

Impact of Cost-Based Factors on the Deployment of Cost-Based Knowledge Management in Nigerian Construction Firms

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Abstract. Deploying cost-based knowledge management (CKM) by Nigerian construction firms (NCFs) requires knowledge of the impact cost-based factors exert on the adoption capacity of NCFs and the implementation processes of CKM. This study aims to assess the impact cost-based factors exert on the CKM adoption capacity of NCFs and the CKM implementation processes towards a complete deployment of CKM by NCFs. This study addresses the knowledge gap on cost-based factors for CKM deployment. It brings coherence to their impact on CKM adoption and implementation in the construction sector. Also, NCFs suffer revenue losses from poor cost performance on large projects. Deploying innovative Cost Management (CM) methods such as CKM can improve cost performance. A quantitative research design deployed a systematic random survey of NCFs with expertise in transport infrastructure projects to generate data for the study. Structured questionnaires were administered to NCFs, and principal component analysis extracted variables for the study. The average commonalities and Spearman's correlation coefficients explained the factors' impact on CKM deployment. CKM adoption capacity in NCFs is impacted by funding/financial resources, tangible and intangible expenditures, and construction project costs. Whereas, for CKM implementation, in addition to the factors mentioned earlier, budget limitations and cost of knowledge combined significantly impact the implementation processes. The study concluded that cost-based factors exist in the construction sector, and they significantly impact CKM deployment. The study recommended that NCFs prioritise cost-based and other factors when strategising for CKM deployment.

Keywords: Cost-based Factors, Cost-based Knowledge Management, Cost Management, Cost Performance, Deployment, Nigerian Construction Firms.

Introduction

The construction sector in Nigeria is primarily dominated by Indigenous small and medium-sized firms that grew from entrepreneurial efforts but desire to develop and become large firms (Saka & Olanipekun, 2020). However, achieving the desired transition to large firms is rare for these firms due to the many challenges they face in the sector (Azeem et al., 2020). Stiff competition from larger, more prosperous firms is evident, especially in the civil works category, where large infrastructure projects are carried out (Saka & Olanipekun, 2020). Also, the inability to innovate on cost-dependent processes reduces the cost-performance efficiency of the firms (Adu et al., 2020). Indigeneity does not favour these firms because the open tendering regime in Nigeria puts the firms at a disadvantage to price low to beat the competition from larger local and foreign firms (Oladimeji, 2021). Larger or expatriate firms, on the other hand, enjoy selective tendering processes, which improve their chances of a fair tender price. Therefore, the economic sustainability of indigenous small and medium construction firms is not assured, and it is further compounded by their inability to evolve newer methods to ensure continuous cost performance and competitiveness (Okolie et al., 2020).

The Indigenous small and medium-sized firms referred to in this study as Nigerian Construction Firms (NCFs) do not show evidence of adoption of innovative processes (Otali et al., 2020) such as Knowledge Management (KM), unlike their larger or foreign counterparts (Eggunatum & Oboreh, 2022). Implementing KM in firms is known to enhance the firm's capacity by improving processes, reducing the incidence of reworks, and ultimately increasing their chances of survival (Bamel et al., 2021). Over time, KM has become a dynamic process in several aspects of the organisation, such as construction project Cost Management (CM) (Okolie et al., 2020). Innovative Cost-based Knowledge Management (CKM) is a KM process that deploys cost-based knowledge through the dynamic KM implementation processes for CM of construction activities. However, implementing innovations such as CKM is still required for coherence in the literature, especially knowledge of cost-related factors that inhibit its deployment (Eggunatum & Oboreh, 2022). KM Cost-based models are primarily deployed in other industries, such as banking and finance (Singh & Pradhan, 2024), rather than construction. The existing construction-based KM models are designed for highly informatized organisations (Yap & Skitmore, 2020), while others are country-specific or process- and activity-based (Hwang et al., 2020). NCFs do not readily adopt or implement knowledge-based innovations such as CKM because of the apparent cost-based factors that will be required (Okolie et al., 2020). Depleting already reduced profits

for innovations is a hard decision for NCFs (Oladimeji, 2021). Understanding the impact these factors exert on adopting and implementing the KM processes can assist the firms in reaching a cost-conscious decision when planning a strategy for CKM deployment.

A construction firm's economic sustainability is mainly dependent on its ability to achieve continuous cost performance on projects (Kim, 2019). NCFs are already pricing low to win projects and require more innovative CM methods to boost their achievable profits from construction projects. The need for steady cost performance cannot be overemphasised in the context of the NCF (Khedr & Abdelalim, 2021). Therefore, the cost performance of the NCFs is a pivot to their competitiveness and growth (Adoji & Paul, 2021).

This study examines the cost-based factors that inhibit deploying innovative CM strategies such as CKM in NCFs. Specifically, the study's objective is to assess the impact of cost-based factors on the CKM adoption capacity of NCFs and the CKM implementation processes. With this knowledge, NCFs can articulate the factors and understand the variables of importance in deploying CKM. This will help NCFs reach cost-conscious decisions in the deployment of CKM and ultimately assist them in achieving enhanced CM strategies towards continuous cost performance. Critical aspects of the literature review for the study are further outlined.

1. Knowledge Management in Nigerian Construction Firms

Rasheed et al. (2019) identified that NCFs' reluctance to adopt KM is due to the perceived high capital outlay that precedes its' deployment, contributing to management's lack of interest. Also, NCFs employ more ad-hoc staff for specific projects; therefore, maintaining a knowledge-centric workforce is difficult (Egwunatum & Oboreh, 2022). Managers' strategic decision to adopt KM is often hampered by the dearth of knowledge workers retained in the firm. To adopt and implement KM, NCFs must be strategic about its adoption (Oliva & Kotebe, 2019). Retaining knowledge workers is essential in addition to providing enabling finances to meet the KM process capacity (Rasheed et al., 2019). To equally exploit the dynamic nature of KM, management must deploy strategies that accommodate the use of KM implementation processes in several other construction-related activities, such as CM, for enhanced cost performance (Bamel et al., 2021).

Growing a firm requires some radical but practical changes in the work methods and means of achieving results that will positively impact the firm (Bhattacharya et al., 2021). Innovative strategies and more ingenious methods must be introduced for enhanced efficiency (Khedr & Abdelalim, 2021). Poor CM processes and abysmal cost performance have been identified as a bane of NCFs (Igwe et al., 2020). The inability of site workers to make cost-conscious decisions in the project space is consistently seen as a contributor to poor project cost performance (Nath-Raj & Mouli, 2018). Therefore, improving the CM processes is essential to achieve better cost performance. As a result, deploying CKM for enhanced CM is an innovation that can positively impact the continuous cost performance of projects by NCFs (Adoji & Paul, 2021). Hence, it is vital that the cost-based factors surrounding the deployment of the CKM is understood.

1.1 Cost-based Factors

The capacity of NCFs to navigate the cost-based factors that inhibit CKM deployment is a critical knowledge required of NCFs. Several cost-based factors were considered important in literature but lack the coherence to articulate their strengths and what they affect clearly. For instance, Nsubuga-Mugoa (2019) posited that funding and financial constraints are vital challenges that hinder the competitiveness of NCFs in the infrastructure sector. Similarly, lack of funding for innovations, poor financial resource management and inefficient credit systems were worries expressed by NCFs for the non-adoption of new methods (Adu et al., 2020).

Another line of thought examined the low derivable profits that emanate from the challenging tender process of NCFs (Oladimeji, 2021). The position averred here is that with the low profits, NCFs cannot create budget heads for innovations such as CKM (Yusof et al., 2019). Therefore, it is difficult to expend resources on tangible investments such as knowledge processes and infrastructure capacity or knowledge management information technology systems (Elfar et al., 2017). Similarly, the need to employ knowledge workers or expenses on intangible dimensions, such as for the development of requisite skills, expertise, and capacities of the human resource to enhance knowledge creation, use and retention is vital (Inkinen et al., 2017). These cost-based factors scare NCFs because of limited knowledge of the extent and the areas the factors affect more. Developing human resources capacity to transform explicit and tacit knowledge into organisational knowledge is critical (Oliva & Kotebe, 2019).

In the firm, KM capacity is measured by the ability to retain knowledge of the firm, its learning capacity and the content of its organisational memory (Olanrewaju et al., 2019). Hence, for KM to be intentional, NCFs must pay attention to the cost of knowledge, bearing in mind that construction is a knowledge-intensive industry (Yan et al., 2020). Planning for

knowledge retention is critical for organisations to thrive and prevents knowledge loss (Levallet & Chan, 2019). Construction project cost is equally a key determinant for construction firms' prosperity. Any factor that affects the construction cost negatively will lead to a loss of revenue for the firm (Snyman & Smallwood, 2017). NCFs battle with incomplete information for cost estimation, often compounded by design changes (Habibi et al., 2018).

1.2 Cost-based Knowledge Management Implementation Processes

KM implementation processes typically involve identifying, creating, capturing, storing, sharing and using knowledge in the firm (Lee et al., 2020). Though not sacrosanct, the processes have evolved to accommodate critical dimensions such as knowledge reuse and updating (Singh & Pradhan, 2020). Similarly, the dynamic nature of KM has necessitated an expanded taxonomy in this area (Wang & Lee, 2020). For KM processes to be adequately defined, the nature of knowledge being managed is essential. For instance, in CKM, cost-based knowledge is managed. This will require constant learning, coding measurement and growth to make it useful in the project space (Zhang et al., 2019). Therefore, CKM implementation processes must accommodate these additional taxonomies in the knowledge creation and capture space. The synthesised conceptual CKM implementation processes are shown in Figure 1 below:

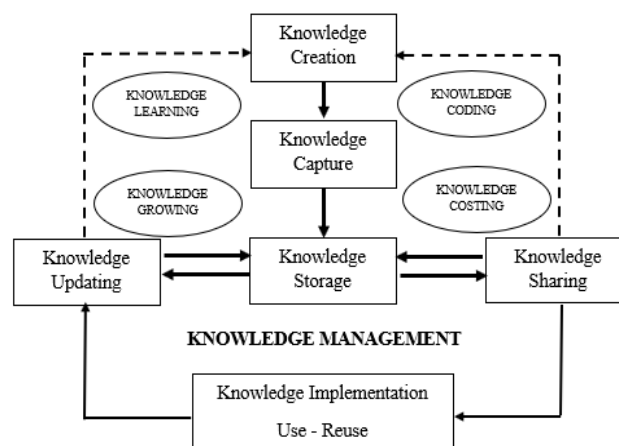


Figure 1: Conceptual Integrated Cost-based Knowledge Management Implementation Processes

The conceptual process comprises the learning, coding, costing, and growing cost-based knowledge within the knowledge creation and capture space. This will ensure that the knowledge stored is useable and can be shared. Equally used knowledge needs to be updated and restored. Similarly, archival cost-based knowledge must also be updated to meet current needs.

Methodology

The study synthesised 48 variables to measure six cost-based constructs following a comprehensive literature review. Principal Component analysis (PCA) was used to reduce the variables to 20 component variables measuring the six constructs. PCA employed varimax rotation with Kaiser normalisation in IBM SPSS 23 statistics (Kumar, 2020). Variable components were selected based on the threshold values of the extracted eigen values ≥ 1 and the rotated communality ≥ 3 , with factor loading ≥ 5 (Hair et al., 2020). Cronbach's values were considered adequate when ≥ 0.7 , while KMO measures of ≥ 0.6 are considered acceptable for the study (Hair et al., 2020; Kaiser, 2018). Finally, the test for sphericity values of $p < 0.005$ indicates adequate correlation among the constructs (Kaiser, 2018; Saunders et al., 2019).

Descriptive statistics of Skewness and Kurtosis were employed to test the normality of the extracted components and to select appropriate statistical tools to test the impact of the factors on CKM deployment (Trochim, 2020). Skewness and Kurtosis values are deemed appropriate to show reasonable normality at 0 to +1.0 and 0 to +3.0, respectively, while the z-score of skewness values above +3 indicates the presence of outliers (Hair et al., 2020; Saunders et al., 2019). Where the distribution shows outliers, a non-parametric test is recommended to test impacts (Saunders et al., 2019). Pearson's rank correlation coefficients examined the linear correlation of the synthesised CKM implementation processes. This process is required to determine how related the implementation processes are to each other and how consistently the relationships between them increase or reduce (Saunders et al., 2019). On the other hand, the non-parametric Spearman's rank correlation analysis examined the impact of the cost-based factors on CKM adoption capacity by the NCFs and the earlier implementation processes outlined (Stephanou, 2021).

The study employed a systematic random sampling procedure (Mostafa & Ahmad, 2020) to select NCFs that are registered with the Nigerian Bureau of Public Procurement (BPP) in the civil works category and with expertise in transport infrastructure comprising road/bridge works, airports/terminals/parks, seaports/waterways and rail mass transport infrastructure. The NCFs in these areas of expertise were considered because they are the most vulnerable to severe competition from larger firms. The NCFs were scrutinised to ensure they are Indigenous and are small and medium-sized firms as defined by the Small and Medium Enterprise Development Agency (SMEDAN, 2021). The study received a total of 1714 registered NCFs, and 630 questionnaires were sent out based on a generated sample size of 315 using the Krejcie and Morgan table (Bukhari, 2021) and a 50% response rate apathy (Saunders et al. (2019).

Results

The study received 252 responses from the survey. Five responses, however, did not match the study's criteria and were eliminated from the analysis. Therefore, a total of 247 responses were used for analysis. This represents a 78.41% response rate when measured against the sample size of 315 generated for the study.

Characteristics of Respondents

The respondents' characteristics are examined first based on the quality of the selected firms and then on the quality of the professionals within the firm who responded to the distributed questionnaire. The characteristics of the NCFs selected for the study are presented in Table 1 below.

Table 1: Characteristics of Respondent NCFs for the Study.

Category	Classification	Freq.	Valid %	Cumulative %
Area of Firm's Specialization	Road Infrastructures	134	54.3%	54.3%
	Rail Infrastructure	26	10.5%	64.8%
	Seaports & Waterways	25	10.1%	74.9%
	Airports/Parks/Terminals	62	25.1%	100.0%
	Total	247	100.0%	
Firm's Experience in NCI	1 - 5 years	3	1.2%	1.2%
	6 – 10 years	43	17.4%	18.6%
	11 – 15 years	76	30.8%	49.4%
	16 – 20 years	81	32.8%	82.2%
	Above 20 years	44	17.8%	100%
	Total	247	100.0%	
Average Projects done in 5yrs.	1 - 5 Projects	72	29.1%	29.1%
	6 – 10 Projects	100	40.5%	69.6%
	11 – 15 Projects	44	17.8%	87.4%
	16 – 20 Projects	19	7.7%	95.1%
	Above 20 Projects	12	4.9%	100.0%
	Total	247	100.0%	

Each firm was contacted to supply a knowledge worker with strategic experience to respond to the questionnaires. The firm's respondent is expected to be able to make cost-conscious decisions relating to strategy deployment at operational, tactical, or strategic levels. Therefore, experience in the project sector and managing large projects is vital. The characteristics of the professionals selected from the firms are presented in Table 2.

The study sampled firms actively participating in the transport infrastructure sector either as main or subcontractors. 40% of the firms handled between 6 and 10 projects in the last 5 years, while more than 25% handled between 10 and 20 projects. Experience-wise, over 80% of the firms have been in the sector for over 10 years. This translates to firms with ample experience and knowledge of the subject area to respond to the study questions.

Table 2: Characteristics of Respondent Professionals from the NCFs

Category	Classification	Freq.	Valid %	Cumulative %
Age	20 – 35 years	35	14.2%	14.2%
	36 – 50 years	139	56.3%	70.4%
	Above 51 years	73	29.6%	100.0%
	Total	247	100.0%	
Profession	Architect	44	17.8%	17.8%
	Quantity Surveyor	73	29.6%	47.4%
	Builder	27	10.9%	58.3%
	Civil/Struct. Engr.	78	31.6%	89.9%
	Mechanical Engr.	12	4.9%	94.7%
	Electrical Engr.	13	5.3%	100.0%
	Total	247	100.0%	
Professional Affiliations	NIA	44	17.8%	17.8%
	NIQS	73	29.6%	47.4%
	NIOB	46	18.6%	66.0%
	NSE	83	33.6%	99.6%
	Others: NIS	1	0.4%	100.0%
	Total	247	100.0%	
Highest Acad. Qualifications	OND	0	0%	0%
	HND	5	2.0%	2.0%
	B.Tech./B.Sc.	62	25.1%	27.1%
	PGD	4	1.6%	28.7%
	MTech. /M.Sc.	129	52.2%	81.0%
	MPhil	7	2.8%	83.8%
	PhD	40	16.2%	100.0%
	Total	247	100.0%	
Length of Experience	1 - 5 years	13	5.3%	5.3%
	6 – 10 years	34	13.8%	19.0%
	11 – 15 years	69	27.9%	47.0%
	16 – 20 years	56	22.7%	69.6%
	Above 20 years	75	30.4%	100.0%
	Total	247	100.0%	

Though the unit of measurement for the study is the firm, the respondents were selected professionals within the firm. The results revealed that 56% of respondents are aged 36 – 50. This represents a high percentage of active-aged participants in the industry (Adu et al., 2020). Similarly, over 30% have more than 20 years of experience in the industry, and over 50% have experience between 10–20 years. The need for diverse opinions was achieved from the spread of the professionals, which has Architects (17.8%), Quantity Surveyor (29.6%), Builders (10.9%), Civil Engineers (31.6%), and Services Engineer (10.2%) the mix. All respondents are professionally affiliated with their respective organisations, while over 70% have additional educational degrees in their respective fields. The professionals' spread and experience indicate that the respondents are suitable for the study. In addition, the respondents represent an informed workforce suitable for the study.

Principal Component Analysis of Cost-based Factors.

Six constructs comprising 48 variables were subjected to factor reduction. PCA extraction using varimax rotation with Kaiser normalisation produced 20 variables measuring the six constructs. The constructs are funding/financial resources, budget limitations, tangible expenditure, intangible expenditure, cost of knowledge and construction project costs. Variables that measure these constructs were extracted based on the thresholds of the factor loadings, eigenvalues, commonalities and statistical significance earlier described in the methodology section. The structure of the extracted components from the PCA analysis for each construct is presented in Tables 3 - 8.

Table 3: PCA Measures for Funding and Financial Resources.

Items	Component*			h ₂	Eigen Value	α	Average h ₂
	1	2	3				
Funding and Financial Resources (FFR)	λ	λ	λ			0.784	0.725
FFR1 - Financial capital/resources	0.960			0.924			
FFR6 - Financial resource Mangt.	0.960			0.928	2.023		0.926
FFR2 - Cost of funding KM Processes		0.792		0.628			
FFR5 - Resource allocation		0.737		0.595			
FFR7 - Working capital management		0.723		0.558	1.632		0.593
FFR3 - Cost of doing business			0.803	0.655			
FFR4 - Access to external financing			0.808	0.658	1.290		0.657
% of Variance Explained							70.64%
Kaiser–Meyer–Olkin measure of sampling adequacy.							0.650
Bartlett’s test of sphericity				Approx. Chi-Square			467.29
				Df.			21
				Sig.			0.000

*PCA extraction using Varimax rotation with Kaiser normalisation. Rotation converged in 4 iterations; h₂ = Communalities; α = Cronbach’s Alpha; λ = Factor Loading

Results from Table 3 show that three components with eigenvalues>1 measured funding/financial resources, explaining 70.64 % of the total variance. Also, the components have high factor loadings > 0.7 and communalities> 0.6, which are above the minimum threshold. The Cronbach’s Alpha of 0.78 and average communality of 0.75 indicate good internal consistency. Similarly, the KMO measure is 0.65, and the construct is statistically significant. Therefore, funding/financial resources are measured using three variables for this study. The three components were renamed (see Table 9), bearing in mind the combined variables to form them.

The budget limitation also has three components explaining 73.46% of the total variance and with eigenvalues>1, as shown in Table 4. In addition, the components have high factor loadings > 0.7 and communalities> 0.6. The Cronbach’s Alpha of 0.70 and average communality of 0.74 indicate good internal consistency. The KMO measure is 0.62, which is statistically significant for the factor. As a result, budget limitation is measured using three variables for this study. The three components were renamed, bearing in mind the variables that combine to form them, as outlined in Table 9.

Table 4: PCA Measures for Budget Limitations.

Items	Component*			h ₂	Eigen Value	α	Average h ₂
	1	2	3				
Budget Limitations (BL)	Λ	λ	λ			0.695	0.735
BL 1 - Tendering price of projects	0.891			0.795			
BL 2 - Budget provisions to org.	0.863			0.761	1.930		0.778
BL 5 - Investment in innovation		0.875		0.668			
BL 4 – Cost of implementing processes		0.810		0.723	1.369		0.696
BL 3 - Budgeting for new initiatives			0.809	0.796			
BL 6 - Cost of strategy adoption			0.793	0.663	1.109		0.730
% of Variance Explained							73.46%
Kaiser–Meyer–Olkin measure of sampling adequacy.							0.622
Bartlett’s test of sphericity				Approx. Chi-Square			229.63
				Df.			15
				Sig.			0.000

* PCA extraction using Varimax rotation with Kaiser normalisation. Rotation converged in 4 iterations. h₂ = Communalities; α = Cronbach’s Alpha; λ = Factor Loading

Three constructs also emerged to measure tangible expenditure, explaining 77.16% of the total variance, as shown in Table 5. The Cronbach’s Alpha for this factor is 0.81, and the average communality is 0.77. Similarly, factor loadings are consistently > 0.7. Although TE3 is loaded on two components, the second-factor loading is just above the three and is below the threshold used in this study.

Table 5: PCA Measures for Tangible Expenditure.

Items	Component*			h ₂	Eigen Value	α	Average h ₂
	1	2	3				
Tangible Expenditure (TE)	λ	λ	λ			0.810	0.772
TE 1 - Manual document archiving	0.900			0.818			
TE 2 - Document Mangt. Systems	0.854			0.806	2.357		0.812
TE 5 - I.T Infrastructure		0.884		0.790			
TE 6 - Knowledge Infra. Capability		0.812		0.739	1.284		0.765

TE 4 - Knowledge Process Capability		0.841	0.778		
TE 3 - Special purpose software cap.	0.341	0.734	0.698	1.059	0.738
% of Variance Explained					77.16%
Kaiser–Meyer–Olkin measure of sampling adequacy.					0.688
Bartlett’s test of sphericity		Approx. Chi-Square			327.88
		Df.			15
		Sig.			0.000

* PCA extraction using Varimax rotation with Kaiser normalisation. Rotation converged in 4 iterations. h2 = Communalities.

α = Cronbach’s Alpha; λ = Factor Loading

Therefore, the weaker loading is ignored in favour of the high loading on component 3. Tangible expenditure is hereby measured with three component variables, renamed to reflect the combined variables to form the new components (see Table 9).

On the other hand, intangible expenditure has four components, which explain 75.94% of the total variance, as shown in Table 6.

Table 6: PCA Measures for Intangible Expenditure.

Items	Component*				h ₂	Eigen Value	α	Average h ₂
	1	2	3	4				
Intangible Expenditure (IE)	λ	λ	λ	λ			0.799	0.766
IE 1 - Organisational Structure	0.883				0.788			
IE 2 - Cultural reorientation	0.825				0.735			
IE 8 - Training of existing staff	0.671		0.378		0.621	2.753		0.715
IE 7 - Recruiting knowledge workers		0.907			0.832			
IE 9 - KM Capacity		0.918			0.843	1.775		0.838
IE 5 - Communication networks			0.874		0.778			
IE 6 - Knowledge repository	0.311		0.799		0.748	1.215		0.763
IE 3 - Internet and elect. mail capacity			0.345	0.718	0.693			
IE 4 - Organisational learning capacity				0.849	0.798	1.091		0.746
% of Variance Explained								75.94%
Kaiser–Meyer–Olkin measure of sampling adequacy.								0.646
Bartlett’s test of sphericity				Approx. Chi-Square				620.92
				Df.				36
				Sig.				0.000

* PCA extraction using Varimax rotation with Kaiser normalisation. Rotation converged in 5 iterations. h2 = Communalities; α = Cronbach’s Alpha;

λ = Factor Loading

The factor loadings equally are mostly > 6, except for three variables (IE8, IE6, and IE3) loaded on two components. The weaker loading was ignored for the more substantial factor loadings. Internal consistency is equally strong at an Alpha value of 0.8 and an average communality of 0.77. KMO values are adequate at 0.65, and the statistic is significant. The four components were renamed for further analysis, as shown in Table 9.

PCA extracted three components for Cost of knowledge with factor loading > 5 and communalities > 3, shown in Table 7. The extracted components all have average communalities > 7, and the Alpha value is also high at 0.71. The three

Table 7: PCA Measures for Cost of Knowledge.

Items	Component*			h ₂	Eigen Value	α	Average h ₂
	1	2	3				
Cost of Knowledge (CK)	λ	λ	λ			0.710	0.758
CK 1 - Knowledge location and use	0.857			0.766			
CK 2 - Cost of data and information loss	0.864			0.777			
CK 3 - Cost of knowledge codification	0.547		0.516	0.573	2.202		0.705
CK 5 - Knowledge creation		0.891		0.799			
CK 6 - Information cost	0.422	0.689		0.671	1.131		0.735
CK 4 - Data security			0.895	0.835	1.094		0.835
% of Variance Explained							73.77%
Kaiser–Meyer–Olkin measure of sampling adequacy.							0.629
Bartlett’s test of sphericity				Approx. Chi-Square			269.12
				Df.			15
				Sig.			0.000

* PCA extraction using Varimax rotation with Kaiser normalisation. Rotation converged in 4 iterations. h2 = Communalities; α = Cronbach’s Alpha;

λ = Factor Loading

components are responsible for 73.77% of the total variances explained. CK3 loaded with similar values on components 1 (0.547) and 3 (0.516). The variable considered for component 1 is the most potent factor loading. Therefore, three components were renamed, as contained in Table 9, for the cost of knowledge.

Construction Project Cost also emerged with four components explaining 73.28% of the total variance, as shown in Table 8. This construct recorded multiple significant factor loadings with positive and negative loadings. The more substantial factor loading is considered in each of the cases. All factor loading considered for this construct are > 0.5 and are positively correlated. The internal consistency value is high, with an Alpha value of 0.75 and an average communality of 0.73. This study, therefore, recorded four components for this factor; they were renamed and used for further analysis, as contained in Table 9.

Table 8: PCA Measures for Construction Project Cost.

Items	Component*				h ₂	Eigen Value	α	Average h ₂
	1	2	3	4				
Construction Project Cost (CPC)	λ	λ	λ	λ			0.748	0.729
CPC 1 - Change in design	0.708			-0.341	0.751			
CPC 2 - Inclement weather conditions	0.658		0.494	-0.371	0.855			
CPC 9 - Economic impact (inflation)	0.827				0.744			
CPC 10 - Diversion of project funds	0.757		0.312	-0.387	0.821			
CPC 11 - Regulatory laws, levies, fees	0.894				0.839	4.654		0.802
CPC 6 - Material/Labour shortages	0.526	0.560			0.678			
CPC 12 - Fluctuation		0.711			0.613			
CPC 13 - Construction rework		0.791			0.693			
CPC 14 - Variations		0.696			0.616	2.325		0.650
CPC 3 - Project complexities	-0.417		0.778		0.797			
CPC 7 - Project size			0.781		0.663			
CPC 8 - Incomplete info. for costing	0.492		0.617		0.699	1.868		0.720
CPC 4 - Add. client requirements		0.414		0.695	0.685			
CPC 5 - Effect of retention				0.883	0.803	1.412		0.744
% of Variance Explained								73.28%
Kaiser–Meyer–Olkin measure of sampling adequacy.								0.663
Bartlett's test of sphericity				Approx. Chi-Square				2171.85
				Df.				91
				Sig.				0.000

* PCA extraction using Varimax rotation with Kaiser normalisation. Rotation converged in 5 iterations. h₂ = Communalities; α = Cronbach's Alpha; λ = Factor Loading

In summary, the produced component variables are distributed amongst the constructs as follows: funding and financial resources (3 variables), budget limitations (3 variables), tangible expenditure (3 variables), intangible expenditure (4 variables), construction project cost (4 variables), and cost of knowledge (3 variables).

The results show that the variables are internally consistent, with Cronbach's Alpha all ≥ 0.7 . Similarly, the average communalities of all the factors are greater than 0.7. This indicates that the variables that measured the factors are all significant; therefore, the factors that impact the outputs are significant.

Descriptive Analysis of Cost-based Factors.

The extracted components were used to test the impact of the cost-based factors on the deployment of CKM. To achieve this, the normality of the data was ascertained, and the presence of outliers was checked to determine an appropriate tool for the correlation analysis. Data for new components were transformed on SPSS from the previous data using the component score method (Hair et al., 2020). The component scores represent the new variable, a linear combination of the original variables. PCA factor loadings of the initial factors are employed to generate the component scores, while the linear combination of the data set also produces new data for analysis.

The skewness values obtained were all below the absolute value of normality of +2.1, but a clear majority shows values above +1 range. Also, kurtosis values are presented above the +3 threshold, and only one factor exceeds the extreme threshold of +7.1. These results indicate a near-normal distribution of data. However, further results from the z-score show the existence of multiple outliers because all values except one exceeded the +3.29 threshold suggested for sample sizes between 50 and 300 (Hair et al., 2020). Despite the distribution being near normal, multiple outliers indicate that the distribution is inappropriate for a parametric test (Stephanou, 2021). The renamed variables and the descriptive analysis are presented in Table 9.

Table 9: Descriptive Analysis of Cost-based Factors.

Code	Cost-Based Factors (Extracted Components)	N	μ	σ	α_3	α_4	Z
NFFR	Funding and Financial Resources						
NFFR1	Funding constraints & economic capital management.	247	4.427	0.837	-	1.793	11.576
NFFR2	Capital charge and resource assignment to KM processes	247	3.889	0.679	-	0.511	0.316
NFFR3	Cost of enterprise and organisational debt financing	247	3.911	0.707	-	0.586	0.058
NBL	Budget Limitations						
NBL1	Budgeting allotment to project tender prices	247	4.494	0.580	-	1.568	5.196
NBL 2	Costing innovative investment in KM process	247	4.235	0.910	-	1.330	0.966
NBL 3	Budgeting for KM strategy adoption	247	4.512	0.524	-	1.868	7.915
NTE	Tangible Expenditure						
NTE1	Document management methods and systems	247	4.709	0.464	-	1.537	2.070
NTE2	Knowledge and informatics infrastructure	247	4.464	0.592	-	1.415	3.014
NTE3	Knowledge process and software capacity	247	4.383	0.595	-	1.565	4.668
NIE	Intangible Expenditure						
NIE1	Capacity building and org. reorientation	247	4.652	0.441	-	1.479	2.971
NIE2	Organisational KM Capacity	247	4.174	0.661	-	0.737	0.679
NIE3	Knowledge repositories and communication	247	4.463	0.591	-	1.415	3.914
NIE4	Org. learning and knowledge sharing capacity	247	4.382	0.585	-	1.565	4.668
NCK	Cost of Knowledge						
NCK1	Knowledge codification management	247	4.476	0.473	-	1.568	3.157
NCK2	Knowledge creation cost	247	5.539	0.498	-	0.904	0.496
NCK3	Data security	247	4.239	0.719	-	0.656	0.116
NCPC	Construction Project Cost						
NCPC1	Project related risk (predictable)	247	3.349	1.160	-	0.589	0.913
NCPC2	Project related risk (unpredictable)	247	4.350	0.494	-	1.543	2.803
NCPC3	Project information and characteristics	247	3.900	0.826	-	0.877	0.389
NCPC4	Client influenced cost factors	247	4.504	0.626	-	1.504	3.320

* Extracted Components; N is the Number of respondents; μ is the mean; σ is standard deviation; α_3 is skewness; α_4 is Kurtosis; and Z is the Z-score. Standard error of skewness is 0.155

Due to the presence of multiple outliers from the z-score values, a non-parametric Spearman's rank correlation coefficient will be employed to test the impact of the factors of CKM deployment (Saunders et al., 2019).

Correlation Coefficients of CKM Implementation Processes

This study used Pearson's rank correlation to check the linear relationship between the implementation processes. Correlation strengths adopted all correlations up to 0.39 as a weak correlation, 0.40 to 0.69 as a moderate correlation, 0.70 to 0.99 as a strong correlation, and a correlation of 1 as a perfect correlation (Dancey & Reidy, 2020). The correlation and dispersion analyses of the CKM implementation processes are shown in Table 10.

Table 10: Pearson's Correlation Estimates for CKM Processes Used in the Study

Processes	N	μ	σ	1	2	3	4	5	6
KCRN	247	3.96	0.740	1					
KCPT	247	3.52	1.354	0.476**	1				
KSTG	247	3.66	0.859	0.236**	0.382**	1			
KSHR	247	3.75	0.770	0.384**	0.355**	0.637**	1		
KURS	247	4.48	0.830	-0.177**	-0.294**	-0.210**	-0.177**	1	
KUPT	247	4.14	0.744	0.179**	0.208**	-0.096	0.054	0.377*	1

** Correlation is significant at the 0.01 level (2 – Tailed)

N = Number of respondents; μ = mean; σ = standard deviation; KCRN = Knowledge Creation; KCPT = Knowledge Capture; KSTG = Knowledge Storage; KSHR = Knowledge Sharing; KURS = Knowledge Use and Reuse; KUPT = Knowledge Update.

The results show that all the KM implementation processes are correlated with each other. Correlations are, however, weak and positive in most cases except for knowledge capture with knowledge creation (+0.48) and knowledge sharing with knowledge storage (+0.64) with moderate correlation. Also, only knowledge use and reuse have a negative and weak correlation with all other processes. Despite the weak correlations, a linear relationship exists between the implementation processes. The dispersion of the mean from the central tendency, as shown with the standard deviation, shows high relationships. The data for the implementation processes were used to determine the impact of the cost-based factors in this study.

Correlation Coefficients of the Impacts of Cost-based Factors on CKM Deployment.

The respondents were requested to provide their KM adoption capacity. Adoption capacity was measured by the level of preparedness of the NCFs to implement a CKM strategy in their respective firms. The impact of the cost-based factors was tested in this capacity as predictor variables. The impact of the cost-based factors exerted on the adoption capacity is presented in Table 11.

Table 11: Spearman's Rank Correlation for Cost-Based Factors on KM Adoption in NCFs:

Factors	N	Rank (rho)	p-value
Funding and Financial Resources (NFFR)	247	0.753**	.000
Budget Limitations (NBL)	247	-0.006	.926
Tangible Expenditure (NTE)	247	0.547**	.000
Intangible Expenditure (NIE)	247	0.455**	.000
Cost of Knowledge (NCK)	247	-0.152*	.017
Construction Project Cost (NCPC)	247	0.644**	.000

*Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed)

rho = Spearman's Rank Correlation; p = Probability Value (Measure of Statistical Significance)

The results show that all the factors have a significant impact except budget limitation (-0.01) and cost of knowledge (-0.15), which are not statistically significant. Funding/financial resources (0.75) has a strong correlation, while construction project cost (0.64), tangible expenditure (0.55), and intangible expenditure (0.46) presented moderate correlations in that order.

Similarly, to test the impact of the factors on the implementation processes, the KM implementation processes were deployed as outcome variables. The predictor variables (cost-based factors) were tested on each outcome variable to fully understand the processes they impact, the nature of the impact (either positive or negative), and the strength of the impact they exert. The correlation coefficients of the cost-based factors on CKM implementation processes are presented in Table 12.

Table 12: Spearman's Rank Correlation for Cost-based Factors on KM Implementation Processes

Predictor Variables (Cost-based Factors)		Outcome Variables (KM Implementation Processes)					
		KCRN	KCPT	KSTG	KSHR	KURS	KUPT
Funding and Financial Resources	rho	0.703**	0.112	0.078	0.664**	0.007	0.572**
	P	0.000	0.079	0.222	0.000	0.910	0.000
Budget Limitations	rho	0.202**	0.235**	0.230**	-0.054	0.135*	0.099
	P	0.001	0.000	0.000	0.397	0.034	0.120
Tangible Expenditure	rho	0.423**	0.827**	0.760**	-0.326**	0.382*	-0.164**
	P	0.000	0.000	0.000	0.000	0.000	0.010
Intangible Expenditure	rho	0.806**	0.749**	0.569**	-0.151	0.375**	0.275**
	P	0.000	0.000	0.000	0.017	0.000	0.006
Cost of Knowledge	rho	0.748**	0.803**	0.222**	-0.142*	0.128*	0.727**
	P	0.000	0.000	0.000	0.026	0.044	0.000
Construction Project Cost	rho	-0.729**	-0.387**	-0.451**	0.597**	-0.318**	0.187**
	p	0.007	0.000	0.077	0.000	0.000	0.003

** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed)

rho = Spearman's Rank Correlation; p = Probability Value (Measure of Statistical Significance); KCRN = Knowledge Creation; KCPT = Knowledge Capture; KSTG = Knowledge Storage; KSHR = Knowledge Sharing; KURS = Knowledge Use and Reuse; KUPT = Knowledge Update.

Funding/Financial Resources strongly impact knowledge creation (+0.70) and moderately impact knowledge sharing (+0.66) and knowledge update (+0.57). Budget Limitation, on the other hand, weakly impacts knowledge creation (+0.20), knowledge capture (+0.24), knowledge storage (+0.23), and knowledge use/reuse (+0.14).

Tangible expenditure strongly impacts knowledge capture (+0.83) and storage (+0.76). In contrast, it has a moderate impact on knowledge creation (0.42) and a weak impact on the other processes of knowledge sharing (-0.33), knowledge use/reuse (+0.38), and knowledge updating (-0.6). Similarly, intangible expenditure strongly impacts knowledge creation (+0.81) and knowledge capture (+0.75). It equally moderately impacts knowledge storage (+0.57) but weakly impacts knowledge use/reuse (+0.38) and knowledge updating (+0.28).

The cost of knowledge impacts all the processes. It strongly impacts knowledge creation (+0.75), knowledge capture (+0.80) and knowledge update (+0.73). Its impact on knowledge storage (+0.22), knowledge sharing (-0.14) and knowledge use (+0.13) is however weak. On the other hand, while construction project costs impact all the processes, their effects are not regular. For instance, it has a strong negative impact on knowledge creation (-0.73) and a moderate negative impact on knowledge storage (-0.45) and knowledge sharing (-0.6). Its impact on knowledge capture (-0.39), knowledge use/reuse (-0.32) and knowledge update (+0.19) is, however, weak, with knowledge update being the only process with a weak positive impact.

Discussion of Findings.

The findings from this study justified existing literature that significant cost-based factors exist in construction small and medium-sized firms (Adu et al., 2020; Rasheed et al., 2019). This position is justified by the strength of the average commonalities of the factors, the factor loading of the extracted variables and the high variance explained in the factors. These factors inhibit the capacity of NCFs to innovate and adopt new processes and strategies, such as CKM (Okolie et al., 2020). Six cost-based factors of funding/financial resources, budget limitation, tangible expenditure, intangible expenditure, cost of knowledge, and construction project cost have been identified by this study as existing in the Nigerian construction industry.

Funding constraints identified in this study are impacted by variables such as the high cost of debt financing and the cost of enterprise in Nigeria. Significant capital charges and capital management in a volatile economy further increase the available resources employed in the firm. This corroboration of existing literature shows that financial resource availability is vital when firms innovate (Nsubuga-Mugoa, 2019). Although budget limitations were regarded as an equally vital factor (Yusof et al., 2019) and have been identified in this study as a factor, its influence is limited to the impact it exerts on CKM implementation processes. NCFs do not allocate sums for innovations when submitting tenders (Otalı et al., 2020). The fear of depleting their already meagre resources (Oladimeji, 2021) usually inhibits budgeting. The pricing regime could contribute to this (Oladimeji, 2021). However, budget limitations influence CKM adoption insignificantly, and compared with their impact on the implementation processes, they are equally weak. This finding contradicts existing literature that posits budget limitation as a vital cost-related factor (Yusof et al., 2019). This study posits that the innovative investment of KM processes is the most potent variable that ties budget limitation as a factor. NCFs need to develop necessary cost centres to make the budgeting function feasible.

Tangible and intangible expenditures have emerged as solid factors from this study. The two factors affect both CKM adoption and the implementation processes. The literature recognises these factors as vital in adopting and implementing KM (Elfar et al., 2017; Inkenen et al., 2019; Oliva & Kotebe, 2019). The provision of document management systems, knowledge of informatics infrastructure and process software capacity is vital to CKM deployment. The capacity-building of knowledge workers and the development of adequate repositories and knowledge management capacity of human resources greatly enhance CKM deployment. Therefore, NCFs must value the cost of related tangible and intangible expenditures when selecting a strategy for CKM implementation. Egwunatum and Oboreh (2022) highlighted the importance of maintaining a knowledge-centric workforce. This study supports this position because creating the enabling environment for accessible knowledge-sharing capacity within the fragmented construction space must be promoted to ease CKM deployment.

This study upholds the belief that NCFs can create knowledge (Rasheed et al., 2019). This is because this study posits that the cost of knowledge is not a significant factor in adopting CKM. Professionals already use codified knowledge and often create knowledge within the industry. However, the cost of knowledge impacts the implementation process when knowledge needs to be recreated, captured and updated. Variables like data security and knowledge retention become vital (Levallet & Chan, 2019). The intensity of knowledge in the industry is highly recognised (Yan et al., 2020); therefore, for CKM implementation, NCFs still need to be intentional about the cost of knowledge (Olanrewaju et al., 2019).

Construction project cost, on the other hand, significantly affects the deployment of CKM in NCFs. This is so because the NCFs directly benefit from the proceeds emanating from the project cost (Adoji & Paul, 2021). Direct and indirect costs that affect the project invariably add to or deplete the derivable benefits. In this study, the construction project cost moderately impacts CKM adoption but impacts all the CKM implementation processes in various degrees. Although the relationship is negative in most instances, it implies that when the prevailing variables impact construction project cost, the implementation processes equally display adverse outcomes. This is so because any effect of the variables on construction project cost is mostly a negative effect. Snyman and Smallwood (2017) described a similar relationship between construction project cost and profitability. Therefore, NCFs must guide against negative influences on the construction project cost, such as stakeholders' influences, project direct influences (design variations, construction variations and cost fluctuations) and project indirect influences (complexities, economic influences and statutory regulation).

Conclusions

This study has identified and articulated the various cost-based factors that exist in the deployment of CKM by NCFs. The cost-based factors are funding/financial resources, budget limitations, tangible expenditure, intangible expenditure, cost of knowledge, and construction project cost. Four of these cost-based factors are critical for CKM adoption in NCFs because they impact CKM adoption capacity in NCFs. The factors critical for CKM adoption are funding/financial resources, tangible expenditure, intangible expenditure and construction project cost. However, all the factors impact CKM implementation processes in various degrees. Although funding/financial resources do not impact knowledge capture, knowledge storage, and knowledge use/reuse. Similarly, budget limitations do not impact knowledge sharing and knowledge updating. Likewise, intangible expenditure does not impact knowledge sharing. Tangible expenditure, cost of knowledge and construction project cost, however, impacts all the implementation processes to various degrees. Over 81% of the correlation impact is significantly explained by cost-based factors. Therefore, it is concluded that all the cost-based factors significantly impact CKM implementation.

This study explained the impact of cost-based factors on the deployment of CKM in NCFs. It is helpful for NCFs when planning to innovate with CKM adoption and implementation. CKM deployed in the project space can enhance CM

and improve project cost performance, especially on large infrastructure projects. With enhanced and continuous cost performance, NCFs can improve profitability and ultimately enhance economic sustainability as they metamorphose into larger firms.

It is recommended that NCFs prioritise cost-based, environmental, and organisational factors when strategising for CKM deployment. According to their organisational strengths, NCFs can create necessary cost centres for cost-based factors. NCF management must intentionally create funding avenues for the cost-based requirements of CKM adoption.

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Authors contributions

Abdulkadir Shehu Rasheed conceptualised, developed, administered, executed and analysed the research. He equally wrote the first draft and completed the reviews. Luqman Oyekunle Oyewobi, Wasiu Adeniran Ola-Awo, and Abdulganiyu Adebayo Oke supervised the research process, checked the appropriateness of data analysis tools, vetted the analysed data and interpreted research findings. They also reviewed and edited the work at every stage of the research development.

Disclosure Statement

The authors declare that there is no conflict of interest in this study.

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