

A framework for Measuring the level of Digital transformation in Ministries, Departments & Agencies (MDA's) in Nigeria

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1.0 Introduction

Nowadays, digitalization is an important topic for Ministries, Department and Government Agencies (MDA) in Nigeria because of the significance and importance of digital transformation. There are important reports published about digitalization or digital transformation; therefore, this report will focus on providing a framework for its measurement of MDAs in Nigeria.

Many models can be developed to measure the digital transformation level of MDAs in Nigeria. However, all the models can be classified through the metrics and by the qualitative analysis based on the definition of digital transformation adopted. The metrics used could include customer satisfaction scores, revenue growth and retention, and employee productivity due to using ICT. It could also include level of ICT infrastructure and investment, in-house IT level, staff ICT skills, funding and research and development activities, use and availability of Internet access, the capacity of Internet subscribed, number of computers available, secure server infrastructure, IoT infrastructure availability among other factors. The metrics to be used largely depend on data availability and the definition of the digital economy adopted.

The benefit of measuring the level of digital transformation would help to understand the need for the implementation of Information Technologies (IT) so that efficiency and efficacy advantages may be obtained. This is necessary because the potential impact of IT has grown exponentially.

Today, the profound appropriation of IT in organizations and MDAs is represented by the concept of digital transformation. Therefore, in the current knowledge era, it is ever more important to understand the value that IT initiatives may bring to these MDAs.

Many terms have been used and evolved to describe the digital transformation evolution, from IT maturity to digital transformation, along with e-readiness. No matter the name the MDA is calling it, the concept is the same. For some MDAs, the evolution has been slow, while some MDAs have evolved very fast because they realize that they would be left behind if quick actions were not taken. Therefore starting with simple studies on the profitability of establishing an IT infrastructure and moving to the concept of digital transformation, there is a need to understand the level of digital transformation in each MDA in Nigeria.

This work proposes an integrated Digital Transformation model and an instrument to assess the digital state of MDAs in Nigeria. This would help in Measuring their level of maturity and provide the MDAs the needed steps to follow to better profit from the intelligent use of IT that considers the opportunities and challenges of a dynamic competitive environment offered by the transition to a digital economy. The proposed integrated model in this work is comprised of metrics relating to six organizational dimensions and transformational objectives known as indicators. In addition, innovation and financial aspects are included to impact across all combinations. Based on this model, a quantitative Six-point scale instrument is developed to establish an MDA's digital transformation maturity level in Nigeria.

It is worthy of note that that is a need to pilot and test this proposed model for reliability, face, and content validity. Also, given the length of the proposed model, a possibility exists for dimension reduction. It is expected that after due process explained later in this work has been followed, the adjusted instrument will allow testing of the model in a greater sample, and a practical consulting

methodology can be derived from it for general application. The validated model could provide cohesion to this research work.

Piloting this model in the Nigerian context will provide a valuable testing ground, provided the particular challenges faced by organizations located where infrastructure and digital awareness may not be strong, and it would allow the country to better understand the limitations to the success of its IT initiatives.

2.0 Digital Transformation Review

Digital transformation is one of favourite topics nowadays. This topic influences on economic environment as well as businesses and countries. There are many approaches to defining digital transformation in the literature. According to Reddy and Reinartz (2012), digital transformation has two definitions, and one of these is to use the Internet and computer to create effective economic value with respect to the traditional sense. The other definition wholly states changes of new technology in operation, interaction, configuration and creation of wealth with respect to a broader sense. Schallmo et al. (2017) investigated the definition of digital transformation and proposed the definition of digital transformation for their digital transformation of business models research. According to Schallmo et al. (2017), digital transformation includes networking business, customers, and segments and requires data analysis to reach information used to evaluate options that increase business performance. Berman (2012) suggested reshaping customer value and transforming operations based on digital technologies to reach greater customer collaboration and interaction for the success of the digital transformation. Digitalization of countries can be measured with six key attributes: ubiquity, affordability, reliability, speed, usability and skill (El-Darwiche et al., 2012). In the literature, Schwarzmüller et al. (2018) investigated how digital transformation affects organizations. Majchrzak et al. (2016) performed an investigation on

designing for digital transformation. Balyer and Öz (2018) investigated digital transformation on education according to academicians' perspectives. Bouwman et al. (2018) investigated generally impacts of digitalization for SMEs. Motta (2016) also investigated the impacts of digitalization about socio economic development. Li et al. (2018) investigated the capability of SME's for digital transformation. Loonam et al. (2018) investigated some case studies about digital transformation. Digital transformation affects the world economy, helps to emergence of concepts such as digital economy (Unctad, 2017). Westerman et al. (2011) investigated a research on executives about digital transformation.

3.0 The need for this framework

The first step to being successful with measuring digital initiatives is to find out if an MDA is making digital transformation progress with the help of clearly defined metrics. This is because one of the main causes of digital transformation failure is the lack of clear objectives. Therefore developing this framework would help MDAs to have a clear objective and understand what should be done to achieve a proper transition to a digital economy. Often a time, organizations pursue digital transformation solely for the sake of digital rather than carefully considering the benefits that digital technologies can bring. Therefore the framework defined the objectives to be specified and measured. Progress towards these goals must be assessed so that appropriate adjustments can be made and resources reallocated along the way, based on real numbers. Thankfully, digital projects lend themselves well to measurement since they can generally be quantified. This data can in turn, be shown to executives the value created. "Good numbers" are key to winning the intra-organizational competition for budgets and other limited resources and securing management support. Therefore this work is of high importance.

4.0 The Proposed Indicators

Our taxonomy of digital transformation indicators encompasses six dimensions, as shown in table 1. Two categories deal with operational efficiency and employee engagement and are largely inward-facing. At the same time, two are customer engagement and new sources of value creation for e-government and are outward-facing. In contrast, the last one deals with opportunities created for the MDA as a result of the transition, and this is a combination of inward and outward-facing. These categories represent the main areas where digital transition can create value through improved operations and efficiency on one side and enhanced revenues on the other.

This framework aims to help measure the relative efficiency of digital transformation among MDA's data analysis. This means that the necessary data are extracted from published or verified sources either by the MDA or an independent consultant, as there is a need to measure the relative efficiency of the information used. This model proposed in this work is for empirical purpose with respect to digital transformation efficiency by using “enablers and output”. The model uses more than 30 key indicators and methodologies to monitor and assess the size and penetration of the digital economy, and they are organized in six themes according to their main purpose of measurement, which are:

1. **Infrastructure.** This covers indicators of the development of physical, service and security infrastructures underlying the digital economy. It includes access to mobile and fixed internet connectivity, the development of next-generation access networks, the dynamics MDAs using secure servers infrastructure, and infrastructure for the Internet of things. This is divided into connectivity availability indicators to show how these infrastructures are made available to staff of the MDA and also the usage aspect of things. The usage aspect is also very important because these services might be available but not used by the employees for a number of possible reasons.

2. **Workforce Empowerment.** This section considers indicators that portray the evolving role of the digital economy in the employee's life, and how they access and use digital technologies. Their abilities to fully exploit their potential. It includes indicators on employees' use of the Internet, education, financial inclusion and interaction with the customer and the employer, among others. This section also deals with the level of ICT training of the employees and the number of employees who use ICT in performing their daily tasks.

3. **Innovation and technology adoption.** This theme contains indicators that address innovation in digital technologies, new digitally-enabled business models and the role of ICTs as an engine for innovation and adoption of ICTs and other emerging technologies, the MDA. It also reflects how the MDA is investing and profiting from the use of technology, the percentage of staff using emails and the level of paperless tasks completed by the MDA. It also includes access to finance for the MDA because this is often important, and it is a critical factor on how easy it would be for the MDA to adopt technology.

4. **Customer Satisfaction.** The customer satisfaction dimension is divided into two dimensions. The Direct customer satisfaction indicators reflect customer retention, product available online and online survey satisfaction. The number of retained customers can be assumed to be the number of happy customers, but this metric might not be accurate for some MDAs as they do not have a substitute, and customers don't just have a choice but to be retained. However, the metrics also include the number of products available online because, in a digital economy, it is expected that the more the online product available, the happier the customers are because they can access the product or services from the comfort of their homes. The indirect indicators are indicators such as

the number of searches the MDA is having on search engines and web visits, among others. However, again this factor must be included with lots of caution because MDAs do not necessarily have a substitute; therefore, due consideration must also be given to these indicators.

5. Jobs and Growth. The metrics is subdivided into job availability indicator and growth indicators. The metrics collected within this section should explore the different ways in which digital technologies contribute to the economic growth of the employees and employment creation. It includes indicators related to the labour market, outsourcing of IT jobs, and revenues from ICT, value-added, international trade, e-commerce, and productivity growth.

6. Digital Public Service for Citizens. This section considers the level of available open data of the MDA, the level of digital service available in terms of the guideline, condition of service and other guide books. This indicator also includes the R&D income and expenditure of the MDA legal framework for adopting emerging technology. These are very important areas that determine an MDA's digital transformation level.

Table 1: Dimensions, Sub-Dimension and Indicators for the proposed model

Dimension	Sub- dimension	Indicators
Infrastructure	Connectivity Availability Indicators	Annual/monthly fixed and active broadband subscription
		Annual/monthly mobile active broadband subscription
		Fast wireless broadband availability to employees
		Type of last-mile connectivity
		LAN availability between offices in a different location
		Software investment
		Annual IT budget
		The number of IT staff employed.
		Percentage of offices covered by mobile internet connection

		Percentage of offices covered with fixed internet connection
		Cloud computing availability
		Cloud computing readiness
		Online platform agility
		Online platform elegance
		Online platform technical depth
		Data centre availability
		Social media usage
		Social media linked to the website
		The annual cost of fixed and mobile broadband
		The use of social media marketing
		Online Platform mobile readiness
	Usage Indicators	Annual/ Monthly Fixed Broadband Usage
		Annual/ Monthly Mobile Broadband Usage
		Use of Big Data for analysis
		Amount of posts on social media handles
		Level of in-house data processing
		Level of Cloud storage usage
		The number of IT staff with an IT degree
		Annual IT expenditure
Workforce Empowerment	Digital Skills Indicators	Education and training available to obtain a certain level of digital skills
		Periodicity and Widespread digital skills
		Number of Staff with at least basic digital skills
		Number of staff above basic digital skills
		Number of staff with basic software skills
		Number of staff who are ICT specialists
		Number of female ICT specialist
		Number of staff who became ICT specialists after employment
		Number of ICT graduate
		Number of staff with access to mobile ICT devices
		Number of staff with fixed ICT devices
		Enterprises possessing and using digital tools
Innovation and ICT Technology Adoption		Percentage of staff working with personal computers
		Percentage of staff with social media handles

		Percentage of staff working with official emails
		Percentage of staff using free email services
		Amount of task completed paperless (start to finish)
		Average paper consumed month/annually
		Annual/Monthly expenditure on papers
		Approvals using digital platforms
		Access to finance
		Revenue from new channels from online platforms
		Revenue from new partnerships from online platforms
		Revenue from new products, offerings, and services from online service
		Workplace Flexibility through the use of ICT (work from home)
		Office located using the online map
		Use of e-invoice
		Percentage of circular via email and electronic means
		Online staff application for casual/annual leave, daily schedule etc.
Customer Satisfaction	Direct Customer Satisfaction	Percentage of direct customer retention by using online platforms
		Number of products fully accessible online
		Number of products partially available online
		Online payment only for services.
		Enterprises possessing and using digital tools
		Online platform usefulness
		Online survey for customer satisfaction
		Customer satisfaction based on an online survey
	Indirect Customer Satisfaction	Search engine metrics (Moz rank, average website rank, backlinks, traffic from Google search, etc.
		Website metrics, such as impressions, visits, downloads, subscribers
		Number of likes on Social media platforms

		Average time spent on your website/mobile app
		App downloads, retention rate, repeat visitors on the website
		Cold/warm/hot traffic, number of new followers
		Feedback, comments/likes/shares on your social media assets
Jobs and Growth	Job Availability indicators	Use of Enterprise Resource Planning software (ERP)
		Number of Jobs created as a result of the use of ICT
		Number of Job losses as a result of the use of ICT
		Incidents reduction as a result of ICT use
		Selling online across the border.
		E-commerce turnover
		ICT for environmental sustainability
	Growth Indicators	Availability of Training and IT-Staff
		Use of Management Consultancy
		Number of IT jobs Outsourced.
		Level of on-the-Job Training
		E-Commerce
		Revenues from the use of digital channels
Digital Public Service for Citizen	E-government	Number of e-service users in the MDA
		Pre-filled online forms
		Digital Service available to citizen
		Digital Service available to business
		Open data available about the MDA
		Availability of ICT guidelines
		Legal framework for emerging technology use
		R& D expenditure
		Privacy guideline
		R & D availability

5.0 Using the Model

To use this model effectively, there is a need for extensive data collection using different sources.

Some of the sources would be surveys filled in by all staff, and some filled in by specific staff, use

of independent consultants to conduct interviews, the information provided by the MDA, gathering of information by carrying out specific tests and the use of publicly available data. No matter the model adopted in gathering the necessary information, some basic tenets must be adhered to. There are explained below for each of the dimensions.

The data collection process must be in phases. Some of the proposed phases are a general background survey, an ICT survey and a specific survey for each of the indicators proposed.

The general background survey

The data collected from the MDA should include an extensive list of the background of the MDA, ranging from basic characteristics, such as the number of employees, or information on the qualifications and age structure of employees, to the use of organizational and human resource practices like incentive pay. The survey information should also contain balance sheet information, such as personnel costs or expenditures on intermediate inputs, which are important for econometric analyses.

ICT Survey

The ICT Survey should also cover a wide variety of performance measures, which are typically included in all waves of the survey, such as total sales or export status and share. Additionally, items should include information on innovation and R&D activities. The ICT survey should also be done periodically as this would be more reflective of the current ICT stand of the MDA. The ICT survey questions should also cover a comprehensive list of items on the use of different social media channels, from corporate blogs to profiles in online social networks. Further questions

should also deal with the goals and barriers to ICT adoption of the MDA and other social media activities.

■ **The Specific Survey**

Survey questions should be designed, and below is the guideline for developing the survey questions. The MDA should obtain data by using a verifiable source of information through national MDA surveys and are either provided directly by the MDA or obtained through research, for example, from the website of the MDA. There are certain data-related limits in the indicator, in which estimates have to be calculated for many MDA which do not yet collect those statistics; however MDAs should be encouraged over time to make more data available as this would help improve the quality of the indicator.

A. ICT Infrastructure

This survey should be designed to reflect four main areas. These are:

ICT readiness – reflecting the level of networked infrastructure and access to it. It should also include survey questions on computer software spending. This would refer to the total value of purchased or leased packaged software, including operating systems, database systems, programming tools, utilities, and applications. The indicator should exclude personal expenses on software purchases from the employee. This should also include internal software development and outsourced custom software development of the MDA. The data should also be combined to get the actual figures and estimates. The platform survey question can be done using a 1-10 (best) scale to assess the quality, relevance, and usefulness of the MDA's websites. Usefulness refers to a website's ability to provide online information and participatory tools and services to citizens. The same scale can be used in survey questions that are a bit subjective.

ICT intensity – This should reflect the level of use of ICTs in the MDA. The survey should reflect the general ICT intensity, share of employees with ICT knowledge, the share of employees working predominantly with personal computers, the share of employees with access to the Internet, the percentage of employees equipped with mobile devices connected to wireless Internet, the IT-expenditures and Quality of internet access available to employees of the MDA. It should also cover measures for overall ICT intensity ranging from the percentage of employees working predominantly with computers, which has been employed in numerous econometric studies as a measure of overall ICT intensity, or proxy for ICT capital respectively, to IT expenditure and the number of IT staff employed by the MDA.

ICT impact- This should reflect the results/outcomes of more efficient and effective use of ICT use by the MDA. This should reflect the percentage of an individual employees using the Internet. The term “individual employee using the Internet” refers to people who use the Internet from any location and for any purpose, irrespective of the device and network used. Usage can be via a computer (i.e. desktop computer, laptop computer, tablet or similar handheld computer), mobile phone, games machine, digital television, etc.). This should be determined separately for fixed and for the mobile network. This is because, generally, fixed networks are considered to be faster and more reliable than mobile networks. The fixed and mobile broadband subscriptions should be collected per number of staff. For example, this can be collected per 10, 50 or 100 depending on the agreed definition to be used. The term “active mobile-broadband subscriptions” refers to the sum of data and voice mobile-broadband subscriptions and data-only mobile-broadband subscriptions either used in the office outside provided it is being paid for by the MDA. It should cover subscriptions actually used to access the Internet at broadband speeds, not subscriptions with potential access, even though the latter may have broadband-enabled handsets. Subscriptions must

include a recurring subscription fee to access the Internet or pass a usage requirement. The data must be collected over a period of time for example the previous three months. It should also include subscriptions to mobile broadband networks. The survey must also specify the available download speeds (e.g. WCDMA, HSPA, CDMA2000 1x EV-DO, WiMAX IEEE 802.16e and LTE) and should exclude subscriptions that only have access to GPRS, EDGE and CDMA 1xRTT.

ICT Investment- This should reflect the amount of money the MDA is investing into ICT. The survey should be carried out to determine the investment in emerging technologies. The average answer to a survey question should also be formulated concerning the extent to which the MDA invest in emerging technologies. The emerging technologies indicator could be a simply worded question regarding the MDA using emerging technologies such as Artificial intelligence, Robotics, App- and web-enabled markets, Big data analytics, and Cloud computing. The data to be collected in this regard must also reflect the rapid proliferation of mobile devices like smartphones, tablets and notebooks, which provide internet access via cellular networks and are supplementing traditional work desktop PCs.

A. Workforce Empowerment

The survey question should be designed to reflect the ICT skills of the employee of the MDA. This should include data about education and training available to employees. The survey questions should also include ICT survey skills related to empowering the workforce. This survey should majorly be administered to all employees of the MDA, and they should provide an answer to survey questions concerning the extent that an MDA has helped them to possess sufficient digital skills, such as “In your MDA, to what extent are staff supported to possess sufficient digital skills (e.g., computer skills, basic coding, digital reading)?” this should be graded efficiently e.g using 1 = not at all; 10 = to a great extent.

The survey question should also include the use of social media networks for both the MDA and the staff. The social media indicator should help determine the penetration of active social media accounts of the MDA and personal social media accounts of staff expressed as a percentage of the total population. There should also be questions to determine the ICT professional level of the employees. The ICT professional’s indicator should be based on the number of ICT professionals as a share of the total workforce.

The survey should also include employment categories such as physical, mathematical, and engineering science professionals, Life science and health professionals, and teaching professionals in legal and social sciences. The categories should also include technicians and associate professionals. Technicians and associate professionals, and all these should be reflected in percentages. This is needed to determine the appropriate background of the staff and how effective it is to use ICT based on the staff background. For example, the technicians and associate professionals indicator would refer to the number of technicians and associate professionals as a percentage of the total workforce.

The survey question should also include the gender gap in Internet use between female and male employees. The gender gap in the Internet use indicator would be to determine the share of women and men in the MDA that uses the Internet and their skills level. These scores should be calculated as the ratio of the share related to the female size over the share related to the male population. Females employed with advanced degrees refers to the percentage of females employed with advanced degrees out of the total employed population.

B. Innovation and ICT technology Adoption

This survey should indicate primarily how to assess the quality of MDA's delivery of online services on a scale of maybe 0-to-10 (best). The survey should create an assessment to evaluate each MDA's website, including the portal, e-services portal, and e-participation portal. The questions or research should also include workplace flexibility as a result of using ICT, and e-invoice, among others, as indicated in the indicators table.

C. Customer Satisfaction

Today, customer experience has become an essential brand differentiator and will probably surpass price and product soon. People expect a consistent experience from MDAs, and it does not matter whether it is an in-person or digital customer. Satisfaction refers to how happy the customers become as this is important as that would be the advocate of the MDA as happy customers are willing to spread a good word about the MDA and its effectiveness. However, as explained earlier, this measure might be difficult except if the survey question would also be sent out to the customers themselves, as most MDA has no substitute, and customers might have no alternative. The survey question should also examine the following.

Customer Engagement: This category refers to improvement in customer satisfaction and interactivity. Measures include customer usage of digital tools, increase in lead generation, customer hours saved, various digital marketing KPIs, customer retention, and platform registrations.

D. Jobs and Growth

This category of survey question should focus on the improvement of employee satisfaction growth and productivity. Measures related to: employee usage of digital tools, hours of work saved, reduction in safety incidents, the extent of remote work, satisfaction with digital tools, and employee recruitment and retention should be included in the survey. The survey should reflect indicators related to working hours saved due to the use of digital technologies; employee incident reduction as a result of the use of the digital platform is also an important indicator to assess a successful digital transformation. The survey question should also include IT staff engagement and IT training for the employee of the MDA.

E. Digital public service

Digital public service reflects the level of digitalization in the MDA. This survey should measure how digital the MDA is in terms of digitalizing products offered to citizens and other businesses, such as when asking for an expression of interest for contracts. R& D expenditure should also be captured because without research, there cannot be development. The indicators in the survey must also include the level of open data available by the MDA, the availability of guidelines in electronic forms for staff to easily access them. R&D expenditure refers to all expenditure, including all current expenditure plus gross fixed capital expenditure for R&D performed by the MDA. The survey should also include indicators of privacy. The survey on privacy should be a simply worded

question on the policy of the MDA in managing the data and privacy of the customers. This could be in the form of an indicator to responses on privacy protection given on a 0-10 scale.

6.0 The Digital Transformation Calculation

The transformation calculation would be mathematically calculated using a weighted average of the six dimensions normalized scores. The normalized score would be based on the most important dimensions identified based on the adopted definition of the digital economy and the goals identified prior to the normalization of the component indicators, the Z-score standardization procedure should be implemented for each component indicator to ensure that the overall value is equally decided by the six component indicators i.e. each component index presents comparable variance subsequent to the Z-score standardization. In the absence of the Z-score standardization treatment, the output would mainly depend on the component index with the greatest dispersion. After the Z-score standardization, the arithmetic average sum becomes a good statistical indicator, where “equal weights” truly means “equal importance. “For standard Z-score calculation of each component indicator, the formula below should be applied.

$$Z_A = \frac{x - \mu}{\sigma}$$

where

x is a raw score to be standardized;

μ is the mean of the population;

σ is the standard deviation of the population.

An example

$$\begin{aligned}
\text{Digital trnsformation}(T) = & \text{Infrstucture}(I) \times 0.166 + \text{Jobs growth}(G) \times 0.166 + \\
& \text{Digital Public service for citicien}(D) \times 0.166 + \text{workforce Empowerment s}(E) \times \\
& 0.166 + \text{Customer Satisfaction}(C) \times 0.166 + \\
& \text{Innovation and ICT Technology Adoption}(A) \times 0.166
\end{aligned}$$

Another method that can be sued is to classify each of the indicators under some basic classification then normalizing the values to a constant which can be 1

$$\text{Digital trnsformation}(T) = \text{Consumption} + \text{Investment} + \text{Satisfaction} + \text{Growth}$$

7.0 Implementation Process

For the implementation of this framework, a number of steps must be taken.

1. The Definition of Digital transformation. There should be a wide consultation on what should be the definition to be adopted, and this would guide the indicators to be used.
2. Roundtable of all MDAs: All MDA should be invited as their cooperation would be critical to implementing this framework.
3. Appoint an independent firm to collect the data pool, and the firm must have a publicly available database. The firm must have a statistic unit and must be legally independent. The firm must stratify sampling design. Stratification cells are defined by MDA size in terms of the number of employees, as well as the MDA's industry affiliation.
4. Telephone interviews should be conducted for randomly selected staff of the MDA to cut across various departments of the MDA. However, this must also include the Head of the IT department of the MDA as well as the Head of the MDA.
5. A separate ICT Survey should be conducted regularly to include questions which are intended to describe the general ICT intensity of the MDA. Survey framework and are therefore comparable to measures used in the administrative surveys.

6. MDA's should be encouraged to make the necessary data set available publicly for verification.
7. Ensure that the questionnaire inquiries about the organization's ability to adapt in terms of value creation as well as organizational adjustments.

8.0 Recommendations on the survey

Holistic Measurement

There is a need to measure in a holistic way. This is because not all the proposed indicators are needed for every digital transformation. However, it is recommended to adopt measures *across* the categories (breadth) in addition to *within* a category (depth). One of the main failure points comes from not considering the wider implications breadth matters.

Even when the necessary data is not available, the consultant engaged should make an extra effort to set up a first version of the indicators s. Measures may start off as percentage improvements or absolute gains, and they can be fine-tuned in time based on additional findings, resources, results obtained and evolving needs– the measurements don't need to be perfect right from the start.

There would also be some Challenges in reviewing an MDA's online presence. The appropriate site/URL must be selected while experts should be involved in the assessment based on the selected pre-criteria. MDAs should be requested to provide information regarding their website addresses (URL) for different purposes, including portal(s). Information should also be requested with regards to open government data, e-participation and the designated authority in charge of e-policies. MDAs with multiple sites should indicate the "official" site in the sense that the gateway

or starting point for users. The survey researchers should not only review the main website or portals but should also do exhaustive research on e-participation and open data where applicable

Data Quality Check

Data quality should be checked in order to ensure data quality, There should be a survey procedure in place and this should be under close monitoring, including by developing a web-based application platform for data collection and storage, preparing the methodological and training guidelines for researchers conducting the survey, and instituting an interactive session for all MDA to resolve thorny issues.

There is also a need to ensure public access to information and protect fundamental freedoms in accordance with national legislation and agreements. The survey should evaluate the provision of online information, including open MDA data.

Imputation of missing data

A critical step in the construction of the indicator is to create a complete data set without missing values. A number of imputation techniques can be applied to estimate missing data. Each of the imputation techniques, like any other method employed in the process, has its own strengths and weaknesses. The most important consideration is to ensure that the imputed data will reflect the actual level of ICT access, usage and skills of the MDA.

Normalization of data

Data normalization must be effected before any aggregation can take place to ensure that the data set uses the same unit of measurement. Regarding the indicators selected to construct the measurement, the values must be converted into the same unit of measurement since some values

are expressed as a percentage of the population/total employees and so on. Furthermore, certain particularities need to be taken into consideration in selecting the normalization method. A further important criterion in selecting the normalization method is replicability by MDA, as some MDAs would show to have shown a strong interest in applying the Index methodology to improve their working method.

Weighting and aggregation

The indicators and sub-indices must be properly weighted. This should be done and agreed to by all MDAs in order for MDAs to agree with the outcome.

Sensitivity analysis

Sensitivity analysis should be carried out to investigate the robustness of the results in terms of the relative position in the overall ranking of MDA using different combinations of methods and techniques to compute the indicators. Potential sources of variation or uncertainty can be attributed to different processes employed in the computation of the result, including the selection of individual indicators, the imputation of missing values and the normalization, weighting and aggregation of the data. Each of the processes or combination of processes affects the final value. A number of tests should be carried out to examine the robustness of the results (rather than the actual values). The tests should compute the possible values.

Finally, to develop an appropriate methodology, there is a need for agreement between representatives of MDAs beforehand.