered and database fingering is performed. Logical errors, syntax errors and type errors are the most common queries that are generated by the hackers. Below are the patterns/signatures peculiar to this type of attack; "ORDERBY", "CONVERT","INT", "CHAR", "VARCHAR","NVACHAR", and "AND" among others

vi. **Inference**: This type of attack is a time-based attack in which invaders employ time delay in order to make difference between true and false responses from a backend database. The following are the attack pattern/signatures; “IF”, “ELSE” and ”WAITFOR”

vii. Piggy-backed queries: In this type of attack, unauthorized user exploits database with the help of query delimiter, such as ";", by appending an extra query with the original SQL query. Below are the patterns/signatures peculiar to this type of attack;.

Table 3: Total number of Attack types Detected, prevented and classified by the approaches

Ref	Attack types	TADPC
[10], [11], [12], [13], [17], [18], [22]	Type1	7
[10], [11], [12], [13], [18], [21],[22]	Type 2	7
[10], [11], [12], [13],[17], [18], [22], [22]	Type 3	8

References = ref, Total Approaches Detected, Prevented and Classified (TADPC)

The table above shows the references, attack types and total number of machine learning approaches that detect SQL injection attack only. The Figure 3 below shows the approaches that detect SQL injection which indicated the number type of SQL injection attack. As shown in the Figure 1 type 3 is more detected by the approaches with the total number of 8. Type 5, 6, 7 has the same number of approaches that detected them which is 5.

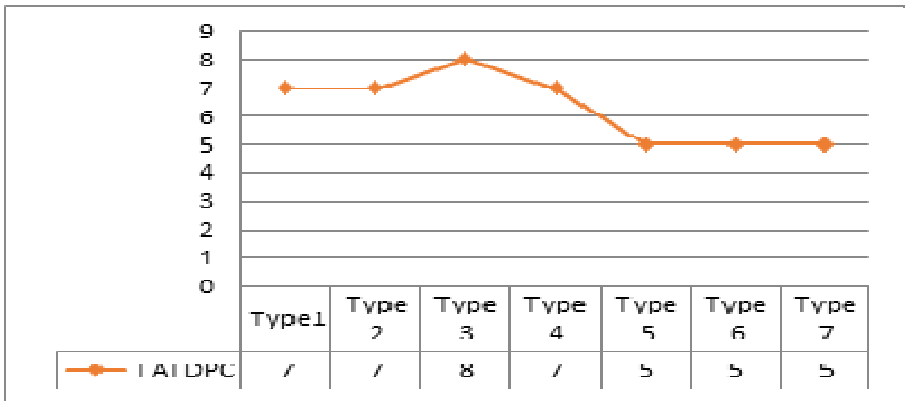


Figure 1: Total number of SQL Injection Attack Type Detected, Prevented and Classified

Research Question IV: What are the proposed machine learning approaches that have been used for detection, prevention and classification of SQL injection attack?

The table 4 below gives the proposed machine learning approaches that are used in detection, prevention and classification of SQL injection stating the Title, Author and Year (TA &Y), Proposed Approach Used (PPU), Types of SQLIA tackled (TSQLIAT), and Accuracy of the Approach (AoP)

Table 4: Proposed Machine Learning Approach used, Types of SQLIA tackled and Accuracy of the Approach

T, A &Y	PPU	TSQLIAT	AoP (%)
[9]	SVM	SQLI	96
[10]	NN	Type 1-7	96
[11]	NN	Type 1-7	NS
[12]	QT,FS & SVM	Type 1-7	94
[13]	NN	Type 1-7	NS
[14]	GFCS	SQLI	98
[15]	HIPPS	SQLI	NS
[16]	BC	SQLI	NS

Machine learning approaches that are used in either detection, prevention, classification or both are presented in the table 4 above each stated the type of type of attack tackled and their accuracy. The Figure 2 below showed the accuracy of the approaches

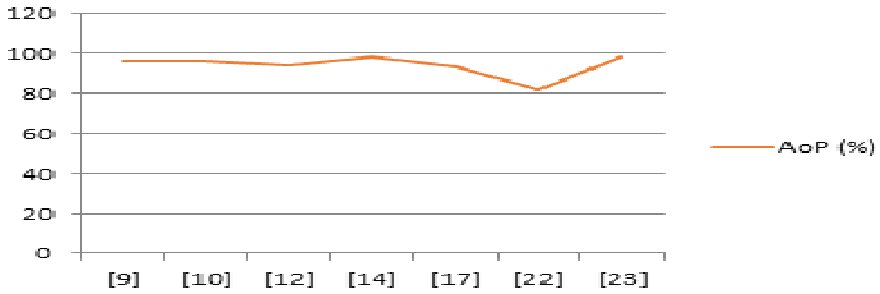


Table 5: Summary of the total number approaches used in detection, prevention classification and combined based on the machine learning

TNSVM	TNNN	TNDT	TNCA	TNGFCS
3	3	1	8	1

The above Table 5 shows the total number of Support Vector machine (TNSVM), Total Number of Neural Network (TNNN), Total Number of Decision Tree (TNDT), Total Number of Combined Approaches (TNCA) and Total number of Genetic Fuzzy System (TNGFCS). The Figure 3 below showed the machine learning approach that is used in detection, prevention, classification or combination of approach in the dealing with issues in the area of SQL injection attack.

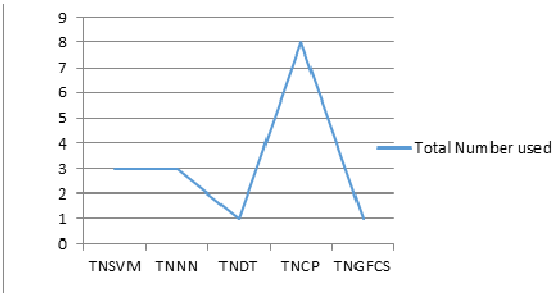


Figure 3: Approaches used in Detection, Prevention and Classification

Table 6 Area of focus and total number of approaches

Area of focus of the Approaches	Total number of Approaches
Detection	9
Prevention	2
Classification	0
Detection & Prevention	1
Detection &	1

Table 6 above showed the area of focus and total number of the approaches.
The Figure 4 below showed the area of focus and the total number of approaches that deals on them.

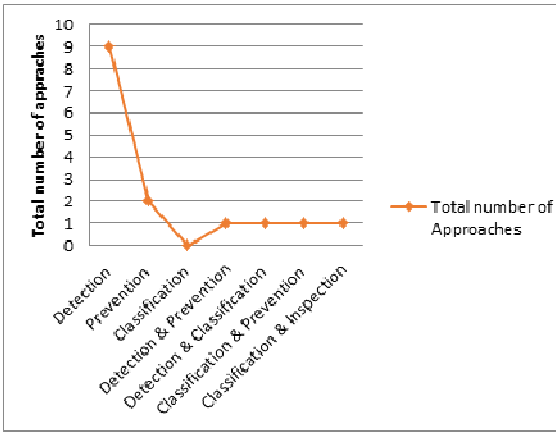


Figure 4: Area of Focus by the Approaches

Research Question V: How Effective are these Approaches in Research Question IV?

The effectiveness of these approaches was evaluated by checking how many attack type a specific approach is able to detect, prevent and classify. How often a particular approach has been used. In Table 3, [10], [11], [12], [13] considered the seven (attack) types, [17], [18], [21] and [22] considered few attack type and the remaining approaches [9], [14], [15], [16], [20], [23] and [24] did not state the particular attack type considered. Type 1, type 2 and type 4 have the same total number of approaches that detect, prevent and classified SQL injection attack. Type 5, 6 and 7 also have the

same total number of approaches, eight (8) approaches were able to detect, prevent and classified attack type 3 making it to be the highest attack type considered by the approaches. As indicated in Table 6 Out of 15 papers reviewed, nine (9) focuses on detection only, two (2) on prevention only, one (1) on detection and prevention one (1) on detection and classification, one (1) on prevention and classification, one (1) on classification and inspection and no approach focused on classification only. In table 5 above, the detection, prevention and classification of SQL injection attack, machine learning approaches are mostly combined. The combined learning approaches has the highest number of eight (8), SVM and NN three (3) and DT one (1). As shown in the 4, the support vector machine is the most commonly used machine learning approach in the detection, prevention and classification of SQL injection attack, though the model is been combined with other techniques such as query tree and Fisher score with the accuracy ranging from 94 to 98%.

4. CONCLUSION

This study presents a broad view of SQL injection attacks by providing theoretical foundations including causes, motives, consequences and way of carrying out SQL injection attack. The study conducts an exhaustive systematic literature review to identify SQL injection attack related publications that are based on machine learning approach. The identified publications were analyzed to determine whether a proposed machine learning approach detects, prevents or classifies SQL injection attack types. The result of the analysis revealed that most of the machine learning approaches is for detection of SQL injection attack. While very few are for either prevention or classification of SQL injection attack types. The authors believe this state-of-the-art systematic literature review on machine learning based approach on detection, prevention and classification of SQL injection attacks contributes to knowledge by providing future researchers with theoretical foundations and open issues in machine learning based approach for detection, prevention and classification of SQL injection attack.

REFERENCES

[1] Kumar, P. & Pateriya, R. k. (2012). A survey on SQL injection attacks, detection and prevention techniques. Proceedings of the 3rd International conference of computing communication and networking technomlogy. July, 26- 28.

[2] Sayyed, M., Sadegh, S. & Bahare. T. P. (2014). Study of SQL Injection Attacks and Countermeasures *International Journal of Computer and Communication Engineering*. 2(5). 2013. Retrieved from http://www.ijcce.org/papers/244-E091.pdf and accessed on 20th march 2017

[3] Jignesh, D. & Bhushan, T. (2017). Assessment of SQL Injection Solution Approaches. *International Journal of Advanced Research in Computer Science and Software Engineering*. . Retrieved from www.ijarcsse.com and accessed on 20th April 2017

[4] Lawal, M. A., Abubakar, M. D. & Ayanloye, O. S. (2016). Systematic literature review on SQL injection. *International Journal of Software Computing*,11(1), 26 32. 2016 Retrieved from http://docsdrive.com/pdfs/medwelljournals/ijscomp/26-35.pdf and accessed on 20th Aprill, 2017

[5] Sumit., D., et al (2015). Applications of Artificial Intelligence in Machine Learning: Review and Prospect. *International Journal of Computer Applications (0975 – 8887) 115 (9).* Retrieved from http://research.ijcaonline.org/volume115/number9/pxc3902402.pdf and accessed on 20th Aprill, 2017

[6] Alex, S., & Vishwanathan, S.V.N. (2008). Introduction to machine learning. University of Cambridge: Press Syndicate published by the press syndicate. Retrieved http://alex.smola.org/drafts/thebook.pdf and accessed on 10th January 2017

[7] Wei-Lun Machine Learning Tutorial 2011. Retrieved from http://disp.ee.ntu.edu.tw/~pujols/Machine%20Learning%20Tutorial.pdf and accessed on 25th January 2017

[8] Ian, H. W., & Eibe F.(2005) .Data mining: A Practical Machine learning tools and techniques. 2nd edition Morgan kaufmanna Publishers.

[9] Romil R., & Shailendra, K. S. (2012) SQL injection attack Detection using SVM. *International Journal of Computer Applications*, 42(13). 2012. Retrieved from http://research.ijcaonline.org/volume42/number 13/pxc3877043.pdf and accessed on 15th March 2017

[10] Naghmeh, M. (2015). A Pattern Recognition Neural Network Model for Detection and Classification of SQL Injection Attacks. Retrieved from https://www.researchgate.net/publication/271072307 and accessed on 20th May 2017

[11] Fredrik, V. Darren, M. & Giovanni, V. (2005). A Learning-Based Approach to the Detection of SQL Attacks 2005. Retrived from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.94.9201&rep=rep1 &type=pdf and accessed on 20th November, 2017.

[12] Aniruddh, L., & Phalke, D. A. (2016). SQL Injection Attack and User Behavior Detection by Using Query Tree, Fisher Score and SVM Classification. *International research journal of engineering and technology (IRJET*) 3 (6).

[13] Naghmeh, M. S. (2014). Employing Neural Networks for the Detection of SQL Injection Attack. Retrieved from https://www.researchgate.net/publication/264799665 and accessed on 4th April 2017

[14] Christine, B., Ahmed. E., & Saad D. (2016). Detection of SQL Injection Using a Genetic Fuzzy Classifier System. *International Journal of Advanced Computer Science and Applications (IJACSA),* 7(6). Retrieved from https://thesai.org and accessed on 25th January 2017

[15] Abdelhamid, M., Youcef, B. & Ahmed, S. (2014). Improving Web Application Firewalls to detect advanced SQL injection attacks. Information Assurance and Security (IAS). 10th International Conference. Retrieved from http://ieeexplore.ieee.org/document/7064617/ and accessed on 20th April 2017

[16] Amit, B and Tushar, V. (2016) SQL Injection detection using Baye's Classification. 3rd International Conference on Resent Innovation of Science Engineering and Management.

[17] Anamika J. & Geetha, V. (2014). SQL Injection Detection using Machine Learning. International Conference on Control, Instrumentation, Communication and Computational Technologies (ICCICCT). IEEE. Retrieved from http://ieeexplore.ieee.org/document/6993127/ accessed on 10th march 2017\

[18] Garima, S., Dev, K., Unique, G. & Akhilesh P. S. (2015). SQL Injection Detection and Correction Using Machine Learning Techniques. Emerging ICT for Bridging the Future - Proceedings of the 49th Annual Convention of the Computer Society of India (CSI) 1(1) pp 435 442.. Retrieved from https://link.springer.com/chapter/10.1007/978-3-319-13728-5_49 and accessed on 15th March 2017.

[19] Yi Wang & Zhoujun. L. (2012). SQL Injection Detection with Composite Kernel in Support Vector Machine International Journal of Security and Its Applications 6(2).

[20] Ritu, A., & Dharmendra, M. (2016). An Approach Based on SVM Classifier to Detect SQL Injection Attack *IJSRSET*,2(3) 2395-1990.

[21] Krit, K. & Chitsutha J. (2016). Machine Learning for SQL Injection Prevention on Server-Side Scripting Soomlek. Retrieved from http://ieeexplore.ieee.org/document/7859950/?denied and accessed on 15th March 2017.

[22] Hanmanthu, B., Raghu, B. R., ,. & Niranjan,. P. (2015). SQL Injection Attack Prevention Based on Decision Tree Classification IEEE Sponsored 9th International Conference on Intelligent Systems and Control (ISCO) 2015.

[23] Solomon, O. U. & J. William, B. (2017). Applied Machine Learning Predictive Analytics to SQL Injection Attack Detection and Prevention. IEEE. 2017. Retrieved from http://www.napier.ac.uk/~/media/worktribe/output-687590/applied-machine-learning-predictive-analytics.pdf and accessed on 26th April 2017.

[24] Cristian, et al. CBRid4SQL: A CBR Intrusion Detector for SQL Injection Attacks 2010. Retrieved from https://www.researchgate.net/publication/221053341_CBRid4SQL_A_CBR_Intrusion_Detector_for_SQL_Injection_Attacksand accessed on 25th January 2017

[25] Kanika, E. & Prabhjot, E. k. (2015). A dynamic approach to detect & prevent sql injection attack to overcome website vulnerability International Journal of Innovative Research In Science, Engineering And Technology 4 (12).

[26] Alexander, A. (2010). A Distributed System for Pattern Recognition and Machine Learning 2010. Retrieved from http://madm.dfki.de/_media/theses/alex-dispare-thesis.pdf and accessed on 7th April 2017

[27] Lambert N., & Lin, K. S. (2010). Use of Query Tokenization to detect and prevent SQL Injection Attacks, in Proc. 3rd IEEE International Conference on Computer Science and Information Technology (ICCSIT), pp. 438-440.

[28] Atefeh. T., Suhaimi, I. & Maslin, M. (2011). SQL Injection Detection and Prevention Techniques. International Journal of Advancements in Computing Technology 3(7). 2011. Retrieved from https://pdfs.semanticscholar.org/0ff9/2dd1d6e0878347be94dae6c06365247aa46b.pdf accessed on 20th march 2017

[29] Rubidha, D.D., Venkatesan, R. & Raghuraman. K. (2016). A Study on Sql Injection Techniques. *International Journal of Pharmacy & Technology*. Retrieved from https://www.researchgate.net/publication/271072307 and accessed on 20th May 2017

[30] Avinash, K.S.(2011). Detection and Prevention of SQL Injection Attack in Web Application. 2011. Retrieved from http://dpSQLklk.og? and accessed on 25th January 2017

[31] W3resource. SQL injection September 2017. Retrieved from https://www.w3resource.com/sql/sql-injection/sql-injection.php and accessed on 23rd Desember, 2017.

[32] Joseph, R., Manoj A.C., & Anto, M. D. (2014). An Approach to Detect and Prevent Tautology Type SQL Injection in Web Service Based on XSchema

validation. International Journal Of Engineering And Computer Science 3(1), pg 3695-3699. 2014.

[33] Kuldeep, R. (2011). Classification of SQL Injection Attacks and using Encryption as a Countermeasure. International Journal of Advanced Research in Computer Science. 2 (1), Jan. –Feb,628-630

[34] San-Tsai, S., Ting, H. W., Stephen, L. & Sheung L. (2007). Classification of SQL Injection Attacks and using Encryption as a Countermeasure.2007. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.620.9731&rep=rep1&type=pdf and accessed on 30th October 017.

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ASSESSMENT OF THE USE OF SOCIAL MEDIA BY UNDERGRADUATE STUDENT OF UNIVERSITY OF ILORIN

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ABSTRACT

Social media as a tool has facilitated interaction, enhanced communication and learning amongst students. In view of this, the purpose of this study is to assess the use of social media among undergraduates student of University of Ilorin in Kwara State by determining the: demographic factors influencing the use of social media among students, types of social media often used by students, frequency of usage of social media by students, activities of student on the social media, highlights the benefits students derived from the use of social media and challenges faced by students in the use of social media. The survey design was adopted for the study. The questionnaire was used as instrument for data collection and descriptive statistics was used to analyze the data. A Structured questionnaire was administered to elicit information from the students conveniently selected students in the University of Ilorin to give a total of 200 respondents. The result of the findings revealed the most commonly used social media by students to be Facebook, Twitter, WhatsApp, Blog, Blackberry Messenger, Instagram. In addition, students spent more time on social media which can reduce the time they dedicate to their studies. It was also revealed that student engaged in various activities such as making friends, keeping in touch with family members and acquaintance, interacting with people with common interest, etc. Furthermore, the findings showed that students faced challenges of distraction, access to illicit material such as pornographic pictures and videos, lack of internet connectivity, and erratic power supply. In essence, excessive use of social media by student should be curbed by the school authorities through the enforcement of rules and regulations.

Keywords- *social media, assessment, undergraduate student, university of Ilorin, use*

1. INTRODUCTION

The media, which is an umbrella term for various means of communication, has become an essential part of human life around the world. The earliest forms of

personal media, speech and gestures, had the benefit of being easy to use and did not necessarily need complex technology. The weakness of not being able to communicate to large audience leads to the development of mass media, such as printing, radio and television. Today, technology has made more universal ability to communicate and reach vast audience through the use of social media such as facebook, blogging, podcasting and internet video among others.

Social media is a form of electronic communication which facilitates interaction based on certain interest and characteristics (Lami, 2011). Also social media are elements of the new media and have become the highest activity on the internet. The rapid growth of social media activities on the internet over the last four years indicative of its entry into normal culture and its integration into the daily lives of the people. In parallel with this, social media have also gained considerable attention from the academic and business worlds. Social networking sites have been widely embraced by students worldwide to enhance communication, interaction, entertainment and improve the sharing of information. Some of these sites include Facebook, Twitter, Myspace, Blogging among others.

In recent years, social media such as facebook, blog, LinkedIn and twitter have become popular particularly with college students. These tools have become part of student's lives and help to build their connections with others. Consequently, academic institutions have realized the importance of social media and a growing number of academic communities are creating accounts and joining groups through these sites (Al Daihani, 2010).

The use of social media by students' population has brought various benefits especially in the area of learning and information sharing. For instance, Zakaria, Watson, and Edwards (2010) studied the use of social media by Malaysian students. They found that students use of the internet applications specifically social media were for both formal and informal media types of learning. The general opinion gathered about the integration of social media tools into learning is positive although some degree of inexperience and hesitancy was noted in particular tools (Zakaria, 2010).

Similarly, Virkus (2008) stresses that social media helps to promote the benefits of working co-operatively with tools that facilitate the aggregation and organization of knowledge while at the same time demonstrating that the diversity of individual research interests research skills that they need in a world where knowledge construction and dissemination make increasingly use of online information networks. Thus, social media applications serve as a platform to socialize collaborate and learn in an informal and flexible manner, although their level of involvement and contribution varies significantly.

However in spite of the benefits of social media to students, it has been found to be abused and misused by student due to the individuality that comes with the use

of these technologies. Such abuses include sharing illicit materials such as pornographic pictures, excessive use of these media in various ways.

In view of this, the study intends to examine the use of social media among university of Ilorin students by assessing the utilization of the social media, determine the demographic factors influencing the use of social media, know the type of social media often used by students, the frequency of the usage of social media, ascertain the activities of the student on the social media, benefits students derived from the use of social media and the challenges faced by students in the use of social media.

2. REVIEW OF RELATED LITERATURE

Social media has been defined in different ways by different authors. Zavatarro (2011) defined social media as technologies that facilitate social interaction, make possible collaboration across stakeholders. These technologies include blogs, wikis, media (audio, photo, video, text) sharing tools, networking platforms (including facebook), and virtual worlds. Social media is also considered as a tool in education, used by more than half of the learners to enable collaboration, real time dialogue and knowledge or data sharing (Caraher&Braselman,2010).

Social media platforms have become thoroughly embedded in contemporary culture. People have woven these platforms into their daily routines, using facebooks, twitter, LinkedIn, online gaming environments and other tools to build and maintain complex webs of professional and personal relationship (Ulbrich et al 2011). Today, establishing these platforms is more important in order to manage changes in technology and expectations in the current economy (Agnieszka, 2013).

As social media continues to evolve and its uses change and expand, so does the definition of social media. In fact, this is attributed to the fact that social media relates to the technology and platforms that enable the interactive web's content creation, collaboration and exchange by participants and the public relations which combines the true gift of real time content with the beauty of authentic peer-to-peer communication (Trubitt & Overholtzer, 2011).

Types Of Social Media

Various researchers have delved into the commonly used social media platforms such as facebook, twitter, and blog among others. Today's students are exposed to all type of technologies in many aspects of their lives (Browning, Gerlich & Westermann, 2011). On a daily basis they use desktop computers, laptops, e-readers, tablets, and cell phones to actively engage in social networking, text messaging, blogging, content sharing, online learning, and much more (Cassidy &Turney, 2011). Duggan, et al., (2015) discovered that Facebook remains popular, other sites such as Instagram, WhatsApp and Pinterest are seeing an increase in their user base. Similarly, Ekwe, Omekwu and Odoh (2014) also discovered that the Categories of social networking

site used by student of include Facebook, 2go, Whatsapp, Googl+, YouTube, Yahoo, Skype, Blackberry messenger, Blog.

Students Utilization of Social Media

Social media has become an integral space for many students to live out their daily personal interaction. A large percentage of students are using social media from the moment they wake up (Mashable, 2010). Today's students are accessing facebook, Twitter, YouTube and even Linkedln to connect and share information with those around them.

According to Quan-Haase and Young (2010), 82% of university students reported logging into Facebook several times a day. A 2014 report shows that 89% of people ages between 18 and 29 in the United States use Facebook (Duggan, *et al.*, 2015) which implies that younger students tend to use Facebook more frequently than older students to keep in touch with friends from high school or from their home town .This shows that students most especially spend quality time on the social network sites which may also have its negative implications.

Gender has been found to have a significant impact on social media use, as there are some differences between use by men and women. Women are more likely than men to have a personal profile on Facebook, but men are more likely than women to sustain a profile on LinkedIn (Lenhart et al., 2010). Furthermore, women were four to five times more likely than men to use social networking sites (Tufemkci, 2008). In reality, 67 percent of U.S. Internet users reported that social media contributed to strengthening relationships with their family and friends (Fox and Rainie, 2014).

The results of the above findings have revealed that most students make use of social media to get in touch with their friends and family, meet new people. Through social media, they can obtain information from their classmate and academic peers. Apart from this, demographic such as gender, age, background of users may have its impact on the activities engaged on these social media.

Social Impact of the Use of Social Media

Social media platforms are infiltrating the educational arena. As a result, online social networks are increasingly being used not only by college students, but also by instructors for different reasons (Mazer, Murphy, & Simonds, 2007). Hence, understanding the way students behave on such platforms is a potentially valuable source of information for educators and researchers. Students who had accounts on social media frequently used it to connect with old friends and family members, find new friends, obtain or share learning materials, receive update of events, post information, while away time among others (Apeanti and Danso 2014).

The connections that students make with classmates through social media can impact the learning environment that is created. Participation in social media creates a more collaborative and communicative learning environment for students by providing opportunities for discussions and interactions with their peers (Hearfner & Friedman, 2008; Liu et al., 2012). Joseph Barker (2013) also distinguished that social media offers plenty of opportunities for learning and interactivity and it is not too hard to see how students and its users benefits from using social media. Joseph believed that students are learning and adapting to the world using a relatively new form of communication.

In using social media for academic purposes, namely group discussions, multiple students can discuss and interact with the same content simultaneously (Patera et al., 2008; Rambel, 2008). In other words, the ability to communicate with each other from different locations allows students to build on conversations, whether related to course content or not. Furthermore, by providing students with a common experience within a virtual community, they are able to dig deeper for content and make connections across multiple sources (Annetta et al., 2009; Frye et al., 2010). This ability produces a network of opportunities to increase student learning beyond the traditional classroom setting.

Social media fulfils different communication needs for different users. Interactions via the computer facilitate communication by allowing users to keep in touch with family and friends in a convenient way, to learn about social events, and to find out about activities of other users feel that they were a part of a peer network of knowing what was going on about events and activities (Quan-Haase et al., 2010).

Immediate communication benefits Facebook users were seen for individuals reporting various levels of shyness. Shyness might cause individuals to avoid social, face-to-face interaction together, so these persons would have less communication and less social support. In a study looking at the association between online social media and friendship quality of shy individuals, result indicated that online social networks provided a comfortable environment in which shy individuals could interact with others (Baker & Oswald, 2010).

Data has shown that individuals who used Facebook for communication had better quality friendships. Using social media sites helped improve the quality of relationships between uses. Some reasons for improving quality of relationships through using Facebook included: it was easier to get to know others better without having face-to-face conversation, users spent more time communicating over the computer so they gained more social support (Baker & Oswald, 2010).

Challenges Faced by Student in the Use of Social Media

Through social media can increase student learning through interactions, challenges arise when social media are incorporated into academic course. The assumption that

students are familiar with and agreeable to using certain types of social media can causes educators to inadvertently fail to provide the resources or encouragement necessary to support student usage and learning (Cole, 2009; Valjataga & Fieldler, 2009).

Arnold and Paulus (2010) found that even when social media is used for an educational purpose, students incorporate the technology into their lives in a way that may differ from the intentions of the course instructor. For example, off-topic or non academic discussions occur on social media because it is primarily design as a social networking tool (Liu et al., 2013). This indicates that while social media may encourage broader discussions of course content, older students may spend more time than younger students engaging in unrelated discussions. Social media can also negatively impact student GPA as well as the amount of time students spend preparing for class (Annetta et al., Junco, 2012). One explanation for this negative impact is that social media provides too much stimulation and therefore can distract students from completing their coursework (Hurt et al., 2012; Patera et al., 2008).

Another reason for this may be that students who spend more time on social media may have difficulty balancing their online activities and their academic preparations. Social media can also be a challenging instructional strategy to incorporate because it attempts to balance the authority of the educator with the active participation of the students. Collaboration through social media supports more of a constructivist approach to learning, where students and educators can work together to create understanding of a particular topic, rather than an approach that emphasizes individual contributions (Steven, 2009). As a result, students and educators become equal participants in the knowledge sharing process. Though this seems beneficial for creating and disseminating knowledge, social media can also become a privacy concern (i.e. cyber-plagiarism) as well as an outlet for abuse and cyber-bullying (Chen & Bryer, 2012; Frye et al., 2010; Jackson, 2011; Smailes & Gannon-Leary, 2011). Social media have negative effects on teenagers such as lack of privacy, distracting students from their academic work, taking most of their productive time (Oshanive, 2015). This suggests that establishing standards for social media use for students should include behavior and attitude guidelines similar to those enforced in the classroom to prevent excessive use.

3. RESEARCH METHOD

A descriptive survey method was used using the survey approach. The target for the study is the undergraduate student of university of Ilorin, Kwara State. A total number of 200 responses were conveniently collected for this study from the faculties in University of Ilorin. The research instrument that was used for this study was a self developed structured questionnaire which was presented to experts on the area of study. The questionnaire items were reviewed base on the comments, corrections and

criticisms. In view of this the validity of the questionnaire item was relatively high base on expert opinion. Data obtained in this research were analyzed using simple frequency counts and percentages. The data generated were analyzed and presented in tables.

Data Presentation and Analysis

Field data was collected on 200 respondents using questionnaire as instrument of data collection. The collected data were further analyzed and interpreted as stated below.

Table 1: Distribution of Respondent by Gender

Gender	Frequency	Percentage %
Male	92	46
Female	108	54
Total	200	100

Table 2: Distribution of Respondent by Age Group

Age	Frequency	Percentage %
16-20	84	42
21-25	101	46
26-30	12	6
31 and above	3	1.5
Total	200	100

Table 3: Amount of Time Spent on Each of the Social Media

Social media Types	Number of users (respondents)	Number of hours spent on each of the social media%			
		Less than 1 hour%	1 - 3 hours %	3 - 5 hours%	5 hours and above%
Facebook	188	6.9	22.3	30.3	40.4
Twitter	118	47.5	24.6	28	0
Linkedln	15	46.7	33.3	20	0
Blog	44	25	18.2	31.8	25
Whatsapp	180	8.9	24.4	17.8	48.9
Badoo	39	48.7	17.9	15.4	17.9
Twoo	14	100	0	0	0
Google+	76	50	3.9	13.2	3.9

Viber	43	65.1	18.6	14	2.3
Skype	57	28.1	50.9	14	7
Palmchat	38	63.2	36.8	0	0
Eskimi	47	66	34	0	0
Wechat	16	68.8	12.5	18.8	0
Instagram	70	30	32.9	24.3	12.9
Youtube	133	21.1	32.4.	42.1	4.5
Freetalk	24	33.3	41.7	25	0
BBM	118	6.8	20.3	41.5	31.4
Email	192	69.6	14.9	10.5	5

Table 4: Challenges Encountered by Student on Social Media

S/N	**Challenges**	**Yes**	**No**
1.	Source of distraction	74	25
2	Lack of concentration in class	42.5	57.5
3	Lack of time to study	53	47
4	Lack of privacy	41	59
5	Lack of internet connectivity	52.5	47.5
6	Erractic power supply	78	22
7	Illicit materials such as pornographic pictures and videos are forwarded by friends	51.5	48.5

Table 5: Activities Engaged on by Students on Social Media

S/N	**Activities**	**Yes**	**No**
1.	Making new friends	73	27
2	Posting messages and chatting	96.5	3.5
3	Posting and viewing photos	84	16
4	Interacting with people with common interest	80.5	19.5
5	Updating profile and status	90	10
6	Discuss and interact with classmate	84	16
7	Keeping in touch with family and friends	94	6
8	Learning about social events	23	27
9	Reading other individual profiles or	77.5	22.5

	news feed		
10	Exchanging news through text or videos	82	18
11	Develop my ability to learn	80.5	19.5

Table 6: Distribution on the Types of Social Media Used by Students

Social media	Response	Frequency	Percentage %
Facebook	Yes	188	94
	No	12	6
Twitter	Yes	118	59
	No	82	41
Linkedln	Yes	15	7.5
	No	185	92.5
Blog	Yes	44	26
	No	156	78
Whatsapp	Yes	180	90
	No	20	10
Badoo	Yes	39	19.5
	No	161	805
Twoo	Yes	14	7
	No	186	93
Google+	Yes	76	38
	No	124	62
Viber	Yes	43	21.5
	No	157	78.5
Skype	Yes	57	28.5
	No	143	71.5
Palmchat	Yes	38	19
	No	162	81
Eskimi	Yes	47	23.5
	No	153	76.5
Wechat	Yes	16	8
	No	184	92
Instagram	Yes	70	35

	No	135	65
Youtube	Yes	133	66.5
	No	67	33.5
Freetalk	Yes	24	12
	No	176	88
BBM	Yes	118	59
	No	82	41
Email	Yes	192	96
	No	8	4

Table 7: Benefits Derived from the Use of Social Media by Students

S/N	Benefits	Yes	No
1.	I have gained more friends	80	20
2	I am able to connect easily with my existing friends	93	7
3	I find it a great way to enjoy my leisure whenever I am alone	95.5	4.5
4	I express myself better	72	28
5	My interpersonal skilled has improved over time	81.5	18.5
6	I learn a lot my classmates, peer groups or friends	88	12
7	Influence my life style in career, socializing, education, religion and spirituality	79	21
8	Use of social media provides an alternative to other communication media (telephone, radio, television, newspaper, etc)	93	7

4. DISCUSSION OF FINDINGS

The findings of this study are discussed in line with the objectives of study and literature review. The findings revealed that female tend to use the social media more than the male (Table 1). It also shows the influence of age on social media usage by students of university of Ilorin in Table 2. Student fall in the age category of 16-20 84(42%), 21-25 101(50.5%), 26-30 12(6%) and 30 and above 1.5%. The result of this finding is in line with Tufemkci (2008) that women are likely to use social networking sites than men. Also, Duggan, *et al.*, (2015) confirm that a 2014 report shows that 89% of people ages between 18 and 29 in the United States use Facebook. The commonly used social media type by the student of university of Ilorin from the findings include Facebook (94%),WhatsApp (90), Google+ (59%), YouTube (66.5%),

email (96%), skype (28.5%) etc among others as revealed in Table 6. This result is in line with the study carried out by Ekwe, Omekwu and Odoh (2014) revealed that the Categories of social networking site used by student of include Facebook, 2go, Whatsapp, Google+, YouTube, Yahoo, Skype, Blackberry messenger, Blog. The study further revealed in Table 3 that the amount of time students of university of Ilorin spent on social media varies differently depending on the type of social media. Most of the student spend a lot of time i.e. 5 hours and above on the social media like facebook (40.4%), Whatsapp (48.9%) while some spent less than 1 hour, 1-3 hour and 3-5 hours.

More so, the findings on the activities student of university of Ilorin engaged on social media in Table 5 reveals that students spend their time on social media to make new friends (73%), post messages and chat, stay in touch with family ()96.5%, learn about social events(73%), interact with people of common interest (80.5%), post and view photos and update status and profile(84%), discuss and interact with classmates(84%), develop their ability to learn(80%) among others. This is in line with the findings of Laura (2013) on the various activities engaged by student on the social media such as staying in touch with friends, sharing a funny video, keeping up with news. He is also of the view that students use social media to seek out, collaborate and obtain information from class mates and academic peers.

It can also be deduced from Table 7 that University of Ilorin undergraduate students derived so many benefits from the use of social media which include gaining more friends(90%), connecting easily with existing friends(90%), enjoying leisure(95.5%) and expressing themselves better(72%), learning a lot from classmates(88%), serving as a great alternative to other communication media like television, radio(93%), etc. and influencing students life style in career, religion, education, socializing and spirituality(79%). This is in line with the study by Apeanti and Danso (2014), who found that students' accessed social media using laptop/personal computers, smart phones, Internet cafes, campus computers and tablets with a few indicating that they did not access social media. It was also found that students who had accounts on social media frequently used it to connect with old friends and family members, find new friends, obtain or share learning materials, receive update of events, post information, while away time among others. Furthermore the findings in Table 4 revealed that various challenges are encountered in the use of social media by the students of university of Ilorin. These challenges are source of distraction (74.5%), lack of concentration in class(45.%) and lack of time to study(53%), erratic power supply(78%), lack of internet connectivity(52.5%), illicit materials being forwarded by friends(51.5%), lack of privacy(41%). This is in line with the study of hurt et al. (2012) who confirmed that social media provides too much stimulation and therefore can distract students from completing their coursework.

5. CONCLUSION

The findings of this study reveals that social media has been widely embraced by students in Higher institution of learning. The commonly used social media by students include, Facebook, WhatsApp, email, YouTube, Instagram and blackberry messenger. Social media has also immensely benefitted students by helping them to connect with friends, express themselves better, enjoy leisure whenever alone and learn a lot from classmates. Social media is used in discussing and interacting with classmates however, despite the numerous benefit that could be derived from the use of social media, students are found to face challenges such as erratic power supply, lack of internet connectivity, privacy issue, lack of time to study, lack of concentration in class and distributing illicit materials such as pornographic videos and pictures by friends which can cause negative impact on students' academic performance either in the present day or in the future. Therefore, excessive use of social media by student should be checked by the parents, guardians and school authorities.

6. RECOMMENDATIONS

Based on the valuable role of social media in today's higher institution of learning, the school authorities should ensure that social media is integrated into the school's curriculum by creating online discussion forums where the students can communicate, share, transfer and disseminate knowledge among themselves. In addition, the school authorities should implement and enforce policy on social media encompassing rules and regulations, procedures and principles that must be strictly adhered to by students in case of interacting and exchanging information on online forums, discussions and platforms.

REFERENCES

Aagard, Bowen, &Olesova, (2010).Hotseat: Opening the backchannel in large lectures.
Educause Quarterly. Retrieved April 23, 2016 from http://www.educause.edu/EDUCAUSE+Quaterly/HotseatOpeningtheBackchannelin/213668

Aguilar-Roca, N.M., Williams, A.E., &O'Dowd, D.K. (2012). The impact of laptop-free zones
on student performance and attitudes in large lectures. Computers & Education, 59, 1300-1308.

Al-Daihani, S. (2010). Exploring the use of social software by master of library and information science students. Library Review, 59(2), 117-131.

Anderson, P. (2007). What is web 2.0? Ideas, technologies and implication for education, JISC technology and Standards Watch. Retreived April 23, 2016 from http://www.jisc.ac.uk/media/documents/techwatch/tsw0701b.pdf.

Annetta, L.A., Minogue, J. Holmes, S.Y., & Cheng, M.T. (2009). Investigating the impact of video games on high school student's engagement and learning about genetics. *Computer & Education*, *53*, 74-85

Apeanti, W. O. and Danso, E. D. (2014). Students' Use of Social Media in Higher Education in Ghana. *Innovative Journal*, *3*(1), 3-9.

Arnett, J.J, (2000). Emerging adulthood: a theory of development from the late teens through the twenties. *American Psychologist*, *55*(5), 469 -480.

Arnold, N., &Paulus, T. (2010). Using social networking site for experimential learning: Appropriating, lurking, modeling and community building. *Internet and Higher Education, 13*, 188-196.

Arrington, M. (2005). 85% of college students use FaceBook, TechCrunch. Retrieved May 12, 2016, from http://www.techcrunch.com/2005/09/07/85-of-college-students-use-facebook.

Baker, L.R., & Oswald, D.L. (2010).Shyness and online social networking services. *Journal of social& Personal Relationships, 27* (7), 873-889.

Barnes, C.; B. Tynan (2007).Learning in a web 2.0 millenium. ALT-J, *Research in Learning Technology,* 15 (3), 189-200.

Baym, N.K., Zhang, Y. B., Kunkel, A., Ledbetter, A., & Mei-Chen, L. (2007). Relational quality and media use in interpersonal relationships. New Media & Society, 9(5), 735-752

Boyd, D. & Ellison, N. (2007). Social network sites: Definition, history, and scholarship. *Journal of Computer-Mediated Communication, 13*(1), 210-230.

Cassidy, E., Britsch, J., Griffin, G., Manolovitz, T., Shen, L., &Turney, L. (2011). Higher education and emerging technologies: Student usage, preferences, and lessons for library services. *Reference & User Services Quarterly, 50*(4), 380-391.

Chen, B. &Bryer, T. (2012). Investigating instructional strategies for using social media in
formal and informal learning. *The International Review of Research in Open and Distance Learning, 13*(1), 87-100.

Duggan, M., Ellison, N., Lampe, C., Lenhart, A., & Madden, M. (2015). "Social media update
2014," *Pew Research Center* (9 January),
at http://www.pewinternet.org/2015/01/09/social-media-update-2014/, accessed 6 October 2016.

Eke, H.N., Omekwu, C.O., &Odoh, J.N. (2014). The Use of Social Networking Sites among the
Undergraduate Students of University of Nigeria, Nsukka, at
https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=3114&context=libphilprac , accessed 6,January, 2018

Fox, S. &Rainie, L. 2014. "The Web at 25 in the U.S.," *Pew Research Center* (27 February),
at http://www.pewinternet.org/2014/02/27/the-web-at-25-in-the-u-s/, accessed 6 October 2016.

Hurt, N. E., Moss, G. S., Bradley, C. L., Larson, L. R., Lovelace, M. D., Prevost, L. B.,…
Camus, M. S. (2012). The 'facebook' effect. College student's perceptions of online discussionsin the age of social networking. *International Journal for the Scholarship of Teaching and Learning, 6*(2), 1-24. Retrieved December 18, 2017 from http://academics.georgiasouthern.edu/ijsotl/v6n2.html.

Lenhart, A., Purcell, K., Smith, A., &Zickuhr, K. (2010). Social media & mobile internet use
among teens and young adults. *Pew Internet & American Life Project*, 1-37.

Liu, Y. (2010). Social media tools as a learning resource. Journal of Educational Technology
Development and Exchange, 3(1), 101-114.

Oshanive, P. (2015). Social Media and Academic Performance. Retrieved January 4, 2018 from
https://www.researchgate.net/publication/273765197

Pempek, T. A., Yermolayeva, Y. A., & Calvert, S. L. (2009). College students'social networking experiences on facebook. Journal *of Applied Development Psychology, 30*(3), 227-238.

Sheldon, P. (2008). Student favorite: Facebook and motives for its use. *Southwestern Mass
Communication Journal*, *23*(2), 39-53.

Solis, B., 2008. The essential Guide to Social Media- A Free eBook. Retrieved 27 January, 2018 from http:/ www.briansolis.com/2008/06/essential-guide-to-social-media-free/

Trubitt, L. Overholtzer,J. (2011). Good communication: The Other Social Network for
Successful Organizations.

Tufekci, Z. (2008). Grooming, gossip, Facebook, and MySpace. Information, Communication &Society, *11*(4), 544-564.

Urista, M.A., Dong, Q., & Day, K.D. (2009). Explaining why young adults use myspace and
facebook through uses and gratifications theory. Human Communication, 12(2), 215-229

West, A., Lewis, J., & Currie, P. (2009). Students' facebook 'friends': public and private
spheres. *Journal of Youth Studies, 12*(6), 615-627.

Virkus, S. (2008). Use of Web 2.0 technologies in LIS education: experiences at Tallinn
University, Estonia. Program: Electronic Library and Information Systems, *42*(3), 262-274.

Zakaria, M. H., Watson, J. & Edwards, S. L. (2010). Investigating the use of web 2.0 technology
by Malaysian students. *Multicultural Education and Technology Journal, 4*(1), 17-29

AN ONLINE DIAGNOSTIC MODEL FOR DETECTING SEVERITY OF DIABETES

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ABSTRACT

Diabetes is a major health problem inherent to people at all age groups in many developing countries. As one in top ten causes of high mortality and morbidity rates prevalent in developing worlds, it has impeded the extant purpose of the human race. Since medical themes have always advocate earlier detection of diabetes in human as a good way to medical control, this paper proposes an online procedural model for diagnosis and management of diabetes. The diagnosis model adopts the fuzzy logic technique to handle imprecise and uncertain information innate with records of diabetes patients. The model was implemented with HTML, Hypertext Preprocessor, JavaScript and XML languages with MySQL taken for backend management. Statistical and sensitivity inferences were drawn from a case study of a dataset from 30 patients, randomly chosen from the patients that were admitted at Obafemi Awolowo University Teaching Hospital Complex, Ile-Ife, Nigeria, between 1994 and 2013. The analysis shows the proposed system has 73.3% sensitivity based on the results obtained by medical experts for similar patients.

Keywords: *Diabetes Mellitus, Medical Diagnosis, Online Diagnostic System, Artificial Intelligence, Fuzzy Logic.*

1. INTRODUCTION

Diabetes is one of the major health problems among people of all ages and one of the top ten causes of death which has increased in prevalence all over the world (Thirugnanam et al., 2012). The International Diabetes Federation (IDF) estimates that there are 381.8 million people in the world live with diabetes in 2013 with a projected increase of 55% to 591.9 million by 2035 (Guariguata et al., 2014). The process of disease diagnosis and management is multifaceted because of the numerous variables involved and it is complex as a result of the imprecision and

uncertainty associated with such variables (Djam et al., 2011). Uncertainty is an important issue in the medical diagnosis (Han et al., 2011). For patients, it is often very challenging trying to explain to physicians what sought of discomfort they experience, and on the part of the physicians, it is also demanding to describe or interpret the observations from different cases.

Artificial Intelligent decision making systems have been deployed to appropriately handle uncertainty and imprecision in foggy information utilized for logical reasoning (Omisore *et al*, 2017). This technique has greater feats in practical application of computer based diagnostic tools for early diagnosis of diseases and also, advancement in information technology has empowered taking quality decisions in several aspects of medical practices (Rawte and Roy, 2015). Expert System (ES) has been applied to the field of medicine for instance, it had been used to diagnose particular diseases and solve several medical problems. As well, it has been modeled to assist surgeons in the developed countries when they operate on patients in the theatres (Gao *et al*, 2012).

The chronic evadable condition had been classified in Ibrahim *et al* (2012) as Type 1, Type 2, and Gestational diabetes. In Type 1, enough destruction results from beta cells and the body does not produce insulin at all leading to absolute insulin deficiency in the body system. The cause of Type 1 diabetes is still unknown and as a result, it is usually diagnosed during childhood or early adolescence (Loghmani, 2005). In a study by Chineye et al., (2007), it was concluded that Type 2 diabetes is one of the fastest growing public health problem in the world. As of 2013, over 89% of 382 million people who were estimated to live with diabetes in the world suffer from Type 2 diabetes (Shi & Hu, 2014). A main rationale for making use of expert systems in medical diagnosis is the self-tuning capability utilized to reduce the variance of treatments by diffusing best practices. Application of expert system for diagnosis of medical diseases has been an interesting area of research since the introduction of MYCIN in 1970 (Samuel *et al*, 2013).

Efforts had been made to evolve emerging techniques for medical diagnosis. Recently, applications of AI techniques such as rule-based expert system, neural and Bayesian networks have assisted in the prognosis of different medical conditions aiding successive diagnosis procedures. In (Ali et al., 2010), a fuzzy based model is proposed for diagnosis of respiratory diseases. Application of computing to diagnosis of diabetes was not left out like other diseases. Garcia (2001) proposes a dual phased computer-based system for monitoring and controlling level blood glucose in the body. Patra (2012) narrated the processes necessary for diagnostic classification of diabetes. The presentation suggests using the signs and symptoms in patients' data to automatically classify the medical condition of patients as Normal, Impaired Fasting Glycaemia, Impaired Glucose Tolerance, or Diabetes Mellitus. In a recent time, great level of focus is being shone to improve the application of artificial systems for

diagnosis of diabetes. For instance, Ambica *et al* (2013) proposes a decision support system for diabetes disease using a two-level classification technique.

This paper presents a online diagnosis system for detecting severity of diabetes in pre-diabetic patients This system propose to help patients to detect diabetes at an early stage and also provide a level of severity of disease for patients at any time in order to provide accurate, fast and reliable diagnosis. The remaining parts of the paper is arranged such that Section 2 of this paper presents review of related works in medical diagnosis and application AI techniques while Section 3 presents an online diagnostic model for detecting severity level of diabetes in human. Section 4 presents an experimental study, results and evaluations of the model using data of pre-diabetic patients from Obafemi Awolowo University Teaching Hospitals, Ile-Ife, Nigeria. And lastly, conclusion and directions for futures works are presented in Section 5.

2. SYSTEM MODEL

Fig. 1 shows the structure of coordinated system for online diagnosis of diabetes in human. The system is constituted with User Interface, Knowledge base, and Fuzzy Logic System as major components. The user interface is the space where interactions are made between the user and the system. The aim of the user interface is to provide an efficient and enjoyable medium that tolerates the effective system's operation.

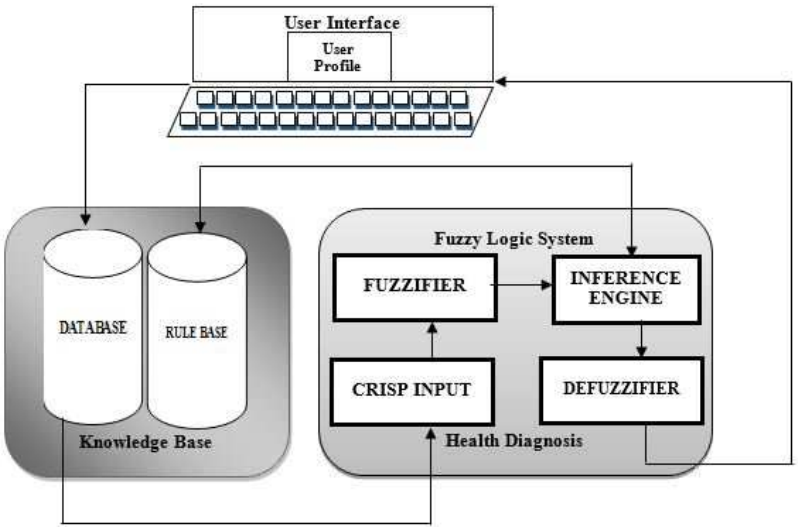


Figure 1: Diagnosis model for diabetes detection.

The medical expert or the user provides values representing signs, symptoms, and laboratory investigations of a particular patient during the diagnosis process. The knowledge base consists of the Database and the Rule Base. The database contains the patients' biodata, patients' anthropometric data, test result and diagnosis history. The rule base consists of a set of 'If-Then' rules which were carefully formulated and

structured with the assistance of a medical expert. The diagnosis processes triggers the system to perform procedures the explained below, in sections 2.1 to 2.3.

2.1 Fuzzification

The set of input variables considered for diagnosis are the Body Mass Index, activity level, blood sugar level, blood pressure. Each is defined with the following fuzzy set: *underweight, Healthy weight, overweight, obese, sedentary, active, very active, normal, pre-diabetes, and established diabetes*. The fuzzification process involves conversion of the input variables into crisp values upon which membership functions are applied to determine the degree of each input variable in the diagnosis procedure. This research adopts the triangular shape Membership Function to represent the degree of membership of each of its input variables. Let X = {$x_1, x_2, x_3, \ldots, x_n$}, X represents the input variables. Equation 1 explains the universe of discourse and its fuzzy set.

$$U = \{(x_i, \mu_u(x_i))| \; x_i \subset U, \quad \mu_U(x_i) \subset [0,1]\} \tag{1}$$

where U is the is the universe of discourse that contains all elements that will be put into consideration, μ_u is the degree of membership of $x_i$and $\mu_u(x_i)$ represents the Membership Function (MF) of x_i in U from Eq. 2, which is also a real number whose interval is from 0 to 1.

Premise and consequent parameters of the triangular membership function expressed in Eq. 2 are used to determine the membership degrees of the input vector. The input vector is a set of variables that are described with linguistic terms in the fuzzy .

$$\mu_u(x_i) = \begin{cases} 1 & if \; x_i < a \\ \frac{x_i - a}{b-a} & if \; a \leq x_i < b \\ \frac{c - x_i}{c-b} & if \; b \leq x_i < c \\ 0 & if \; c \leq x_i \end{cases} \tag{2}$$

where a, b, c, are the premise and consequent parameters of the membership function in Eq. (2).

2.2 Rule Base

The rule base is a part of the fuzzy logic system. It is characterized by a set of 'If-Then' rules, in which the antecedents (IF part of the rule) and consequents (THEN part of the rule) involves linguistic variables. The collection of these rules forms the rule base for the fuzzy logic system. The rules are carefully formulated and structured with the assistance of a medical expert from the field of dietetics.

2.3 Inference Engine

The inference engine is a decision making engine that receives input from rule base and fuzzification interface, apply suitable procedures in order draw deductions as output. This research adopts the Root Sum Square (RSS) method of drawing inference. RSS combines effects of fired rules with their respective magnitudes to compute a composite area. Inference Engine was driven by RSS inferential mechanism, given as Eq. 3, to handle the rules in the knowledge base. Each rule has is of the form:

R_X: IF BMI is *Healthy weight* AND AL is *Active* AND BP is *High* AND BS LEVEL is *High,* THEN Result = *Severe*.

where BP, and AL are the input variables, *very high*, *moderately active* are the fuzzy sets of the input variables, and hypertension is the output and severe is fuzzy set of the output variable within the fuzzy region specified by the rule.

$$RSS = \sqrt{\sum_{x=1}^{n}(RX^2)} \qquad (3)$$

where RX represents a fired rule and X = 1,2,3, . . .,n represents the number of fired rules for a particular diagnosis.

2.4 Defuzzification

The defuzzification interface translates the output of the fuzzy inference engine into crisp values. Defuzzification process is important due to the fact that the output from the inference engine is usually a fuzzy set, and crisp values are required for proper analysis and interpretation. Centroid of Gravity (CoG) technique for the defuzzification of the output of the fuzzy inference engine to obtain a crisp value in Equation (4). This technique is accurate and computationally simple (Pant and Holbert 2004).

$$CoG(Y') = \frac{\sum_{i=1}^{n}\mu_Y(x_i)x_i}{\sum_{i=1}^{n}\mu_Y(x_i)} \qquad (4)$$

where x_i is the crisped input value, $\mu_Y(x_i)$ is the membership function for the ith variable, and $CoG(Y')$ is the crisped output value obtained.

On several consultations with medical experts and existing standard literature in tropical medicine, it was deduced that the attributes considered for diagnosis of diabetes are categorically done as part of physical examination or medical test. Categories of the attributes are maintained as shown in Table 1.

Table 1: *Attributes used for diagnosis of diabetes*

Cate	Attributes
Medical Test	Fasting Blood
	Random Blood
	Creatinin Test
	Lipid Profile Test
	Glycated
Physical Examination	Body Height
	Body Weight
	Body Mass Index
	Blood Pressure
	Activity Level

3. EXPERIMENTAL STUDY

The system was implemented using Hypertext Markup Language, Hypertext Preprocessor, Java Script, JavaScript & XML programming languages with My Structured Query Language as the database management system. Information of the patients' is stored in the system's database with the aid of web form presented in Fig. 2. The web form comes up at each new session with any registered users to record users' current vitals. Apart from vitals, intensity of symptoms experienced patients are entered into the system via the third section of Fig. 2. Patients' state of health regarding diet related diseases were evaluated by domain experts based on BMI, Activity Level, Blood Pressure and Blood Sugar Level. The intensity of BMI was classified as Underweight (1), Healthy Weight (2), Overweight (3), Obese (4). The intensity of Blood Pressure and blood sugar Level was rated as normal (1), Severe (2), very severe (3). The intensity of Activity level was rated as Low (1), Active (2), Very Active (3).

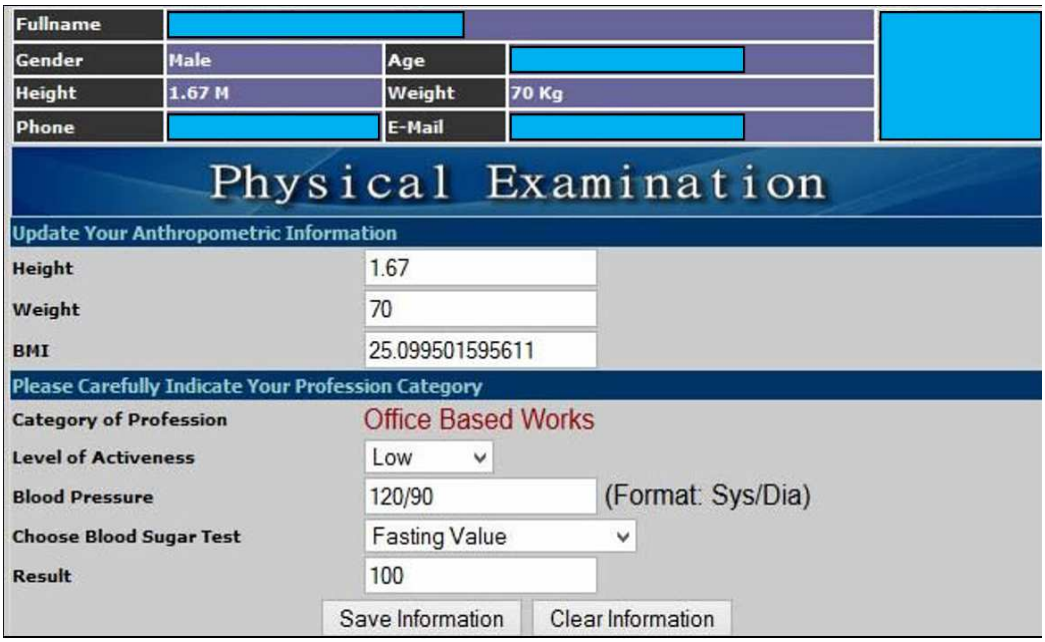


Figure 2: Web interface for patient's information entry

The information elicited from different patients' records are firmly sent to the database upon a click of "Save Information" and diagnosis procedures commence. However, information entry can be cancelled in cases of mistakes or other reasons once a user clicks 'Clear Information', and the home page interface is reloaded. Medical information of different groups of people were considered for the experiment though more focus was set on patients that are overweight and obese because they could be ordinarily imagined pre-diabetic. For instance, on entering the information of Patient P030 as seen in Fig. 2, the diagnostic result is given in Fig. 3. The results confirm that the patient is normal with a severity level of 23.34%. Tt means the patient is not diabetic despite having an overweight condition.

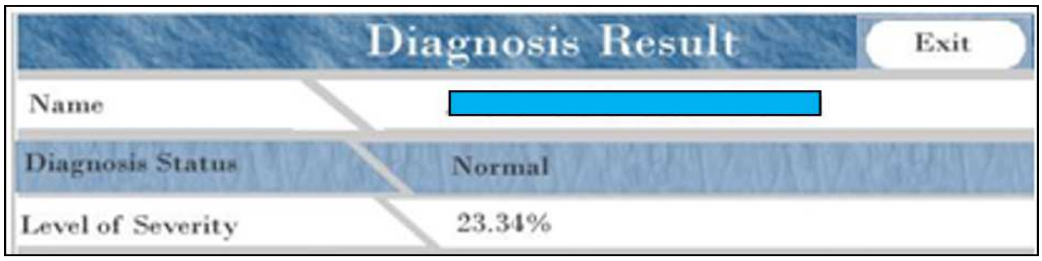


Figure *3: Web display of the diagnosis result*

Experimental results of all the patients considered in the study are given in Table 2. The raw information was sent through the fuzzy logic system which helps in better handling imprecise information inherent with system. At the end of first three steps in the fuzzy procedure, the intermediate data obtained are presented in Table 3.

Finally, the fuzzy values were defuzzified using the central mean measure described in section three. The diagnosis results obtained for the 30 patients are presented as crisp outputs in Table 4.

Table 2: *Rating of Patients with respect to diagnosis attributes*

Id	B	AL	BP	BS	Id	B	AL	BP	BS
001	3	2	1	1	01	2	1	1	3
002	2	3	1	1	017	4	2	3	2
003	2	3	1	1	018	2	2	2	1
004	2	1	1	2	019	2	2	1	3
005	4	2	1	2	020	4	1	3	1
006	2	1	3	3	021	2	2	1	2
007	2	1	2	2	022	2	2	1	2
008	4	3	1	2	023	3	2	3	3
009	3	2	3	3	024	4	1	2	3
010	2	1	1	1	025	2	1	2	2
011	2	1	1	2	026	3	2	1	3
012	3	2	1	2	027	2	1	1	3
013	4	1	2	1	028	4	1	1	3
014	3	2	2	1	029	3	2	3	1
015	2	3	2	3	030	2	1	1	1

Table 3: *Fuzzy Values of Patients' Diabetes Data*

Id	B	AL	BP	BS	Id	B	AL	BP	BS
001	0.6	0.1	0.1	0.1	016	0.3	0.1	0.1	0.8
002	0.3	0.8	0.1	0.1	017	0.8	0.5	0.6	0.5
003	0.3	0.8	0.1	0.1	018	0.3	0.5	0.3	0.1
004	0.3	0.1	0.1	0.5	019	0.3	0.5	0.1	0.8
005	0.8	0.5	0.1	0.5	020	0.8	0.1	0.6	0.1
006	0.3	0.1	0.6	0.8	021	0.3	0.5	0.1	0.5
007	0.3	0.1	0.3	0.5	022	0.3	0.5	0.1	0.5
008	0.8	0.8	0.1	0.5	023	0.6	0.5	0.6	0.8
009	0.6	0.5	0.6	0.8	024	0.8	0.1	0.3	0.8
010	0.3	0.1	0.1	0.1	025	0.3	0.1	0.3	0.5
011	0.3	0.1	0.1	0.5	026	0.6	0.5	0.1	0.8
012	0.6	0.5	0.1	0.5	027	0.3	0.1	0.1	0.8
013	0.8	0.1	0.3	0.1	028	0.8	0.1	0.1	0.8
014	0.6	0.5	0.3	0.1	029	0.6	0.5	0.6	0.1
015	0.3	0.8	0.3	0.8	030	0.3	0.1	0.1	0.1

Table 4: *Diagnosis Status of Examined Patients*

I	Crisp	Stat	I	Crisp	Stat
0	11.7	Nor	0	92.5	Very
0	24.2	Nor	0	88.4	Very
0	24.2	Nor	0	23.0	Nor
0	30.2	Mil	0	61.0	Sev
0	43.0	Mil	0	66.1	Sev

0	71.8	Sev	0	44.2	Mil
0	54.2	Mil	0	45.6	Mil
0	56.8	Sev	0	81.3	Very
0	84.1	Sev	0	95.4	Very
0	14.1	Nor	0	42.2	Mil
0	30.2	Mil	0	56.7	Sev
0	18.0	Nor	0	83.3	Very
0	77.6	Very	0	11.1	Nor
0	23.2	Nor	0	46.0	Mil
0	99.7	Very	0	24.3	Nor

4. ANALYSIS OF DIAGNOSIS RESULTS

The proposed system was evaluated based on diabetes data of patients that was obtained from Obafemi Awolowo University Teaching Hospitals, Ile-Ife, Nigeria, between 1994 and 2013. The diagnosis results presented in this study are based on data of 30 patients that were randomly selected for this study. Statistical and sensitivity analyses were observed based on result of the diagnosis obtained for each patient's case record. Analysis made from the diagnosis results are documented in the following sub-sections.

4.1 Statistical Analysis

Statistical analysis, from bar chart in Fig. 4, shows that the system diagnosed the diabetes condition of nine patients as normal, eight as mild, six as severe, and seven as being very severe.

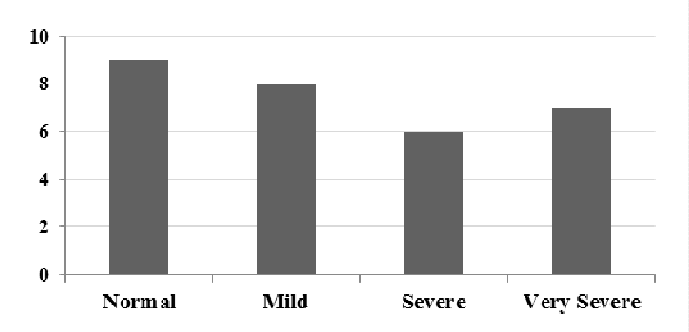


Figure 4: Number of users with respect to the diagnosis status

Hence, 30% of the patients were reported to be normal while some 26.7% were mild diabetic. Also, 20% of these patients were diagnosed and reported to be severely diabetic and lastly, 23.3% of the patients had very severe diabetes. Classifying by gender, Fig. 5 shows that 14 of the patients are female while the remaining 16 are male. Not just that, seven of the female patients were diagnosed as normal, one as mild, one as severe and the remaining five were very severe on diabetes. However, two of the male patients were diagnosed normal, while seven were diagnosed as

having mild diabetes, five were severe and other two had very severe diabetes. Hence, 47% of the users are female while the remaining 53% of the patients are male.

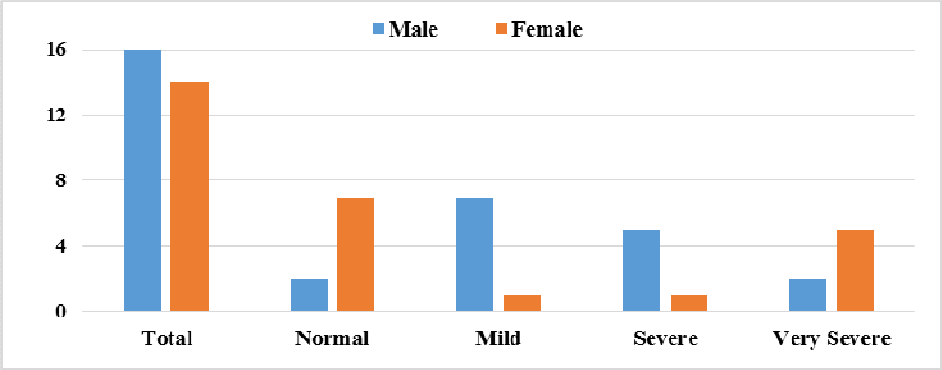


Figure 5: Analysis of Patients by Gender

Finally, classification by age group is a key analysis that shows category of people fond of or prone to diabetes. Fig. 6 shows that 19.04% of patients diagnosed diabetic are between the ages of 34 and 44, 23.81% are between the ages of 45 and 54 while 57.14% are above the age of 54. This analysis connotes that the older people grow, the more likely their chance of having diabetes, as seen in Fig. 6, number of users with diabetes increased as age group increases. Also, Fig. 6 has clearly shown that diabetes is common in people that are above 54.

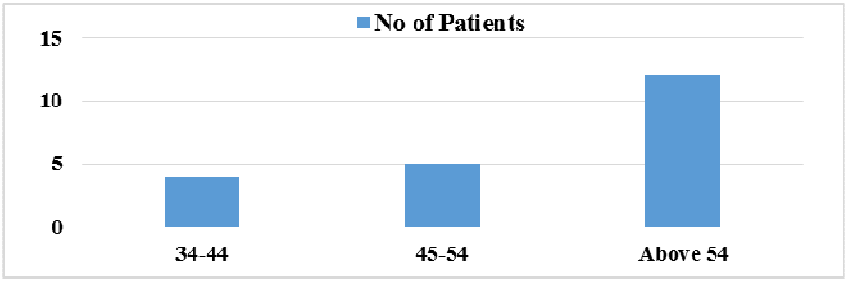


Figure 6: Analysis of Diabetic Patients by Age Group

4.2 Sensitivity Analysis

Acceptability of the proposed model for diagnosis of diabetes is a great factor but strongly depends on the accuracy and reliability of output by the model. Nonetheless, algorithmic and mathematical models are imperfect abstractions of reality due to nature of input from human. To ascertain the diagnosis output from this model, sensitivity analysis is observed to how changes in model input affects its output. This analysis is a set of procedures tailored by human to quantify the error rate of a modeled system. Sensitivity analysis helps to predict how a model will respond to input of any type. In this study, sensitivity analysis is observed to quantify performance of the proposed system. In effect, it is computed as ratio of the patients

that were properly diagnosed to the total number of patients that were diagnosed with the system.

$$Sensitivity = \frac{\text{True positive}}{\text{True positive} + \text{False negative}} * 100\% \quad (5)$$

True positive is the number of patients with diabetes and also diagnosed to be diabetic by the system; False negative is the number of patients also with the disease but were diagnosed as not having diabetes by the system. Diagnosis results from medical experts as contained in the patients' records are compared against the results that were observed by the proposed system, as presented in Table 5. Thus, sensitivity of the proposed system was as 73.3%.

Table 5: *Results from both the proposed system and experts*

Propo	M	Pro	Me
Norm	N	Ver	Ver
Norm	M	V.	Ver
Norm	N	Nor	Nor
Mild	M	Sev	Sev
Mild	M	Sev	Nor
Severe	M	Mil	Mil
Mild	M	Mil	Mil
Severe	V	Ver	Sev
Severe	S	Ver	Ver
Norm	N	Mil	Sev
Mild	N	Sev	Sev
Norm	N	Ver	Ver
Very	V	Nor	Nor
Norm	N	Mil	Mil
Very	S	Nor	Nor

This shows that the model behaves very close to the medical experts in the field of diabetes diagnosis. Furthermore, it can be interpreted that the system responds appropriately to changes in the input values from dataset of the 30 patients used in this study.

5. CONCLUSION AND FUTURE WORKS

The need for application of artificial intelligence has been perceived in different areas of medicine. This study presents an online diagnostic approach to diagnosis diabetes in human. The proposal adopts use of fuzzy inference system to analyze the multiple variables considered during manual diagnosis process. Implementation and evaluation of the model were observed on case study of medical records from 30 patients diagnosed in Obafemi Awolowo University Teaching Hospital Complex, Ile-Ife, Nigeria. Statistically, 43.3% of the samples are severely diabetic of which 53.8% are male patients, 57.14% of who were above the age of 54 are confirmed diabetic

meaning people who are old are prone to diabetes. Moreover, the model demonstrates a great sensitivity. The potential of this evaluation is that it is highly controlled, stylized and sufficiently responsive to dynamic changes possible in humans. However, it indicates no information about the performance of the system.

Lastly, the study presents a step-wise diagnosis procedure for detecting severity of diabetes in human. Adopting fuzzy inference mechanism, the system demonstrates its potentials to easily work around imprecise and vague information that is very domicile in medical data. However, membership functions which serves as a basis for this approach is a significant issue which becomes very critical in the presence of new medical records never learnt nor perceived by the model at design time. Unlike neural network and optimization algorithms, fuzzy approaches do not feature self-tuning and self-learning functionalities which can be utilized to enhance the efficiency of the proposed system.

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REFERENCES

Ambica A., Gandi S., and Kothalanka A. (2013), An Efficient Expert System for Diabetes By Naïve Bayesian Classifier, International Journal of Engineering Trends and Technology, Vol 4(10), pp. 4634-4639.

Chineye, S., Unachukwu, C., & Hart, A. (2007), Diet and diabetes: theory and practice for care providers. Diabetes International, Vol 15 (1): pp. 9-11.

Djam, X. Y., Wajiga, G. M., Kimbi, Y. H., & Blama, N. V. (2011), A fuzzy expert system for the management of Malaria. International Journal of Pure and Applied Science and Technology, Vol 5(2), pp. 84 108.

Gao B., Guo S., Xiao N., & Guo J. (2012), Development of a 3D blood vessel model for the Simulation of the Minimally Invasive Surgery, Proceedings of 2012 IEEE International Conference on Mechatronics and Automation Chengdu, China, August 5 - 8, 2012

Garcia M., Gandhi A., Singh T., Duarte L., Shen R., Dantu M., Ponder S., & Ramirez H. (2001), ESDIABETES: An Expert System in Diabetes, J. Comp. in Small Coll. 16(3), pp. 166 – 175

Guariguata, L., Whiting, D. R., Hambleton, I., Beagley, J., Linnenkamp, U., & Shaw, J. E. (2014), Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes research and clinical practice, 103(2), 137-149.

Han, P. K., Klein, W. M., & Arora, N. K. (2011), Varieties of Uncertainty in Health Care A Conceptual Taxonomy. Medical Decision Making, 31(6), 828-838.

Ibrahim M., Abeer M., Mostafa A., Abdel-Badeeh M. , A study on Expert Systems for Diabetic Diagnosis and Treatment, Recent Advances in Information Science, pp. 363-367

Loghmani, E. (2005), Diabetes mellitis: Type 1 and 2, epi.umn.edu/let/pubs/img/adol_ch14.pdf

Omisore O. M., Samuel O. W., & Atajeromavwo E. J. (2017), A Genetic-Neuro-Fuzzy Inferential Model For Diagnosis of Tuberculosis, Applied Computing and Informatics, 13(2017), pp. 27–37

Patra, P. (2012), Automatic Diagnosis of Diabetes by Expert System. IJCSI International Journal of Computer Science Issues, 9(2), 1694-0814.

Samuel, O. W., Omisore, M. O., & Ojokoh, B. A. (2013), A Web Based Decision Support System Driven by Fuzzy Logic for the Diagnosis of Typhoid Fever. Expert Systems with Applications, 40(10), 4164-4171.

Shi, Y., & Hu, F. B. (2014), The Global Implications of Diabetes and Cancer. The Lancet, 383, pp. 1947-1948

Thirugnanam, M., Kumar, P., Srivatsan, S., & Nerlesh, C., (2012), Improving the Prediction Rate of Diabetes Diagnosis Using Fuzzy, Neural Network, Case Based Approach. Procedia Engineering, 38, 1709-1718.

Rawte, V., & Roy, B. (2015), Ontology Based Expert System for Thyroid Disease Diagnosis. International Conference on Nascent Technologies in the Engineering Field, pp. 1-6

Zadeh, L.A. (1965), Fuzzy sets, Information and Control, Vol 8 (3): pp. 338–353.

PROVIDING INFORMATION ACCESS TO ALL AND SUNDRY: A PANACEA FOR BETTER LIVELIHOOD AND SUSTAINABILITY IN THE 21ST CENTURY

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ABSTRACT

This study examined issue on access to information and how this can results to better livelihood and sustainability especially for people resident in poor societies of developing countries such as Nigeria. The study discussed issues like information access, sustainable development, information access for better life and sustainability, the role of libraries in providing access to information for better life and sustainability, and identified hindrances to information access for better life and sustainability. The study concluded by emphasizing provision of access to information to users irrespective of their status and location is indispensable for better livelihood and sustainability of all and sundry. The study recommended that libraries should welcome opportunity to cooperate with other actors in providing access to information and working in the development realm to go beyond where they are currently in terms of ensuring better life for people.

Keywords: *Information provision, Information access, Better livelihood, Sustainable development, 21st century, Developed and developing countries.*

1.INTRODUCTION

In this 21st century, access to information by the citizens is considered a necessity and a fundamental right as it has been ordered and incorporated in the freedom of expression and information. Information access is the ability to obtain the resources necessary to satisfy an information need (RUSA Access to Information Committee,

1999, Askin, 2015). The Act respecting access provides that every person is entitled to access documents held by public bodies. In the world of IFLA (2017), it was succinctly stated that access to information (A2I) is not an end in itself, but rather a driver of progress across the board. It empowers people and communities, laying the foundations for equality, sustainability, and prosperity. It provides a clear illustration of the rights based, holistic approach to development taken in the 2030 Agenda.

Nevertheless, access to information needs to be more than access to computers and cables to be meaningful. Locally relevant content needs to be available, in local languages. Without this, there will be less reason to go online in order to learn or seek information. It is already clear that levels of use of news and similar sites remain lower in developing countries than in developed ones, where more local content is available. Libraries can make a real contribution to development by providing access to information.

The contention in this paper is that information access should improve the lives of the users for sustainability. However, it should be noted base on IFLA (2017) observation that, even when there is access to physical connectivity and relevant content, it is meaningless if users are unable to apply the information they access to real-world problems. IFLA report explained that, users need the skills and attitudes necessary to find and use existing information, and create new information which they can share with their communities. The skills identified include ICT skills such as Copying/moving a folder, Sending emails, Pasting within a document, Transferring files (Garrido, & Koepke, 2017). The IFLA report (2017) pointed out emphatically that it is in the poorest countries that the ability to use productivity-enhancing digital tools is least developed. This implies that the developing countries lack the skills and capacity to access and use available information for better life and sustainability. In short, meaningful access to information requires four key elements (IFLA, 2017): information and communications access infrastructure; a positive social context for use; sufficient capabilities in communities and their members; and a favourable legal and policy landscape.

Worthy of note at this point is the fact that access to information is advantageous to all and sundry in many respects. Access to information can contribute to more effective infrastructure and innovation systems as reflected in the sustainable development goal number 9 (SDG9). With a growing number of active researchers in the world, and ever more powerful analytical tools, once information is made accessible it can become the raw material for new ideas, products and services (Garrido & Koepke, 2017). The experience of the Human Genome Project shows that openness is a driver of, and not a threat to, investment in innovation. Similarly, enhancing access to, and use of, information around infrastructure is providing solutions to congestion and poor quality of life in the world's cities. It is implied from these that, access to information can create a virtuous circle. An information

empowered society which will be better placed to create and share data which can further drive improvements in agriculture, health, economic empowerment, efficient infrastructure and innovation. But delivering meaningful access itself will need to be a team effort. Laws, regulations, investments and infrastructure will need to align, and global, national and local efforts will need to be coordinated (IFLA, 2017). More importantly, it should be noted that, a well-supported library sector will play a major part in delivering success.

IFLA report (2017), feature some pertinent questions can access to information create more socially and economically inclusive societies? Given the unprecedented ability we have today to gather, use, create, and exchange information, how can we capitalize on the strengths of the information society to help combat poverty and inequality, make governments more transparent and accountable, improve gender equity, increase youth's social and economic participation, and promote civic life in our communities? Answer to all of these questions cannot be provided in this single paper. In the light of this, this paper only focus on how access to information can lead to better life and sustainability especially for people the bulk of which are resident in poor societies of developing countries such as Nigeria. To achieve this therefore, the paper discusses information access, sustainable development, information access for better life and sustainability, the role of libraries in providing access to information for better life and sustainability, Hindrances to information access for better life and sustainability, and the way forward.

2. INFORMATION ACCESS

Access is the ability or right to approach, enter, exit, communicate with, or make use of something. Access involves a subject and an object - a person who accesses a resource (Habler, 2009). The demand for better access to information is marked in society as a whole. This therefore implies that, in this era, to succeed, and live a better life of sustainability, access to information is indispensable. Information access is an important part of answering questions concerning the creation, organization, dissemination, and use of information (Oltmann, 2009). The right of access to information has become the dominant right in the information and knowledge era (Lor & Britz, 2007, p. 392; Cramer, 2009).

Freedom of information and right of access to information was captured during the first session of the General Assembly of the United Nations in 1946. The assembly unanimously adopted a resolution on freedom of information which says: "Freedom of information is a fundamental human right and is the touchstone of all the freedoms to which the United Nations is consecrated. Regarding definition of "freedom of information, different international documents define its content in a broader or narrower sense. This varies from the broader meaning of freedom of expression and information as a whole through the freedom to seek, receive and disseminate information to the narrower sense of freedom to seek and obtain information. The

narrowest definition of "freedom of information" implies the right of each individual to inspect or copy documents held by government bodies. In view of a greater precision and preclusion of ambiguity, the latter can be defined as the right of "access to information" (Access to Information Programme, 2017).

Table 1 provide more details information about the conceptualization of access to information or information access.

Table 1. Conceptualizations of Access to Information.

Category	Examples	Implications
Knowledge	Message sent, information flow; Observations, visual sources, evidence; Documents, books, periodicals, numerical or digital data, databases, citations; Analysis, advice, interpretation, debate, answers, education	Can lead to decision-making, control over information flow; To quality of life, quality of work life; To power, influence; To socioeconomic opportunities: equity, funds, legal advantage, participation in democratic society and citizenship activities
Technology	Range of technologies and media: computer, telephone, movies, books, newspapers, magazines, music, tv, etc.; Information delivery systems, systems that generate, store, create information; Interface or command language, software, programming; Use of system; Linking technologies: interactive, communication, networking technologies	Assumes that access to technologies leads to access to information; assumes an infrastructure of support; Assumes knowledge of how to use; Can lead to access to multiple data sources, automatic methods of surveillance, increased control, creativity; Compounding effect: access to one technology can increase future access, experience, advantage
Communication	Making sense of things: content, comprehension, retention, explanation; Making use of information:	Assumes communication competence; Requires broader meaning of relevance;

	accuracy, relevance, format, level, decision making; Connectivity; Communication competence	Can lead to social, political participation with implications for democracy, equity, power relations; Compounding effect: access likely to lead to greater competence, access
Control	Over who has access to what to whose advantage; Over the agenda, terms of debate, content, organization, design, program; Over processes and flows of information; Over production of culture	Assumes that power and control are associated with information and knowledge; Compounding effect: those who control access are more likely to decide, design in favor of others most like them
Goods/ Commodities	Information as social, economic good with value, costs, benefits; Distribution of control capacities, availability of resources; New markets for information industry	Assumes potential for public good, social value; Value not known until used; Compounding effect: potential for economic barriers and paths to be reinforced by social dynamics
Participation	Services: governmental, communication, information; Advocacy; Privacy	Can influence right to participate as citizen; Compounding effect: those most in need often least likely to obtain services

Source: McCreadie and Rice, 1999a, p. 50; Oltmann, 2009, p.10.

This conceptualization, McCreadie and Rice (1999) noted, frequently assumes that access to technology, or use of some system, is equivalent to access to information. However, a host of factors can intervene or complicate the relationship between access, information, and use. In addition, technology mediates individuals‟ access to information, either intensifying or compensating for individuals‟ abilities. Finally, McCreadie and Rice explain that “access to technology” can have a compounding effect: the more access one has, the easier and more effectively one can gain further access (pp. 51-53).

The target 16.10 of the millennium development goal state: “Ensure public access to information and protect fundamental freedoms, in accordance with national

legislation and international agreements". Public access to information should enables people to make informed decisions that can improve their lives. Communities that have access to timely and relevant information for all are better positioned to eradicate poverty and inequality, improve agriculture, provide quality education, and support people's health, culture, research, and innovation (IFLA, 2014). As stated in target 16.10: a well-informed society contributes significantly to the development of the nation as the availability of information resources would promote peaceful and inclusive societies for sustainable development, providing access to justice for all and build effective, accountable and inclusive institutions at all levels (Bradley, 2014). In the word of Neuman (2002), poor public access to information feeds corruption. Secrecy allows back-room deals to determine public spending in the interests of the few rather than the many. Lack of information impedes citizens' ability to assess the decisions of their leaders, and even to make informed choices about the individuals they elect to serve as their representatives (Neuman, 2002). The United Nations Development Programme (UNDP) and the Open Working Group Focus Area Report, identified the crucial role of access to information in supporting development can play. In the light of this, they recognized that:

1. Poverty is multidimensional, and progress in eradicating poverty is linked to ensuring sustainable development across a variety of areas.
2. Sustainable development must take place in a human-rights based framework, where: inequality is reduced by the empowerment, education and inclusion of marginalized groups, including women, indigenous peoples, minorities, migrants, refugees, persons with disabilities, older persons, children and youth; gender equality, along with full social, economic and political engagement, can be significantly enhanced by empowering women and girls through equitable access to education; dignity and autonomy can be strengthened by ensuring access to employment and decent jobs for all; equitable access to information, freedom of expression, freedom of association and assembly, and privacy are promoted, protected and respected as being central to an individual's independence; and public participation of all is ensured to allow them to take ownership of change needed to improve their lives.
3. Increased access to information and knowledge, underpinned by universal literacy, is an essential pillar of sustainable development. Greater availability of quality information and data and the involvement of communities in its creation will provide a fuller, more transparent allocation of resources.
4. Information intermediaries such as libraries, archives, civil society organizations (CSOs), community leaders and the media have the skills and resources to help governments, institutions and individuals communicate, organize, structure and understand data that is critical to development. This can be achieved by (Lyon Declaration, 2014):

- Providing information on basic rights and entitlements, public services, environment, health, education, work opportunities, and public expenditure that supports local communities and people to guide their own development.
- Identifying and focusing attention on relevant and pressing needs and problems within a population.
- Connecting stakeholders across regional, cultural and other barriers to facilitate communication and the exchange of development solutions that could be scaled for greater impact.
- Preserving and ensuring ongoing access to cultural heritage, government records and information by the public, through the stewardship of national libraries and archives and other public heritage institutions.
- Providing public forums and space for wider civil society participation and engagement in decision-making.
- Offering training and skills to help people access and understand the information and services most helpful to them.

5. Improved ICT infrastructure can be used to expand communications, speed up the delivery of services and provide access to crucial information particularly in remote communities. Libraries and other information intermediaries can use ICTs to bridge the gap between national policy and local implementation to ensure that the benefits of development reach all communities.

6. Access to information, and the skills to use it effectively, are required for sustainable development. Nations of the world need to recognised this in their post-2015 development agenda by (Lyon Declaration, 2014):

- Acknowledging the public's right to access information and data, while respecting the right to individual privacy.
- Recognising the important role of local authorities, information intermediaries and infrastructure such as ICTs and an open Internet as a means of implementation.
- Adopting policy, standards and legislation to ensure the continued funding, integrity, preservation and provision of information by governments, and access by people.
- Developing targets and indicators that enable measurement of the impact of access to information and data and reporting on progress during each year of the goals in a Development and Access to Information (DA2I) report.

3. SUSTAINABILITY

As explained by deJung (2013), sustainable development was first defined in 1987 by the World Commission on Environment and Development (Brundtland Commision, 1987) as development which meets the needs of the present without compromising the

ability of future generations to meet their own needs. The most commonly quoted definition of sustainable development stresses the meeting of needs and puts a clear focus on intergenerational equity along with responsibility in a broad sense. In September 2015, the adoption by United Nations Member States of the 2030 Agenda for Sustainable Development (UN, 2015) set the global, national and local framework for putting that responsibility into action.

Sustainable development is no longer just a possible alternative: it is the path of reason. Several means of action already exist. Decisions involving their implementation concern all the economic participants. Each person on his own level can be a participant in this gigantic project, which will affect the lives of future generations. Lyon Declaration(2014) believe that increasing access to information and knowledge across society, assisted by the availability of information and communications technologies (ICTs), supports sustainable development and improves people's lives. The Lyon Declaration of August 2014 on sustainable development seeks to ensure the long-term socio-economic prosperity and well-being of people everywhere. The ability of governments, parliamentarians, local authorities, local communities, civil society, the private sector and individuals to make informed decisions is essential to achieving it.

In this context, a right to information would be transformational. Access to information will bring about better life and sustainability for people, supports development by empowering people, especially marginalised people and those living in poverty. And this will enable them to (Lyon Declaration 2014):

- Exercise their civil, political, economic, social and cultural rights.
- Be economically active, productive and innovative.
- Learn and apply new skills.
- Enrich cultural identity and expression.
- Take part in decision-making and participate in an active and engaged civil society.
- Create community-based solutions to development challenges.
- Ensure accountability, transparency, good governance, participation and empowerment.
- Measure progress on public and private commitments on sustainable development.

However, it observed that access to information can leads to better life and sustainability for the world populace. The next section discusses this in details as follows.

INFORMATION ACCESS FOR BETTER LIFE AND SUSTAINABILITY

As put forward by Baker and Musker (2017), the aim of Sustainable Development Goal 2 (SDG2) is to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" (UN, 2015). Eliminating hunger and all forms of malnutrition cannot focus only on increasing crop yields. Attention must also be paid to increasing food quality and nutritional value, raising smallholder farmer incomes, empowering women, supporting ecosystem resilience in a changing climate, maintaining genetic diversity, and improving access to healthy food for everyone. These crucial components to the elimination of hunger are outlined in the SDG2 subgoals.

As Baker and Musker (2017), observed, **c**urrently, there are approximately 570 million farms in 161 countries. Out of these, 13 percent are in lower-income countries and 36 percent are in lower-middle-income countries. Farms less than two hectares comprise 12 percent of the world's agricultural land, and family farms make up 75 percent of the world's agricultural land (Lowder et al., 2016). Forty-three percent of the agricultural labor force in less developed countries is made up of women (FAO, 2012). It is therefore worthy of note that, if sustainable agriculture and SDG2 are to be achieved, smallholders, especially women, and low-middle-income farmers must be able to access, analyze, and apply information to their production systems (FAO, 2012). Improved access to information for farmers increases the likelihood of achieving the SDG2 and its sub-goals. Similarly, Baker and Musker (2017) remarked that access to information can help put an end to hunger and promote nutrition. They also suggested that open data lies at the heart of improved access to information for farmers. In the light of this, Farmers need open data and access to information (See table 2):

Table 2: Open Data as Information to Poverty Eradication

S/N	Need of open data by farmers and For What?
1.	Modern farming
2.	Methods, on appropriate inputs such as seeds and fertilizers,
3.	Methods, on appropriate inputs such as seeds and fertilizers,
4.	Market opportunities, prices, weather, environmental protection,
5.	Health, agricultural laws and regulations and, where appropriate
6.	How to apply for subsidies.

To find and use such information as reflected on table 2, farmers need access to, and training in, information and communication technology (ICT). Global initiatives,

governments, foundations, industry, NGOs and research institutions will be able to use open data that smallholder farmers provide to make positive decisions for the food system and to ensure food security, while holding one another accountable for SDG2 monitoring.

Similarly, information also needs to be available in the language of farmers, which is often a local or minority language. Baker and Musker (2017) also argued that open data and open access information A2I are crucial for achieving Sustainable Development Goal 2 which is Zero Hunger. As it has been emphatically stated by Baker and Musker, access to information entails the rights and capacity to use, create, and share information in ways that are meaningful to each individual, community, or organization. However, it should be noted that access to information to achieve better life and sustainable development is usually bedeviled by some hindrances. These hindrances are discussed in the next section of this paper.

HINDRANCES TO INFORMATION ACCESS FOR BETTER LIFE AND SUSTAINABILITY

It is noted by Baker and Musker (2017) that tremendous amount of open data and useful information exists online, farmers in less developed countries lack the education, ICT skills, and access to computers and connectivity needed to use the internet effectively to improve their livelihoods. Family farms often rely on inefficient and unprofitable methods and often operate at subsistence levels. Many farmers speak only a local language and some are non-literate. They lack access to information about markets and new farming methods that might help them improve productivity. Baker and Musker (2007) identified several obstacles that smallholder farmers must overcome in order to not only receive the correct information, but translate that information into an actionable decision. The obstacles are summarised as:

- Access to print materials
- Access to web materials
- Access to information in local languages
- Access to facilities and training for creating videos
- Access to computers
- Access to ICT training for farmers
- Access to information in remote areas
- Access to information and assistance with
- Markets
- Training for volunteers
- Building partnerships

Furtherance to the Baker and Musker (2017), Buchland (1991) emphasized that six types of barrier have to be overcome if access to information is to be achieved. The barriers are discussed as follows:

1. Identification. A suitable source needs to be identified. This indicative access is the realm of bibliography, documentation, classification, indexing, and of information retrieval. Commonly one thinks of this in terms of finding pertinent data or documents about the topic of the inquiry, but, more generally, the retrieval system may need to be responsive to requests for retrieval on any of several attributes, often, but not necessarily, what they are about. (This is usually at least a two-stage process: deciding where to look ("channel-selection") as well as identifying a specific book, record, or other source.)

2. Availability. The inquirer needs to be able to inspect the source or a copy of it. This physical access, or document delivery, is a matter of logistics and technology. If a source that has been identified cannot be located and made physically available in an acceptable fashion, then another source needs to be identified and made available.

3. Price to The User. We use price to denote what the would-be user must expend to use the service. The price may include, but is not restricted to, money. "The real price of everything, what everything really costs to the man who wants to acquire it, is the toil and trouble of acquiring it" (Adam Smith 1976, Book 1, Chap. 5, para. 2). The "real price" includes time, effort, and discomfort ("I was too embarrassed to ask...") as well as money. In particular, price includes the effort of learning to use difficult, user-unfriendly systems (Culnan 1985). The price, as discussed in chapter 10: Demand, must be acceptable to the inquirer. To the extent to which it is not, price is a barrier to access.

4. Cost to The Provider. Not all expenditure of money and effort is borne by the inquirer, least of all in archive and library services which are traditionally free, in the sense that monetary charges are not usually made. In this context we use the term cost to denote what has to be expended by the providers of service. To the extent that the sponsors or providers of service may incur expenditure of effort, money, space, or inconvenience, the arrangement would have be acceptable to or, at least, not incompatible with their view of their role, mission, and values. Meeting the need may encroach on values of a social, cultural, or political nature. The detailed profile of any information service is largely defined by the allocation of resources and this allocation is based on the resources and social values of those who allocate.

Providing access to appropriate evidence might in some cases be regarded as an unacceptable challenge to these values: to national security, to private or corporate vested interest, or to social values as in the case of indecent or irreligious materials (*Library Trends* 1986, 3-183). These nonmonetary values have a long history of restricting access in a manner similar in nature to restrictions caused by financial shortages. "How strange it is that for most liberal thinkers -- academics as well as

statesmen -- knowledge is almost always `good' and worthy of wide diffusion, although history is full of attempts by governors -- political, moral, and religious leaders, and well-meaning parents -- to discourage the spread of `dangerous' or `unwholesome' knowledge." (Machlup 1980, 12).

5. Cognitive Access. Once physical access to a suitable source has been achieved, another condition for successful access is that the inquirer has sufficient expertise to understand it. If not, then some combination of two remedies are possible: Explanation and education. Explanation would involve additional interpretation of the source -- translation, perhaps, if the existing source is in a foreign language or an explanation by someone with more expertise, either on an informal basis or by the creation of a new summary that is easier to understand. Education is another solution in that the inquirer may be able to acquire more expertise, for example, by consulting a dictionary, an encyclopedia, or someone who has the requisite expertise, and may then be able to understand the book.

There is one further aspect involved in "acceding to knowledge", which has not traditionally been thought of as having to do with access yet plays the same kind of role in practice as the other aspects and so can reasonably be included in the discussion of access: acceptability.

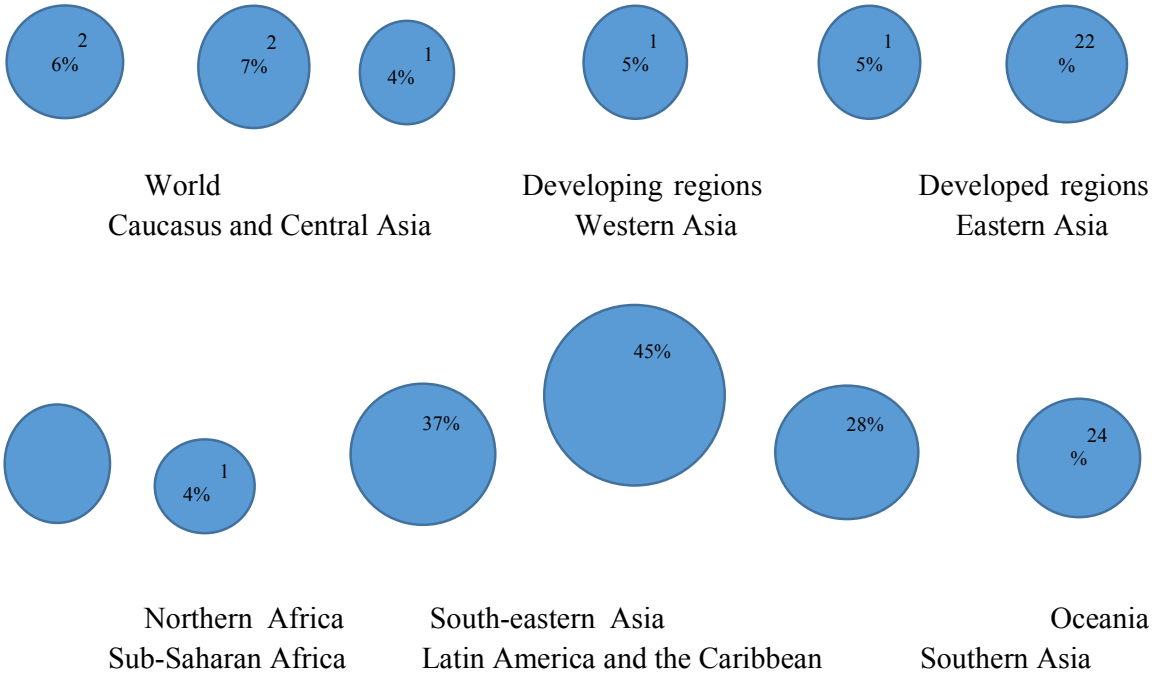
6. Acceptability. Acceptability denotes two related issues: First, inquirers may be reluctant to accept a particular source as credible, regarding it with suspicion as having inadequate "cognitive authority" (Wilson 1983). Second, the inquirer may be unwilling to accept the evidence of the source because it is unwelcome in what it signifies and conflicts with other beliefs, a matter of cognitive dissonance (Festinger 1957; Greenwald and Ronis 1978).

INITIATIVE ACROSS THE WORLD TO INCREASE ACCESS TO INFORMATION FOR BETTER LIFE AND SUSTAINABILITY

Poverty affects all aspects of life. Poverty and inequality are among the main drivers constraining people's agency to live the lives they choose to live (Sen, 2001). From 2002-2012, the share of people in abject poverty (living below the international poverty line) dropped from 26 percent to 13 percent (SDGs 2016 Report). If economic growth rates of the past decade continue for the next 15 years and this growth benefits everybody equally, poverty could fall to 4 percent of the population. Despite this optimistic forecast, poverty still affects the lives of almost 1 billion people around the world today (IFLA Report, 2017). Regional poverty rates provide a clearer picture of persistent poverty that is masked by international estimates. By 2015, close to a third of people around the world lived below national poverty lines – 45 percent in Sub-Saharan Africa, 37 percent in Oceania, and 27 percent in Latin America. (See Figure 1) for national poverty rates by region). While more revealing than international estimates, regional rates still mask significant variations by country. For example, in

Mexico, one of the richest countries in Latin America in terms of GDP, 53 percent of the population lives below the national poverty line. This percentage is almost double the regional average of 28 percent. In Sub-Saharan Africa where Nigeria is located, poverty rates range from a high of 76 percent in Equatorial New Guinea to a low of 19 percent in Botswana.

Percentage Of People Living Below The National Poverty Line By Region



Source: UN (2015).

Note: 122 countries, year varies between 2005 and 2015, depending on country. Latest year available used for each country. Technology & Social Change Group, University of Washington

To increase access to information for better life and sustainability, there are range of access to information initiatives that have improved agricultural production and farmer livelihoods through available technology worldwide. Access to information is important to the farmer at all stages of agricultural production. Information can be used to decide which crops to grow and how to price them for the market; and it is essential to promoting the importance of nutrition. Some of the initiatives are featured in table 3.

Table 3a: Access to Information Initiatives and Improvement of Livelihoods for Sustainability

Country	Initiative	The Details
Rwanda	Improving transparency of land rights with a digital registry	In Rwanda, farmers did not have exclusively named land rights, resulting in conflicts among neighbors and time lost to resolve disputes. The government of Rwanda has developed a nationwide, digital-based land registry system, Rwanda Natural Resources Authority (RNRA), which is both online and machine-readable. RNRA is the first large-scale land registration program of its kind in Africa.
Kenya	Smartphone app for decision-making	In Kenya, the Haller Foundation has developed the Haller Farmers App, which has organized 60 years' worth of farming data and expertise into a usable format for smallholder farmers. The app draws data and results from a local test farm. The information is provided openly in both English and Swahili in text form, with Swahili also available in audio format. The Haller Training and Demonstration Farm trains farmers on innovative agricultural techniques for sustainable living. Farmers receive face-to-face advice and information tailored to their local needs.
Uganda	Helping farmers with satellite data and extension services	The Market-led, User owned ICT4Ag Enabled Information Service (MUIIS) based in Uganda is an extension service provided to farmers that includes data, knowledge, and advice to help farmers make effective decisions. Through the platform, farmers have access to assistance, as well as advice on crop insurance. This platform incorporates several partnerships from both the public and private sectors. Although the project is in early stages, MUIIS hopes to see a crop yield increase of 25 percent, and farmer incomes increase by 20 percent (CTA, 2016).

Uganda	Connecting rural community libraries to the internet	The Connect Uganda Pilot Project supplied each of five rural libraries with three netbooks and internet connectivity. Seven hundred farmers were trained to use ICT to search the web, where they could find available open data and information to learn about new species of plant, for example, or sources of tools. In the three libraries that lacked electricity, the project installed solar panels, which also allowed them to hold meetings and support internet access at night.
Chile	Bringing information to farmers in remote areas	Farmers in remote mountain villages of southern Chile have limited access to information about modern farming methods. A van equipped with a computer lab for teaching ICT skills can reach isolated farming communities and allow farmers to interact with experts on local radio stations. The ICT training, attended primarily by women farmers, covers internet search, use of an existing social network platform where farmers exchange experience and news, and use of an online market where farmers advertise their produce.

Table 3b: Access to Information Initatives and Improvement of Livelihoods for Sustainability

Country	**Initiative**	**The Details**
Asia and Africa	Producing and screening videos on farming practices	Digital Green helps provide open data to farmers in a usable and culturally appropriate way. The organization has developed a participatory approach using open national sample survey data to study the effectiveness of knowledge sharing among peers. Digital Green has worked with local women to develop videos that provide information on field operations, improved agricultural practices, and performance targets. Four thousand videos in have been produced in

		28 languages. Data is gathered about the dissemination of the videos, as well as adoption of the procedures described in the videos, and community interest is gauged to further tailor the videos to the appropriate audience (GODAN, 2017).
Thailand	Helping rice farmers with low-tech cardboard information wheels	There are large amounts of data for Thai agricultural researchers or companies that have access to computers, but there is no way for the least-resourced farmers to benefit from this data. To present information in an accessible way, the Hia Chai Rice Seed Center has designed a cardboard rice wheel. The wheel helps farmers to know when to grow their rice and when to harvest, based on the weather and the variety of rice grown. Due to the rice wheel, yields of rice increased by 10 percent (GODAN, 2016).
Worldwide	Helping farmers improve plant health	Farmers need information about plant pests and plant diseases, often in response to infestation or other urgent problems. Plantwise, a program led by the Center for Agriculture and Biosciences International (CABI) in the U.K., aims at helping farmers achieve higher yields through combating plant health problems. In partnership with national agricultural advisory services, Plantwise has established a network of more than 1,800 plant clinics that are run by more than 5,000 trained plant doctors in 34 countries (CAB, 2017).
Serbia	Helping farmers reach new markets	Farmers in central Serbia lacked the computer skills and network connectivity needed to access information and market their products. After years of war in the 1990s, followed by economic recession, four village libraries that existed in name only, gathering dust, reinvented themselves as information centers through the AgroLib-Ja project. In 2010, the libraries purchased computers with a grant from EIFL-

		PLIP and offered free internet access.
Ethiopia	Electronic commodity exchange for farmers	The Ethiopian Commodity Exchange Network (ECX) is an electronic commodity exchange for farmers that, through open data, gives open access to the price of crops and ensures the seller gets the correct price on a given day.

To ensure better livelihood and sustainability, the following among others must be achieved:

- Ensuring access to food
- Ensuring sustainable food production
- Investing in productive capacity
- Ending malnutrition
- Support food commodity markets
- Doubling the productivity of small-scale producers

THE ROLE OF LIBRARIES IN ACCESS TO INFORMATION AND IMPROVEMENT OF LIVELIHOODS FOR SUSTAINABILITY

Libraries are, by definition, institutions dedicated to shaping and improving access to information in the communities they serve. On a technical level, libraries are part of the physical infrastructure necessary to ensure everyone can obtain the kinds of information they need (Jowaisas, 2017). Libraries services which contribute to improved livelihood and sustainability include the following (Dada, 2016; Tella et al., 2018).

- Promoting universal literacy, including media and information literacy
- Closing gaps in access to information and helping government, civil society, and business to better understand local information needs.
- Providing a network of delivery sites for government programmes and services.
- Advancing digital inclusion through access to Information & Communications Technologies (ICT), and dedicated staff to help people develop new digital skills (Advancing Sustainable Development, 2014).
- Serving as the heart of the research and academic community.
- Preserving and providing access to the world's culture and heritage.
- More specifically, libraries has supported the implementation of the SDGs by providing access to information, support for literacy and ICT skills, and access to community space.

Some of the existing initiatives of library support to SDGs may include:

- UN Depository Libraries that support dissemination of information and research to help decision makers achieve the SDGs.
- Access to health, environmental, and agricultural information that are targets of the SDGs; including Open Access resources
- Media and information literacy programmes for marginalized populations to make an important contribution to achieving universal literacy (Bradley, 2016).

There are also some examples of various ways libraries have developed people's skills while working toward the types of outcomes represented in the SDGs: health and well-being, entrepreneurship, and educational attainment.

In Burkina Faso, the Girls' Mobile Health Clubs found in four village libraries expand access to quality health information while also providing support to the participants to increase their information literacy and technology skills. While library staff provide training in information literacy skills, local health

In Indonesia, public libraries have offered micro entrepreneurship training to more than 84,000 women and youth over the past six years. Training participants have researched a variety of ideas for small or household-based businesses, including starting or expanding initiatives related to food processing, growing markets for traditional fabric crafts, and improving methods for crop and livestock production (Global Libraries Program (Bill & Melinda Gates Foundation, 2017).

In Ghana, the Volta Regional Library began using a mobile library in 2012 to improve educational opportunities for students attending schools with limited resources. The program provides hands-on computer classes, addressing a subject area in which rural schools have had high failure rates in national exams.

In Germany, the Cologne Public Library renovated a portion of the main library to build a makerspace that provides access to technologies such as a 3D printer, advanced software and hardware, and additional print and physical resources used in creative pursuits.

In terms of Libraries promoting civic engagement**,** Colombia, public libraries have taken an active role in reconciliation as the country tries to end hostilities with rebel forces and normalize previously militarized zones. The program, "Comparte Tu Rollo" (loosely translated as "Tell Your Story"), is a partnership between the National Library and HistoryPin, a nonprofit organization.

In South Africa, a partnership has emerged between the National Library of South Africa and private industry aimed at expanding ICT-related employment opportunities for youth. The program includes training in digital skills and a graduate internship program for youth to gain practical experience. The collaboration also contributes to the skills development initiatives of the National Development Agenda (National Library of South Africa, 2017).

In the United States, the Kansas City Public Library responded to poor health indicators in the communities served in an economically depressed area of the city by

partnering with local health-care providers and other organizations to deliver fitness and health management classes and expand access to healthy foods (Berry, 2017).

Libraries are also partnering for community development. For instance, most public libraries recognize that partnering with other organizations is a very effective way to leverage their respective strengths and resources to achieve far-reaching impact.

However, it is unfortunate that, arising from the information above and the one on Table 3 nothing reflect Nigeria. The implication is that Nigerian libraries efforts towards improving livelihood and sustainable development of her citizens has no antidotal record. In Africa generally, countries such as South Africa, Uganda, Kenya, Namibia Ghana and Ethiopia's record of efforts are captured in terms of what are doing in this regards.

4. CONCLUSION

This study has discussed issue on access to information and how this leads to better life and sustainability especially for people, the bulk of which resident in poor societies of developing countries such as Nigeria. The paper looked at information access, sustainable development, information access for better life and sustainability, the role of libraries in providing access to information for better life and sustainability, and identified some hindrances to information access for better life and sustainability. The paper concluded by emphasising that access to information is key to achieving better livelihood and Sustainable Development Goal for people in developing countries.

5. RECOMMENDATIONS

As reflected from this discussion, provision of access to information to users irrespective of their status and location is indispensable for better livelihood and sustainability of all and sundry. In the light of this, libraries should welcome opportunity to cooperate with other actors working in the development realm to go beyond where they are currently in terms of ensuring better life for people. In addition, governments and development agencies, including libraries in such partnerships should offer more vast opportunities to reach more people.

It is also important to pay special attention to libraries' physical and infrastructural needs, whether in the form of reliable power supplies (through backup generators or solar panels, for example), use of universal service funds to support high-speed internet connections, and well-designed, user-friendly facilities.

REFERENCES

Access to Information Programme (2017). The right of access to information concept on legislation. A registered non-profit organization in Sofia, Bulgaria, Reg. #13 849/97, Sofia City Court.

Askin, N. (2015). Managing barriers: provision of information access for underserved groups. *The UBC School of Library, Archival and Information Studies Student Journal,* 1, Retrieved from http://ojs.library.ubc.ca/index.php/seealso/issue/view/182659

Baker, T. & Musker, R. (2017). Chapter 3: A2I for Sustainable Agriculture: How access to information can help end hunger and promote nutrition. In Garrido, M. & Wyber, S. Eds. (2017). *Development and Access to Information*. International Federation of Library Associations and Institutions: The Hague'.59-66.

Berry, J. N. III. (2017). Finding and Filling Needs 2017 LibraryAware Community Award. Retrieved from http://lj.libraryjournal.com/2017/03/lj-in-print/finding-and-filling-needs-2017-libraryaware-communityaward.

Bradley, F. (2014). *What are the UN SDGs and what do they mean for libraries?* Retrieved: http://eifl.net/sites/default/files/resources/201511/3._eifl-fbradley-2030agenda.pdf

Bradley, F. (2016). *Contribution of Libraries to the SDGs*. Retrieved: http://www.ifla.org/files/assest/wlic/2015/Contribution of Libraries to the SDGs - United Nations Partnerships for SDGs platform [October 2016].

Buckland, M. (1991). Access to Information. Chapter 8 of *Information and Information Systems.* Retrieved from Chapter 8 of *Information and Information Systems*.

CABI Plantwise. (2017). Plantwise. Retrieved from http://www.plantwise.org.

CTA. (2016). Ugandan farmers look to the future with smartphone and satellite technology. Retrieved from http://www.cta.int/en/article/ 2016-06-29/ugandan-farmers-look-to-the-future-with-smartphone-and-satellite-technology.html.

Culnan, M. J. (1984). The dimensions of perceived accessibility to information. *Journal of the American Society for Information* 36: 302-308.

Dada, K.J. (2015).The role of library in achieving vision 2030 goals. *CEC Journal*, 46(2), Retrieved: http://scalar.usc.edu/works/cec-journal-issue-2/the-role-of-the-library-in-achieving-vision-2030 goals

deJung, W. (2013). The female face of sustainable development. Library Briefing. Retrieved http://www.library.ep.ec

FAO. (2012). Smallholders and Family Farms. Retrieved from http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/Factsheet_SMALLHOLDERS.pdf.

Festinger, L. 1957. *A Theory of Cognitive Dissonance*. Stanford: Stanford University Press.

Garrido, M., M & Koepke, L. (2017). Chapter 1: The State of Access to Information and Development in the United Nations 2030 Agenda. In Garrido, M. & Wyber, S. Eds. (2017). *Development and Access to Information*. International Federation of Library Associations and Institutions: The Hague'.15-50.

GODAN. (2016). Success Stories - Issue 1. Retrieved from http://www.godan.info/documents/godan-success-stories-issue-1.

GODAN. (2017). Success Stories - Issue 2. DOI: 101079/CABICOMM-25-8057

Greenwald, A. G. & D. L. Ronis. 1978. Twenty Years of Cognitive Dissonance: Case Study of the Evolution of a Theory. *Psychological Review* 85:53-57.

Habler, B. (ed.) (2009). Access to open educational resources: report of a UNESCO OER community discussion. Retrieved April 7, 2010, from http://oerwiki.iiepunesco.

org/images/2/27/Access2OER_final_report.pdf

Jowaisas, C. M. (2017). Chapter 2: Libraries as Agents for Sustainable Development. In Garrido, M. & Wyber, S. Eds. (2017). *Development and Access to Information*. International Federation of Library Associations and Institutions: The Hague'.51-58.

IFLA in partnership with the Technology & Social Change Group (2017). Development *and*

Access to Information. Retrieved from DA2I.ifl a.org

Lor, P.J., & Britz, J.J. (2007). Is a knowledge society possible without freedom of access to information? *Journal of Information Science, 22*(4), 387-397.

Lowder, S. K., Skoet, J., & Raney, T. (2016). The number, size, and distribution of farms, smallholder farms, and family farms worldwide. *World Development*, 87, 16-29.

Lyon Declaration (2014). Lyon Declaration on Access to Information and Development. International Federation of Library Associations and Institutions (IFLA).

McCreadie, M. & Rice, R.E. (1999a). Trends in analyzing access to information. Part I: Cross-disciplinary conceptualizations of access. *Information Processing & Management, 35*(1), 45-76.

McCreadie, M., & Rice, R.E. (1999b). Trends in analyzing access to information. Part II: Unique and integrating conceptualizations. *Information Processing & Management, 35*(1), 77-99.

Machlup, Fritz. (1980). *Knowledge and Knowledge Production*. Princeton, NJ: Princeton University Press.

Neuman, L. (2002). Access to information: A key to democracy. The Carter Center Report.

Oltmann, S.M (2009). Information access. Qualifying Paper. School of Library & Information Science Indiana University, Bloomington.

RUSA Access to Information Committee (1999). *Issues in Access to Information*. Retrieved from http://archive.ala.org/rusa/access_biblio.html

Sen, A. (2001). *Development as freedom.* Oxford Paperbacks.

Smith, Adam. (1976). *An Inquiry into the Wealth of Nations*. Oxford: Clarendon Pr.

United Nations. (2015). The Millennium Development Goals Report 2015. New York: Author. Retrieved: www.un.org/.../2015.../MDG%202015%20rev%20(July%201).pdf

Wilson, Patrick G. (1983). *Second-hand Knowledge: An Inquiry into Cognitive Authority*. Westport, CT: Greenwood Press.

Tella, A., Ajao, A.M., Ajibola, T.S., Akanbi, M.L., Ogunsola, O.R. & Bashorun, M.T. (2018).

Knowledge management and 21st century libraries as panacea for sustainable development. *Paper Presentation at the First International Conference ICT4 Sustainable Development, University of Ilorin.*

ELECTRONIC VOTING SYSTEM IMPLEMENTATION IN NIGERIA HIGHER INSTITUTIONS

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ABSTRACT

Electronic voting system, Elections form a critical process in democratic systems and application of information technologies to the management is a great milestone towards realizing effectiveness and efficiency not only in the results of the election process itself but also in the financial implications that come up with the process. One of best and oldest universities in Nigeria needs a computerized management of student union elections due to the shortcomings in the 'human clerk 'electioneering system. The existing voting system did not provide reliable statistics on voting history in the university and thus campaigners lacked the ground to apply scientific voter forecasting methods resolving to trial and error methodologies which are error prone and inconsistent. Reinforcing a one voter one vote policy is difficult in such a situation and malpractices as rigging are not uncommon in human clerk system. The aim of this paper is to develop an electronic voting system in Nigeria Higher Institution a case study of University of Ilorin.To replace the current inefficient manual system of voting in the existing system. To ensure credibility in elections by preventing double voting, this system will also help the student union government reduce the huge costs incurred in conducting elections. In conclusion this system should be implemented using software e.g. oracle database or other types of related software in order to increase security of data and vita information that might be very important to the user. The proposed system was implemented with a Web Application which makes use of the following script to achieve result from above problems are HTML,CSS, JavaScript, PHP, JQuery and the Back End MYSQL Database.

Keyword: *Election, Voting System, Students, Database, Electronic*

1. INTRODUCTION

Elections are believed to be the key pillars of democracy all over the world and voting is one of the election processes that ensure the democracy in any civil society. (Abimbola and Addesote, 2012). The result of presidential elections in Nigeria is usually fiercely contested. This is obvious from the numerous law suit that normally precede the result of any presidential

elections. Tribunal's springs up everywhere and an array of legal experts are organized to dispute the result of the election. And in most cases, the point is usually that of electoral fraud, multiple voting, and falsification of electoral results.

This article is aimed at investigating the current trends in election at the Student Union Government (SUG) University of Ilorin, discovering the problems associated with the existing modus and proffer solutions where possible by design and implementing it.

Voting is a means of selecting or choosing leaders. It does not apply only to SUG but also in different or various departments and institutes and social organizations. Therefore, the conduct of elections in a democratic society is very important not only because through it a change of government is effected but also because voting is the main form of political participation for most people for democracy to be sound and smooth, it should be enhanced on election free from fraud. Many centuries ago, most societies were societies were primitive and had not evolved a system of voting to elect the leaders that will govern then and promote societal harmony and peace. This means that people have to devise a system whereby a leader or a set of leaders have elected from the ranks of the people. At that point the idea of voting and being voted for became important and necessary. But before an individual can cast his or her vote, there are certain conditions to be met, one of which is to be registered as a voter (Caarls and Susanne, 2010).

Watt (2002) Student politic scene has witnessed incessant upheavals, wide scale dishonesty and societal bitterness, which in most instances, degenerated into lawlessness and destruction of lives and property. These unfortunate situations paved the way for and served as spring boards for the emergence and growth of unskilled democrats and military leaders in the governance of the nation. Many Nigeria's are disappointed that a post independent 46years-old Nigeria is still operating constitution which does not enjoy an overwhelming national acceptance, as evident in the persistent calls for the convocation of a sovereigns national conference on the one hand, and the growing demand for ethnic nationalities on the other. For about four and half decades since independence, the nation had shifted position between parliamentary and presidential system of government, with several military in cursions into polities over the years. Even the present presidential democratic dispensation is still undergoing experimentation with varying degrees of trial and error approach. It is in the light of the foregoing, that this system on voter registration is written to serve as a useful tool of enlightenment in the hands of voters, the electorate and the general public. However, voter registration is a critical aspect of the electoral process. A credible voters register is a prelude to free and fair elections. It is also important for people to know is qualified to vote, where, when and how to vote. Also, a full knowledge of the registration procedure will encourage eligible voters to participate in the electoral process (Mitrou,et.al., 2013).

However, the inefficiency of manual voting process in Nigerian Universities has resulted in a lot of Pandemonium between the students and the school management. These

problems have continued to obstruct the peace some institutions because the choice of capable candidate is not encouraged by the paper based voting system.

2. REVIEW OF RELATED LITERATURE

Voting theory formally began in the 18th century and ever since, many proposals have been made towards using electronic technologies to improve elections (Sobia, et.al. 2013). One of the essential features of democracy is Election, democracy encourages individual's freedom with respect to the rule of law, so that individuals can express their opinion the way they wish, giving individuals the opportunity to decide their leaders, and uninhibitedly express their feelings on issues. Because of the All-inclusive Affirmation of Human Rights in the year 1948 that puts import on compelling circumstance of free elections, countries focused on an improved and new voting process that are of significance to the election processes in the 21st century (Salomonsen, 2015).

Election through voting system is the process that enables individuals to choose their delegates and express their feelings on the way they will be administered (Khasawneh, et.al., 2008)

Nigerian election process has been done manually (voting for local and general elections done by electors with ballot papers and ballot boxes in which the papers are placed) since returned to democratic rule in the year 1999, the manual voting process was associated with a lot of problems and always resulted to post-election violence (Yekini, et.al., 2012).

It is necessary to use the new technologies to make the election system faster, economic and trustable because the trust that every vote will be tallied and recorded correctly is the foundation of a genuine democracy (Ademand & Metin, 2014).

The Electronic Voting System (EVS) involves presenting eligible student with a list of contestants on a computer, to select against their favorite contestants, this system of voting is used for Student Union Government (SUG) election in the polytechnic. The improvement of information and communications technologies has allow for a completely computerized election process whereby counting of vote are carried out in real time, that the results are automatically out by the end of elections day (Rubin, 2002).

Comparison of Electronic Voting System

Besides many vendors who develop and sell commercial electronic election machines, there are various open source E-voting systems. The following examples were cited:

(1) AccuVote-TS:

AccuVote-TS's vendor is Diebold Election Systems. This system includes touchscreen, card reader, keyboard, headphone, and paper tape printer. The voter selects his favorite candidate on touchscreen, and the vote will be printed on the paper tape. Its design balances the policy, electoral procedure and technology (Malkawi, et.al., 2009). But all the

electoral information (including identity authentication, audit, or counting of votes) are stored in Microsoft Access database without setting password so there are high risks of attack.

(2) iVotronic:

The vendor of iVotronic is Election Systems and Software (ES&S). iVotronic provides multi-language, and uses flash memory to save voting records. Electoral workers use PEB (Personal Electronic Ballot, a device which is similar to disk) to start polling machine up. When the election is finished, the workers use PEB to access voting records in the polling machine, then delivers PEB to electoral center or transmits data from network. Because the PEB's password is only three characters, the risk of password breaking exists. This system have made mistake in the past elections, such as the number of voters is not corresponding between master server and backup server, the candidate selected on the ballot is not the voter's selection, and so forth.

(3) eSlate 3000:

Hart InterCivic invented eSlate 3000. The voter gets a personal identity number (PIN) as four digits from electoral workers, then goes to the booth to input the PIN into polling machine to login. He can rotate selector wheel to select the candidate whom he want to poll for. Each terminal connects to the server which is named JBC (Judges Booth Controller). Counting of votes will send to JBC from every terminal by network, then save it in MBB (Mobile Ballot Box). This system doesn't encrypt voting data, so there are some risks of data security. Furthermore, the electoral functions are not protected with password, anyone, even the voter, can finish the election.

(4) AVC Edge:

AVC Edge is a multi-language polling machine which is manufactured from Sequoia Voting Systems. This machine includes touchscreen and flash memory for saving voting recorded, and its electoral procedure is similar to a foregoing E-voting machine, Accu Vote-TS. There were some stumbles when this machine operated in the elections. For example, the E-voting system crashes when the user chose language; the counting of votes is not correct; and the ballot became blank because of the system breakdown.

(5) SAVIOC:

SAVIOC is an open source E-voting system and all the source code and software can download from its official website. This system is written in C language, and it can be saved in disk with FreeDOS. This system operates from disk, so hard disk is not necessary and the discarded computer is enough. This system is not connected to any networks and most of keys on the keyboard are disabled, attackers can't find the way to invade. SAVIOC's advantages are its simple disposition and low cost, but on the other hand, there are short of GUI and ease of use on SAVIOC.

Quality of a good Electronic Voting System

The following is a description of desirable characteristics that should exist in any good system and the reason for each characteristic with respect to the voting process.

- **Accuracy**

"A system is accurate if it is not possible for a vote to be altered, it is not possible for a validated vote to be eliminated from the final tally, and it is not possible for an invalid vote to be counted in the final tally." (Cranor & Cytron, 2012). Accuracy is one of the most important factors to any system. If the input is not correct, then the result will not be correct; garbage in garbage out (GIGO). Not only should the system be accurate in counting votes and maintaining the integrity of cast ballots, the system should be accurate in identifying voters. Some of the problems in Nigeria could have been prevented by checking that the number of precincts reporting matched the number of existing precincts.

- **Verifiability**

"A system is verifiable if anyone can independently verify that all votes have been counted correctly." (Cranor & Cytron, 2012). Currently, many experts believe that the best method to verify votes and perform recounts is with paper ballots. However, in Georgia, it was impossible to perform a recount in 2002 because some counties did not have any paper trail to audit. In addition, the voter should be able to verify that their ballot is entered correctly and allow them to adjust their vote if necessary. The process needs to verify the validity of the voter as well. Perhaps the use of a nation wide database of registered voters' information and a method of non-intrusive biometrics could identify participants. The system should also verify that the electronic system has not been compromised. This includes validation of the physical machines for consistency (quality control) and for material weaknesses.

- **Democracy**

"A system is democratic if it permits only eligible voters to vote and it ensures that each eligible voter can vote only once" (Cranor & Cytron, 2012). This characteristic can be accomplished by incorporating accuracy and verifiability. Currently, many counties require that voters vote in their own precinct so that they can sign their name in the approved voter list. Some counties have implemented a database that tracks voters. A voter must be able to show proof of their identity; the database is then updated, which prevents that voter from going to another precinct and voting again.

- **Privacy**

"A system is private if neither election authorities nor anyone else can link any ballot to the voter who cast it and no voter can prove that he or she voted in a particular way." (Cranor & Cytron, 2012). Privacy is a concern to all users of a voting system. While it is important to have an audit trail available to verify the system, aggregate data should be accessible as opposed to an individual's vote. Some voters have problems using the voting machines, this requires that a staff volunteer assists

them and this can interfere with the privacy of the voter. "The second privacy factor is important for the prevention of vote buying and extortion. Voters can only sell their votes if they are able to prove to the buyer that they actually voted according to the buyer's wishes." (Cranor & Cytron, 2012).

- **Convenience**

"A system is convenient if it allows voters to cast their votes quickly, in one session, and with minimal equipment or special skills" (Cranor & Cytron, 2012). The introduction of touch screens into the voting process was first used to aid the disabled population. (Alan and John, 2005) This increased convenience of touch screens could lead to higher voter participation and decreased time at the polls. If the system utilizes technology that society is already comfortable using, voters will perceive the system to be more convenient.

- **Flexibility**

"A system is flexible if it allows a variety of ballot question formats, including open ended questions. Flexibility is important for write-in candidates and some survey questions." (Cranor & Cytron, 2012). It is probably less common now for voters to write in candidate choices; however, the system should be dynamic especially in our ever-changing fast-paced society. This means the system, if designed properly, could be used for not only national elections, but state and county elections as well. Additionally, the system should be able to accept more than one method of input to accommodate both voters at the polls and absentee ballots.

- **Mobility**

"A system is mobile if there are no restrictions (other than logistical ones) on the location from which a voter can cast a vote." (Cranor & Cytron, 2012). Mobility in the system could allow voters the capability of voting anywhere Internet access is available. This characteristic is better suited for an online e-voting system. However, the designs of the physical machines need to be small enough to accommodate various polling locations where space could be an issue. While usability is definitely a concern in looking at the list of system failures, Cranor and Cytron (2012) compare this characteristic to convenience. However, some of the underlying system problems affect characteristics that are not described by Cranor and Cytron. This author proposes the following three additional characteristics needed for a good e-voting system.

3. MATERIAL AND METHOD

Simple bit manipulation operations that allow the implementation of crossover, mutation and other operations of matching a vote for an aspirant and not allowing more than

one vote from each student to an aspirant was used to achieve the electronic voting system. Although a substantial amount of research has been performed on variable, length strings and other structures, the majority of work with genetic algorithms is focused on fixed-length character strings.

This electronic voting system is segmented into two environments the administrator environment and the voter's environment.

Administrator Environment: The administrator environment entails the following

3. Add a voter Detail
4. Add post
5. Add Contestant
6. View Result
7. List of Contestant
8. Voted User
9. Not Voted User
10. Registered Voter

- Add Voter Detail: This page allows the accredited voter details to be added to the database and this allows the registered user to be able to log in and vote in the voter's environment.
- Add Post: This allows the list of constitutionally backed up post of the organization, association or government parastatals that want to adopt the system to be added to the database.
- Add Contestant: It allows the list of contestant who has gotten the form and submitted to be added to the database with their details. This includes their pictures and nicknames together with the pot aspired for.
- View Result: Result of the election can be viewed and not able to be edited by the administrator to avoid biasness and all other forms of the problems which arise from the traditional voting system. The result is grouped in the order of the post displaying the score of each candidate immediately after their names.
- List of Contestant: This displays the list of previously added contestant with equivalent post applied for.
- Voted User: It displays the list of user who has voted in the on going voting exercise.
- Not Voted User: This displays the list of user who has not voted in the on going exercise
- All Voters: This displays the list of all registered voter for the election.

4. DISCUSSION OF RESULT

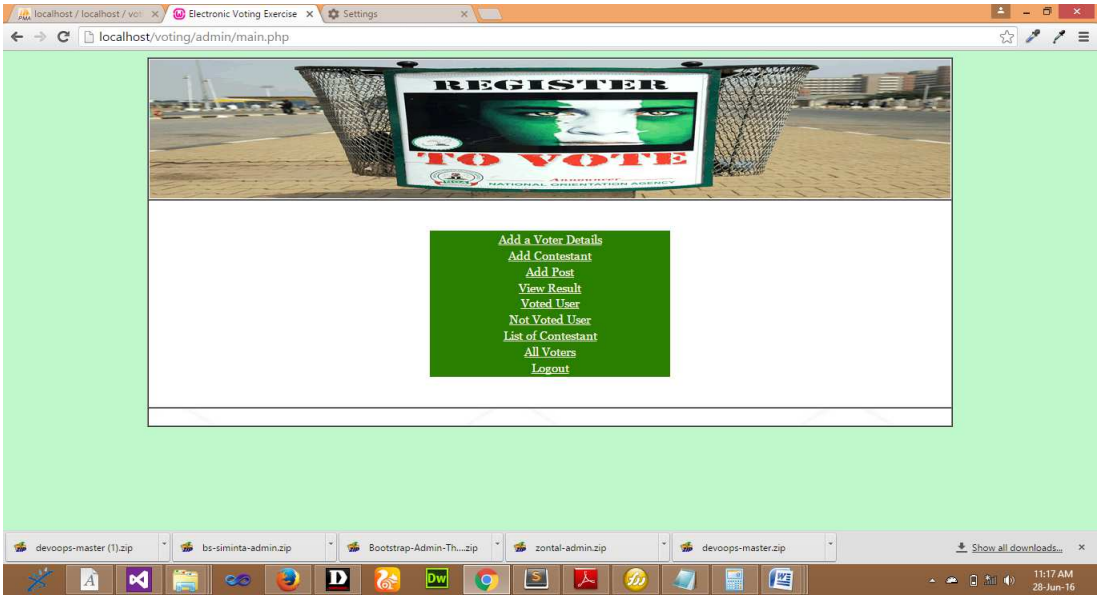


Figure 1: Main page:

Figure 1 display the Main Page of the Electronic voting system. This is the admin page which allow the admin to perform multiple functions such as add a voter details, add contestant, add post view result view user, not voted user, list of contestant, all voters and logout menu.

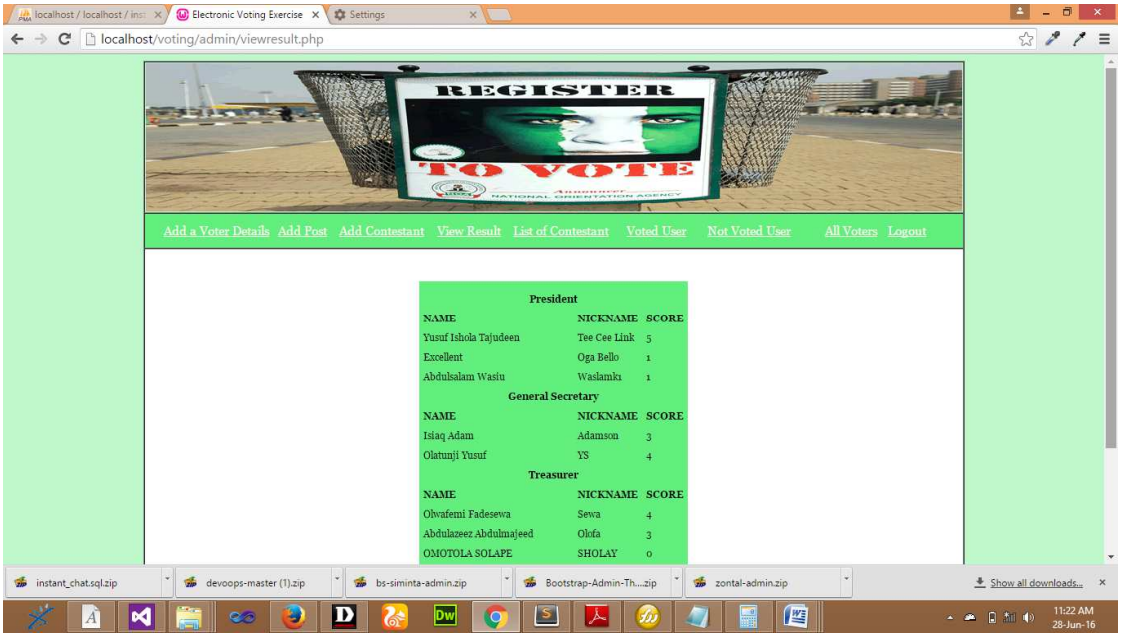


Figure 2: Election Result Page.

This page displayed the results of all the candidates and the post each candidate applied for. The figure 2 shows the winner of each post while displaying their name. This is real time counting as each voters is voting for the candidate they wish to vote for.

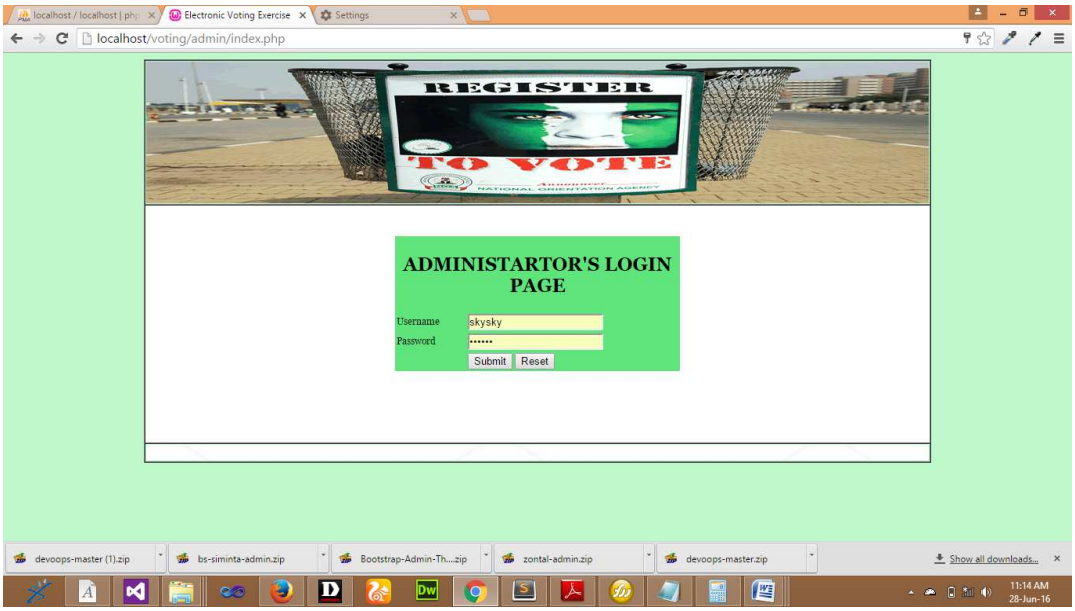


Figure 3: Administrator Login Page

Figure 3 displays the login page for the electoral administrator. This page can only be view by the electoral not the voters.

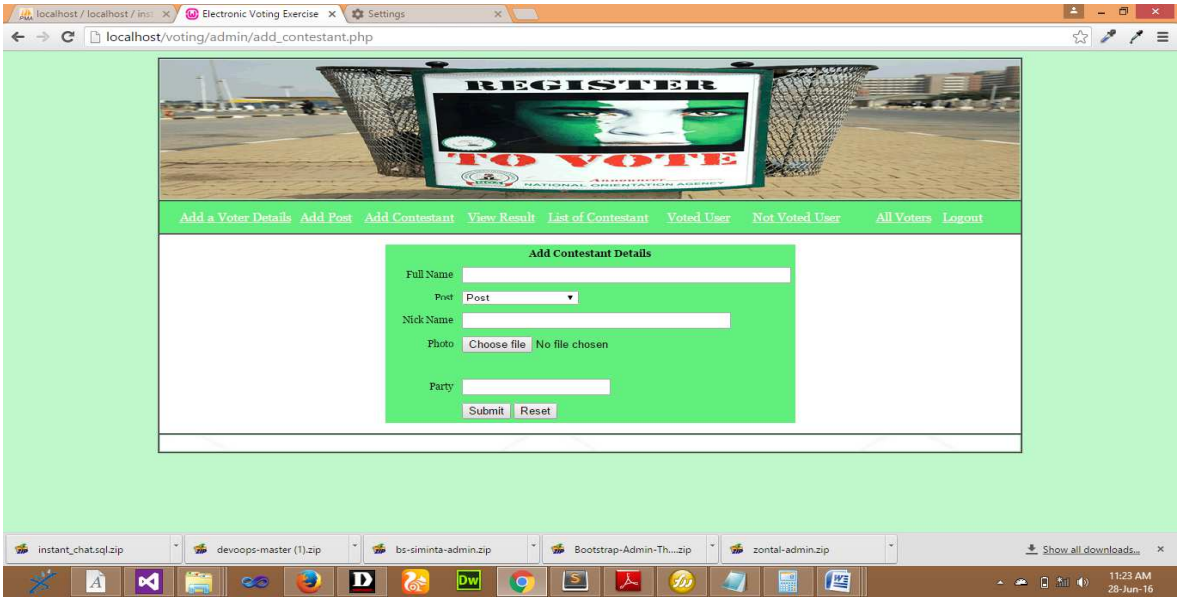


Figure 4: Add Contestant Details

Figure 4 displayed the fields where the electoral register each contestant with their post, political party and photography.

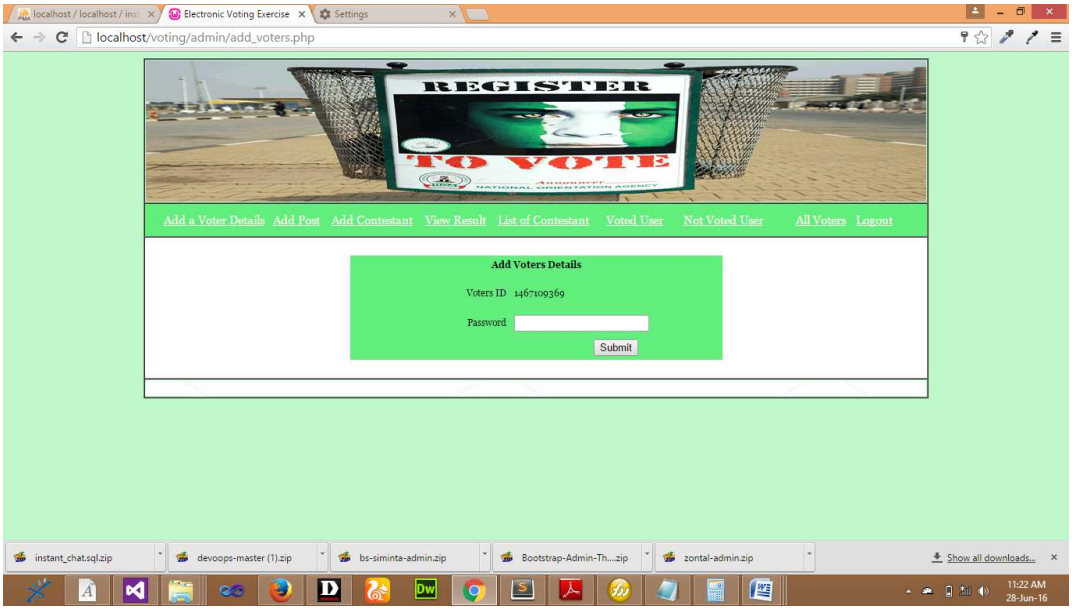


Figure 5: Add voters Page.

Figure 5 is a page where the electoral can add the voters details in order to authenticate such voters ID for voting process.

5. CONCLUSION AND RECOMMENDATION

Having gone through the rudiments of the paper and electronic voting system in Nigerian higher institutions; it can bevconcluded that the need for a electronic voting system in our higher institutions cannot be over emphasized. From the two systems discussed, the manual system has a lot of draw backs and can be easily manipulated by the electoral body. In view of this, the new system is hereby recommended to all private and government institutions in Nigeria in order to have transparent voting process at any level of the managements. This system can also be adopted for Independent National Electoral Commission for electing credible leaders, thereby reducing rigging of election.

REFERENCES

Abimbola J. O, and Adesote S. A. (2012). Political parties and the quest for good governance in Nigeria. In: Edo VO, Salami EF, editors. Issues and trends in Nigeria's development. A Festschrift for Rev. Fr. Abiodun, F Akinseye. Ibadan: John Asher Publishers; 2012;18:248–265.

Ademand, S. and Metin, Y. (2014). The future of Technologies and Electoral system. The electoral knowledge network. Encyclopedia.

Alan, D. S. and John, S. C., (2005)," Revolutionalising the Voting Process through Online Strategies, USA Journal on Online Voting Vol. 29, No.5, pp 513-530.

Caarls and Susanne (2010). E-voting Handbook: Key Steps for Introducing E-voting', Council of Europe, 2010.

Cranor L. F. and Cytron R. K., (2012), "Design and Implementation of a Practical SecurityConscious Electronic Polling System" ,Department of Computer Science, Washington University St. Louis, Technical Report, WUCS-96-02port.

Khasawneth, M., Malkawi, M., Al-Jarrah, O., Hayajneh, T.S., Ebaid, M. S. (2008). A biometric-secure evoting system for election processes. Proceeding of the 5th International Symposium on Mechatronics and its Applications.

Malkawi M., Khasawneh M., Al-Jarrah O., (2009), "Modeling and Simulation of a Robust Evoting System", Communications of the IBIMA, Volume 8, 2009. ISSN: 1943-7765.

Mitrou, L., Gritzalis, D., Katsikas, S., Quirchmayr, G. (2003) "Electronic Voting: Constitutional and Legal Requirements, and their Technical Implications" Secure Electronic Voting (Ed. Gritzalis, D.A.), pp. 43-60. Kluwer, Boston.

Rubin, A. (2002). Communications Policy and Information Technology: Promises, Problems, Prospects of Electronic voting system.

Salomonsen, S. (2015). Design and implementation of an electronic voting system with fingerprint authentication. Journal of computer science.

Sobia, B., Ummer I., Ayesha, K., Usman, I., and Hassan, J. (2013). Electronic Voting System Using Fingerprint Matching with Gabor Filter. Department of Electrical Engineering COMSATS Institute of Information Technology, Lahore.

Watt, B. (2002) "Implementing Electronic Voting" A report addressing the legal issues by the implementation of electronic voting, University of Essex.

Yekini, N.A., Oyeyinka I. K., Oludipe O.O., Lawal O.N (2012): Computer-Based Automated Voting Machine (AVM) for Elections in Nigeria. International Journal of Computer Science and Network Security, VOL.12 No.5, May 2012.

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CRYPTOGRAPHIC SYSTEM USING CAESAR CIPHER AND DNA SEQUENCES

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ABSTRACT

Data is any form of stored digital information. Security is all about the safeguarding of assets and belongings. Data or Information security encompasses protective digital privacy strategies that are applied to prevent unauthorized and unapproved access to classified data or information, databases, computing devices and websites. In order to solve this problem, a cryptographic system using Ceasar Cipher is implored. Cryptography is a method of creation of cipher text from information and DNA Sequences is uniquely generating secured keys based on DNA characteristics. The result of the proposed system is that data security issues will be resolved by enhancing the existing ceasar cipher algorithms with the Cryptography of Caesar Cipher and DNA Sequences. In the proposed algorithm, a method of generating keys to secure data with encryption and decryption methods are implemented. In the methodology a new generation key scheme based on DNA is proposed by using nucleotides and RNA present in a human being living cell. DNA consists of 2 types of purine and pyrimidine bases A, T, C and G. In conclusion the proposed system will provide high level security for data or information when compared to existing algorithms.

***Keyword**: Cipher, Caeser, DNA*

1. Introduction

The practice of keeping one's property out of the reach of intruders who prey on people's properties illegally is as old as man himself, when this property is In form of data or information it is called information security (Rhodes-Quisley, 2013). Information security encapsulates and provides services such as confidentiality, data integrity authentication and non-repudiation (Rhodes-Quisley, 2013).Henk and Van (2000) opined that "The protection of sensitive information against unauthorized access or fraudulent changes has been of prime concern throughout the countries". One of the oldest methods of securing data is the use of cryptography (Rhodes-Quisley, 2013).

Cryptography can be traced from its initial and limited use by the Egyptians some 4000 years ago, to the twentieth century, where it had played a very critical role in the outcomes of both world war one and two (Khan, 1973). Cryptography protects users by allowing functionality for the encryption of data and authentication of several users (Sarita, 2017). Cryptography in data security offers three essence areas that protect data from attempt break-ins, theft or an unauthorized use of stored data and possible fraudulent activity. Cryptography protects these extremely important areas, authentication, integrity, and confidentiality (Sujit, 2007). With

the advent of computers and with the vast amount of information being shared on the internet, there has been a need to create better, more efficient encryption strategies to protect private information, such as credit card numbers and private communications (Kahate.2009). One of the earliest known cryptographic systems was first used by Julius Ceaser around 50 BC.

Caesar cipher happens to be the weakest method of cryptography that could be quite easily decoded by hacker because of its simplicity and size of encryption (Michael,, 2017).The Caesar cipher is also known as shift cipher, Caesar's cipher or Caesar shift. It uses a substitution approach to generate or derive the encrypted text (Kahate, 2013).According to Lucklano and Pricbbert, (1987) this Cipher works by shifting the alphabet three places to the right and wrapping the last three letters X,Y,Z back unto the first three letters thus, the alphabets and their corresponding cipher encrypted plain text:

A.B.C.D.E.F.G.H.I.J.K.L.M.N.O.P.Q.R.S.T.U.V.W.X.Y.Z
D E F G H I J K L M N O P Q R S T U V W X Y Z A B C

However Ceaser Cipher can be further enhanced with DNA sequences to further strengthen data or information security, it is an exceedingly long chain of molecules which contains all the details essential for the everyday living functions of a cell. The individual molecules which make up DNA are called nucleotides. There are only four nucleotides that are ever used; these are Adenine (A), Thymidine (T), Guanine (G), and Cytosine (C). A strand of DNA is much like an extremely long sentence that uses only four letters. DNA actually has two strands much like a zipper and the nucleotides are like the teeth of that zipper. This two-strand system is the key to how DNA is able to make copies of itself. This could certainly occur considering the fact that one strand is 'complementary' to another strand. A continuously matches up with T and G constantly matches up with C. For the reason that they pair up, they are called "base pairs ().The work by (Monica & Olga ,2010) has as main purpose to assist in the understanding of principles and some techniques of the new innovative born field of DNA steganography and cryptography.From studies, most approaches based on Ceaser Cipher are either single shift or double shifts (Abdulkareem & Imran, 2014), But the problem of easy decryption still lingers. Enhanced approaches are needed to better secure data by doing multiple shifting and transformation of Cipher text using another Cryptographic mechanism (Balogunn, Mojeed, Sadiku & Raifu, 2018).

2.LITERATURE REVIEW

Cryptography is defined as “the science or study of the techniques of secret writing such as code and cipher systems, methods e.t.c.” Cryptography is needed so that text can be kept secret. It is easy to imagine situations in ancient times where a writer who sent a message via courier would want to make sure that if the runner were intercepted, the interceptors could not read the message. Cryptography has been important throughout history particularly in times of war when a general would not want the enemy to figure out the plans he was distributing among his troops. Recently, the uses of cryptography have grown drastically. Cryptography is still important in times of war, but with the advent of computers and the vast amount of information being shared on the internet, there has been a need to create better, more efficient encryption strategies to protect private information, such as credit card numbers and private communications (Kahate.2013).

Caesar cipher happens to be the weakest method of cryptography that could be quite easily decoded by hacker because of its simple style and mode of its encryption and decryption (Michael, 2017).The Caesar cipher is also known as shift cipher, Caesar's cipher or Caesar shift. It uses a substitution approach to derive the encrypted text.(Kahate, 2013).

Consider an Example,

Plain text: ZYXWVUTSRQPONMLKJIHGFEDCBA

Cipher text: WVUTSRQPONMLKJIHGFEDCBAZYX

When encrypting, an individual looks up each letter of the text message in the "plain text" and writes down the corresponding letter in the "cipher text". Deciphering is done in exactly reverse manner, with a right shift of 3. This could also be represented using modular arithmetic by transforming the letters into numbers, as per the scheme,

a→0, b→1, c→2 … x→23, y→24, z→25.

Encryption is done using the expression: Dn (x) = (x + n) mod 26. Decryption is performed by using the expression Dn (x) = (x – n) mod 26 which is an inverse form of the expression. The replacement is done for each alphaet, thus Caesar cipher is classified as mono alphabetic substitution (Stallings, W. 2006). The major drawbacks of Caesar cipher is that it can easily be broken, even in cipher-text only scenario. Various methods have been detected which crack the cipher text using frequency analysis and pattern words. One of the approaches is using brute force to match the frequency distribution of letters. This is possible because there are only limited numbers of possible shifts; 26 in English.(Singh et al., 2012). Additionally, the techniques of DNA sequence can be used to enhance Caesar Cipher algorithm for a stronger encryption and make it more difficult to decrypt.

2.1 Ceaser Cipher

Caesar cipher is a simple encryption method that was used because it is straightforward to compute but used less frequently due to its lack of robustness. Straightforwardness in implementation but difficulties in intercepting is the creativity of the presented encryption technique (Sabrina et al., 2017). During the research, successful wireless secured data transmission was conveyed using LASER, within 1 meter range because of low power of laser transmitter. The distance was determined by the beam focusing capacity, optical transmission power, and use of optical amplifier etc. By introducing these or ensuring light coupling to fiber network, long distance secured optical communication can easily be achievable. It was discovered that only specified receiver after knowing the security parameters can easily intercept the message due to the symmetric nature of the proposed algorithm.

The work by Monica and Olga, (2010) assist in the understanding of principles and some techniques of DNA steganography and cryptography. The presentation was illustrated with small examples using bioinformatics toolbox for parts of the algorithm not requiring DNA laboratory experiments, very expansive at this moment. Taking into account the huge advance in DNA technology, especially in microarray, the today bio-processor, obeying Moore’s law and the expectation of a faster repetition of microprocessor evolution at a larger scale. The presented algorithms and simulations are developed by the authors and represent results of the ongoing research in the field. Features and advantages of the DNA

cryptography are pointed out along the presentation and the algorithm using chromosome indexing, which is not properly a DNA cryptographic algorithm, it will be using the huge potential of randomness that DNA offers. Taking into account the frontier application, requiring backgrounds from cryptography, steganography, molecular biology and bioinformatics, basic elements of these domains will be presented.

Purnama and Rohayani (2015) also performed a modification whereby the algorithm is designed such that the cipher text formed will be legible but not readable or decipherable. The authors carried out this enhancement to overcome the problem of illegibility of cipher text obtained from majority of modifications in the past.

Imran and Abdulkareem (2014) proposed an enhancement method for Caesar cipher which uses modulo 26, has a fixed key and scrambles its characters for difficult cryptanalysis purpose. Also, the key formulation is based on various methods such as the address of the message, the length of the first word, and the number of words in the first line.

Omolara *et al*., (2014) proposed a modified hybrid of Caesar cipher and Vigenere cipher to amplify the diffusion and confusion characteristics of cipher text by making use of techniques from modern ciphers like xoring key to the first letter of plain text, xoring first letter of the plain text to second letter and so on. The limitation of the research work was that it used less key values for shifting in Caesar Cipher algorithm.

Disina, Abdulkadir and Hassan (2014) proposed a method of encryption that depends on the position of the bit in the message. The sender will transpose the bits in the message by shifting the characters in the odd position to the left and characters in the even position to the right side. The research work did not use large key shifting in the algorithm for proper enhancement of data security algorithm.

Goyal *et al*., (2013) proposed a modification to the traditional Caesar cipher where he keeps the key size fixed as one. While substitution he checks the index of alphabet, if the index is even then he increases the key value by one else if the index is odd then he decreases the key value by one. The weakness of the method was that it used less key values for shifting in Caesar Cipher algorithm.

Atish *et al*., (2015) improved Caesar algorithm to conquer some of the drawbacks and downsides of Caesar cipher. The proposed algorithm works by using a randomized method for substitution which is then combined with double columnar transposition technique to maximize the strength. On carrying out cryptanalysis on the modified algorithm, it found it difficult to break it by usig frequency analysis. It is practically difficult to decode the algorithm by brute force approach since the attacker would have to try a total of key length raised to 256 different combinations of keys. Security provided by the algorithm was limited by using an encryption algorithm and by using symmetric key approach instead of asymmetric key.

Singh *et al*. (2012) proposed an approach that makes use of Caesar cipher substitution and Rail fence transposition techniques on an individual basis, cipher text obtained by both the

methods is not difficult to crack. The research work present a concept of combining techniques substitution and transposition. Combining classical Caesar cipher with Rail fence technique can eradicate their fundamental weakness which enables them to produce a cipher text that is difficult to decode.

Srikantaswamy and Phaneendra (2012) proposed a procedure to improve Caesar cipher with random number generation method for key generation methods. The authors tinclude classical cipher with modern cipher properties, encryption is done using columnar transposition with arbitrary random order column selection. Hence the proposed approach is a mixed method of classical and modern cipher properties. Their proposed procedure provides enhanced Security with high throughput and occupies minimum memory space. The method is secured against brute-force attack with 93! Combination of keys for Caesar.

3. METHODOLOGY

To encrypt a text proposed algorithm requires Text and encryption key. The encryption key is an integer value and it determines alphabet to be used for substitution. It is based on modulus of equivalent number of alphabet of the four languages arithmetically to ensure that integer value wraps round in case encryption key supplied is more than number of alphabet. Decryption follows reverse operations per Formed during the process of encryption. It requires decryption key, and encrypted text. The decryption key should be complement to the encryption key so that reverse character substitution can be achieved. As stated earlier, Caesar cipher simply shifts encrypted character by number of positions. In this work we will use cipher text from Caesar cipher as an input in bioinformatics algorithm .Decryption and encryption bio-informatics techniques are implemented based on DNA properties like replication, mRNA, translation and transcription. A new generation key scheme based on DNA is proposed. By using nucleotides and RNA present in a human being living cell. DNA consists of 2 types of purine and pyrimidine bases A, T, C and G. (Chang et al., 2007).

Furthermore, the characters of the encrypted text are scrambled in such a way that if an attempt is made to decrypt the cipher text it would not be easy or impossible to decrypt the cipher text.

4. EXPECTED CONTRIBUTION TO KNOWLEDGE

This proposed research work will contribute to enhancement of existing Caesar Cipher cryptography algorithm by integrating it with DNA sequences technique to further strengthen data security.

5. DISCUSSION

From some of the literature review on the proposed work DNA has been found suitable for encryption because of the following shortcomings In the papers reviewed:

The work by Omolara *et al*., (2014) proposed a modified hybrid of Caesar cipher and Vigenere cipher to amplify the diffusion and confusion characteristics of cipher text by making use of techniques from modern ciphers. The limitation of the research work was that it used less key values for shifting in Caesar Cipher algorithm.

The work by Disina, Abdulkadir and Hassan (2014) proposed a method of encryption that depends on the position of the bit in the message however the research work did not use large key shifting in the algorithm for proper enhancement of data security algorithm.

The work by Goyal *et al* (2013) proposed a modification to the traditional Caesar cipher where he keeps the key size fixed as one. The weakness of the research work was that it used less key values for shifting in Caesar Cipher algorithm.

The work by Atish *et al*., (2015) improved Caesar algorithm to conquer some of the drawbacks and downsides of Caesar cipher. The proposed algorithm works by using a randomized method for substitution which is then combined with double columnar transposition technique to maximize the strength. Security provided by the algorithm is limited by using an encryption algorithm and by using symmetric key approach instead of asymmetric key.

The work by Singh *et al*. (2012) proposed an approach that makes use of Caesar cipher substitution and Rail fence transposition techniques on an individual basis, cipher text obtained by both the methods is not difficult to crack.

The inclusion of DNA for the proposed algorithm will help to eliminate the above shortcomings and enhance the existing Ceasar Cipher algorithms.

6. CONCLUSION

Data Security has become a primary concern in order to provide better security of important information in a hostile environment. In this paper, the proposed algorithm focuses on encryption of plain text. The proposed algorithm has attempted to remedy observed shortcomings and limitations In the research work carried out by the following researchers on the existing Ceasar Cipher Cryptographic systems. The work by Omolara *et al*., (2014) proposed a modified hybrid of Caesar cipher and Vigenere cipher to amplify the diffusion and confusion characteristics of cipher text by making use of techniques from modern ciphers, The work by Disina, Abdulkadir and Hassan (2014) proposed a method of encryption that depends on the position of the bit in the message, The work by Goyal *et al* (2013) proposed a modification to the traditional Caesar cipher where he keeps the key size fixed as one and others.The proposed algorithm is better than AES and DES because it make use of large key values for shifting in Caesar Cipher algorithm and DNA sequencing uses uniqueness of DNA characteristics. Each DNA consists of 3 Billion keys for small information of binary data. It will be able to provides stronger protection against the various intruder's attacks like cipher text only, chosen cipher text etc.

REFERENCES

Atish, J, Ronak, Dedhia., & Abhijit, Patil.(2015). Enhancing the security of caesar cipher substitution method using a randomized approach for more secure communication

Abbdulkareem, F.A. & Imran, E.I. (2014). Enhancement of caesar cipher for better security. *iosr journal of computer engineering* 16(3), 1-5.

Balogun, A.O., Majeed, H.A, Sadiku. P.O. and Raifu, H.A. (2018). Enhancement of caesar cipher for improved security using multiple encryption system: abacus – in press.

Checkland, P., and S. Holwell. 1998. Action research: its nature and validity. systemic practice and action research 11, no. 1: 9-21.

Chatterjee, Nath, Dasgupta & Nath (2011) A New symmetric key cryptography algorithm using extended msa method: djsa symmetric key algorithm, 2011 international conference on communication systems and network technologies, pp 89-94, June 2m011.

Disina, Abdulkadir. & Hassan. (Eds.). (2014). "Robust caesar cipher against frequency cryptanalysis using bi-directional shifting." diss. universiti tun hussein onn malaysia, 2014.

Goyal, Kashish, & Supriya Kinger (2013). "Modified Caesar Cipher for Better Security Enhancement." International Journal of Computer Applications (0975–8887) Volume (2013).

Henk, C.A & Van, T. (2000)Fudamentals of cryptology *a professionnal reference and interactive tutorial* boston /dordrecht/london: KLUWER ACADEMIC PULISHER Retrieved from https://www.hyperelliptic.org.lanjia/techinng/crpto113/crptodiet.pdf

Khan, D, (1973).The codereakers: *The story of secret writing* (aridged ed.). new york: the macmillan companny. retrieved from http://mindgurunndia.com/wp-contentuploads//2014/06/MP069-TheCodeBreakers.pdf

Kahate, A, (2013). Cryptography and network security (third edition).india: the tata mcgraw-hill education pm, ltd. retrieved from https://abcooks.com

Lucianno, D. & Prichett, G. (1987). Crptography: from caesar ciphers to public-key cryptosystems. the college mathematics journal, 18, 2-17. doi:10,1,1,110, 6123&rep=rep1&type==pdf.

Michael E. Whitman (2010). Security policies management of information security third ed.

Michael E. Whitman (2017) Security policies management of information security third ed. by: michael e. whitman computer ethics & professional responsibility

Monica .B and Olga .T (2010) DNA secret writing techniques .conference: conference: communications (comm), 2010 8th international conference on nov 28 2017.

6/vyMs. Hemlata Sharma,Ms. MithleshArya, Mr. Dinesh Goyal (2013). Secure Image Hiding Algorithm using Cryptography and Steganography

M. E. Borda, O. Tornea, T. Hodorogea, M. Vaida,2010 "Encryption system with indexing dna chromosomes cryptographic algorithm ", iasted proceedings, pp. 12 – 15, 2010.

Omolara, O. E., A. I. Oludare, and S. E. Abdulahi. (2014): "Developing a modified hybrid caesar cipher and vigenere cipher for secure data communication." *computer engineering and intelligent systems 5.5 (2014): 34-46.*

Rhsoles- Quley, m, (2013). *Information security: a complete reference melirar-hill company.*

*Sri*kantaswamy and Phaneendra (2012), Improved caesar cipher with random number generation technique and multistage encryption, international journal on cryptography and information security (ijcis). Vol. 2, No.4. pp. 39-49, December 2012.

Stallins, W, (2005). *Crotography and network security principles and practices* (4th ed.). united states of america: prentice hall, retrieved from https://ovals.files. workpress.com/2013/03/cryptography-and-nnnetwork-security-principles-and-practices-4th-ed-william-stallinnngs.pdf

Singh, Ajit, Aarti Nandal, & Swati Malik. (2012).. "Implementation of caesar cipher with rail fence for enhancing data security." *international journal of advanced research in computer science and software engineering* 2.12

Sujit, Prakash, Gujar,Sabrina, Abedin, Tasfia,..Avijit, (2017). Optical wireless data transmission with enhanced substitution caesar cipher wheel encryption. *international conference on cryptography: an art and science september* 15, 2007.

Sarita K, (2017). A research paper on cryptography encryption and compression techniques. *international journal of engineering and computer science* issn: 2319-7242 volume 6 issue 4 april 2017, page no. 20915-20919 index copernicus value (2015): 58.10 doi: 10.18535/ijecs/v6i4.20

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EFFECT OF REPETITIVE SEARCH ON BINARY AND LINEAR SEARCH ALGORITHMS

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ABSTRACT

The binary search algorithm is one of the popular search methods for pragmatic purposes. Its efficiency is derived from its technique of 'divide and conquer'. That is its ability to split a search into two and pick only one side for further searching. The linear search on the other hand has to go through the entire search to conclude a search. The general view therefore, is that, the binary search is more efficient than the linear search especially when dealing with large data set. This assertion has however been challenged by some researchers based on the fact that the efficiency implicit in the binary search assumes that the items to be searched have been sorted, which may not be true in all cases. Their study shows that when sorting time is added, the linear search proves to be more efficient than the binary search. This conclusion however, could also be said to be hasty as it did not take into cognisance the variations in the number of times a search is to be conducted on a specific data set. This research therefore examines the efficiency of the two search methods; the linear and binary with sorting time added, when a search is gradually increased from the very 1st to the 100,000th search. The result shows that despite the argument that the linear search is more efficient than the binary search when sorting time is considered, the binary search may eventually recover to prove itself as the more efficient method when a search is conducted multiple times on the same data set.

Keywords: *Linear Search, Binary Search, Sorting, Data.*

1. Introduction

Many of the tasks of computer science in general, and artificial intelligence in particular can be phrased in terms of a search for the solution to the problem at hand. Indeed, basic search techniques provide the key to many historically important accomplishments in the area of artificial intelligence.

Firebaugh (1987), an important property of most of the significant search problems studied in artificial intelligence is that they suffer from combinatorial explosion. That is, the number of states which must be searched generally grows very rapidly with the size and complexity of the system studied. Various strategies for effective search have emerged; some of them are;

i. Binary search
ii. Breadth – First Search
iii. Depth – First Search
iv. Hill – Climbing heuristic
v. Best – First heuristic

vi. Linear Search

In this study the binary and linear search techniques are considered. These two techniques belong to the class of fundamental algorithms in data structures. But these search algorithms as with others are not without their shortcomings. The binary search algorithm which is believed to be a very efficient algorithm requires that the array elements be sorted using any of the sorting algorithms. Writing code for binary search also requires care to ensure that all the special cases are accurately implemented. If there is an error in the code used for the implementation of binary search algorithm, then the search itself becomes ineffective.

The linear search on the other hand, neither requires a sorted data to operate nor any special care to write its codes as they are straight forward and relatively simple, but that is not to say it is without its own disadvantages (Trims, 2013); it is inefficient when the array being searched contains large number of elements. The algorithm will have to look through all the elements in order to find a value in the last element. The average probability of finding an item at the beginning of the array is almost the same as finding it at the end.

2. Literature Review

Searching is a process whereby huge amounts of data kept on the computer system are retrieved according to some search criterion. Thus, the proper storage of data to enable fast searching is an essential issue in data processing. A search typically answers either true or false as to whether the item is present. On occasion it may be modified to return where the item is found (Brad and David, 2014).

The difference between a fast program and a slow one is the use of a good algorithm for the data set (Prelude, 2011). Any imperfections in search algorithms would undoubtedly affect most if not all computer users as users are likely to engage in search activities at one time or the other while using the system. There is therefore a need to know which search techniques should or should not be used in data processing to minimize the effects of their shortcomings on the output.

Brian, (2017) tried to display the advantages of binary search over linear search. He noted that the more the elements present in the search array, the faster a binary search will be (on average) compared to a linear search. The downside, he continued, is that binary search only operates on a sorted array, which means the data must be pre-sorted using some means. However, some other factors such as the data size can determine the choice of the search technique used (Dalal, 2004).

Furthermore, John Morris, (1998) affirmed that the binary and linear search algorithms as with others are not without their shortcomings. The binary search algorithm which is believed to be a very efficient algorithm (Shield, 1983) requires that the array elements be sorted using any of the sorting algorithms. Its efficiency therefore depends on the sorting algorithm used. This is not the case with the linear search, but it also has its own shortcomings. The algorithm will have to look through all the elements in order to find a value in the last element. The average probability of finding an item at the beginning of the array is almost the same as finding it at the end. (Thomas and Devin, 2017).

Nell, Daniel and Chip,(2016), tried to improve on the performance of the linear search by stopping a search when an element larger than the target element is encountered, but this is based on the condition that the elements in the array be sorted in ascending order. The

disadvantage of this method is that, it is also dependent on sorting just like in the binary search. Its efficiency would be dependent on the sorting algorithm used for its implementation.

2. 1 Research Motivation and Methodology

Asagba, Osaghae and Ogheneovo (2010) conducted an experiment, whereby the time complexity of the bubble sort was added to that of the binary search. They made a comparison of the execution time of finding an integer in an array of integers using linear and binary search algorithms. They concluded in their report that if the sorting complexity is added to that of the binary search, then the binary search cannot be said to be more efficient in terms of time complexity. They judged that the research works in existence came to a hasty conclusion by stating that the binary search is more efficient without considering the time complexity of the sorting method used in the execution of the search algorithm.

Balogun B.G. and Sadiku J.S. (2013) took the research further by considering three sorting techniques; namely: bubble sort, insertion sort and quick sort in the implementation of binary search technique. The three sorting methods were applied one at a time on various sets of data before applying binary search technique.

The system clock was set to know the duration of time taken by the following computations.

BinBS	=	Bubble sort based binary search
BinQS	=	Quick sort based binary search
BinIS	=	Insertion sort based binary search
BS	=	Binary search only
Lin	=	Linear search only

The authors demonstrated that the subsisting assertion that quick sort is superior to both the bubble sort and insertion sort, stands. They also noted that the insertion sort is more efficient than bubble sort. However, irrespective of the efficiency of one sort method over the other, the authors concluded that linear search may be preferred if the data items to be searched have not been sorted. They believe that the efficiency implicit in the binary search assumes that the items to be searched have been sorted which may not be true in all cases. Finally, they recommended that if there is need to sort data before being searched, then both bubble sort and insertion sort methods should be used for small data sets while quick sort should be used otherwise

What these authors did not consider however, is that, when a particular data set is to be searched repeatedly, these assertions may be challenged as a specific data needs not be sorted more than once to carry out as many search incidents on it as possible. This study therefore investigates the average sorting time 'AQS' added to a search from the very first search to the 100, 000th search to identify the impact of sorting time on their efficiency.

Take the example of Table 1.0 below extracted from Balogun and Sadiku (2013), the time efficiency of the linear search far outperforms that of the binary based quicksort method. This research however investigates whether the efficiency implicit in the linear search is maintained when a search is conducted multiple times on the specific data set of 100,000.

Table 1.0 Time Spent in Millisecond for the Execution of 100,000 to 400,000 Data Set

|--Return only Qick with Binary Search, Binary Search Only and Linear Search--|

Set (D)	BinQS	BS	Lin
100000	819.4682	0.0032	1.67
200000	1637.5814	0.0032	2.3353
300000	2477.2522	0.0057	3.5299
400000	3267.3536	0.0032	4.6533

3. *Result and Analysis*

3.1 Result

i. BinQS = Quick sort based binary search
ii. BinAQS = Average Quick sort based binary search
iii. BS = Binary search only
iv. Lin = Linear search only
v. AQS = Average Quick sort

For Data Set D=100,000; BinQS= 819.4682

Table 2.0 : Average Time used with Repeated Binary and Linear Search on the 100,000 Data Set (D)

No of searches(N)	BinAQS	BS	AQS	Lin
1st search	819.4682	0.0032	819.4650	1.67
2nd search	409.7357	0.0032	409.7325	1.67

3rd search	273.1582	0.0032	273.1550	1.67
4th search	204.8695	0.0032	204.8663	1.67
5th search	163.8962	0.0032	163.893	1.67
6th search	136.5807	0.0032	136.5775	1.67
7th search	117.0696	0.0032	117.0664	1.67
8th search	102.4363	0.0032	102.4331	1.67
9th search	91.0549	0.0032	91.0517	1.67
10th search	81.9497	0.0032	81.9465	1.67
1000th search	0.8227	0.0032	0.8195	1.67
100,000th search	0.0114	0.0032	0.008195	1.67

Table 3.0 : Time Efficiency of the Search Algorithms after the First Search

1st Search			
BinAQS	BS	Lin	
81946.82	0.32	167	X1 0^{-2}

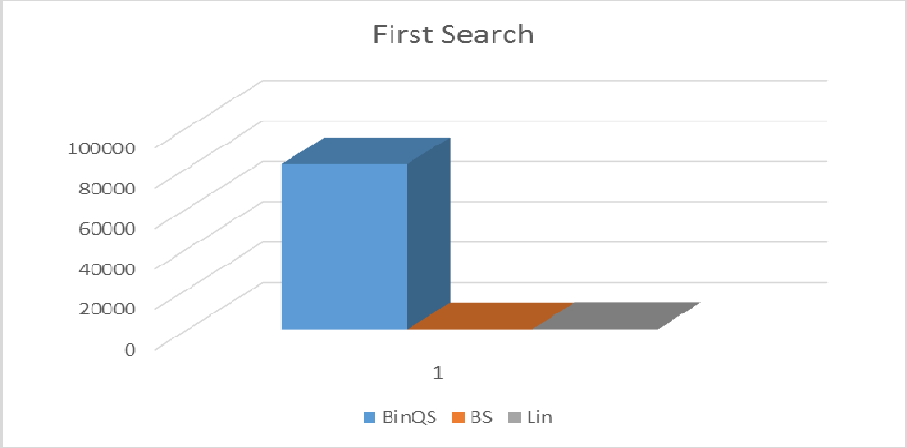


Figure 1 : Pictorial Analysis of the Search Algorithms after the First Search

Table 4.0 : Time Efficiency of the Search Algorithms after the 10,000th Search

10,000th Search			
BinAQS	BS	Lin	
8227	32	16700	X1 0^{-4}

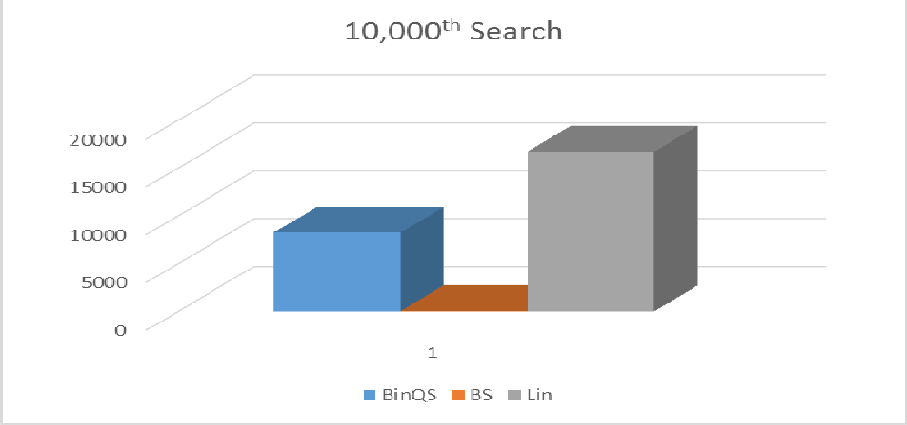


Figure 2 : Pictorial Analysis of the Search Algorithms after the 10,000th Search

Table 5.0 : Time Efficiency of the Search Algorithms after the 100,000th Search.

100,000th search			
BinAQS	BS	Lin	
114	32	16700	X1 0^{-4}

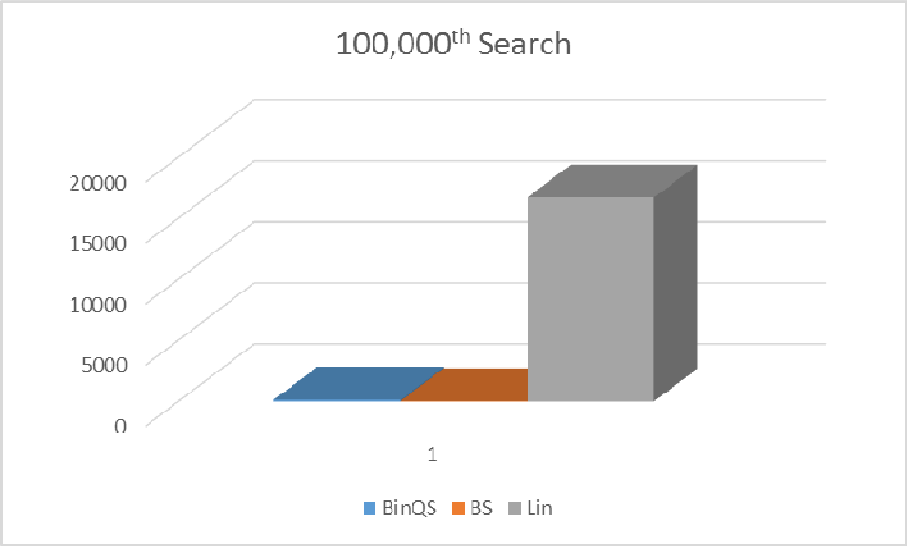


Figure 3 : Pictorial Analysis of the Search Algorithms after the 100,000th Search.

3.2 Analysis of Results

From the results obtained in Table 2.0 and Figures 1 to 3, it is observed that, as the number of repeated binary searches conducted on a specific data increases from the very first search to the 10th search, and then to the 1000th search and finally to the 100,000th, so does the impact of the sorting time on the total time efficiency of the binary search decrease from very strong to very weak so much so that it approaches zero. It can be concluded that, as the number N for searches tends to infinity, $N \rightarrow \infty$, so does the average time complexity AQS of the quicksort (or any other sort method) tend to zero $AQS \rightarrow 0$. In fact, by the 1000th search upwards to the 100,000th search in Table 2.0, the value of AQS drops dramatically, thereby making the binary search overthrow the linear search as the more efficient search algorithm. Based on this, it can be deduced that, the smaller the data set D, the larger the number of times the search N has to be repeated to make the binary search more efficient than the linear

search and vice versa. That is, D α 1/N**.** Conclusively, the type of search method that should be used is not only dependent on the size of data set D but also on the number of times the data D is to be searched; N.

4. Conclusion

There are many factors affecting the choice of search methods used in computer science. This choice is usually made based on the performance, efficiency or shortcomings of a search algorithm. Another major factor given consideration is the data size. However, this work has shown that not only is the efficiency of a search method important and not only is the size of data to be used important but the number of times a specific data set would be subjected to a particular search method is crucial in making a decision as to the type of search method to be adopted in a particular situation. The linear search may prove to be more efficient than the binary search when sorting time is added to the binary search, but the binary search would eventually recover to prove to be more efficient when the search is conducted multiple times on a specific data set.

REFERENCES

Asagba, P. O, Osaghae, E. O. and Ogheneovo, E. E.(2010). 'Is binary search technique faster than linear search technique?' Scientia Africana, Vol. 9 (2) December 2010. 83-92 , ISSN 1118-1931.

Balogun B.G and Sadiku J.S. (2013). Simulating Binary Search Technique Using Different Sorting Algorithms. International Journal Of Applied Science And Technology. Volume 3, No 6, pp. 67-75.August, 2013.

Brad, M. and David, R. (2014). Problem Solving with Algorithms and Data Structures. © Copyright 2014 Brad Miller, David Ranum.

Brian. F. (2016). Computer Programming, C Programming. What are the Advantages of binary search on linear search in c? Copyright © answers.com/Q.

Dalal. A.C. (2004). Searching and Sorting Algorithms. Supplementary Lecture Notes. Copyright © cs.carleton.edu/faculty.

Firebaugh, (1987). Artificial Intelligence. A knowledge – Based Approach. Boyd & Fraser Publishing Co, Boston.

John. M. (1998). Data Structures and Algorithms. Copyright © John Morris j.morris@auckland.ac.nz (1998).

Nell D, Daniel T., Chip (2016). Weems Object-Oriented Data Structures Using Java Copyright © Jones & Bartlett Learning.

Prelude, (2011). Linear Search, Binary Search and other Searching Techniques. Copyright © 1997-2011 Cprogramming.com. All rights reserved.

Shield. F (1983): Theory and Problems of Computers and Programming, Schaum's Outline Series.

Thomas. C and Devin. B (2017). Binary Search. Khan Academy computing curriculum team. Copyright © CC-BY-NC-SA.

Trims. (2014). What are advantages and disadvantages of linear search? Java Programming, C Programming. Eishet Eilon Industries.

http://www.answers.com/Q/What_are_advantages_and_disadvantages_of_linear_search.

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A SPATIOTEMPORAL DECISION SUPPORT SYSTEM FOR SOFTWARE COLLABORATION USING X-KRUSKAL ALGORITHM

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ABSTRACT

Recently, there has been a paradigm shift from a single site software development to a distributed software development due to the global demands for software products and services. The collaboration for knowledge sharing in a distributed software development should be enacted without spatial and temporal limitations. In this paper, a spatiotemporal decision support system using x-kruskal algorithm is proposed to combat the afore-mentioned challenges in distributed software development. The approach embedded a rating module and enhances the identification of relevant organisation or collaborators in a specialised area based on location, language and expert levels. The approach was evaluated using average final objective values, standard deviation and running time criteria on 500 and 1000 nodes respectively. The evaluation showed that the X-kruskal method produces quicker and superior results compared to the Prim-based and ordinary kruskal approaches. The runtime criteria is almost insignificant but the X-kruskal method still indicates a slight improvement over the other methods.

Keywords- *Spatiotemporal, Distributed Software, Minimum Spanning Tree, Weighted Score*

1. INTRODUCTION

Recently, there has been a paradigm shift from a single site software development to a distributed software development due to the global demands for software products and services (Espinosa *et al*., 2007; Herbsleb & Mockus, 2003; Wu *et al*., 2015; Jiang *et al*.,

2017; dos Santos & Nunes, 2017; Ferdous & Ikram, 2017). Moreso, software companies tends to outsource some of the activities of software development to companies renowned to be an expert in those activities for better efficiency. The concept of distributed software development has also been abetted by the continuous growth in Internet technology which often makes distances irrelevant, and has made remote collaboration possible (Sengupta *et al*., 2006). Distributed Software Development (DSD) permits team members involving different organisations to be geographically separated during the software development lifespan, thus creating a network of detached sub-teams (Sengupta *et al*., 2006, Steinmacher *et al*., 2013; Richardson *et al*., 2010). Single site software development are, therefore, no longer common, and collaboration between remote members needs intelligent technology to simplify team interaction and coordination (Sengupta *et al*., 2006; Li *et al*., 2017; Rajivan & Cooke, 2017; Kennedy *et al*., 2017; Finnerty *et al*., 2017).

However, team interaction and coordination cannot be accomplished simply by storing knowledge in the repository. It requires an intelligent mechanism which help organisations find the best collaborator(s) with relevant knowledge specifications. Collaborators can be any virtual users or organisation who interact to achieve set goals rooted in knowledge discovery and sharing (Hornett, 2004; Kane, 2017; Poppe *et al*., 2017; Han *et al*., 2017; Djordjevic & Dimitrakos, 2004). The collaboration for knowledge sharing should be enacted without spatial and temporal limitations. In addition it should take place over a medium such as the internet and therefore beyond the geographical limitations (Eng, 2004; Zhang *et al*., 2004; Melis, 2017; Soto-Acosta *et al*., 2017; Uden *et al*., 2017).

Due to the popularity of an open source and off-shoring development models, software development is one of the most distributed and knowledge intensive business, in which people with different backgrounds and expertise levels collaborate (Sengupta *et al*., 2006; . Šmite *et al*., 2017). Software companies increasingly chose to focus on expertise and outsourcing of some essential software development activities to firms specializing in those areas. This process of outsourcing has been aided by noteworthy technological advances; in particular, the explosive growth of the Internet, which often eliminate geographical boundaries. Moreso, outsourcing accrues further benefits - availability of a large pool of expert and trained labor, the possibility of a round-the clock development, and most notably, enormous savings that could be accumulated through low labor cost in developing countries (Sengupta *et al*., 2006; Ojala *et al*., 2017; Duc & Abrahamsson, 2017).

The apparent benefits notwithstanding, distributed software development is filled with challenges. Past literatures (Herbsleb & Moitra, 2001; Damian & Zowghi, 2003) has recognised a number of these challenges to be *inadequate communication* between team members separated by difference in distance and time zone. A well-coordinated communication enhances better understanding between team members. It has been asserted, however, that the frequency of communication generally declines with physical separation among collaborators (Herbsleb & Mockus, 2003; Allen, 1977) and in a distributed

environment such communication can be virtually non-existent. Additionally, time-zone differences degrade communication between team members, in many situations, considerably dropping the time-slot for effective concomitant communication between distant teams. Apart from physical separation, cultural differences (Krishna et al., 2004) across sites also impede easy communication. The primary spoken language may vary from one site to another, or a common spoken language may have subtle differences in meaning. Studies indicate that distributed teams that are culturally alienated may not be as unified as single site teams, and this may translate to less trust (Jarvenpaa et al., 1998), poor cooperation and finally, conflicts. These difficulties are mostly pronounced for those software development activities that are communication-intensive. Although, the challenges of distributed software development are not limited to inadequate informal communication, lack of trust and cultural differences but represent heavy penalty slowing down distributed work e.g. (Herbsleb & Mockus, 2003) reports that distributed work items take about two and one-half times as long to complete as related items where all the work is positioned close together. Hence, while it is healthy to argue that costs are saved in distributed software development, there are increased coordination costs involved leading to cost-benefit trade-offs. Cost-benefit trade-offs in distributed development have emerged as a topic of interest to both researchers and practitioners and ample studies have been published in this regard - studying coordination in distributed software teams (Carmel, 1999; Grinter *et al*., 1999; Espinosa *et al*., 2001) and geographically dispersed teams in general (McDonough et al., 2001; Kiesler & Cummings, 2002; Olson & Olson, 2001).

In this paper, a spatiotemporal decision support system using x-kruskal algorithm is proposed to combat the afore-mentioned challenges in distributed software development. The approach embedded a rating module and enhances the identification of relevant organisation or collaborators in a specialised area based on location, language and expert levels. Kruskal algorithm is chosen because researchers have recognised that a wider sense of collaborator network is a self-organised structure of people, information and communities (Toral *et al*., 2009; Kautz *et al*., 1997; Raghavan, 2002). A collaborator network represents a social network that can be modelled by a net structure consisting of nodes and edges. Nodes represent individuals or organisations. The edges connecting nodes are called ties, which represent the relationship between the individuals or organisations. The strength of a tie which can come in various kinds indicates how strong the relationship is between members in a distributed software development environment. Aside from the afore-mentioned challenges, the approach intend to also address difficulty in finding relevant knowledge and collaborators to interact with (Yang & Chen, 2008; Clauss & Kesting, 2017; Okere, 2017).

The rest of this paper is organized as follows: Section 2 presents related work. Methodology is presented in Section 3. The implementation procedure and evaluation of the proposed approach is well highlighted in Section 4. Section 5 presents the conclusion and future work.

2. Related Work

2.1 Distributed Software

It is apparent that distributed software development has some advantages over standalone software development, but not without some challenges. Past literatures (Herbsleb & Moitra, 2001; Damian & Zowghi, 2003; Šmite *et al*., 2017; Akgün *et al*., 2017; Storey *et al*., 2017; Alahyari *et al*., 2017; Aslam *et al*., 2017) has recognised a number of these problems with different viewpoints. In practical application, ample of the identified problems can be summarized as *inadequate communication* between team members constrained by spatiotemporal (distance and time) differences. It has been asserted, however, that the frequency of communication generally declines with physical separation among collaborators (Herbsleb & Mockus, 2003; Allen, 1977; Herbsleb & Mockus, 2003; Inayat *et al*., 2017; Šmite *et al*., 2017; Beecham *et al*., 2017; Zhang *et al*., 2017). Consequently, in distributed software, the likelihood of consistent and efficient interaction between team members are often not certain, causing misplaced interests and sometimes reappraisal (Heredia et al., 2017; Herbsleb & Moitra, 2001). Apart from geographical constrains, *cultural differences* (Krishna *et al*., 2004; Storey *et al*., 2017; Bhatti & Ahsan, 2017; Šmite *et al*., 2017; Beecham *et al*., 2017; Akgün *et al*., 2017; Zanatta, *et al*., 2017) across remote locations also obstruct easy communication. The major spoken language may vary across remote sites, or a common spoken language may have reserved variances in connotation. Moreover, two sites may also follow different corporate cultures (Heeks *et al.*, 2001). Scholars have indicated that distributed teams that are culturally alienated may not be as effective as standalone counterparts with issues such as trust (Jarvenpaa & Leidner, 1998), poor cooperation and eventually, conflicts. These complications are predominantly more pronounced for those software development projects that are driven by communication. For example, (Damian & Zowghi, 2003) reports on the undesirable influences of remote communication, cultural diversity and time differences on the requirements analysis phase of the software lifecycle. Although, the problems of distributed software engineering encompasses but not limited to inadequate communication, trust issues and cultural differences, there are strategic issues, relating to the coordination and distribution of work across remote sites; *process differences* that can lead to hitches in harmonization and system integration; *knowledge management* problem that inhibit real time knowledge sharing and reduce liberty for code reuse; and finally, *technical issue*s such as poor bandwidth, connectivity problems etc., that can slow down productivity of remote teams. Herbsleb & Mockus (2003), reports that distributed projects take about two and one-half times as long to complete as similar projects where all the work is assembled. In most cases, distributed development accounts for less production costs but increased coordination costs compared to development assembled in a concentrated environment. Distributed development in terms of its cost-benefit trade-off have generated heated research concern to both scholars and experts in the area of coordination in distributed software teams (Carmel, 1999; Grinter *et al*., 1999; Espinosa *et al*., 2001) and geographically

dispersed teams in general (Van den Bulte & Moenaert, 1998; Olson & Olson, 2000; McDonough *et al*., 2001; Kiesler & Cummings, 2002).

2.2 Graph Theory

Graphs in this paper are assumed to be undirected and without loops. In our approach, the nodes in a graph represent collaborators, and edges represent network connections. $N(v)$, shall denote the set of neighbors of collaborators, $v \in V$ and $\sigma(V)$ will denote the number of such neighbors.

Let $(i,j) \in E$ denotes each edge of collaborator network links representing the specifications of the connectivity between collaborators in the network. Moreso, let $w(i,j)$ represent the minimum weight function and $r(i,j)$, denotes the rating for $i,j \in V$. Considering each edge $(i,j) \in E$, there exist a weighted score $w \times r$ representing the minimum cost connecting collaborators meeting the required specifications in the network.

A path in graph G is a sequence of collaborators $v_{i1}, \ldots, v_{ij}$ where (v_{ik}, v_{ik+1}) is in E, for all $k \in \{1, \ldots j-1\}$. In a distributed software collaboration, we want to locate the path from a source of collaborator s to a set D of destination collaborators meeting the source requirements. The rating $r(P)$ of a path P represent the sum of the weighted score of the ratings of all edges (v_{ik}, v_{ik+1}) in P.

A path P between collaborators u and v is termed a minimum path if there exist no path P' in G such that $w(P') < w(P)$. The score $s(P)$ is defined as the ratings incurred by a destination collaborator based on the criteria specified by the source collaborator. It is denoted by (1).

$$s(P) = \arg min \sum_{i=1}^{k-1} w_i * (r_i) \qquad (1)$$

Kruskal algorithm

The Kruskal's algorithm (Kruskal, 1956) is an optimal minimum spanning tree which construct the edge of the smallest possible weight that connect any two node in the forest without any cycles. All the edges are first sorted according to their cost in a nondecreasing order. This means it finds a subset of the edges that forms a tree that includes every vertex, where the total weight of all the edges in the tree is minimized. This process continues and then terminated when the number of elements of the stack is (n-1), thus forming a minimum spanning tree. A stack is defined to store the set of edges which is part of a minimum spanning tree.

From the Minimum Spanning Tree shown in Figure 1, we can find the trajectory from node A to node B. As we can see from the Figure 2, there are more than one way of getting from node A to node B, which are distinguished by dash line.

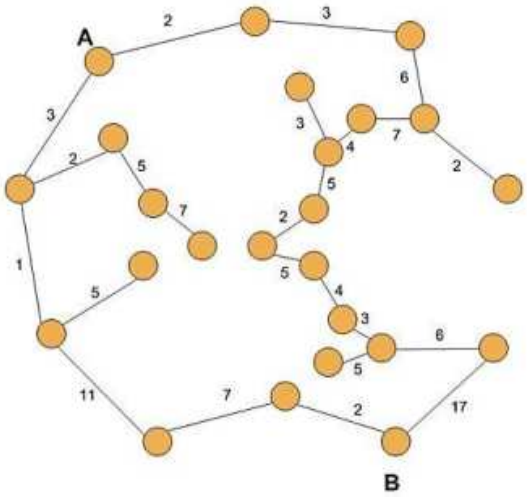


Figure 1. Minimum Spanning Tree (Likaj *et al*., 2013)

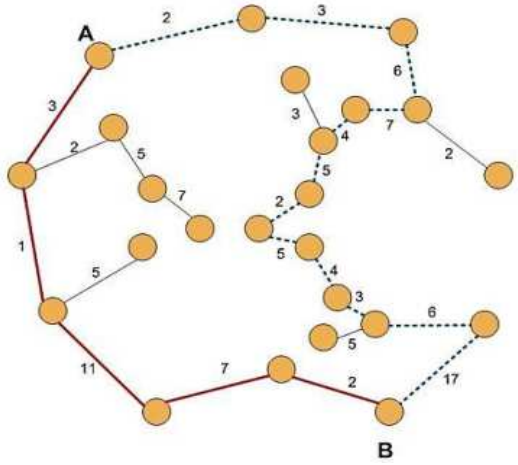


Figure 2. Minimum cost path (Likaj *et al*., 2013)

Dijkstra's algorithm

Dijkstra's algorithm (Dijkstra, 1959) is able to find the shortest distances from a node to all other nodes. Firstly, the algorithm start from a single node A, which is chosen as permanent node. Analysing the distances of the neighborhoods nodes of the node A, one can find the shortest path to node 2 (its distance is equal with 2). Afterwards node 2 is chosen as permanent node, and we have to check after the distances from node 2 to the neighbor nodes. To the each neighbor node is added the length of the permanent node.

Dijkstra's algorithm begins from minor tree consisting only of the source *s*. The algorithm iteratively adds the edge $e = (u, v)$ and the node v to T, where u and v are chosen to minimize cost as in (2).

$$Cost[u] + C(u, v) \ni u \in T, v \in V - T \qquad (2)$$

Let us illustrate Dijkstra's algorithm with Figure 3 and 4. A single node A representing the source is chosen at first as in Figure 3, then iteratively find the minimum distance from node A. Minimum distance is taken as permanent node at each iteration, since the 3+2 distance is smaller than 7 as in Figure 4, this translates that distance 7 will be discarded and distance 5 used instead.

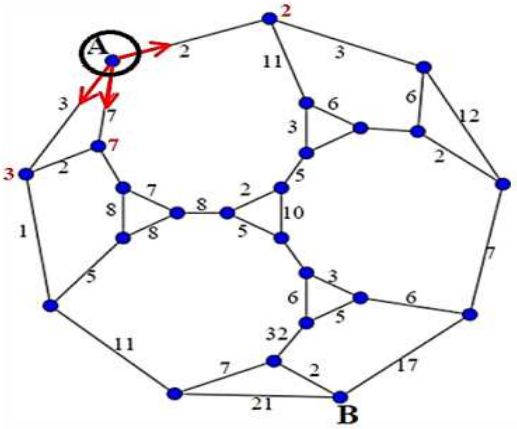


Figure 3. Minimum path (Likaj *et al*., 2013)

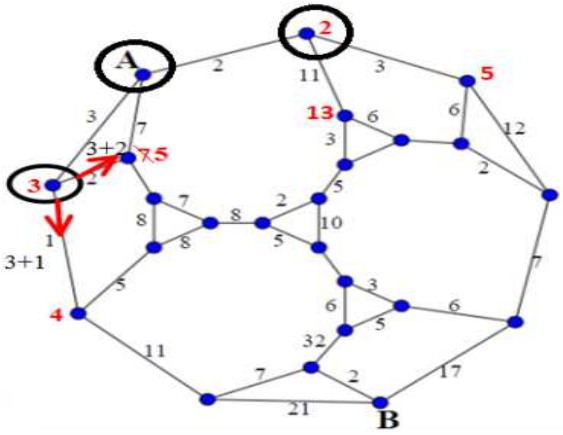


Figure 4. Minimum path (Likaj *et al*., 2013)

In (Kershenbaum & Van, 1972) the authors acknowledged that the criteria for choosing an algorithm is not limited to speed (Table 1) but also depends on some other vital criteria such as: storage requirements, form of input, availability of the algorithm and difficulty of implementation, the particular application and the number of problems to be solved. The best

algorithms relating to the best connection and choice of collaborators in a distributed software environment based on selected collaboration specifications is Kruskal's algorithm.

Table 1. Analysis of Prim's, Dijkstra's and Kruskal's algorithms (Aissa *et al*., 2009)

Algorithm	Program	Max Spanning Tree	Stored Elements	Added Elements	Time Complexity
Prim	Long and complicated	From a fixed source node to other nodes	Vertices	Leaves one at a time	$O(\|E\|\log\|V\|)$
Dijkstra	Long and complicated	From a fixed source node to other nodes	Vertices	Leaves one at a time	$O(\|E\|\log\|V\|)$
Kruskal	Short and simple	To any pair of source node and destination node	Edges	Two trees	$O(\|E\|\log\|E\|)$

Prim's algorithm

Prim's algorithm (Prim, 1957) starts firstly with a tree containing only of a source *s*. The algorithm iteratively increases the edge $e = (u, v)$ and the node v to T, where u and v are chosen to minimize capacity as in (3).

$$C[u] + C(u, v) \ni u \in T, v \in V - T \quad (3)$$

3. THE METHODOLOGY

In this paper, a spatiotemporal decision support system for software collaboration using a modified kruskal algorithm (x-kruskal) is proposed. The motivation for the use of kruskal

algorithm is based on the analysis results provided in Tables 1. Next we present our x-kruskal algorithm.

3.1 The proposed x-kruskal algorithm

We introduce rating module in the original kruskal algorithm which we called x-kruskal method. This greedy strategy combines the minimum cost and the rating score to determine the best collaborator in the network of collaborators. The embedded rating module works by assigning value 0 for expert level collaborator, 1 for beginner and 2 for intermediate. Figure 5 presents the proposed architecture for the x-kruskal method.

A. User

The user represent the software organisation seeking for collaborators in a distributed software development environment. The user select the specifications needed for potential collaborators through the GUI (Graphical User Interface). The user denote individual software organisation (C_k) in search of optimum collaboration.

B. GUI

The GUI is the interface through which the user interact with the decision support system. The GUI represent the front end application through which queries from the user are processed based on collaborator specifications using the x-kruskal algorithm and decisions from the system returned for reliable decision making.

C. X-kruskal algorithm

We introduce a rating module in the x-kruskal algorithm to improve the reliability of the decision from the system. From the network of collaborators in the database as in (4), the algorithm repeatedly sort all the edges connecting individual collaborators in a non-decreasing order of their weight. A rating is then provided by the system on the attributes presented by a collaborator in the database. This rating is then used as a weighted score (1) for the determination of the best solution when the algorithm terminate after forming a minimum spanning tree.

$$C_k = \{C_1, C_2, \ldots .., C_n\} \quad (4)$$

D. Database

Microsoft access was used for the database management which contains: registration table, programming language table and language level table for all collaborators. These database are linked together using organisation registration number as primary key, which serve as foreign key in the other two tables. The database and embedded rating module is illustrated in Figure 6. It depicts the system rating for each of the collaborators from the database based on their location, language and level specifications.

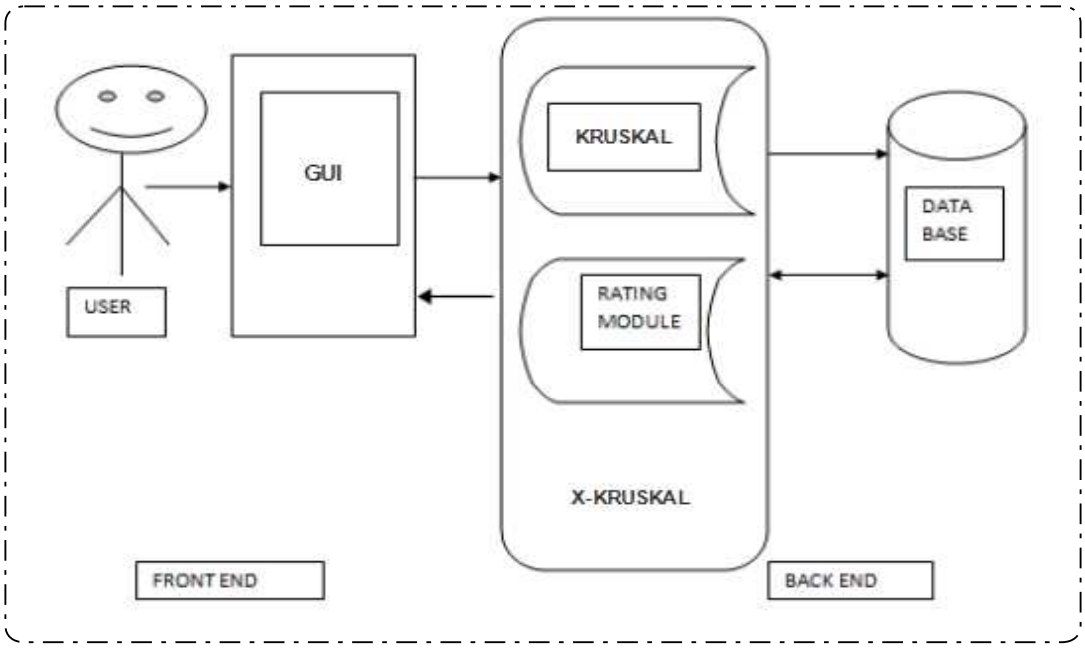


Figure 5. Proposed x-kruskal method

Similarly, the overall flowchart for the proposed decision support system is shown in Figure 7. It summarise the operational process of the system. The proposed x-kruskal algorithm is outlined in Table 2.

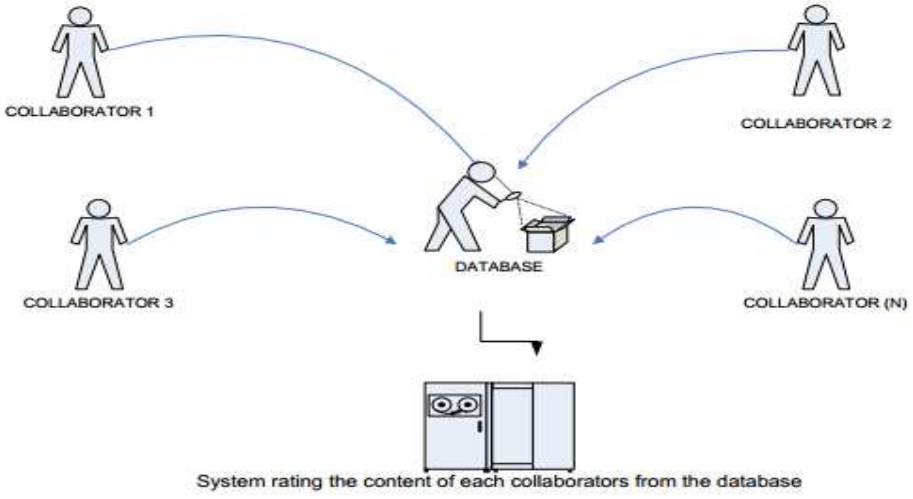


Figure 6. Database and Rating module

The proposed x-kruskal algorithm in Table 2 consist of three inputs- Collaborator (A), choice of programming language (V) and Location (E). The algorithm begin with graph $A = (V, \emptyset)$ consisting of only the choice of programming language of A and no location. It then arrange E in the order of increasing weights; and iteratively select the next smallest cost E and add E to A if it connects two different components. Next, the algorithm retrieve the rating for each collaborator based on the level criteria. A weighted score for each collaborator is computed and minimum selected to determine the optimum collaborators in a distributed software environment.

Table 2. X-KRUSKAL (G)

Input- Collaborator (A)

Choice of programming lang. (V)

Location (E)

Level- 0-expert, 1-biginner, 2-intermediate

Output- A

1 A = ∅

2 **foreach** v ∈ G.V:

3 MAKE-SET(v)

4 **foreach** (u, v) in G.E ordered by weight(u, v), increasing:

5 **if** FIND-SET(u) ≠ FIND-SET(v):

6 A = A ∪ {(u, v)}

7 UNION (u, v)

8 assign score (Level)

9 find weighted score

10 select minimum

11 **return** A

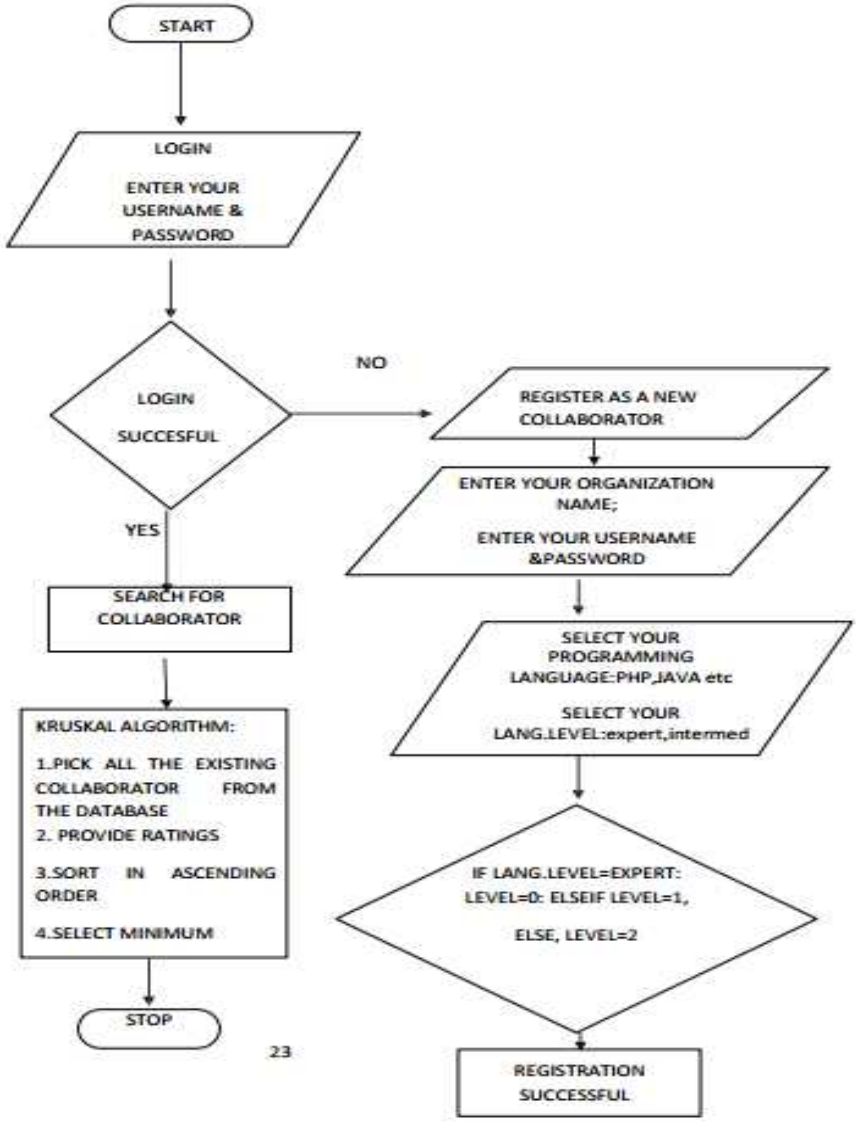


Figure 7. System flowchart

4. Implementation, analysis and evaluation

4.1 Implementation

In the implementation, Microsoft visual basic 2010 programming language was used for the front-end, while Microsoft access was used to handle the back-end (Database). The system requires registration from all new member collaborators and possible update as shown in Figure 8.

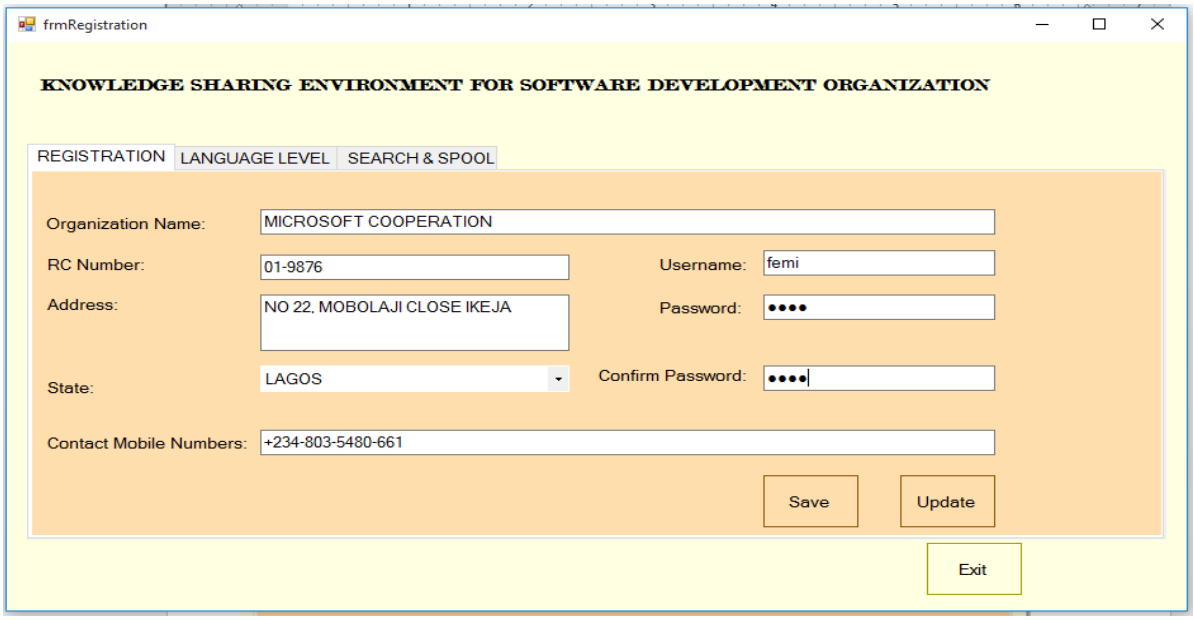


Figure 8. Registration portal

The login interface for a source collaborator searching for a destination collaborator(s) is as shown in Figure 9. The login details are provided in the registration phase for use in the authentication process. The login interface is meant for registered software organisation to enable them access to the system in selecting co-software organisation for collaborative software development.

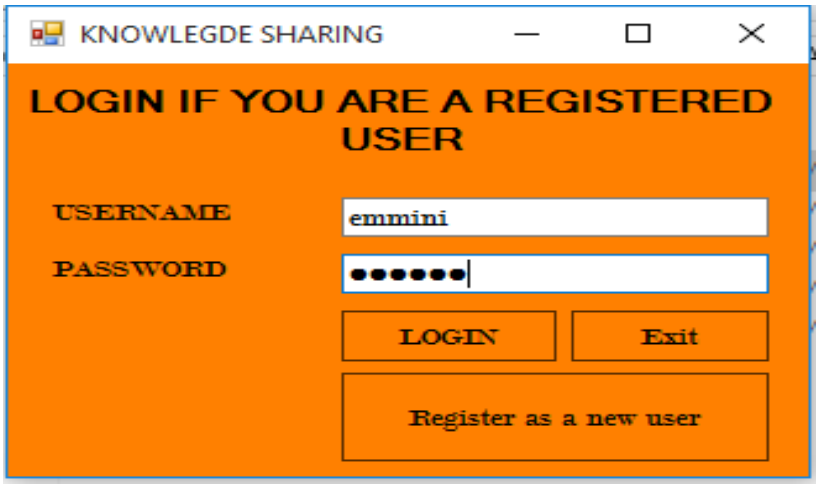


Figure 9. Login Interface

Software organisation can select collaborator based on three criteria: The location, programming language and level (Expert, beginners and intermediate) as in Figure 10. These criteria are the basis for the system to determine the optimum collaborators based on the selected specifications.



Figure 10. Search and Spool Interface

The programming language criteria consist of eight different programming languages which can be selected during registration. These languages are: PHP, VB.NET, C#, C++, JAVA, RUBY, PYTHON, F#.NET.

The language level is the rate at which a programming language is being used which are: EXPERT, BEGINNERS AND INTERMEDIATE. However, values of 0, 1, and 2 are attached to these levels respectively. The location represent the connecting distance between the source collaborator and the destination collaborator(s). The interface for the programming language options to be specified during the registration phase is as shown in Figure 11.

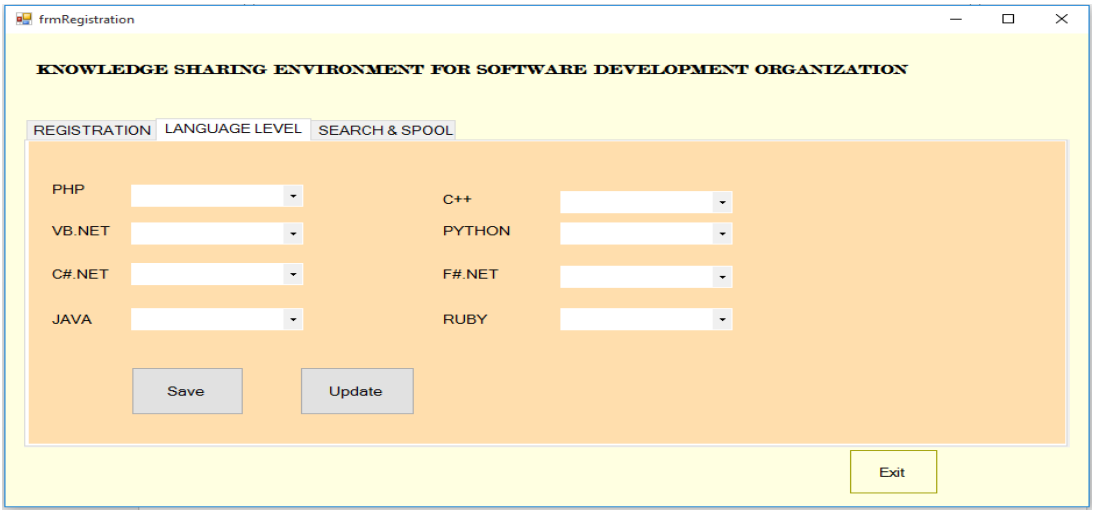


Figure 11. Language level Interface

4.2 Analysis and evaluation

The evaluation was done on sets of 500 and 1000 collaborators each representing number of nodes in the network. The analysis is based on three criteria: Average final objective values, Standard deviation and Running time in seconds. The root node is fixed to node 0 in all tests. The evaluation based on 500 nodes (Table 3 & 4) shows that our X-kruskal-based method yields considerably better results than the Prim-based and ordinary kruskal algorithms. Regarding the runtime, the X-kruskal-based method suggests better time complexity compared to the other two methods as indicated in Table 5. We can observe that the runtime is nearly similar for the ordinary and X-kruskal method with the X-kruskal proving to be slightly superior while the Prim-based method presents less superior runtime. The insignificant increase of the runtime for Prim-based and ordinary kruskal algorithm may be due to the rating module embedded in the X-kruskal algorithm for a more feasible and optimum solution.

Similarly, the evaluation based on 1000 nodes (Table 6, 7 & 8) also suggests that our X-kruskal-based method yields superior solutions than the Prim-based and ordinary kruskal algorithms.

In order to visualize the superiority of the X-kruskal method for an optimum solution to collaborative software development, Figure 12, 13, 14 & 15 confirms that Prim-based and ordinary kruskal algorithm is a less superior solution than the X-kruskal method for the determination of optimum collaborators for a distributed software development. For both instances of 500 and 1000 nodes respectively, the graph pattern for the X-kruskal method shows a more optimum solution compared to the other methods.

Table 3. Average final objective values

500 Collaborators		
Prime algorithm	Kruskal algorithm	X-kruskal
18641	10896	9678
12020	8386	8074
8565	7182	7077
5784	5676	5497
3236	4845	4766

Table 4. Standard deviation

500 Collaborators		
Prime algorithm	Kruskal algorithm	X-kruskal
1473	754	675
1618	537	502
1557	438	417
1146	514	511
857	469	423

Table 5. Running time in seconds

500 Collaborators		
Prime algorithm	Kruskal algorithm	X-kruskal
0.1	0.1	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.1	0.0	0.0
0.1	0.1	0.0

Table 6. Average final objective values

1000 Collaborators		
Prime algorithm	Kruskal algorithm	X-kruskal
25054	15626	13547
16383	12868	12427
12384	11367	10259
6854	7787	7575
4763	6876	6466

Table 7. Standard deviation

1000 Collaborators		
Prime algorithm	Kruskal algorithm	X-kruskal
4134	831	654
1735	564	543
2272	513	514
1235	524	526
874	446	457

Table 8. Running time in seconds

1000 Collaborators		
Prime algorithm	Kruskal algorithm	X-kruskal
0.4	0.0	0.0
0.0	0.0	0.0
0.0	0.0	0.0
0.2	0.1	0.0
0.1	0.1	0.0

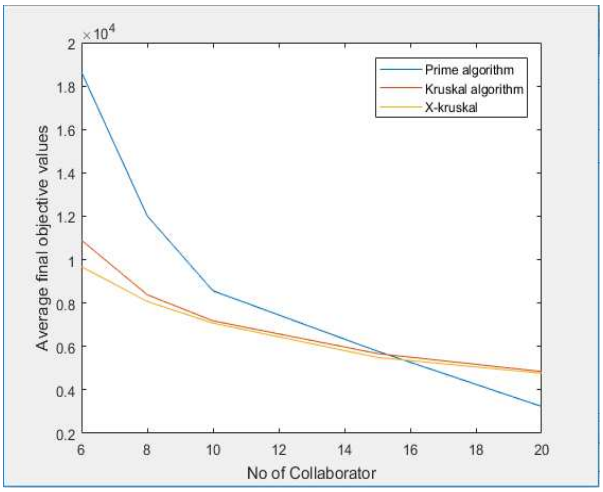


Figure 12. Average final objective values for 500 collaborators

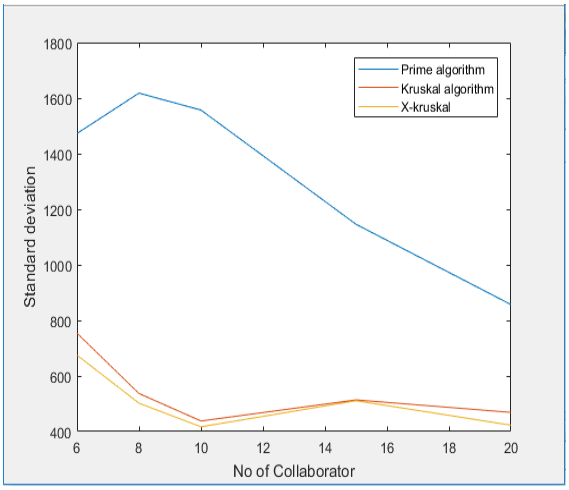


Figure 13. Standard deviation for 500 collaborators

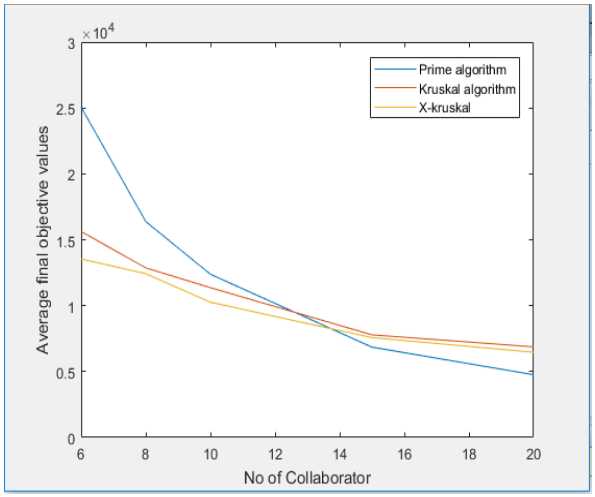


Figure 14. Average final objective values for 1000 collaborators

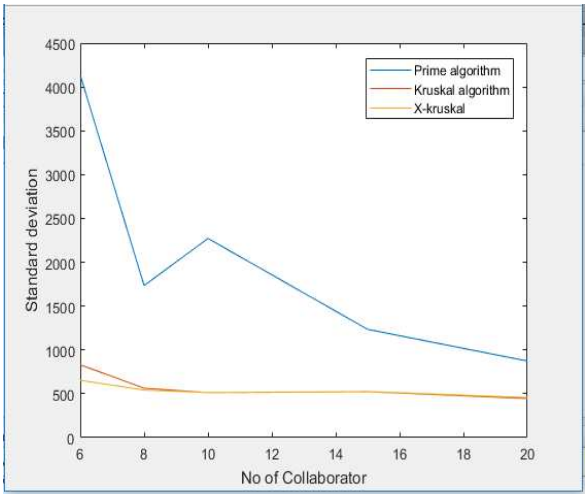


Figure 15. Standard deviation for 1000 collaborators

5. CONCLUSION AND FUTURE WORK

We introduce an approach called X-kruskal algorithm rooted in a rating module for the determination of optimum collaborators in a distributed software development. The approach was evaluated using average final objective values, standard deviation and running time criteria. The evaluation showed that the X-kruskal method produces quicker and superior results compared to the Prim-based and ordinary kruskal approaches. The runtime criteria is

almost insignificant but the X-kruskal method still indicates a slight improvement over the other methods in the runtime evaluation for both cases of 500 and 1000 collaborators.

In the future, we want to extend the X-kruskal method with some optimization algorithms to better optimize the search and as a result discover new feasible solutions.

REFERENCES

Aissa, M., Mnaouer, A. B., & Belghith, A. (2009). A novel extension of Kruskal's algorithm in multicast routing. In *Local Computer Networks- LCN. IEEE 34th Conference on* IEEE, pp. 289-292.

Akgün, A. E., Akgün, A. E., Keskin, H., Keskin, H., Ayar, H., Ayar, H., ... & Okunakol, Z. (2017). Knowledge sharing barriers in software development teams: a multiple case study in Turkey. *Kybernetes*, *46*(4), 603-620.

Alahyari, H., Svensson, R. B., & Gorschek, T. (2017). A study of value in agile software development organizations. *Journal of Systems and Software*, *125*, 271-288.

Allen, T. J. (1977). Managing the flow of technology: Technology transfer and the dissemination of technological information within the R & D organization (Book). *Research supported by the National Science Foundation. Cambridge, Mass., MIT Press, 329 pp*.

Aslam, W., Ijaz, F., Lali, M. I., & Mehmood, W. (2017). Risk Aware and Quality Enriched Effort Estimation for Mobile Applications in Distributed Agile Software Development. *Journal of Information Science and Engineering*, *33*(6), 1481-1500.

Beecham, S., Clear, T., Barr, J., Daniels, M., Oudshoorn, M., & Noll, J. (2017). Preparing tomorrow's software engineers for work in a global environment. *IEEE Software*, *34*(1), 9-12.

Bhatti, M. W., & Ahsan, A. (2017). Global Monitoring and Control: A Process Improvement Framework for Globally Distributed Software Development Teams. *Journal of Global Information Technology Management*, *20*(1), 43-63.

Carmel, E. (1999). *Global software teams: collaborating across borders and time zones*. Prentice Hall PTR.

Clauss, T., & Kesting, T. (2017). How businesses should govern knowledge-intensive collaborations with universities: An empirical investigation of university professors. *Industrial Marketing Management*, *62*, 185-198.

Damian, D. E., & Zowghi, D. (2003). RE challenges in multi-site software development organisations. *Requirements engineering*, *8*(3), 149-160.

Dijkstra, E. W. (1959). "A note on two problems in connection with graphs", *Numerische Mathematik,* 1, 269-271.

Djordjevic, I., & Dimitrakos, T. (2004). Towards dynamic security perimeters for virtual collaborative networks. In *International Conference on Trust Management* (pp. 191-205). Springer, Berlin, Heidelberg.

dos Santos, E. W., & Nunes, I. (2017). Investigating the Effectiveness of Peer Code Review in Distributed Software Development. In *Proceedings of the 31st Brazilian Symposium on Software Engineering* (pp. 84-93). ACM.

Duc, A. N., & Abrahamsson, P. (2017). Exploring the outsourcing relationship in software startups: A multiple case study. In *Proceedings of the 21st International Conference on Evaluation and Assessment in Software Engineering* (pp. 134-143). ACM.

Eng, T. Y. (2004). Implications of the internet for knowledge creation and dissemination in clusters of hi-tech firms. *European management journal*, *22*(1), 87-98.

Espinosa, J. A., Slaughter, S. A., Kraut, R. E., & Herbsleb, J. D. (2007). Team knowledge and coordination in geographically distributed software development. *Journal of management information systems*, *24*(1), 135-169.

Espinosa, J., Kraut, R.E., Lerch, F.J., Slaughter, S.A., Herbsleb, J. and Mockus, A. (2001). Shared Mental Models and Coordination in Large-Scale, Distributed Software Development. International Conference in Information Systems (*ICIS) Proceedings* 64pp. New Orleans, Louisiana, USA.

Evaristo, J. R., Scudder, R., Desouza, K. C., & Sato, O. (2004). A dimensional analysis of geographically distributed project teams: a case study. *Journal of Engineering and technology Management*, *21*(3), 175-189.

Ferdous, S., & Ikram, N. (2017). Communication and Coordination Using Facebook: A Case Study of Distributed Software Development. *Journal of Information Science & Engineering*, *33*(6).

Finnerty, N., Sterling, R., Coakley, D., & Keane, M. M. (2017). An energy management maturity model for multi-site industrial organisations with a global presence. *Journal of Cleaner Production*, *167*, 1232-1250.

Grinter, R., Herbsleb, J., Perry, D. (1999). The geography of coordination: dealing with distance in R&D work, Proceedings of the international ACM SIGGROUP conference on Supporting group work, pp.306-315, Phoenix, Arizona, United States.

Han, S. J., Han, S. J., Chae, C., Chae, C., Macko, P., Macko, P., ... & Beyerlein, M. (2017). How virtual team leaders cope with creativity challenges. *European Journal of Training and Development*, *41*(3), 261-276.

Heeks, R., Krishna, S., Nicholsen, B., & Sahay, S. (2001). Synching or sinking: global software outsourcing relationships. *IEEE software*, *18*(2), 54-60.

Herbsleb, J. D., & Mockus, A. (2003). An empirical study of speed and communication in globally distributed software development. *IEEE Transactions on software engineering*, *29*(6), 481-494. doi:10.1109/TSE.2003.1205177.

Herbsleb, J. D., & Moitra, D. (2001). Global software development. *IEEE software*, *18*(2), 16-20.

Herbsleb, J.D. & Mockus, A. (2003). An empirical study of speed and communication in globally-distributed software development, IEEE Transactions on Software Engineering 29 (3), 1–14.

Heredia, A., Colomo-Palacios, R., & Soto-Acosta, P. (2017). Tool-supported continuous business process innovation: a case study in globally distributed software teams. *European Journal of International Management*, *11*(4), 388-406.

Hornett, A. (2004). Varieties of virtual organizations and their knowledge sharing systems. In *Virtual teams: projects, protocols and processes* (pp. 186-119). IGI Global.

Inayat, I., Marczak, S., Salim, S. S., & Damian, D. (2017). Patterns of Collaboration Driven by Requirements in Agile Software Development Teams. In *International Working Conference on Requirements Engineering: Foundation for Software Quality* (pp. 131-147). Springer, Cham.

Jarvenpaa, S. L., & Leidner, D. E. (1998). Communication and trust in global virtual teams. *Journal of Computer-Mediated Communication*, *3*(4), 0-0.

Jarvenpaa, S. L., Knoll, K., & Leidner, D. E. (1998). Is anybody out there? Antecedents of trust in global virtual teams. Journal of Management Information Systems, 14(4), 29-64.

Jiang, J. J., Wang, Z. Y., & Yin, M. (2017). Research on impact of team conflict upon employee satisfaction in geographically distributed software development team.

In *Information Management (ICIM), 2017 3rd International Conference on* (pp. 136-139). IEEE.

Kane, G. C. (2017). The evolutionary implications of social media for organizational knowledge management. *Information and organization*, *27*(1), 37-46.

Kautz, H., Selman, B., & Shah, M. (1997). Referral Web: combining social networks and collaborative filtering. *Communications of the ACM*, *40*(3), 63-65.

Kennedy, D. M., Sommer, S. A., & Nguyen, P. A. (2017). Optimizing multi-team system behaviors: Insights from modeling team communication. *European Journal of Operational Research*, *258*(1), 264-278.

Kershenbaum, A., & Van Slyke, R. (1972). Computing minimum spanning trees efficiently. In *Proceedings of the ACM annual conference*-ACM, 1, 518-527.

Kiesler S., & Cummings, J.N. (2002). What do we know about proximity and distance in work groups? A legacy of research. In Distributed Work (Hinds P. and Kiesler S., Eds), 1, 57–80, The MIT Press, Cambridge, MA.

Krishna, S., Sahay, S., and Walsham, G. (2004). "Managing Cross-Cultural Issues in Global Software Outsourcing," Communications of the ACM, 47(4), 62-66.

Kruskal, J. B. (1956). On the shortest spanning subtree of a graph and the traveling salesman problem. *Proceedings of the American Mathematical society*, *7*(1), 48-50.

Li, Y., Rau, P. L. P., Li, H., & Maedche, A. (2017). Effects of a Dyad's Cultural Intelligence on Global Virtual Collaboration. *IEEE Transactions on Professional Communication*, *60*(1), 56-75.

Likaj, R., Shala, A., Mehmetaj, M., Hyseni, P., & Bajrami, X. (2013). Application of graph theory to find optimal paths for the transportation problem. *IFAC Proceedings Volumes*, *46*(8), 235-240.

McDonough, E. F., Kahnb, K. B., & Barczaka, G. (2001). An investigation of the use of global, virtual, and colocated new product development teams. *Journal of product innovation management*, *18*(2), 110-120.

Melis, G. (2017). Collaborative Planning Through Visualization: Learning from Urban Living Labs. In *Citizen Empowerment and Innovation in the Data-Rich City* (pp. 91-104). Springer International Publishing.

Ojala, A., Paavilainen-Mäntymäki, E., Su, N., & Lyytinen, K. (2017). Software Complexity and Organization of Firms' Offshoring Activities. In *Scandinavian Conference on Information Systems* (pp. 15-27). Springer, Cham.

Okere, G. O. (2017). Barriers and Enablers of Effective Knowledge Management: A Case in the Construction Sector. *Electronic Journal of Knowledge Management*, *15*(2).

Olson, G. M., & Olson, J. S. (2000). Distance matters. *Human-computer interaction*, *15*(2), 139-178.

Olson, G. M., & Olson, J. S. (2001). "Distance Matters." In J. M. Carroll (Ed.), Human-Computer Interaction in the New Millennium, ACM Press, New York, pp. 397-417.

Poppe, E., Brown, R., Recker, J., Johnson, D., & Vanderfeesten, I. (2017). Design and evaluation of virtual environments mechanisms to support remote collaboration on complex process diagrams. *Information Systems*, *66*, 59-81.

Prim, R. C. (1957). Shortest connection networks and some generalizations. *Bell Labs Technical Journal*, *36*(6), 1389-1401.

Raghavan, P. (2002). Social networks: From the web to the enterprise. *IEEE Internet computing*, *6*(1), 91-94.

Rajivan, P., & Cooke, N. (2017). Impact of team collaboration on cybersecurity situational awareness. In *Theory and Models for Cyber Situation Awareness* (pp. 203-226). Springer, Cham.

Richardson, I., Casey, V., Burton, J., & McCaffery, F. (2010). Global software engineering: A software process approach. In *Collaborative Software Engineering* (pp. 35-56). Springer Berlin Heidelberg.

Sengupta, B., Chandra, S., & Sinha, V. (2006). A research agenda for distributed software development. In *Proceedings of the 28th international conference on Software engineering* (pp. 731-740). ACM.

Šmite, D., Moe, N. B., Šāblis, A., & Wohlin, C. (2017). Software teams and their knowledge networks in large-scale software development. *Information and Software Technology*, *86*, 71-86.

Soto-Acosta, P., Popa, S., & Palacios-Marqués, D. (2017). Social web knowledge sharing and innovation performance in knowledge-intensive manufacturing SMEs. *The Journal of Technology Transfer*, *42*(2), 425-440.

Steinmacher, I., Chaves, A. P., & Gerosa, M. A. (2013). Awareness support in distributed software development: A systematic review and mapping of the literature. *Computer Supported Cooperative Work (CSCW)*, *22*(2-3), 113-158.

Storey, M. A., Zagalsky, A., Figueira Filho, F., Singer, L., & German, D. M. (2017). How social and communication channels shape and challenge a participatory culture in software development. *IEEE Transactions on Software Engineering*, *43*(2), 185-204.

Toral, S. L., Rocío Martínez-Torres, M., Barrero, F., & Cortés, F. (2009). An empirical study of the driving forces behind online communities. *Internet Research*, *19*(4), 378-392.

Uden, L., Uden, L., He, W., & He, W. (2017). How the Internet of Things can help knowledge management: a case study from the automotive domain. *Journal of Knowledge Management*, *21*(1), 57-70.

Van den Bulte, C., & Moenaert, R. K. (1998). The effects of R&D team co-location on communication patterns among R&D, marketing, and manufacturing. *Management Science*, *44*(11-part-2), S1-S18.

Wu, D., Rosen, D. W., Wang, L., & Schaefer, D. (2015). Cloud-based design and manufacturing: A new paradigm in digital manufacturing and design innovation. *Computer-Aided Design*, *59*, 1-14.

Yang, S. J., & Chen, I. Y. (2008). A social network-based system for supporting interactive collaboration in knowledge sharing over peer-to-peer network. *International Journal of Human-Computer Studies*, *66*(1), 36-50.

Zanatta, A. L., Steinmacher, I., Machado, L. S., de Souza, C. R., & Prikladnicki, R. (2017). Barriers Faced by Newcomers to Software-Crowdsourcing Projects. *IEEE Software*, *34*(2), 37-43.

Zhang, S., Shen, W., & Ghenniwa, H. (2004). A review of Internet-based product information sharing and visualization. *Computers in Industry*, *54*(1), 1-15.

Zhang, X., Song, X., Feng, L., Chen, L., & Törngren, M. (2017). A Case Study on Achieving Fair Data Age Distribution in Vehicular Communications. In *Real-Time and Embedded Technology and Applications Symposium (RTAS), 2017 IEEE* (pp. 307-318). IEEE.

ENGLISH COMPETENCE AND SEARCH FOR INFORMATION RESOURCES FOR ACADEMIC DEVELOPMENT AMONG COLLEGES OF EDUCATION STUDENTS IN KWARA STATE, NIGERIA

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ABSTRACT

The study examined competence of students in English language and its relationship to effective search for relevant information resources in the Colleges of Education in Kwara State, Nigeria. Three Colleges surveyed are spread across Kwara State senatorial zones with a 250 respondents randomly sampled by using a questionnaire that was pretested and yielded 0.82 reliability value. Data collected was statistically analyzed using Pearson Moment Correlation (PMC) and frequency and percentage. Respondents were drawn from final year students across academic divisions of arts, social science, and pure sciences who have attended courses in Use of English language. The study found students with high relationship in competence in English language skills with search for information in academic pursuits. Gender and different courses of study have no relationship to search for information among students of Colleges of education in Kwara State. It is, therefore, recommended that stakeholders in the Use of English programme should make it reflect its ancillary status to general academic pursuit, and interdisciplinary collaboration should be encouraged among experts to enhance all-round resourcefulness in students.

Keyword: *Language Competence, relationship, information resources, Information searches, Information literacy*

1. Introduction

The need to investigate the possibility of an effect of College of Education students' mastery of English language in their quest for necessary information resources to support learning activities informed this study. This is particularly needful since learning in the Colleges of Education in Nigeria has been an arduous task premised on English language as the only medium of instruction in Nigeria schools and the country's official language; and a reality that information resources are mostly written in the medium of English.

Therefore, this study used the medium of General English programme, a mandatory programme of study that every student must pass to meet the graduation requirements in Nigeria. The test in the use of English Language determines students' competence in the English language correlate to seamless search for information resources in the College libraries. Colleges of education in Nigeria were established to meet the masses yearning at producing qualified teachers to manage the primary and junior secondary schools that formed the foundation for quality higher education in the country. Ebisine (2014) asserted that Nigerian colleges of education provide full-time courses in teaching, instruction and training and courses in education to qualify their students as teachers. In pursuant of this, the Nigerian Commission for Colleges of Education was established through the decree No. 3 of January 1989 and as amended by Decree No. 12 1993 to perform among others the following functions:

a. Recommend on the national policy necessary for the full development of teacher education and the training of teachers.

b. Provide minimum standards for all teachers programmes and accredit their certificates and other academic awards after obtaining prior approval of the Honourable Minister of Education thereof.

c. Make guidelines approval and setting out criteria for accreditation of all Colleges of Education in Nigeria.

d. Determine the qualified teachers needs of Nigeria for the purpose of planning facilities and in particular, prepare regular master plans for the balanced and coordinated development of Colleges of Education.

e. Harmonise entry requirements and duration of courses at the Colleges of Education.

f. Collate, analyse and publish relevant information relating to teacher education in Nigeria.

In tandem with the Federal government of Nigeria vision and objectives on the Colleges of Education, state governments also established the Colleges of education to advance teachers

skill and knowledge in their domain. For instance, Kwara State government established colleges of education across the senatorial districts in the state through the instruments of law under the supervision of the state ministry of education. Gannicott (2008) averred that the three Colleges of Education in Kwara State provide primarily three-year, pre-service teacher training for both primary and secondary schools. All the Colleges of Education in Kwara State award the National Certificate of Education in all subject Arts and science subjects while the College of Education technical Lafiagi, also, specialises in training teachers for technological subjects.

2. Literature Review

The term competence found its way to language discourse through extant studies. House (2013) asserted that the display of pragmatic language jurisdiction called pragmatic power through creatively re-interpreting of discourse for structuring and expression for study purposes can be achieved. The linguistic competence as against 'performance' captures the intrinsic knowledge of grammar that native speakers of a language have of which is grammatically correct in that language to generate a limitless set of sentences informed by their mastery of the rules of grammar (Kitao, 1993). Mastery of language according to Odendaal (2015) is not sufficient that errors will be alienated as the error is part of language acquisition. Cannale and Swain (1980) opine a model of communicative competence split into four types:

a. Grammatical competence – the knowledge to understand and use vocabulary, the knowledge of word formation, pronunciation and spelling, comprehension and summary among others.

b. Sociolinguistic competence – the knowledge to articulate and understand expressions sufficiently based on the environment and roles of all participants involved.

c. Discourse competence – the hindsight to fuse grammatical tenets into a coherent aural or written text suitable to the context and its essence.

d. Strategic competence – appropriate use of communication strategies to mend breakdown of communication and attain goals.

For the purpose of this study, the grammatical competence of participants, the English language is focused as it relates to its application to search for information resources in the libraries and online sources. Teng and Wong (2015) described English language competence as involving the overall development of four skills also called language expression to include, speaking, reading and writing. Similarly, to be a competent user of the English language, a person is required to be able to draw an inference from the situation in context and to have a

broad range of possible actions to take from relevant inferences drawn from available information resources (Clegg & Birdi, 2007). The Association of College and Research Libraries (ACRL & ALA 2000) advocates information literacy (IL) standards as capable of specifying the degree of information required for academic purposes. Mahmood (2013) observes that it is getting increasingly evident that students cannot learn exhaustively in their field at the college without opportunity for independent learning, which information literacy offers them to become life-long learners. Students were exposed to training on information literacy, according to them groomed for lifetime learning as they can always access information resources when they need it to take an informed decision or perform tasks (Ojedokun (2007).

The Institution College of Education in Nigeria is an outcome of the Ashby Commission of 1959, which examined and weighed the need for upgrading the existing educational institutions to address the deficient teaching manpower across the country (Ajeyalemi, 2013). According to Ajeyalemi (2013) Ashby Commission found that many of the school teachers then were not professionally trained and therefore recommended for the creation of a new institution including Colleges of Education, and the Nigeria Certificate of Education (NCE) respectively. Similarly, Iliyas (2014) reported that the first set of the Colleges are called Advanced Teachers' Colleges (ATCs) Owerri, Lagos and Zaria (1961/ 62); Kano (1964) and Abraka with the name College of Education in 1968. The preceding shows the anomaly of the creation of Colleges of Education intended to balance making the study of her students' performance relevant.

In 1967, Kwara State was created as one of the 36 Nigeria States and the Federal Capital Territory (FCT) (Olatinwo, Muntaka, and Taiwo, 2014). The state is located in the North central region of Nigeria with the three Colleges of Education spread across the three geopolitical senatorial zones in Ilorin, Oro and Lafiagi (Technical) owned by the State government used for the study. Iliyas & Olajide, (2014) observed that the Colleges of Education in Kwara State awards Nigeria Certificate in Education (NCE) that is looked down on as a bit lower than a university degree, but a highly qualitative professional certificate in education. Kwara State Ministry of Education (2016) supported that the three Colleges of Education offers conventional and non-conventional courses, conventional being those courses in the Sciences, Languages, Arts and Social Sciences, Vocation and Technology. The Ministry of Education regulates the Colleges pointed to the non-conventional as the College of Education (Technical), which presents major courses in all areas of knowledge but Languages, Arts and Social Sciences (Kwara State Ministry of Education, 2016).

The National Commission for Colleges of Education (NCCE) is responsible for setting the standard, assure quality and supervise the activities of Colleges of Education by the federal government of Nigeria. The NCCE (2012) presents in her latest edition of minimum standard for NCE teachers a programme of English language proficiency courses. The programme is tagged Use of English I-V, five courses in all run one per semester in the five semesters (three years) that students are available for academic instruction in the College (one semester

for Teaching Internship). The NCCE (2012) further states that Information Literacy (Introduction to Library Studies) is a core course of the NCE study in the same General Study Department with the Use of English courses. Given this, the NCC guidelines, Ebisine (2014) retreated that the decree establishing the National Commission for Colleges of Education (NCCE) mandates it to make a recommendation for full development of teacher education and the training of teachers. It also states the minimum standards for all education programmes of teacher and accredit their certificate and other academic awards. The scenario is contrary to the like of China where a large-scale English language test body established for Colleges and University bound students (Cheng, 2008). Weigle (2013) opined that in the U.S. educational system, English language learners (ELLs) are increasing in indicating that even in countries where The English Language is the native and official language the teaching of the language for academic performance still prominence. In Saudi Arabia, Zafar, Mueen, Awedh & Balubaid (2014) investigated the Game-based learning through mother tongue and its effects on student academic performance in a College. The Study revealed that the use of game and native language hint in learning language showed a better understanding of subject and enjoyment than without mother tongue hint method. Similarly, Berman & Cheng (2010) in a survey of first-year Bachelor's- and Masters level students in Canadian university revealed that English language skills that are necessary for academic study at different levels to overcome academic difficulty but the difficulty do not appear to affect their academic performance. The study confirmed that acquiring necessary English language skill is akin to students in academic institutions to achieve academic success. Previously, Fakeye and Ogunsiji (2009) reported that English language proficiency among students has a significant positive relationship academic achievement with significant impact on the overall academic achievement of students. The study further recommended increased proficiency in the English language among Nigerian students for improved academic performance. Additionally, parents were counseled to create conducive home environments for improved English Language attitude among students and that teachers of English should consider varying academic ability when planning instructional programmes to evolve effective teaching and learning strategies to develop students' positive attitude to English Language (Fakeye, 2010). Meanwhile, Graham (1987) points the relationship between English language proficiency and academic success in universities and colleges. The position relates the difficulties associated with academic success other than English proficiency being critical too. It, therefore, confirmed the scene role that library can play in English language competence and student information searches for their academic performance.

In the recent, academic libraries are adjudged to be the most standard library given the quality of human, material resources, and the services provided as meeting the benchmark required for universities and colleges accreditation to improve academic quality, competencies, and performances for accountability (Asogwa, 2014). Academic libraries play a pivotal role in promoting scholarship in the higher institution of learning for both the teaching personnel, learners and other community of researchers. Dimitriadis, Vrana,

Dimitriou, Kalaitzis, and Drogalas (2013) investigated the customers' satisfaction and quality service policies in the academic libraries in a Central Macedonia University. The study confirmed that in the recent academic libraries' management has improved in service and staff qualities. Also, academic libraries have an important role in selecting books and making them available to learners, scholars, and researchers among other roles toward supporting academic excellence in the tertiary institutions (Vasileiou, Hartley, & Rowley, 2012). In the context of Nigeria despite the dwindling economy, academic libraries are still waxing stronger in delivering their mandates to support in the area of improving students library use skills for academic performance. Contrarily, Aderibigbe and Ajiboye (2013) revealed that the user education program in a higher institution library in Nigeria provides library orientation than bibliographic instruction and information literacy skills with periodic training in the library through the efforts of some library staff and friends. Baro, Eberechukwu Eze, and Nkanu (2013) opine that academic librarians should be equipped with the necessary skills to render services efficiently and also to train users to use e-resources effectively. Their opinion indicated the need for training of the library personnel and their patrons with skills to maximally use the library and resources in the academic libraries. Rasaki (2009) revealed the deficiencies in the information literacy skills programmes of the three in Nigerian tertiary institutions in the area of computer and information technology skills. Although, the survey pointed to information literacy skills as enabling skills for students to identify, locate, evaluate, organize, create, use and communicate information to address problems in their studies to empower and equip students with the necessary skills for independent and lifelong learning. Also, it was suggested that varying ways including the use of the e-library resources and computers as well as the Internet and online searching skills should be employed to encourage students in acquiring information literacy (Issa, Blessing, & Daura, 2009).

Akeredolu-Ale (2007) observed that a sharp decline in the motivation of young English-language learners as a result of certain historical developments as a component of literacy skills among students in Nigeria academic institutions. Previous studies (Ijaiya, 2008; Issa et al., 2009; Rasaki, 2009) shows that focus on literacy skills in Nigerian tertiary institutions are predominantly on the Universities neglecting the Colleges of Education. Therefore, the need to investigate the correlation of college of education students English language proficiency and information searches for academic performance.

Statement of the Problem

There has been persistent claim that inadequate competence in the English language revealed obstacle to students' performance in academic disciplines (Osakwe, 1999; Iliyas,2011). Therefore, the stimulus to empirically investigate this common perception as it relates to search for information resources. This study, therefore, sought to determine the degree to

which sufficient mastery of English language impact on students' search for information resources among students of Colleges of Education in Kwara State, Nigeria.

The study was intended to correlate competence in English language and find information resources among Colleges of Education students in Kwara State, Nigeria. It as well examined the correlation by gender, as male and female; and by the different courses of study of the students broadly grouped into three as Sciences and Technical Education, Arts and Humanities, and Social Sciences and Business Education.

The findings of this study will significantly equip teachers, students, College administrators and curriculum planners at that level with sufficient information on the interconnectedness of English language and information literacy and how the two can be so strategically designed to facilitate further the other. It will also enable students and College personnel to identify the source of students' academic poor performance to (or "intending to") remediate them.

3. Theoretical framework

This study adopts Dweck 1986 that consist of orientations goal, language mastery, and performance orientations. Dweck (1986) evolves a framework of students' orientation to learning activities. The framework identifies the patterns of orientations as goal, mastery and performance orientations that contrast orientation as work avoidance orientation towards learning and academic performance. The Dweck 1986 theoretical framework shows how motivational processes influence acquisition, transfer, and use of knowledge and skills presenting the performance or learning goals at shaping students reactions to success and failure and affect the quality of their cognitive performance. Albert and Dahling (2016) point to Dweck 1986 as making a distinction between learning (or mastery) objective orientation and performance goal orientation.

Goal orientation as a construct in Dweck 1986 places its foundation on the strategies learners' device to tackle learning tasks while mastery orientation centres on students' concern gains in knowledge and personal performance (Jang, Dunlop, Park, & van der Boom, 2015; Lauzier & Haccoun, 2014). The other orientation that Dweck (1986) calls work avoidance describes a disposition of learners with a weak attention to learning where she puts minimal effort to the learning task and envisioned learning task to get well accomplished.

The framework for the study derives from the perception that to attain the desired learning outcomes, the interplay of mastery of competence in English language and information literacy is a requirement. The synergy impact positively on the other towards attaining academic success goals. A thorough facilitation/learning of the Use of English courses for competence in Introduction to Library course of the College programme of study and appropriate experience of the search for information resources is expected to make students grasp information literacy. The learning outcomes and some of its manifestations listed under may characterize their realization among students, and the loops from the learning outcomes to competence in English and information literacy capture the continuum

nature of the process from every stage of the educational ladder and at every point of meeting life challenges.

For the purpose of this study, therefore, a continuation of Dweck's 1986 goal and mastery orientation constitute the theoretical model propelling English Language competency as a correlate to search for information resources in the Colleges of Education. Below is the conceptual framework to guide this study. Previously, the theoretical framework had earlier used in similar studies include (Albert & Dahling, 2016; Dweck & Leggett, 1988; Jang et al., 2015; Lauzier & Haccoun, 2014).

3.1 Research Question

The research questions for this study are:

1. What is the view on correlation between competence in English language and effective search for information resources among students of Colleges of Education in Kwara State, Nigeria?

2. Does gender have a significant difference in the correlation between English language competence and search for information resources among students of Colleges of Education in Kwara State, Nigeria?

3. What significant difference exists by different courses of study on the correlation between competence in English language and effective search for information resources among students of Colleges of Education in Kwara State, Nigeria?

3.2 Hypothesis

1. Significant difference does not exist between English Language competence and search for information resources among students of Colleges of education in Kwara State based on gender.

There is no significant different between English Language competence and search for information resources among students of Colleges of education in Kwara State based on the varying courses of study (Arts, Sciences, and Social Sciences).

3.3 Objectives of the Study

The broad purpose of this study is to investigate the correlation between competence in English language and effective search for information resources among students of Colleges of Education in Kwara State, Nigeria. Therefore, the study specific objectives are:

1. To explore the correlation between competence in English language and effective search for information resources among students of Colleges of Education in Kwara State, Nigeria.

2. To ascertain if gender has a significant difference in the correlation between English language competence and search for information resources among students of Colleges of Education in Kwara State, Nigeria.

3. To determine whether a significant difference exists by different courses of study on the correlation between competence in English language and effective search for information resources among students of Colleges of Education in Kwara State, Nigeria.

4. Research Approach

The research is a correlation research type that examined the possibility of students' competence in English language having a positive impact on their search for information resources. Population for the study consisted of the entire 200 level students of the three participating Colleges of Education spread across the three geopolitical regions (Ilorin, Oro, and Lafiagi). Three hundred students participated in the study, a hundred from each institution and the participants were selected through quota sampling techniques to make for representations across the three broad divisions of courses in the Institution (Arts, Sciences, and Social Sciences).

Participating students responded to a self-designed questionnaire consisting of nineteen items structured in Likert rating scale 5-1. The instrument was trial tested through a split-half measure in two non-participating Colleges of Education in Ilemona and (Nana Aisha) Ilorin and the data obtained was subjected to Pearson-moment correlation and a value of 0.773 was obtained. Therefore, the instrument could be said to be reliable. Data collected for the study was analysed using the Pearson-Moment Correlation Statistical instrument of the IBM Statistical Package for Social Sciences version 17.

5. Results

Research question one: *What is the correlation between competence in English language and effective search for information resources among students of Colleges of Education in Kwara State, Nigeria?*

Table2: Showing Correlation among Competence in English and effective search for Information

Correlations

		My proficiency in the English language vocabulary has helped me in locating needed information resources in the catalogue box.	Search for information resources has positively influenced my learning of English language.
My proficiency in the English language vocabulary has helped me in locating needed information resources in the catalogue box.	Pearson Correlation	1	.502**
	Sig. (2-tailed)		.000
	N	279	279
Search for information resources has positively influenced my learning of English language.	Pearson Correlation	.502**	1
	Sig. (2-tailed)	.000	
	N	279	279

**. Correlation is significant at the 0.01 level (2-tailed).

Table 1 above shows statistical relationship between teachers competence in English language and their effective search for information as the $p<0.01$ level of significant.

Research questions Two: *Does gender have a significant difference in the correlation between English language competence and search for information resources among students of Colleges of Education in Kwara State, Nigeria?*

Table2: Adjusted R square Value of the model on Gender

Model Summary

Mode	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.487[a]	.238	.232	.43718

a. Predictors: (Constant), Do you agree that the result this survey will assist in the English Language competency skill course in your College? ,

b. Searching for information resources among students

From the result in table 2, the Adjusted R square (.23) has poor fit. This revealed that the constructed multiple regression model of the independent variables (English Language competence and search for information resources) account for .23% variance in the dependent variable (Gender). The results on the analysis of variance (ANOVA) for the model are as shown in Table 3.

Table 3: ANOVA for dependent Variables on Gender

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.440	2	8.220	43.009	.000[b]
	Residual	52.750	276	.191		
	Total	69.190	278			

a. Dependent Variable: Gender

c. Predictors: (Constant),

d. English Language competency skill course in your College

e. Searching for information resources.

The results of the analysis of variance (ANOVA) which revealed that $F(df\ 2, 276 = 43.009, p < 0.05)$, indicated a statistically significant relationship (less than 0.05) between the independent variables (English Language competency and searching for information) and dependent variable (Gender).

Research: *What significant difference exists by different courses of study on the correlation between competence in English language and effective search for information resources among students of Colleges of Education in Kwara State, Nigeria?*

Table4: Adjusted R square Value of the model on Course of Study

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.424[a]	.180	.174	.74727

a. Predictors: (Constant),

b. Competence in the English language.

c. Search for information resources.

From the result in table 4, the Adjusted R square (.174) has poor fit. This revealed that the constructed multiple regression model of the independent variables (English Language competence and search for information resources) account for .174% variance in the dependent variable (Course of Study). The results on the analysis of variance (ANOVA) for the model are as shown in Table 5.

Table5: ANOVA for dependent Variables on Course of Study

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	33.863	2	16.931	30.320	.000[b]
	Residual	154.123	276	.558		
	Total	187.986	278			

a. Dependent Variable: Course of Study
b. Predictors: (Constant)
c. Competence in the English language.
d. Search for information resources.

The results of the analysis of variance (ANOVA) which revealed that F (df 2, 276 = 30.320, $p < 0.05$), indicated a statistically significant relationship (less than 0.05) between the independent variables (English Language competency and searching for information) and dependent variable (course of study).

REFERENCES

Aderibigbe, N. A., & Ajiboye, B. A. (2013). User education program as determinant of electronic information resources usage in Nimbe Adedipe University Library, Nigeria. The Electronic Library, 31(2), 244-255.

Aina, J. K., Ogundele, A. G., & Olanipekun, S. S. (2013). Students' proficiency in English language relationship with academic performance in science and technical education. American Journal of Educational Research, 1(9), 355-358.

Ajeyalemi, D. (2013). The Issues of Quality & Quantity in Nigeria's Teacher Education System. Available at: http://www.deta.up.ac.za/archive2007/presentationAjeyalemi% Accessed 2/4/2016

Albert, M. A., & Dahling, J. J. (2016). Learning goal orientation and locus of control interact to predict academic self-concept and academic performance in college students. Personality and Individual Differences, 97, 245-248.

Asogwa, B. E. (2014). Libraries in the information age: A measure of performance, competencies and constraints in academic libraries in Nigerian universities. The Electronic Library, 32(5), 603-621. doi:doi:10.1108/EL-07-2012-0097

Association of College and Research Libraries (ACRL). (2013). Introduction to Information Literacy. Available at: http://www.ala.org/acrl/issues/infolit/overview/intro.

Association of College and Research Libraries, and American Library Association. (2000). Information Literacy Competency Standards for Higher Education. Chicago, IL: ACRL. Available at: https://arizona.openrepository.com/arizona/handle/10150/105645. Accessed July 25, 2013.

Baro, E. E., Eberechukwu Eze, M., & Nkanu, W. O. (2013). E-library services: challenges and training needs of librarians in Nigeria. OCLC Systems & Services: International digital library perspectives, 29(2), 101-116.

Berman, R., & Cheng, L. (2010). English academic language skills: Perceived difficulties by undergraduate and graduate students, and their academic achievement. Canadian Journal of Applied Linguistics/Revue Canadienne de Linguistique appliquée, 4(1), 25-40.

Canale, M., & Swain, M. (1980). Theoretical, bases of communicative approaches to second language testing and teaching. Applied Linguistics, I; 89-112.

Cheng, L. (2008). The key to success: English language testing in China. Language Testing, 25(1), 15-37.

Clegg, C., & Birdi, K (2007).Forecasting future competency requirements: A three-phase methodology.PersonnelReview,36(1),6590. Available at http://dx.doi.org/10.1108/00483480. Accessed 20/01/2016

Dimitriadis, S. G., Vrana, V., Dimitriou, S., Kalaitzis, V., & Drogalas, G. (2013). Investigating customer satisfaction and service quality in academic libraries: the case of Technological Educational Institute of Central Macedonia. International Journal of Decision Sciences, Risk, and Management, 5(2), 161-179.

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. Psychological review, 95(2), 256.

Ebisine, S. S., Tittenbrun, J., Garner-O'Neale, L., Maughan, J., Ogunkola, B., Shingjergji, A., & Akor, P. U. (2014). Academic Quality Assurance in the Colleges of Education: Challenges and Ways Forward for Future Development. International Letters of Social and Humanistic Sciences, 2, 1-9.

Fakeye, D. (2010). Students' personal variables as correlates of academic achievement in English as a second language in Nigeria. Journal of social sciences, 22(3), 205-211.

Gannicott, K. (2008). Kwara State: Education Sector Analysis. Second Draft, March.

Graham, J. G. (1987). English language proficiency and the prediction of academic success. TESOL Quarterly, 505-521.

Head, A. J. (2013). Project information literacy: What can be learned about the information-seeking behavior of today's college students? In Invited Paper, Association of College and Research Librarians Conference, Forthcoming. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2281511, Accessed 20/01/2016

House, J. (2013). Developing pragmatic competence in English as a lingua franca: Using discourse markers to express (inter)subjectivity and connectivity. Journal of Pragmatics, 59, Part A, 57-67. doi:http://dx.doi.org/10.1016/j.pragma.2013.03.001

Ijaiya, N. (2008). Strengthening the quality of teacher education: The role of the Faculty of Education in Nigerian Universities. Towards quality in African higher education, Ibadan: HERP-NET, 188-198.

Iliyas, R. A. (2011). An Assessment of the Use of English programme in higher education: The Nigerian College of Education case, Journal of Research in Education. An official journal of the Collaboration of Education Faculties in West Africa (CEFWA) Vol.1 No 1,157-171.

Iliyas, R. A. (2014) Enhancing academic performance through post-listening organisers and note-taking among Colleges of Education students in Kwara State, Nigeria, International teacher education conference held at the Sharjah Centre, Dubai, the

United Arab Emirates between 5-7th February 2014. Available at: http://www.ite-c.net/ Accessed 20/01/2016

Iliyas, R. A., & Olajide, S. B. (2014). Facilitating the Nigeria College of Education students' listening skill through advance organiser and note-taking, International Journal of Educational Issues, 7 (13)

Issa, A. O., Blessing, A., & Daura, U. D. (2009). Effects of information literacy skills on the use of e-library resources among students of the University of Ilorin, Kwara State, Nigeria. Library Philosophy and Practice (e-journal), 245.

Jang, E. E., Dunlop, M., Park, G., & van der Boom, E. H. (2015). How do young students with different profiles of reading skill mastery, perceived ability, and goal orientation respond to holistic diagnostic feedback? Language Testing, 32(3), 359-383.

Kitao, S.K. (1993).Communicative competence in English: teaching about functions. Doshisha Women's College, Annual Reports of Studies;v44 (1), 148-65.

Kwara State Ministry of Education (2016). Available at: http://www.kwarastate.gov.ng/education/ Accessed 2/4/2016

Lauzier, M., & Haccoun, R. R. (2014). The Interactive Effect of Modeling Strategies and Goal Orientations on Affective, Motivational, and Behavioral Training Outcomes. Performance Improvement Quarterly, 27(2), 83-102. doi:10.1002/piq.21169

Mahmood, K. (2013). Relationship of Students' Perceived Information literacy skills with Personal and Academic Variables, http://www.academia.edu/4472268/Libri63 journal/pdf Accessed 20/01/2016

NCCE (2012). Minimum standard for Nigeria certificate in education. Abuja: Government Press.

Odamtten, H., Denkabe, A., & Tsikata, I. E. (2015). The Problem of English Language Skills at the University Level: A Case Study of First-Year Law and Administration Students at the University of Ghana. Multilingualism, Language in Education, and Academic Literacy: Applied Linguistics Research in the Language Centre.

Odendaal, M. S. (2015). Error Correction In a Communicative Language Teaching Framework. Stellenbosch Papers in Linguistics Plus, 21, 109-128.

Ojedokun, A. A. (2007). Information Literacy for Tertiary Education Students in Africa. Ibadan, Nigeria: Third World Information Services.

Okebukola, P. A., Owolabi, O., & Okebukola, F. O. (2013). Mother tongue as the default language of instruction in lower primary science classes: Tension between policy prescription and practice in Nigeria. Journal of Research in Science Teaching, 50(1), 62-81. doi:10.1002/tea.21070

Olatinwo, K., Muntaka, M., & Taiwo, M. A. (2014). Constraints to Productivity of Cooperative and Non-Cooperative Women Farmers in Kwara State, Nigeria. International Journal of Innovative Research and Development, 3(11).

Osakwe, N. N. (1999). The nature of reading problems at the tertiary level in Aboderin, Y. (Ed.) Literacy and Reading in Nigeria, 8 1&2, Lagos: NERDC.

Osakwe, N. N. (1999). The nature of reading problems at the tertiary level in Aboderin, Y. (Ed.) Literacy and Reading in Nigeria, 8 1&2, Lagos: NERDC.

Rasaki, O. E. (2009). A comparative study of credit earning information literacy skills courses of three African universities.

Teng, F., & Wong, J. (2015). Applying Speed Speaking into the Foreign Language Classroom. Metacognitive Strategy Use: Effects on Metacognitive Awareness,…… 3 Self-efficacy, Reading Performance and Motivation, 50.

Vasileiou, M., Hartley, R., & Rowley, J. (2012). Choosing e-books: a perspective from academic libraries. Online Information Review, 36(1), 21-39.

Weigle, S. C. (2013). English language learners and automated scoring of essays: Critical considerations. Assessing Writing, 18(1), 85-99.

Zafar, B., Mueen, A., Awedh, M., & Balubaid, M. (2014). Game-based learning with native language hint and their effects on student academic performance in a Saudi Arabia community college. Journal of Computers in Education, 1(4), 371-384.

Instrument

Dear students,

The questionnaire respondents are filling is strictly for research purpose meant to examine the possible impact of competence in the English language on the effective search for information resources among colleges of Education students. Respondents views would be confidential, and the outcome of the study will further assist students to simplify required search for information in the library through proficiency in the English language

PART A

Name of Institution ----------

Course of study ----------

Course of study ----------

Sex ---------- Female ( ) Male ( )

PART B

KEY

SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree, N= Neutral

		SA			SD	
1.	Competence in the English language offers a greater advantage for students' search for information resources.					
2.	My proficiency in the English language vocabulary has helped me in locating needed information resources in the catalogue box.					
3.	The mastery of the reading skill has been very helpful in locating relevant information resources to my course of study.					
4.	The skimming (thorough reading and keeping hold of keywords) knowledge I have gained in reading has been useful for me in getting the most general information required from extensive information resources search.					
5.	The knowledge of English vocabulary has always helped in using books index to locate and utilize needed information resources.					
6.	Scanning skill (rapid screening of texts to locate vital information within a large chunk of reading materials) attained from reading class often help me to locate specific detail in my search for information.					
7.	Reading speed instruction I have had greatly help in searching for complex information resources.					
8.	The knowledge I have gained in grammar lessons have always been useful for me in reducing and summing lengthy information resources found.					
9.	I am more efficient in managing information resources sourced through effective note-taking.					
10.	Search for information resources has positively influenced the learning of English language.					
11.	The inability to pass the Use of English language well is responsible for the personal problem in accessing the required information resources in the Library.					

12.	Making advantage of information resources has been tough because English used are usually not understood.					
13.	Searching for information resources I need has become difficult because it requires greater competence in the English language.					
14.	To locate and make use of the information resources I need does not require any use of the knowledge of English.					
15.	Even when reading difficulties, Retrieving and use of information resources needed are still possible.					
16.	Critical thinking has always been very useful in locating and making proper use of information resources.					
17.	The course content of the Use of English programme presented in the College provides useful knowledge in the search for information resources.					
18.	Do you agree that the result this survey will assist in the improvement of the English Language competency skill course in your College?					
19.	The result of this survey will assist the College management in the provision of information resources.					

RELATIONSHIP BETWEEN ENGLISH COMPETENCE AND SEARCH FOR INFORMATION RESOURCES AMONG COLLEGES OF EDUCATION STUDENTS IN KWARA STATE, NIGERIA

Keyword: English language competence**,** relationship, information resources, Information searches, Information literacy

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Research Question

The research questions for this study are:

1. What relationship exist between competence in English language and effective search for information resources among students of Colleges of Education in Kwara State, Nigeria?

2. Does gender have any basis to determine the relationship between English language competence and search for information resources among students of Colleges of Education in Kwara State, Nigeria?

3. What relationship exists on the basis of the different courses of study between competence in English language and effective search for information resources among students of Colleges of Education in Kwara State, Nigeria?

Hypothesis

$H0_1$: Significant relationship does not exist between English language competence and search for information resources among students of Colleges of education in Kwara State based on gender as mala and female.

$H0_2$: There is no significant relationship between English language competence and search for information resources among students of Colleges of education in Kwara State based on the varying courses of study (Arts, Sciences, and Social Sciences).