Indigenous Contractors' Knowledge Management Maturity Level for Construction of Healthcare Vaccines Cold Store in Nigeria

N. Gambo, M. M. Musa, and A. N. Zadawa

Department of Quantity Surveying, Faculty of Environmental Technology
Abubakar Tafawa Balewa University PMB 0248 Bauchi, Nigeria.

Abstract

This study evaluates the level of knowledge management maturity (KMM) of Nigerian indigenous contractors for the construction of vaccine cold stores in line with the World Health Organization's (WHO) best practices. This study identifies the significant factors influencing contractors' KMM for the construction of vaccine cold stores. The study adopted a quantitative research approach, and the comparison methodologies between the contractors' KMM and WHO's practices were achieved through ANOVA with Post Hoc. The study respondents were mainly the project managers working with contractors and the ones working with the public sector in Nigeria. The total population of the project managers was 2150 which 322 respondents were selected for the analysis. The results indicated that the level of the contractors' KMM is "Knowledge Quantitative Managed Level" against WHO's "Knowledge Optimization Level". The contractor's level of KMM was found to be at the quantitative knowledge-managed level. Meaning i.e., the organizational standard level which is less than the recommended WHO's optimization level. This research work establishes a new KMM level for Nigerian contractors which was based on the perception of project managers in the Nigerian construction industry. The findings from this study create awareness of the process of KMM measurement in healthcare facilities in developing countries like Nigeria. This implies that the Nigerian indigenous contractors are at a level of knowledge quantitative managed. Hence, the knowledge-quantitative managed level is the technical requirement level. This implies that the Nigerian indigenous contractors fall short of the WHO's recommended level of KMM optimization level. Therefore, there is a need to improve KMM practices for the indigenous contractors in Nigeria,

Keywords: *Contractors, Knowledge management maturity, Nigeria, Vaccines cold store.*

Introduction

The most common challenge facing indigenous contractors in developing countries is the issue of the immaturity of knowledge management for the construction of special healthcare infrastructural facilities such as vaccine cold stores (Davidson, 2018; Nichter, 1995). The continues manufacturing of vaccines against COVID-19 has necessitated the increased need for the construction of a vaccine cold store (Wouters, 2021).

Healthy vaccine storage can only be provided in ultra-cold storage that requires high technology. The construction of a vaccine cold store serves as a way of improving healthcare delivery in developing countries (Taylor, 2016). The construction of a vaccine cold store is critical to developing nations for the provision of adequate reserve of vaccines against pandemic and epidemic diseases (Davidson, 2018; Hawker et al., 2018).

The KMM models are the process of application of systematic, disciplined, quantifiable approach- to the development, implementation, and successive progression to attain maturity in knowledge management. (Khatibian & Jafari 2010).

The KMM is defined as the state of the effectiveness of an organization or the state of the organization's capability and expertise in managing the processes, programs, or projects effectively (Sa'eed, Gambo, Inuwa, and Musonda, 2020). On the other hand, it is seen as the performance of an organization becoming better, and more productive, effective, more competitive, and profitable.

Therefore, the maturity of an organization refers to the state of effectiveness in managing and leveraging knowledge assets through effective knowledge management processes (Hsieh, Lin & Lin 2009).Also, Khatibian & Jafari (2010) described that the KMM of an organization is the degree to which the organization constantly operates knowledge assets and is leveraged effectively.

Lin, Wu, and Yen (2012) described the four stages of KMM that include initiation, propagation, integration, and linking knowledge with external partners, i.e., networking. However, Kruger & Johnson (2010) contend that the KMM has five (5) stages, which are initiation, awareness in the development of KMM, the establishment of formations, measurement of KMMKMM, and optimization or KMM, this assertion is

also supported by Wibowo & Waluyo, (2015), In general, KMM is categorized under five (5) levels: knowledge initiation, knowledge managed, knowledge defined, quantitatively managed, and knowledge optimization (Khatibian & Jafari 2010). Therefore, this study adopted the five-level classification of KMM. Knowledge initiation entails the KM implementation in an irregular and undefined form and informs nothing of its concept and congenital application by a construction organization (Khatibian & Jafari 2010; Lin, Wu & Yen, 2012).

In contrast, knowledge practice refers to policies and decision-making units provided for KMM project implementation. The knowledge-defined level entails the level of technical requirements studied, and the quantitative-managed level is coordination and cooperation among teams, and groups are performed at this level. Lastly, the optimization level refers to the organization uses its profound knowledge to improve the processes (Khatibian & Jafari 2010) continuously,

Over the years, indigenous contractors in developing countries have recorded a low level of participation and skewed from the procurement of special healthcare construction projects because of the immaturity level of their KMM, and this was attributed to quite several factors, which include: low-level KMM, knowledge strategy, poor convergence with organization strategy, poor knowledge management vision, poor knowledge management goals among others (Wibowo & Waluyo, 2015; Hawker et al., 2018).

Vaccines cold store infrastructure refers to building construction that cools the interior compartment to a temperature below the room's ambient temperature, which is designed for storage of sensitive products in compliance with regulatory requirements of WHO (Musonda, and Gambo, 2021). The WHO's regulatory requirements recommend an optimization level of KMM to construct vaccines cold store (WHO, 2016). The KMM advocated an optimization level of knowledge regarding the design, fabrication, and installation of cold storage facilities (Blount, 2018).

Some studies in the past attempted to address problems associated with the construction of vaccines cold stores; for example, Matthias *et al.* (2007) systematically reviewed a literature on the effects of freezing temperatures in the vaccine cold chain and concluded that 75%-

100% of vaccines are exposed to freezing temperatures, this influences fully potent vaccines deployment to health centres for vaccination exercises, and this is as a result of contractors' level of KMM with regards construction of cold stores. One of the study's shortcomings is that it does not assess the contractors' level of KMM for the construction of vaccine cold stores.

Similarly Comes et al., (2018) examined the use of technology and information for decisions that keep humanitarian vaccines cold. The study identified the need for technology such as the delivery of vaccines through drones, the use of solar refrigerators to improve vaccines supply chain capacity, and information and decisions that need to be aligned together. The study also does not examine the KMM of contractors in developing countries towards achieving this target.

Moreover, Ashok *et al.* (2017) attempted to address the challenges associated with vaccine cold chains in ten (10) developing countries in Africa by improving cold chain capacity, using the latest technology, and preventing equipment failure. The study also failed to address local contractors' ability to deliver vaccines through the assessment of contractors' KMM. Yet very little research compares the level of KMM of contractors in developing countries with WHO standard practices. Therefore, this study would fill the vacuum created due to the scarcity of literature in the area of KMM for the construction of special healthcare infrastructure facilities.

Based on the background information presented, this study sets the following objectives:

i. To evaluate the level of KMM of Nigerian indigenous contractors.
ii. To compare the level of KMM of Nigerian indigenous contractors for the construction of a vaccine cold store with the WHO standard practices.

Literature Review

Knowledge management maturity and WHO standards

Broadly, knowledge maturity' is the state of being complete, exact, perfect, or ready fullness of development. On the contrary, 'immaturity' is the state of being unripe, imperfect, or incomplete (Velásquez & Lara 2021; Comes, Bergtora Sandvik, & Van de Walle, 2018). Applying the concept of maturity to contractors' knowledge management refers to being technically

equipped with the requisite skills to carry out construction activities. The contractor's knowledge maturity is defined in terms of the firm's technical experience, wisdom, independence, willingness, and ability to execute a project based on specifications and work towards achieving stated goals (Chandra & Kumar, 2019; Kruger & Snyman, 2007).

The purpose of the WHO management system standard for knowledge management is to support organizations to develop an optimum KMM system that effectively promotes and enables value-creation through knowledge. KM is a discipline focused on how organizations create and use knowledge (Olatunji, Aje, & Makanjuola, 2017).

The level of KMM focuses on the management and delivery of value through expertise. Each organization crafts a knowledge management approach concerning its own business and operational environment, reflecting its specific needs and desired outcomes—similarly, the WHO set out an optimization level of KMM to construct vaccine cold stores. The levels of maturity are categorized as follows: level 1 to level 5, i.e., initiation, knowledge managed, knowledge defined, quantitatively managed and, knowledge optimization (WHO, 2016; Khatibian & Jafari 2010). Therefore, WHO recommended an optimum level of KMM for the construction of vaccine cold store projects. Such projects are classified based on the cold stores' KMM with regards to the design, fabrication, and installation of facilities.

Vaccines cold store construction

The vaccine is a fragile biological, and even slight temperature changes may alter the vaccine's molecular structure, thereby rendering them ineffective or toxic (WHO, 2016). More than 90% of all vaccines require temperature-controlled housing. The storage unit guidelines recommended a unit that maintains temperature better than households/commercial unit refrigerators therefore, a standard cold store is required (Muhammad, Usman & Gambo, 2020). The construction of vaccines cold store is classified based on the contractors' KMM regarding the design, fabrication, and installation of facilities. The vaccine's cold store design is the art and science of drawing the project according to standard specifications (WHO, 2016).

The contractors' KMM regarding the design of vaccines cold store provides the roadmap for the way the design will be managed and

needs to be prepared at the inception stage of the project process for best results (Manning & Baker, 2018; WHO, 2016). The contractors' KMM regarding the fabrication of vaccines cold store is the process of construction/manufacturing of different components of the vaccines cold store structure; structural elements are commonly used for the construction of vaccines cold stores. The various parts should be of high strength, toughness, rigidity, and tensile properties.

KMM for a temperature change of each element of vaccines cold store construction is one of the essential elements of fabrication, followed by the capacity and location, shelving layout, power system and safety regulation, panel construction, and insulation (Sinesilassie, Tabish, & Jha,2018; Riley, Cotgrave & Farragher, 2017).

The contractors' KMM for installing vaccines cold store components such as refrigerators and freezers should be rightly installed to ensure safety, reliability, and maximum life. All electrical wiring in the vaccines cold store should be effectively earthed, and coiled cables heat up and quickly melt because of temperature change. The temperature zones of the vaccines' thermal transmittance of the vaccines' cold store enclosure element, panel installations, understanding of tongued and grooved joints, and gasket are the most critical factors of KMM (Reiner-Roth, 2018; Odediran, Adeyinka, Opatunji, & Morakinyo, 2012).

.

Research Method

This research work revised the literature to assess the ideas about the level KMM of indigenous contractors for the construction of healthcare vaccine cold stores in Nigeria. Then, the findings from the literature were used in adapting a structured questionnaire that was used to collate data on the contractors' KMM factors. Therefore, this research work adopts a quantitative design method and the study covered indigenous healthcare contractors in the Nigerian construction industry.

Research Population, Sample Size, and Sampling Method

According to Everitt and Skrondal (2002), the population of any study is a term used for any limited or unlimited group of units, usually a group of people, for example, organizations and items. Therefore, the population for this research work is the total registered project managers in the Nigerian construction industry. According to the information supplied by the Nigerian

Business Directory (2018), the total population of project managers in Nigeria was 2150 objects. A sample size of 322 respondents (subjects) was determined using Krejcie and Morgan's (1970) rule of thumb. A simple random sampling technique was adopted to collect data from the respondents. The choice of this category of respondents is informed by their professional background and complete representation of indigenous contractors (Jungudo, Usman, Aliyu, & Zadawa, 2020). The random sampling technique is used in quantitative research as a tool for generalization of the results to the whole population (Polit and Beck, 2010)

Data Collection and Analysis

According to Sekaran and Bougie (2011), the data for any study are collected in diverse ways and various sceneries from other sources. This research work used structured questionnaires and collect data from the project managers in the Nigerian construction industry, the data for this study were first-hand data collected from the primary source (Abdullahi, Gambo, & Mohammad, 2019).

Moreover, Sekaran and Bougie (2011) stated that the primary data is the original datasets sourced first-hand on the variables of interest for a specific purpose of the study. This study administered a total of 600 questionnaires to the respondents through a simple random sampling technique. Also, a total of 330 questionnaires were returned, and 322 were used for analysis, while eight (8) were rejected because of inconsistencies in the responses. A statistical package, IBM SPSS version 22, was used for data analysis.

The datasets were analyzed by using a one-way ANOVA test in assessing the level of KMM, and Post Hoc was also used in comparing the differences and where it appears and further comparison with the WHO standard practices (An optimum level of KMM). One-way ANOVA with post hoc is the most appropriate test for evaluating the levels and the differences among two (2) or more groups (Pallant, 2010). This study recorded a return rate of 55% and a valid response rate of 54% compared to the studies of Darroch (2005) with a 27.8% response rate and that of Chen and Huang (2009) with a 19.47% response rate.

The following hypotheses were developed to test the differences in the levels of KMM of Nigerian indigenous contractors compared with WHO standard practices; the hypotheses are based on null hypotheses:

H_{01}. There are no significant differences among the levels of contractors' KMM for the design of vaccines cold store.

H_{02}. There are no significant differences among the levels of contractors' KMM for the fabrication of vaccines cold store.

H_{03}. There are no significant differences among the levels of contractors' KMM for the installation of vaccines cold store.

Questionnaire Development

The primary research instrument for this study was a self-administered questionnaire. The questionnaires were administered to obtain data from the respondents. The KMM factors were adapted from the research indicated in table 1 as follows:

Table 1: Items Adapted from previous literature

S/N	Items	Sources
1.0	Design of Vaccines Cold store Facilities (MATDGN)	
D.1.1	Knowledge design management strategy	(Manning & Baker, 2018; WHO, 2016)
D1.2	Convergence with organization design strategy	(Manning & Baker, 2018; WHO, 2016)
D1.3	Design knowledge management vision	Sinesilassie, Tabish, and Jha,(2018)
D1.4	Design knowledge management goals	Sinesilassie, Tabish, and Jha,(2018)
D1.5	Design pattern role	Sinesilassie, Tabish, and Jha,(2018)
D1.6	Design leadership style and strategic role	Sinesilassie, Tabish, and Jha,(2018)
D1.7	Design support and commitment of senior manager	Sinesilassie, Tabish, and Jha,(2018)
D1.8	Design participate leadership	Sinesilassie, Tabish, and Jha,(2018)
D1.9	Specifying design goals and strategies	Sinesilassie, Tabish, and Jha,(2018)
D1.10	Securing and allocating resources for design	Sinesilassie, Tabish, and Jha,(2018)
D1.11	Design change management	Sinesilassie, Tabish, and Jha,(2018)
D1.12	Free design environment for discussion	Sinesilassie, Tabish, and Jha,(2018)
D1.13	Design confidence	Sinesilassie, Tabish, and Jha,(2018)
D1.14	Humanism culture in design	(Ruger, 2018)
D1.15	Learning culture in design	(Ruger, 2018; WHO, 2016)
D1.16	Change adaptation culture for design	(Ruger, 2018; WHO, 2016)
D1.17	Knowledge-oriented culture for among designers	(Ruger, 2018; WHO, 2016)
D1.18	Cooperation culture among designers	(Ruger, 2018; WHO, 2016)
D1.19	Creavity and innovation culture among designers	(Ruger, 2018; WHO, 2016)
D1.20	Unconcentrated structure for design	(Ruger, 2018; WHO, 2016)
D1.21	Less formality in design	(Ruger, 2018; WHO, 2016)
2.0	Fabrication of Vaccines Cold Store Facilities (MATLAB)	
F.2.1	Communication channels among fabricators	Sinesilassie, Tabish, and Jha,(2018)
F2.2	Team-based fabrication structure	Riley, Cotgrave, and Farragher, (2017)
F2.3	Defined roles and responsibilities among fabricators	Odediran et al., 2012)
F2.4	Use of ICT infrastructure during fabrication	Manning & Baker, (2018).
F2.5	Information quality during fabrication	Halpin, Lucko, & Senior, 2017)
F2.6	Fabrication appropriating with users' needs	Halpin, Lucko, & Senior, 2017)
F2.7	Critical knowledge of fabrication in the organization	Sinesilassie, Tabish, and Jha,(2018)
F2.8	Fabrication knowledge creates and production	Odediran, Adeyinka, Opatunji, & Morakinyo, (2012).
F2.9	Fabrication knowledge share	Seeley, (1996)
F2.11	Fabrication knowledge store	Sinesilassie, Tabish, and Jha,(2018)
F2.12	Fabrication knowledge gain	Reiner-Roth, (2018)
F2.13	Fabrication knowledge application	Sinesilassie, Tabish, and Jha,(2018)
F2.14	Fabrication knowledge documentation	Sinesilassie, Tabish, and Jha,(2018)
F2.15	Fabrication knowledge integration	Reiner-Roth, (2018)
F2.16	Reward and motivation systems for Fabricators	Silva et al, (2017)
3.0	Installations of Vaccines Cold Store Equipment (MATINS)	
I.3.1	Training of personnel on the installation	Odediran, Adeyinka, Opatunji, & Morakinyo, (2012).
I.3.2	Cooperation of personnel during installation	Odediran, Adeyinka, Opatunji, & Morakinyo, (2012).
I.3.3	Protection of personnel	Odediran, Adeyinka, Opatunji, & Morakinyo, (2012).
I.3.4	Strengthening of personnel	Odediran, Adeyinka, Opatunji, & Morakinyo, (2012).
I.3.5	Installation knowledge-oriented assets	Odediran, Adeyinka, Opatunji, & Morakinyo, (2012).
I.3.6	Measuring effectiveness of KM for installation	Reiner-Roth, 2018).
I.3.7	Installation knowledge creates and production	Reiner-Roth, 2018).
In.3.4	Installation knowledge share	Odediran, Adeyinka, Opatunji, & Morakinyo, (2012).
I.3.8	Installation knowledge store	Halpin, Lucko, & Senior, 2017)
I.3.9	Installation knowledge gain	Silva et al., (2017)
I.3.10	Installation knowledge application	Silva et al., (2017)
I.3.11	Installation knowledge documentation	Silva et al., (2017)
I.3.12	Installation knowledge integration	Silva et al., (2017)
I.3.13	Installation management strategy	Silva et al., (2017)

Results

Table 2 shows the reliability test for this study's constructs. The reliability test was attained by determining the Cronbach's alpha for each construct. The alpha coefficient indicated how consistent the survey instrument is in the measurement of the intended purpose. The values of the Cronbach's alpha for the three areas of contractors' KMM are the MATDGN, MATLAB, and MATINS were all above the threshold Cronbach's alpha value of 0.70 (Pallant, 2010; Sekaran & Bourgie, 2011). The Cronbach alpha values for the three sections thus confirm that the survey instrument is reliable and consistent in measuring the parameters.

Table 2: Reliability statistics test

	MATDGN	MATFAB	MATINS
Cronbach's alpha	**0.918**	**0.746**	**0.883**
No. of Items	**21**	**15**	**16**

Table 3 shows the validity of the variables for this research work. The technique used to achieve the constructs validity is factor analysis. This was carried out to assess the problems associated with multi-collinearity and singularity of the survey instruments that measured the constructs MATDGN, MATLAB, and MATINS. The common Kaiser-Meyer-Olkin measure of sampling adequacy KMO was found to be 0.94, 0.88, and 0.89, for the three (3) constructs respectively, and all were significant at *p*-value of 0.00 level of significance. The total variance obtained were 65.68%, 69.30%, and 71.77% respectively. Similarly, the determinants of the R-matrix were 0.004, 0.002, and 0.003 for the same constructs respectively. This indicated that the three (3) determinants of the R-matrix were all significant $p \leq 0.0$ level of significance. The results indicated that the items in the constructs were not affected by either multicollinearity or singularity. Therefore, this indicated that there is no single item was removed from the research instrument because of either multi-collinearity or singularity (Field, 2009).

Table 3: Construct's validity

Constructs	Total variance explained (%)	R-Matrix	KMO	*p*-value
MATDGN	**65.68**	**0.004**	**0.94**	**0.00**
MATFAB	**69.30**	**0.002**	**0.88**	**0.00**
MATINS	**71.77**	**0.003**	**0.89**	**0.00**

Descriptive Statistics

The technique used to assess and compare the level and the differences among the levels of the contractors' KMM was One-way ANOVA with a Post Hoc test. Therefore, the level of the contractors' KMM was compared with the WHO standard practices. The contractors' KMM levels were considered into five groups. The first group involves the KMM initiation level rated between 0.1-1.0, then KMM managed, rated between 1.1-2.0 scores, the KMM defined was rated between 2.1-3.0, then the KMM quantitatively managed was rated between 3.1-4.0, and lastly, the KMM Optimization was rated between 4.1-5.0 ratings (WHO, 2016; Gambo et al., 2016).

Descriptive Statistics of the KMM of the Contractors

Table 4 shows the descriptive statistics of the vaccine the contractors KMM for the construction of vaccine cold store for the construct MATDGN. The mean score value of the contractors' KMM was found to be at a 3.02 level of KMM with a standard deviation of 0.58 figure. Therefore, this result indicated that the KMM of the contractors was at the level of quantitative knowledge. The mean score for the descriptive statistics for the construct MATFAB was found as of 3.71 with a standard deviation of 0.84, indicating that the level of KMM of the contractors concerning MATFAB was still at the level of quantitative knowledge.

Lastly the mean score of 3.77 with a standard deviation of 0.81 indicating quantitative knowledge level. Therefore, the total mean score for the KMM with regards to the construction of vaccine cold store was 3.50 indicating a quantitative level of KMM. The results showed a short in the standard of WHO (2016) KMM optimization level.

Table 4: Descriptive Statistics of KMM for the Construction of Vaccine Cold Store

			Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
		N				Lower Bound	Upper Bound		
MATDGN	Initiation	8	2.8929	.66752	.23600	2.3348	3.4509	2.29	4.24
	Managed	41	3.0000	.56715	.08857	2.8210	3.1790	1.86	4.05
	Defined	123	3.0918	.57422	.05178	2.9893	3.1942	1.81	4.62
	Quantitative	28	3.0238	.53789	.10165	2.8152	3.2324	1.57	4.00
	Optimization	122	2.9496	.59568	.05393	2.8429	3.0564	1.76	4.19
	Total	**322**	**3.0154**	**.58094**	**.03237**	**2.9517**	**3.0791**	**1.57**	**4.62**
MATFAB	Initiation	8	4.1500	.54598	.19303	3.6935	4.6065	3.60	5.00
	Managed	41	3.5626	.88645	.13844	3.2828	3.8424	1.67	5.00
	Defined	123	3.7984	.92854	.08372	3.6326	3.9641	1.00	5.00
	Quantitative	28	3.5690	.80400	.15194	3.2573	3.8808	1.47	5.00
	Optimization	122	3.6710	.73893	.06690	3.5386	3.8035	1.53	5.00
	Total	**322**	**3.7089**	**.83976**	**.04680**	**3.6168**	**3.8010**	**1.00**	**5.00**
MATINT	Initiation	8	2.7941	.64880	.37649	1.9039	3.6844	1.82	4.53
	Managed	41	3.3156	.78334	.12234	3.0684	3.5629	1.59	5.00
	Defined	123	3.4543	.67521	.06088	3.3338	3.5749	1.88	4.88
	Quantitative	28	3.8718	.49838	.09418	3.6786	4.0651	2.76	4.94
	Optimization	122	4.2811	.66712	.06040	4.1615	4.4007	2.24	5.00
	Total	**322**	**3.7698**	**.80721**	**.04498**	**3.6813**	**3.8583**	**1.59**	**5.00**

Table 5 indicated the test of homogeneity of variance, which shows that the significance value (Sig.) for Levene's test. The Levene statistics showed that contractors' KMM for the construct MATDGN had a $p_{\text{-value}}$ of 0.618. The test of homogeneity on KMM for the construct MATFAB had a $p_{\text{-value}}$ of 0.430. The KMM for the construct MATINS had a $p_{\text{-value}}$ of 0.230, all above the threshold value of 0.00; this indicated that the homogeneity of variance assumption was not violated.

Table 5: Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
MATDGN	.664	4	317	.618
MATFAB	2.490	4	317	.430
MATINS	2.875	4	317	.230

Comparisons Among the Levels of Contractors' KMM

Table 6 indicated the results of the ANOVA test. The results indicated that the level of contractors' KMM had a significant effect on the construct MATDGN, the result value was *F (4, 317) =1.020, at p= 0.039* indicating that the mean score value for the five KMM levels of the construct progressed from the lower level of the KMM i.e., initiation level to the higher level of KMM i.e., optimization level. These results show a very significant improvement. Hence, resulted in the rejection of the hypothesis

that there are no significant differences among the contractors' KMM levels with regards to the construct MATDGN for the construction of vaccines cold store. The *ETA* effect calculated was found to be 0.013, considered as a small effect change among the five contractors' levels of KMM regarding the construct MATDGN (Cohen, 1988).

Table 6: ANOVA test for levels of contractor's knowledge management maturity

		Sum of Squares	df	Mean Square	F	Sig.
MATDGN	Between Groups	1.376	4	.344	1.020	.039
	Within Groups	106.960	317	.337		
	Total	108.337	321			
MATFAB	Between Groups	4.141	4	1.035	1.477	.020
	Within Groups	222.227	317	.701		
	Total	226.368	321			
MATINS	Between Groups	60.499	4	15.125	32.252	.000
	Within Groups	148.662	317	.469		
	Total	209.161	321			

The level of contractors' KMM regarding the construct MATFAB was also significant at *F (4, 317) =1.47, p= 0.020* indicating a significant difference among the levels of the contractors' KMM for the fabrication of vaccine cold store.

The results are indicating improvement from the lower level of KMM i.e., initiation to a higher level of KMM i.e., optimization level. The calculated *ETA* effect was found to be 0.018 indicating a small effect size (Cohen, 1988). This resulted in the rejection of the hypothesis that there are no significant differences among the levels of contractors' KMM for the fabrication of vaccines cold store.

Similarly, the KMM for the construct MATINS was significant at *F (4, 317) = 32.252, p= 0.000*. The contractor's KMM levels progressed from the lower level of KMM i.e., initiation to a higher level of KMM i.e., optimization level.

The calculated *ETA* effect was 0.289, indicating large effect sizes (Cohen, 1988). Generally, the comparisons among the various levels of contractors' KMM among the Nigerian indigenous contractors for the construction of vaccines cold store were significant. They had small effect sizes for the constructs MATDGN, MATLAB, and MATINS respectively. In contrast, the MATINS construct had a large effect size. This led to the rejection of the hypothesis that there are no significant differences among the contractors' KMM for the installation construct of vaccines cold store.

Comparisons Among the Group Levels of Contractors' KMM

Table 7 indicates the multiple Post Hoc comparisons among the contractors' levels of KMM. The group levels of contractors' KMM ranged from the lower level of KMM i.e., initiation to a higher level of KMM i.e., optimization level regarding the three research constructs MATDGN, MATLAB, and MATINS. The levels of KMM were assessed and indicated which group a contractors' KMM level stand.

The group of contractors with the lower KMM i.e., initiation level varies significantly from all other groups at *a p= 0.05* level of significance. This was a result of the consensus among respondents' ratings. The group of contractors with a level of KMM i.e. managed level also varies significantly from all other groups at *the p=0.05* level of significance. This is the same for all other groups under the construct MATDGN. The results indicated that the level of contractors' KMM concerning the MATDGN construct progresses whenever a contractor moves from a lower to a higher level of KMM.

The Post Hoc comparisons among the five levels of contractors' KMM for the construct MATFAB indicated that the contractors' with the lower KMM level varies with the contractors' with higher KMM i.e., managed level and all other levels at *p=0.05* significance level. This is because of the consensus among respondents rating the levels. The group of contractors with KMM initiation levels differs significantly from all other groups at *the p=0.05* significance level. This is the same for all the groups of KMM under the construct MATLAB. This indicated that the construct MATFAB progresses whenever a contractor moves from a lower KMM level to a higher KMM level.

The Post Hoc comparisons among the groups of contractors' KMM levels for the construct MATINS show that a group of contractors with lower KMM i.e., initiation level varies significantly with the groups of contractors with other levels at a *p=0.05* significance level. This is the same with all other groups under the construct MATINS at the *p=0.05* significance level. This indicated that the construct MATINS progressed whenever a contractor gains a higher KMM level regarding the installation of the vaccine cold store.

Dependent Variable	(I) LEVEL OF MATURITY	(J) LEVEL OF MATURITY	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
MATDGN	Initiation	Managed	.10714*	.22451	.029	-.7231	.5088
		Defined	.19890*	.21194	.022	-.7804	.3826
		Quantitative	-.13095*	.23287	.048	-.7698	.5079
		Optimization	-.05679*	.21200	.029	-.6384	.5248
	Managed	Initiation	.10714*	.22451	.029	-.5088	.7231
		Defined	-.09175*	.10475	.046	-.3791	.1956
		Quantitative	-.02381**	.14241	.000	-.4145	.3669
		Optimization	.05035*	.10486	.019	-.2373	.3380
	Defined	Initiation	.19890*	.21194	.022	-.3826	.7804
		Managed	.09175*	.10475	.046	-.1956	.3791
		Quantitative	.06794*	.12163	.011	-.2658	.4016
		Optimization	.14211*	.07422	.012	-.0615	.3457
	Quantitative	Initiation	.13095*	.23287	.048	-.5079	.7698
		Managed	.02381**	.14241	.000	-.3669	.4145
		Defined	-.06794*	.12163	.011	-.4016	.2658
		Optimization	.07416*	.12172	.014	-.2598	.4081
	Optimization	Initiation	.05679*	.21200	.029	-.5248	.6384
		Managed	-.05035*	.10486	.019	-.3380	.2373
		Defined	-.14211*	.07422	.012	-.3457	.0615
		Quantitative	-.07416*	.12172	.014	-.4081	.2598
MATFAB	Initiation	Managed	.58740*	.32362	.017	-.3005	1.4753
		Defined	.35163*	.30550	.049	-.4865	1.1898
		Quantitative	.58095*	.33566	.027	-.3399	1.5018
		Optimization	.47896*	.30557	.039	-.3594	1.3173
	Managed	Initiation	-.58740*	.32362	.017	-1.4753	.3005
		Defined	-.23577*	.15099	.033	-.6500	.1785
		Quantitative	-.00645*	.20527	.000	-.5696	.5567
		Optimization	-.10844*	.15114	.025	-.5231	.3062
	Defined	Initiation	-.35163*	.30550	.049	-1.1898	.4865
		Managed	.23577*	.15099	.033	-.1785	.6500
		Quantitative	.22933*	.17532	.046	-.2517	.7103
		Optimization	.12734*	.10698	.050	-.1662	.4209
	Quantitative	Initiation	-.58095*	.33566	.027	-1.5018	.3399
		Managed	.00645*	.20527	.000	-.5567	.5696
		Defined	-.22933*	.17532	.046	-.7103	.2517
		Optimization	-.10199*	.17545	.028	-.5833	.3794
	Optimization	Initiation	-.47896*	.30557	.039	-1.3173	.3594
		Managed	.10844*	.15114	.025	-.3062	.5231
		Defined	.12734*	.10698	.050	-.4209	.1662
		Quantitative	.10199*	.17545	.028	-.3794	.5833
MATINS	Initiation	Managed	.52152*	.26469	.028	-1.2477	.2047
		Defined	.66021*	.24987	.015	-1.3457	.0253
		Quantitative	.07773**	.27453	.001	-1.8309	-.3245
		Optimization	.48698**	.24993	.000	-2.1727	-.8013
	Managed	Initiation	.52152*	.26469	.028	-.2047	1.2477
		Defined	.13869*	.12349	.034	-.4775	.2001
		Quantitative	.55621**	.16789	.009	-1.0168	-.0956
		Optimization	.96546***	.12362	.000	-1.3046	-.6263
	Defined	Initiation	.66021*	.24987	.015	-.0253	1.3457
		Managed	.13869*	.12349	.034	-.2001	.4775
		Quantitative	-.41752**	.14339	.031	-.8109	-.0241
		Optimization	.82677***	.08750	.000	-1.0668	-.5867
	Quantitative	Initiation	.07773**	.27453	.001	.3245	1.8309
		Managed	.55621**	.16789	.009	.0956	1.0168
		Defined	.41752**	.14339	.037	.0241	.8109
		Optimization	.40925**	.14350	.037	-.8030	-.0155
	Optimization	Initiation	.48698***	.24993	.000	.8013	2.1727
		Managed	-.96546***	.12362	.000	.6263	1.3046
		Defined	-.82677***	.08750	.000	.5867	1.0668
		Quantitative	.40925**	.14350	.037	.0155	.8030

*. The mean difference is significant at the 0.05 level.

Discussions

This study considered the three (3) important constructs for the construction of vaccine cold stores and also the study assessed the levels of indigenous contractors' KMM. The constructs considered in this study are namely: MATDGN, MATLAB, and MATINS.

The contractors' KMM were further re-grouped and evaluated from the lower level of KMM i.e., the initiation to the higher level of KMM i.e., the optimization level. The contractors' level of KMM is a benchmark that evaluated which level of KMM does a contractor belongs to? The KMM ratings were adapted from the WHO (2016) report and Gambo *et al.* (2016).

The overall contractors' KMM for the study constructs i.e., MATDGN, MATFB, and MATINS levels WHO (2016), Riley, Cotgrave and Farragher (2017), Halpin, Lucko, and Senior (2017), and Silva et al., (2017). The study indicated a small effect among the various levels of contractors' KMM with regards to the constructs MATDGN and MATLAB. It also indicated a significant impact concerning the construct MATINS and the total mean score values of indigenous contractors' KMM for constructing vaccines cold store in Nigeria was 3.02, 3.71, and 3.77 for the constructs MATDGN, MATLAB, and MATINS, respectively. The mean score values further categorized the Nigerian indigenous contractors' level of KMM as quantitative managed compared with the WHO (2016) standard rating practice (optimization level). This is possible because of the level of contracting businesses exposure in Nigeria being a predominantly small size. This supports the findings of Gambo (2016), which compares the performance of small-scale local government contractors with international practice.

Also, the study supports findings from the study of Assaf et al. (1996) on the factors affecting construction contractors' performance. The paper outlines characteristics and their degree of influence on performance level based on a study of royal commission projects executed by 36 different Saudi and joint venture firms in the Eastern province of Saudi Arabia. The paper found that the level of the contractors was moderate.

Similarly, Doloi and Sawhney (2011) used the structural equation model to assess the impacts of contractor's performance on project success; the study found that contractors' success on the project was

moderate. This study contradicts Yasamis, Arditi, and Mohammadi (2002) on the level of contractors' quality performance because the study assessed significant international contractors' quality performance.

The results further indicated that there were significant differences among the levels of the contractors' KMM. The respondents all agreed that there were differences between the levels of contractors' KMM. Also, it indicated that there were weak and significant effect sizes among the various levels of the contractors' KMM. This is because of the agreement among project managers. Compared with the WHO standard, the contractors' KMM in respect of the MATDGN, MATLAB, and MATINS constructs was knowledge quantitative managed level as against optimization level.

Conclusion

This research work measured and assessed the levels of the three (3) constructs of KMM of Nigerian indigenous contractors for the construction of vaccine cold store following the recommendations of the World Health Organisation, namely: (MATDGN, MATLAB, and MATINS respectively) with the view to identify contractors' points of shortcomings and improve upon them. The study also creates awareness and serves as a wake-up call for the Nigerian indigenous contractors to doubly enhancing their performance level and comply with standard practice. It also serves as a call for the clients mainly in the health sector on the methodology of assessing the levels of KMM of their potential contractors in the country before any invitations to tender.

The study further found that indigenous contractors' level of KMM for the construction of vaccines cold store in Nigeria was at knowledge quantitative managed level, i.e., a level between 3.1-3.9 compared with WHO standard s practices of optimization level between 4.1-5.0 on a five-point Likert scale. It was also discovered that there were significant variances, from small and large effects among the five levels of contractors' KMM. This implies that Nigerian indigenous contractors would not be assigned with sophisticated and complex projects like the construction of vaccine cold stores as the contractors fall short of WHO standards.

The study recommended introducing an indigenous contractors training institute for the construction of vital, special, and complex infrastructure facilities in the country. This would enhance their levels of KMM. The study also recommends

establishing a construction institution for the training of contractors on the construction of unique and complex infrastructure like vaccines cold stores.

References

Abdullahi, N. Z., Gambo, N., & Mohammad, S. A. (2019). A framework for ethical procurement of construction projects in Nigerian Federal Universities. In IOP Conference Series: *Materials Science and Engineering* 615(1), 012026.

Abdulraheem, I. S., Olapipo, A. R. & Amodu, M. O. (2012). Primary health care services in Nigeria: Critical issues and strategies for enhancing the use by the rural communities. *Journal of Public Health and Epidemiology, 4*(1), 5-13.

Aibinu, AA, & Jagboro, GO. (2002). The effects of construction delays on project delivery in the Nigerian construction industry. *International journal of project management, 20*(8), 593-599.

Aluko, Olaniyi Olanipekun. (2008). Construction project abandonment in Nigeria: A threat to the national economy. *Knowledge Review, 16*(3), 18-23.

Assaf, S. A., Al-Hammad, A. M., & Ubaid, A. (1996). Factors affecting construction contractors' performance: This paper outlines characteristics and their degree of influence on performance level based on a study of royal commission projects executed by 36 different Saudi and joint venture firms in the Eastern province of Saudi Arabia. *Building research and information*, *24*(3), 159-163.

Ashok, A., Brison, M., & LeTallec, Y. (2017). Improving cold chain systems: Challenges and solutions. *Vaccine*, *35*(17), 2217-2223.

Ayodele, Elijah Olusegun. (2011). Abandonment of construction projects in Nigeria: causes and effects. *Journal of Emerging Trends in Economics and Management Sciences, 2*(2), 142-145.

Baba, M. M, & Ayivor, Michael. (2013). Polio vaccination in Nigeria: the good', the bad, and the ugly. *International Journal of Medical Science and Public Health, 2*(1), 137-146.

Babatunde, Oluwayomi Kayode, & Low, Sui Pheng. (2013). Chinese construction firms in the Nigerian construction industry. *Habitat International, 40*, 18-24.

Babatunde, Yomi, & Low, Sui Pheng. (2015). Construction Industry in Nigeria *Cross-Cultural Management and Quality Performance* (pp. 45-57): Springer.

Chen, C. & Huang, J. (2009). Strategic human resource practices and innovation performance—The mediating role of knowledge management capacity. *Journal of business research, 62*(1), 104-114.

Cohen J. 1988. Statistical power analysis for the behavioural sciences. 2nd ed. Hillsdale. NJ. Lawrence Earlbaum Associates Inc.

Comes, T. Bergtora S. K. & Van de Walle, B. (2018). Cold chains, interrupted: The use of technology and information for decisions that keep humanitarian vaccines cool. *Journal of Humanitarian Logistics and Supply Chain Management, 8*(1), 49-69.

Criscuolo, E., Caputo, V., Diotti, R. A., Sautto, G. A., Kirchenbaum, G. A., & Clementi, N. (2019). Alternative Methods of Vaccine Delivery: An Overview of Edible and Intradermal Vaccines. *Journal of Immunology Research*, *2019*.

Darroch, J. (2005). Knowledge management, innovation, and firm performance.

Journal of knowledge management, 9(3), 101-115.

Davidson, Tish. (2018). *The Vaccine Debate*: ABC-CLIO.

Dawoud, Belal. (2007). A hybrid solar-assisted adsorption cooling unit for vaccine storage. *Renewable Energy, 32*(6), 947-964.

Diaconu, K., Chen, Y. F., Cummins, C., Moyao, G. J., Manaseki-Holland, S., & Lilford, R. (2017). Methods for medical device and equipment procurement and prioritization within low-and middle-income countries: findings of a systematic literature review. *Globalization and health*, *13*(1), 59.

Dillon, Krystal, & Colton, Jonathan. (2014). A design methodology for the economic design of vaccine warehouses in the developing world. *Building and Environment, 82*, 160-170.

Doloi, H., Iyer, K. C., & Sawhney, A. (2011). Structural equation model for assessing impacts of contractor's performance on project success. *International journal of project management*, *29*(6), 687-695.

Ernest, K., Isaac, O., Emmanuel, B. B., & Edward, B. (2016). Networking for knowledge capacity building of procurement professionals in Ghana. International Journal of Construction Supply Chain Management, 6(2), 34-47. doi:10.14424/ijcscm602016-34-47

Giudici, P. (2003), Applied Data Mining Statistical Method for Business and Industry, 1st ed., Wiley, London.

Halpin, Daniel W, Lucko, Gunnar, & Senior, Bolivar A. (2017). *Construction management*: John Wiley & Sons.

Hawker, Jeremy, Begg, Norman, Reintjes, Ralf, Ekdahl, Karl, Edeghere, Obaghe, & Van Steenbergen, Jim E. (2018). *Communicable disease control and health protection handbook*: John Wiley & Sons.

Hillebrandt, Patricia M. (2000). *Economic theory and the construction industry*: Springer.

Hsieh, P. J., Lin, B., & Lin, C. (2009). The construction and application of knowledge navigator model (KNM™): An evaluation of knowledge management maturity. *Expert Systems with Applications*, *36*(2), 4087-4100.

Ignatavicius, Donna D, & Workman, M Linda. (2015). *Medical-Surgical Nursing-E-Book: Patient-Centered Collaborative Care, Single Volume*: Elsevier health sciences.

Jungudo, A. M., Usman, N., Aliyu, A. A., & Zadawa, A. N. (2020). A Conceptual Review of Factors Influencing Succession in Small-and Medium-Sized Construction Firms in Nigeria. Supporting Inclusive Growth and Sustainable Development in Africa-Volume I, 41-50.

Khatibian, N., & Jafari, H. A. (2010). Measurement of knowledge management maturity level within organizations. *Business strategy series*. Vol. 11, No. 10, pp 54-70

Krejcie, R.V. and Morgan, D.W. (1970), "Table for determining sample size from a given population", Educational and Psychological Measurement, Vol. 30 No. 3, pp. 607-610.

Kruger, C. N., & Johnson, R. D. (2010). Information management as an enabler of knowledge management maturity: A South African perspective. *International journal of information management*, *30*(1), 57-67.

Kruger, C. J., & Snyman, M. M. M. (2007). Guidelines for assessing the knowledge management maturity of organizations.

Lin, C., Wu, J. C., & Yen, D. C. (2012). Exploring barriers to knowledge flow at

different knowledge management maturity stages. *Information & Management*, *49*(1), 10-23.

McCarney, Steve, Robertson, Joanie, Arnaud, Juliette, Lorenson, Kristina, & Lloyd, John. (2013). Using solar-powered refrigeration for vaccine storage where other sources of reliable electricity are inadequate or costly. *Vaccine, 31*(51), 6050-6057.

Miles, Derek, & Neale, Richard. (1991). *Building for tomorrow: International experience in construction industry development*: OIT.

Muhammad, Usman & Gambo (2020). Effect of binary blended pozzolanic materials on properties of self-compacting concrete, *International Journal of Construction Management*, DOI: 10.1080/15623599.2019.1707500

Musonda, I. and Gambo, N. (2021), "Mediation effect of partnership on procurement strategy factors influencing sustainable smart housing development, Nigeria", *Built Environment Project and Asset Management,* Vol. 11 No. 3, pp. 454-467. https://doi.org/10.1108/BEPAM-12-2019-0139

NBS (2018). Nigerian Business directory https://buzznigeria.com/vconnect/ Retrieved 12/12/2018

Neuman, W. L. *(2011)*. Social Research Methods(7th ed.): *Qualitative and Quantitative Approaches.* Pearson Inc. the USA

Nichter, Mark. (1995). Vaccinations in the Third World: a consideration of community demand. *Social Science & Medicine, 41*(5), 617-632.

Nieto, Alejandra, Roehl, Holger, Adler, Michael, & Mohl, Silke. (2018). Evaluation of Container Closure System Integrity for Storage of Frozen Drug Products: Impact of Capping Force and Transportation. *PDA journal of pharmaceutical science and technology, 72*(6), 544-552.

Obiegbu, ME. (2005). *Due process and the procurement methods in the construction industry.* Paper presented at the Proceedings of the 35th Annual Conference of The Nigerian Institute of Building.

Odediran, Sunday Julius, Adeyinka, Busayo Funmilola, Opatunji, Oladele Ayinde, & Morakinyo, Kolawole Opeyemi. (2012). The business structure of indigenous firms in the Nigerian construction industry. *International Journal of Business Research and Management, 3*(5), 255-264.

Ofori, George. (2000). *Challenges of construction industries in developing countries: Lessons from various countries.* Paper presented at the 2nd International Conference on Construction in Developing Countries: Challenges Facing the Construction Industry in Developing Countries, Gaborone, November.

Ogbu, C. P. (2018). Survival practices of indigenous construction firms in Nigeria. *International Journal of Construction Management, 18*(1), 78-91.

Ogunlana, Stephen O. (2010). Beyond the 'iron triangle': Stakeholder perception of key performance indicators (KPIs) for large-scale public sector development projects. *International journal of project management, 28*(3), 228-236.

Okpala, Daniel C, & Aniekwu, Anny N. (1988). Causes of high costs of construction in Nigeria. *Journal of Construction Engineering and Management, 114*(2), 233-244.

Oladiran, Olatunji J. (2009). Innovative waste management through the use of waste

management plans on construction projects in Nigeria. *Architectural Engineering and Design Management, 5*(3), 165-176.

Olatunji, O. A., Aje, O. I. & Makanjuola, S. (2017). Bid or no-bid decision factors of indigenous contractors in Nigeria. *Engineering, Construction, and Architectural Management, 24*(3), 378-392.

Omole, FK. (2000). Urban renewal process issues and strategies. *Concept Book and Publication Company Nigeria Limited, Lagos, Nigeria*.

Oppenheim, A.N. (2000), Questionnaire Design, Interviewing and Attitude Measurement, 2nd ed., Continuum International Publishing Group.

Tan, W. (2015). Knowledge management in the construction industry: The strategy of Singapore. International Journal of Construction Management, 15(1), 10-16. doi:10.1080/15623599.2015.1012138

The organization, World Health. (2005a). Monitoring vaccine wastage at country level: guidelines for program managers: Geneva: World Health Organization.

The organization, World Health. (2005b). WHO-UNICEF effective vaccine store management initiative: modules 1-4: Geneva: World Health Organization.

Owoh, Kenna. (1993). Gender and Health in Nigerian Structural Adjustment: What Does it Mean for Women? *Canadian Woman Studies, 13*(3).

Pallant, J. (2010), SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS, Allen & Unwin, Crows Nest.

Polit, D. F, & Beck, C. T. (2010). Generalization in quantitative and qualitative research: Myths and strategies. *International journal of nursing studies, 47*(11), 1451-1458.

Proverbs, D. G., Holt, G. D. & Olomolaiye, P. O. (1998). A comparative evaluation of reinforcement fixing productivity rates amongst French, German, and UK construction contractors. *Engineering Construction and Architectural Management, 5*(4), 350-358.

Procurement, Australian, & Council, Construction. (1997). Construct Australia: Building better construction industry in Australia. *The Australian Procurement and Construction Council Inc., Deakin West, ACT, Australia*.

Reiner-Roth, Shane. (2018). *Tropical Islands; or, how the architectural interior became the primary site of aesthetic mediation.* Massachusetts Institute of Technology.

Rickson, Colin David, & Pring, John Bernard. (2003). Thermally insulated container: Google Patents.

Riley, Mike, Cotgrave, Alison, & Farragher, Michael. (2017). *Building Design, Construction, and Performance in Tropical Climates*: Routledge.

Velásquez, R. M. A., & Lara, J. V. M. (2021). Knowledge management in two universities before and during the COVID-19 effect in Peru. *Technology in Society*, *64*, 101479.

Wang, Luyao, & Hu, Yuqiao. (2018). Third-party healthcare logistics: A study of third-party logistics providers in China.

Wells, Jill. (1986). *The construction industry in developing countries: Alternative strategies for development*: Taylor & Francis.

Wibowo, M. A., & Waluyo, R. (2015). Knowledge management maturity in construction companies. *Procedia Engineering*, *125*, 89-94.

Wirkas, Theo, Toikilik, Steven, Miller, Nan, Morgan, Chris, & Clements, C John.

(2007). A vaccine cold chain freezing study in PNG highlights the technology needs for hot climate countries. *Vaccine, 25*(4), 691-697.

World Health Organisation WHO (2016) Guideline for establishing or improving primary and intermediate vaccine stores Retrieved from www. who. int/vaccines-documents/ https://apps.who.int/iris/bitstream/handle/10665/67807/WHO_V-B_02.34_eng.pdf;jsessionid=2FB291B72D082A71F8899A58C94C025B?sequence=1

Wouters, O. J., Shadlen, K. C., Salcher-Konrad, M., Pollard, A. J., Larson, H. J., Teerawattananon, Y., & Jit, M. (2021). Challenges in ensuring global access to COVID-19 vaccines: production, affordability, allocation, and deployment. *The Lancet*.

Yasamis, F., Arditi, D., & Mohammadi, J. (2002). Assessing contractor quality performance. *Construction Management & Economics*, *20*(3), 211-223.