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Assessing innovative tools and techniques for managing knowledge in construction firms in Nigeria

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ABSTRACT

The construction industry is plagued with projects that are often complex, involve numerous risks and require the input of several stakeholders. Therefore, there is a need to help organisations identify, assess, and manage these risks, reducing the likelihood of project delays, cost overruns, and other problems faced in the industry through effective Knowledge Management (KM). Previous studies on knowledge management and its practices in construction firms have dealt extensively with identifying these practices, how KM practices are carried out, and their importance to better construction performance and service. However, these studies have yet to recognise and discuss the innovative ways knowledge is managed. The practices of knowledge creation, acquisition, transfer, storage and use have seen recent developments in how they are being carried out, and this is primarily a result of the application of Information Technology (IT) to construction. The study sought to assess the innovations in KM practice in construction firms in Lagos state, Nigeria. The specific objectives were to assess innovative KM practices carried out by construction firms and examine the innovative tools and techniques for managing knowledge in construction firms. A quantitative research method was used in this study. The targeted population was construction professionals in construction firms. Data collection was through a structured questionnaire administered to the targeted population, and a response rate of 62% was achieved. The data was analysed using statistical tools. The study revealed that knowledge management is particularly important to the construction industry, and there is a need to improve and invest in knowledge management practices through adopting Information and Communication Technology (ICT) to improve project delivery and performance. The study recommended that construction firms be open to learning and adopting innovative ideas, tools and techniques to ensure that knowledge is properly managed.

Keywords: Construction firms, Innovations, Knowledge Management, Nigeria

1. INTRODUCTION

Construction firms must recover all relevant knowledge before the commencement of new projects to better estimate the time, costs, quality and sustainability of projects (Heisig et al., 2016). It is, therefore, critical for construction firms to transfer data and information from projects completed in the past, as this helps to ensure better project delivery as improvements are made on successes and corrections on mistakes. Tengan et al. (2014) noted that the construction industry is recognised as a knowledge centre. However, there have been issues with the comprehensive capture and management of project knowledge for growth and competitiveness.

The construction industry is plagued with complex projects that involve numerous risks and require the input of several stakeholders (Fischer & Kunz, 2017). Therefore, a need has been aroused to help organisations identify, assess, and manage these risks, reducing the likelihood of project delays, cost overruns, and other problems faced in the industry through effective Knowledge Management (KM). According to Elfar and Elsaid (2017), most

organisations, including construction companies, have a competitive advantage depending on the knowledge available to them. Lee et al. (2016) noted that construction firms all over the world have identified the need to improve and implement best practices to improve their performance in order to improve the quality of project delivery, savings in cost and increase efficiency in service delivery. Therefore, good KM practice is critical for the success of construction projects. Innovation has become fundamental for all industries and countries due to its contribution to national economic growth, competitiveness, and higher living standards. This makes it a complex phenomenon with a wide range of inputs and outputs creating diverse impacts on performance at the company, sector and national level (Blayse & Manley, 2015). Paul et al. (2015) noted that innovations in knowledge management can be facilitated by providing employees with access to best practices, lessons learned, and other relevant knowledge. This can help construction firms identify new opportunities and improve their products and services. Technological tools play a critical role in ensuring innovations in KM practice, as new technologies and tools can facilitate knowledge sharing, collaboration and learning, leading to the development of new KM approaches (Alshamrani & Bahattab, 2018).

Al-Debei et al. (2015) noted that the construction industry is inherently complex, and effective knowledge management can be challenging due to fragmented information, diverse stakeholders and various disciplines involved. Therefore, innovations in KM, particularly in the area of Information and Communication Technology (ICT), have the potential to improve KM processes and outcomes in the construction industry. Previous studies carried out on knowledge management and its practices in construction firms have dealt extensively with identifying what these practices are, how KM practices are carried out and their importance to better construction performance and service. However, these studies have yet to recognise and discuss the new innovative ways that knowledge is being managed. The practices of knowledge creation, acquisition, transfer, storage and use have seen recent developments in how they are being carried out, and this is primarily a result of the application of Information Technology (IT) to construction. Therefore, this study will look into the innovative tools and techniques used to carry out KM practices in construction firms in Lagos state, Nigeria. Most of the ways of carrying out KM practices are either outdated or not as effective as they used to be due to the growing competition in the construction industry, and so innovative ways are being developed to stay competitive and meet the growing demands of clients.

Shujahat et al. (2019) affirmed that organisations with superior knowledge management practices are likely to achieve greater organisational performance. As a result, it is expected for construction firms to improve on their knowledge management practice to improve project performance and delivery. Several studies have been conducted on knowledge management in construction. Adegbembo et al. (2015) established that Quantity surveying firms were aware of the KM practice in construction; however, knowledge maintenance was lacking in most firms. The study recommended that QS firms should develop and implement a proper knowledge policy that will act as a guide for the organisations to direct their staff in managing knowledge and their application for effective practices. Oludolapo and Mohammed (2019) explored the barriers, benefits and capabilities of knowledge management for construction professionals. The study recommended that construction firms should pay keen attention to time management and the development of appropriate methodology that will foster KM implementation, and professional bodies should collaborate with government parastatal and construction firms to train professionals on KM. However, no such study focuses on the innovations and innovative tools and techniques in knowledge management. The study sought to assess the innovations in KM practice. The specific objectives were to assess innovative KM practices carried out by construction firms and examine the innovative tools and techniques for managing knowledge in construction firms.

2. CONCEPT OF KNOWLEDGE MANAGEMENT PRACTICE IN CONSTRUCTION

In the Construction industry, it is critical to transfer data and information from projects completed in the past; this helps to ensure better project delivery as improvements are made on successes and corrections on mistakes. Construction firms must recover all relevant knowledge before the commencement of new projects to better estimate the time, costs, quality and sustainability of projects (Heisig et al., 2016). Using this framework, construction firms are expected to reduce time, costs, delays and increase quality, efficiency and sustainability. Handzic and Durmic (2015) noted that construction organisations have utilised the project management tools in project planning and execution to achieve project management performance outcomes in terms of time, cost and quality. It was concluded that the construction industry uses a considerable number of knowledge workers and implementing KM for project planning and execution is the key to sustaining the growth of construction organisations and industry, particularly when KM implementation is linked to project performance outcomes. Research studies have shown that, while the construction industry is recognised as a knowledge centre, there have been issues with the comprehensive capture and management of project knowledge for growth and competitiveness (Tengan et al., 2014). It was concluded that to effectively incorporate KM, the organisational framework of construction policies must be considered. By comprehensively identifying and integrating the resources and expertise of project team members, knowledge management will greatly improve the institution's overall resolution capacity. Geisler and Wickramasinghe (2015) shared their dissatisfaction with the industry's challenges, which include a lack of KM system, a lack of managerial guidance and a misperception of KM practices.

Knowledge management is defined as the explicit and effective management of important knowledge and its related practices of identification and exploitation (Ngah, 2016). Alaarj (2016) identified that effective knowledge resources make up knowledge capability among organisations with the help of knowledge sharing, knowledge creation, innovativeness, and knowledge absorption. Therefore, when these resources merge, it determines the KM practices, which ultimately turn into a relationship with organisational performance. KM is a systematic, organised and continuous process whose objectives are to increase competitiveness, promote organisational learning and preserve knowledge (Kim, 2014; Liu et al., 2019). It is applied throughout the organisation, adapting to policies and always requiring monitoring and evaluation. Good knowledge management becomes a competitive strategy because it works on learning from previous lessons, avoiding mistakes and repeating successes (Dong & Ni, 2018). Akhavan (2016) stated that knowledge management practices such as knowledge sharing, knowledge acquisition, and knowledge application contribute to innovation, which helps to improve organisational performance. KM practices in construction firms involve the systematic identification, acquisition, organisation, sharing, and application of knowledge to improve project performance, enhance organisational learning, and foster innovation within the construction industry. These practices aim to capture both tacit and explicit knowledge and facilitate its effective utilisation throughout the organisation.

2.1 Innovations in knowledge management practice in construction firms

Innovation not only represents the creation of new things, but, it can also be considered within the adoption, adaptation and modification of processes as well as the management and organisation of work (Pellicer et al., 2015). Lindgren et al. (2018) considered it an advanced activity, in both the scientific and technical aspects, that requires more complex communication processes. Small companies in the construction sector have the characteristic of being more disposed to innovation; this is because of their proximity to suppliers, which are sources of knowledge that can be captured, as identified by Hartono et al. (2019). Also, they can more easily strengthen their organisational learning without the need for

excessively institutionalised management, as a precursor of innovation processes (Wen & Qiang, 2016; Ni et al., 2018). Innovation being an advanced activity implies being holistic, continuous and systematic, which means, integrating both process and people, thus eradicating the isolated perception of it (Sujan et al., 2020).

The present-day society relies on Information and Communication Technology (ICT) tools to manage intangible and tangible knowledge; this implies that ICT has the capacity to support KM through its multiple technologies, which combine microelectronics, computer hardware and software, telecommunications, and optoelectronics, such as microprocessors, semiconductors and fibre optics, which enable the processing and the storage of large amounts of information, as well as its rapid dissemination through computer networks (Ngenge, 2013). It was concluded that knowledge needs to be managed because it is at risk of becoming extinct if appropriate measures are not taken to preserve and manage it. ICT plays a significant role in creating knowledge as well as its management. In this regard, ICT systems provide useful tools for creating and capturing knowledge as well as its application (Sarlak, 2018). Forati (2018) discussed that ICT comes with a variety of capabilities, such as archiving, transferring and sharing of information. In addition, these tenets enable efficient and effective classification of information and its dissemination. Lopez et al. (2015) identified that ICT assists individuals and organisations with information. However, the relevance and usefulness of that said information need to be first confirmed and determined by the people. ICT assist in knowledge creation and in other KM practices. Consequently, the proper ICT infrastructure is required as a precursor to successful KM (Afrazeh, 2017). In this regard, strategic use of ICT becomes a necessity to keep abreast of globalisation and the rapid changes in the workplace. Therefore, organisations should strive to establish knowledge management systems that utilise ICT systems to enhance the creation, acquisition, transfer, storage and application of information/knowledge. The innovations in knowledge management practices are discussed below.

2.1.1 *Knowledge creation*

Knowledge creation consists of the generation of new knowledge or replacing content that already exists with new explicit or tacit forms of knowledge (Swartbooi, 2010). Although paper-based knowledge is still relevant, it was concluded that cognitive workload and memory measures are replaced by the use of a computer and electronic-aided tools. Lamproulis (2017) noted that technology plays a significant role in enhancing the creation of knowledge in organisations. Thus, the adoption of ICT enhances the efforts of staff to increase the speed and efficiency of work.

2.1.2 *Knowledge acquisition*

An organisation's ability to acquire, synthesise, manipulate and exploit knowledge has been considered paramount to efficiently working on projects and improving organisational performance (Anumba, 2011). According to Vanyzk (2014), the traditional knowledge acquisition process involves observing the person solving real problems, through discussions, identifying the kinds of data, knowledge and procedures required to solve different types of problems, through building scenarios with the expert that can be associated with different problem types, have the expert solve a series of problems verbally and ask the rationale behind each step. Blick and Grit (2019) identified in their research on innovative processes of knowledge acquisition that knowledge can be acquired with the aid of ICT tools such as online Libraries, digitalised past project reports and project review meetings.

2.1.3 *Knowledge transfer*

According to Alashwal and Abdul-Rahman (2014a), knowledge transfer is the flow of knowledge from a source to a receiver for assimilation and reuse based on previous experience. Innovation in knowledge sharing/transfer is encouraged through tape/voice

recording, videos and film reels, as identified by Kremer et al. (2019). Knowledge can be transferred as well through collaborations within the organisation and with other organisations (Adams et al., 2017).

2.1.4 *Knowledge storage*

Knowledge that has been created should be captured and stored in formats that allow reuse because organisations may create knowledge, generate ideas and learn from experiences, but this knowledge is bound to be forgotten and lost if not captured and stored (Swartbooi, 2010). Shen (2016) also identified other innovative systems for storing knowledge, such as Document management systems that are used to store and manage a wide range of knowledge assets, including project plans, technical documents, and best practices; Cloud-based storage systems used to store and assess data and can be accessed from any device with an internet connection; Big data, for analysing large sets of data. With this, organisations can gain insights and identify patterns and trends that can inform decision-making and improve performance.

2.1.5 *Knowledge use/application*

According to Ni et al. (2018), the application of knowledge is the direct aim of KM, which leads to improvement in working efficiency and the enhancement of work results. With knowledge application, an organisation is able to become more innovative, which leads to the creation of more new knowledge, which enables the continuation of the KM process. The innovative ways of applying knowledge are seen in the use of current ICT tools such as GIS, robotics, BIM, Project Management software, knowledge portals and other ICT performance tools as identified by Forati (2018).

2.2 Innovative tools and technique for managing knowledge in construction firms

Innovative Management Tools and Techniques (IMTTs) have a wider and more accurate consideration and have been defined as a range of tools, techniques, and methodologies that help companies adapt to circumstances and meet market challenges in a systematic way (Hidalgo & Albors, 2008). IMTTs result from a new way of thinking and are49related to the capacity of firms to apply their knowledge to improve their businesses internally and their relationship with external actors (Albors, 2015). Al-Khaldi and Koushki (2019) noted that intranet infrastructure facilitates the sharing of knowledge and information among employees, leading to improved project performance and reduced errors. Intranet infrastructure also provides a platform for collaboration, which enhances teamwork and promotes innovation. Additionally, intranet infrastructure allows employees to access information and knowledge anytime, anywhere, thereby improving decision-making processes and reducing project delays. Intranet infrastructure provides basic functionality for communication through means such as email and teleconferencing and also enables storage, sharing, searching and retrieval of knowledge, documents and data (Zanjani & Moghaddam, 2016). Intranet infrastructure has been recognised as a powerful tool for knowledge management innovation in the construction industry.

Bock et al. (2018) noted that Artificial intelligence (AI) technologies can analyse large volumes of data to identify patterns and predict construction projects. AI-powered virtual assistants can help construction workers access critical information in real-time; including safety procedures, project schedules, and building codes (Gheisari & Memarian, 2019). Intelligent Agents are software programs or codes that accept input in the form of a user profile indicating the information that is deemed significant in a particular job or in a specific working environment and produce the information in an easy-to-understand manner (Petter, 2015). It was further noted that, intelligent agents are rarely stand-alone programs; rather, they are embedded in other applications programs such as E-mails, Decision support systems, Groupware systems, Simulation systems, Taxonomy based systems, word processors, or

scheduling programs. Project management software, which is used to plan, organise, and control construction projects, can support the application of knowledge in the construction industry by providing access to project-related information and knowledge assets (Shen et al., 2015). This can help project teams make informed decisions and manage projects more effectively.

Mobile devices have become a popular tool for knowledge management due to their portability, ease of use, and versatility. According to a study published in the International Journal of Information Management, the use of mobile devices for knowledge management is on the rise, with more and more individuals and organisations using these devices to capture, store, and share information (Ji & Lin, 2019). Mueller and Oppenheimer (2017) identified that one way that mobile devices can be used for knowledge management is through note-taking apps. These apps allow users to quickly capture ideas, insights, and information on the go. Research has shown that using a mobile device for note-taking can improve the quality of the notes taken and lead to better retention of the information. Mobile devices can also be used for task management. There are many task management apps available for both Android and iOS devices, such as Trello and Todoist, which allow users to keep track of tasks, assign deadlines, and prioritise their work (Deng et al., 2019). Another way that mobile devices can be used for knowledge management is through communication apps. Apps such as Slack and Microsoft Teams allow users to communicate with colleagues, share information, and collaborate on projects (Lee & Kim, 2019). This has helped to improve teamwork and collaboration.

3. METHODOLOGY

The study sought to assess the innovations in KM practice in construction firms in Lagos state and the innovative tools and techniques for managing knowledge in these firms. To achieve this aim, a quantitative research method was adopted. In line with the quantitative method, a survey research approach would be used for this study because it is suitable for obtaining answers from a broad population and also, it is good for gathering data from a relatively large number of respondents within a limited period.

The target population of the study comprised construction professionals from registered quantity surveying firms, architectural firms and other construction firms in Lagos state, Nigeria. The choice of Lagos is due to its high population of construction firms situated there, which enabled the obtaining of reliable and relevant data. The accessible population for the study was from the list of registered quantity surveying firms from the Nigeria Institute of Quantity Surveyors (NIQS), which indicated that 57 quantity surveying firms were registered in Lagos in the year 2022. According to FineLib.com (Nigeria Directory and Search Engine), in correlation with the Architects Registration Council of Nigeria (ARCON) and Council for the Regulation of Engineering in Nigeria (COREN), the number of registered architectural and construction firms in Lagos state in the year 2022 is indicated at 336 and 195 respectively.

3.1 Sample and sampling techniques

Convenience sampling method was used to obtain the necessary data. The reason for choosing this method is in line with the affirmation of Abrams (2010) that described the convenience sampling as a method of sampling in which respondents are picked based on convenience considering the accessibility, availability, proximity and other relevant conditions by the researcher. A total of 179 questionnaires were administered, out of which 111 responses were obtained, representing a response rate of approximately 62%. This response rate is considered acceptable since the average and the acceptable response rate is 60% $\pm$ 20% (Fincham, 2008).

3.2 Data collection and analysis

This study used a structured, close-ended questionnaire as an instrument for collecting primary data. The questionnaires were self-administered to the various construction professionals who are concerned through direct contact with them. This was done in order to ensure relevant information is provided on the objectives of this research. Frequency and percentage were used to analyse the background information of the respondents. The background information included information such as "highest academic qualification of the respondents", "years of working experience", and other relevant information necessary to underpin the suitability of the respondents to give valid information to achieve the aim of this study. Construction professionals were requested to respond to items on innovations in knowledge management in construction and the innovative tools and techniques for managing knowledge in construction firms on a 5-point Likert scale, assessing level of awareness and level of use.

The data was analysed with the aid of Statistical Package for the Social Sciences (SPSS) software. The data was analysed by means of Mean Score (M.S), Standard deviation (S.D), Kruskal-Wallis test and Paired sample T-test. The mean score and standard deviation helped present the data in a meaningful and understandable way, thereby simplifying the interpretation. Kruskal-Wallis test, a non-parametric test used in testing the significant difference in the perception of three or more categories of respondents, was employed in assessing the relationship in the view of the three categories of the respondents as to the level of awareness and use of innovations in knowledge management practices in construction firms. The T-test helped to determine whether the mean difference between two sets of observations is a null hypothesis or an alternate hypothesis. The null hypothesis assumes that the mean difference between the paired samples is zero, and the alternate hypothesis assumes that the true mean difference between the paired samples is not equal to zero. Significance is determined by looking at the p-value; a low p-value indicates decreased support for the null hypothesis, taking the confidence level to be 95%, and the precision level is 0.05.

4. RESULTS

4.1 Demographics of the respondents

Table 1 shows the background information of the respondents. The distribution of respondents according to the type of profession of the respondent revealed that 49.5% of the respondents were Architect, Engineers were 29.7%, and Quantity surveyors were 20.7%. The distribution of respondents according to their professional qualification revealed that many of the respondents (49.5%) were ARCON/MNIA, (20.7%) MNIQS/QSRBN while (29.7 %.) were COREN/NCE. The distribution of respondents according to academic qualification revealed that 49% of the respondents were B.Sc/B.Tech, 39% were M.Sc/M.Tech, while 4% were HND and 8% of the respondents were PhD. All of the respondents (100%) had completed tertiary education. Additionally, the distribution of respondents according to professional experience, the results revealed that 34.2% were between 11-15 years of experience, 22.5% were between 16-20years of experience, 18.9% were between 6-10 years of experience, 13.5% were between 1-5 years of experience and 10.8% were above 21 years of professional experience.

Table 1: Summary of the characteristics of the respondents

Factor	Variable	Frequency	Percentage
Respondents Profession	Architect	55.0	49.5
	Quantity Surveyor	23.0	20.7
	Engineer	33.0	29.7
	Total	**111.0**	**100.0**
Years of working experience	Less than 5 years	15.0	13.5
	6 to 10 years	21.0	18.9
	11 to 15 years	38.0	34.2
	16 to 20 years	25.0	22.5
	Above 21 years	12.0	10.8
	Total	**111.0**	**100.0**
Academic Qualification of respondents	M. Tech/Msc	54.0	49.0
	B.Tech /Bsc	43.0	39.0
	PhD	9.0	8.0
	Hnd	5.0	4.0
	Total	**111.0**	**100.0**
Professional Qualification of the respondent	ARCON/MNIA	55.0	49.5
	MNIQS/QSRBN	23.0	20.7
	COREN/NCE	33.0	29.7
	Total	**111.0**	**100.0**

4.2 Innovations in knowledge management practice in construction firms

In Table 2, the mean item score was used in ranking the level of awareness of innovations in knowledge management practices in the construction industry. The Kruskal-Wallis test, a non-parametric test used in testing the significant difference in the perception of three or more categories of respondents, was employed in assessing the relationship in the view of the three categories of the respondents as to the level of awareness of innovations in knowledge management practices in construction firms. The result is presented in Table 2.

Following a similar approach to Ahadzie et al. (2008), for each of the identified processes, a benchmark of 3.5 was fixed. This implies that a level of awareness of innovations in knowledge management practices in the construction industry is being used if it has a mean of 3.5 and above, while it is not when its mean value is less than 3.5.

From the Table, it is evident that Architect identify nine (9) out of the fifteen (15) as their common awareness of innovations in knowledge management practices in the construction industry, Quantity surveyors identified twelve (12) as their common awareness of innovations in knowledge management practices in the construction industry, and Engineers identified eleven (11) as their common awareness of innovations in knowledge management practices in the construction industry due to their mean item score is high than 3.5.

The respondents were made aware of the following: Structural Design Software with a mean of 4.15, 2D/3D AutoCAD Packages with a mean of 4.77, Electronic Mails with a mean of 4.01, Word Editor Packages with a mean 4.46, Spreadsheet Package with mean 4.68, Internet (websites and social platforms) with mean of 4.57, Collaborations with other Organisations with mean of 3.53, Digitalized Past Project Reports with mean of 3.78, Tape/Voice Recordings with mean of 4.14, Cloud Computing Technique with mean of 3.99 and Augmented Reality with mean 4.21.

Kruskal-Wallis test showed that only seven (7) out of the identified levels of awareness of innovations in knowledge management practices in the construction industry are very popular in construction project performance and have a significant p-value of below 0.05. These are Structural Design Software with a significant p-value of 0.012, Word Editor Packages with a significant p-value of 0.000, Database Systems with a significant p-value of 0.001, Internet (websites and social platforms) with a significant p-value of 0.026,

Digitalised Past Project Reports with a significant p-value of 0.000, tape/voice recordings with a significant p-value of 0.025 and Big Data with a significant p-value of 0.001.

Table 2: Level of awareness of the innovations in knowledge management practices in construction firms

	ARC		QS		ENG		Overall		Kruskal-Wallis	
Variables	**MIS**	**RK**	**MIS**	**RK**	**MIS**	**RK**	**MIS**	**RK**	**Chi**	**Sig.**
Structural Design Softwares	3.98	9	4.13	6	4.45	3	4.15	6	8.785	0.012*
2D/3D AutoCAD Packages	4.75	2	4.70	1	4.85	1	4.77	1	1.998	0.368
Electronic Mails	4.05	8	4.17	5	3.82	9	4.01	8	3.380	0.185
Word Editor Packages	4.73	3	4.00	7	4.33	5	4.46	4	18.226	0.000*
Spreadsheet Package	4.76	1	4.57	2	4.61	2	4.68	2	3.917	0.141
Database Systems	3.38	11	3.83	9	3.15	13	3.41	12	13.246	0.001*
Internet (websites and social platforms)	4.71	4	4.43	3	4.42	4	4.57	3	7.322	0.026*
Collaborations with other Organisations	3.40	10	3.57	11	3.73	10	3.53	11	2.871	0.238
Online Libraries	3.13	13	3.43	12	3.15	13	3.20	13	2.551	0.279
Digitalised Past Project Reports	3.33	12	4.22	4	4.09	8	3.78	10	23.417	0.000*
Tape/Voice Recordings	4.27	5	3.74	10	4.18	7	4.14	7	7.405	0.025*
Video and Film Reels	2.80	14	3.04	13	2.64	14	2.80	15	2.845	0.241
Cloud Computing Technique	4.16	7	3.91	8	3.76	11	3.99	9	5.686	0.058
Application of BIM, Robotics and Augmented Reality	4.22	6	4.13	6	4.24	6	4.21	5	0.237	0.888
Big Data	2.55	15	2.96	14	3.27	12	2.85	14	13.268	0.001*

*Significant at the 0.05 level (2-tailed)

In Table 3, the mean item score was used in ranking the level of uses of innovations in knowledge management practices in the construction industry. Kruskal-Wallis test, a non-parametric test used in testing the significant difference in the perception of three or more categories of respondents, was employed in assessing the relationship in the view of the three categories of the respondents as to level of uses of innovations in knowledge management practices in construction firms. The result is presented in Table 3.

Following a similar approach to Ahadzie et al. (2008), for each of the identified processes, a benchmark of 3.5 was fixed. This implies that a level of use of innovations in knowledge management practices in the construction industry is being used if it has a mean of 3.5 and above, while it is not when its mean value is less than 3.5.

From the table, it is evident that Architects identified twelve (12) out of the fifteen (15) as their common use of innovations in knowledge management practices in the construction industry, Quantity surveyors identified ten (10) as their common use of innovations in knowledge management practices in the construction industry, and Engineers identified twelve (12) as their common use innovations in knowledge management practices in the construction industry due to their mean item score is high than 3.5.

The respondents made use of Structural Design Software with a mean of 4.47, 2D/3D AutoCAD Packages with a mean of 4.61, Electronic Mails with a mean 4.08, Word Editor Packages with mean 4.27, Spreadsheet Package with mean 4.53, Database Systems with mean of 4.57, Internet (websites and social platforms) with mean of 4.84, Collaborations with other Organisations with mean of 4.28, Tape/Voice Recordings with mean of 4.11and Cloud Computing Technique with mean of 4.06.

Kruskal-Wallis test showed that only four (4) out of the fifteen (15) identified innovations in knowledge management practices in the construction industry are used in construction projects and have a significant p-value of below 0.05. These are Electronic Mail with a significant p-value of 0.026, Word Editor Packages with a significant p-value of 0.011,

Online Libraries with a significant p-value of 0.046 and Application of BIM, Robotics and Augmented Reality with a significant p-value of 0.000.

Table 3: Level of use of the innovations in knowledge management practices in construction firms

	ARC		QS		ENG		Overall		Kruskal-Wallis	
Variables	**MIS**	**RK**	**MIS**	**RK**	**MIS**	**RK**	**MIS**	**RK**	**Chi**	**Sig.**
Structural Design Software	4.36	5	4.70	2	4.48	3	4.47	5	4.081	0.130
2D/3D AutoCAD Packages	4.64	2	4.61	4	4.58	2	4.61	2	0.052	0.974
Electronic Mails	3.89	10	4.09	8	4.39	5	4.08	9	7.279	0.026*
Word Editor Packages	4.11	7	4.65	3	4.27	6	4.27	7	8.961	0.011*
Spreadsheet Package	4.62	3	4.48	5	4.42	4	4.53	4	3.729	0.155
Database Systems	4.55	4	4.61	4	4.58	2	4.57	3	0.165	0.921
Internet (websites and social platforms)	4.84	1	4.78	1	4.88	1	4.84	1	0.916	0.632
Collaborations with other Organisations	4.16	6	4.26	7	4.48	3	4.28	6	5.120	0.077
Online Libraries	3.55	12	3.00	12	3.24	12	3.34	12	6.174	0.046*
Digitalised Past Project Reports	3.60	11	3.48	9	3.27	11	3.48	11	2.969	0.227
Tape/Voice Recordings	3.98	9	4.35	6	4.15	7	4.11	8	3.358	0.187
Video and Film Reels	3.11	13	2.96	13	3.52	10	3.20	13	5.646	0.059
Cloud Computing Technique	4.05	8	4.35	6	3.88	9	4.06	10	4.581	0.101
Application of BIM, Robotics and Augmented Reality	3.00	15	3.39	10	3.91	8	3.35	14	15.739	0.000*
Big Data	3.09	14	3.22	11	2.70	13	3.00	15	4.070	0.131

*Significant at the 0.05 level (2-tailed)

4.3 Innovative tools and techniques used in knowledge management in construction

Table 4 shows how a paired sampled t-test was used to analyse innovative techniques and tools for managing knowledge in construction, which shows the paired difference between the two variables to be compared. The paired samples t-test determines whether the mean difference between two sets of observations is a null or alternate hypothesis. The null hypothesis assumes that the mean difference between the paired samples is zero, and the alternative hypothesis assumes that the true mean difference between the paired samples is not equal to zero. Significance is determined by looking at the p-value; a low p-value indicates decreased support for the null hypothesis, taking the confidence level to be 95%, the precision level is 0.05

From the Table below Sig. (2-tailed) is also known to be p-value; when the p-value (sig 2-tailed) is greater than 0.05, that means there is no statistically significant difference between the two samples, but if the p-value (sig 2-tailed) is less or equal to 0.05, there's a statistically significant difference between the two samples. From the Table below, in the case of having 0.460 as the p-value (Sig. 2-tailed) of Decision Support Systems, this shows there is no statistically significant difference between the two samples because the p-value (Sig. 2-tailed) 0.460 is greater than 0.05. In the case of Intranet Infrastructure, in which 0.030 is the p-value (Sig. 2-tailed), there is a statically significant difference between the two samples because the p-value is lesser than the precision value, which is 0.05. These shows Intranet Infrastructure, Groupware Systems, Document Management Systems, Simulation Systems, Ontology/Taxonomy Based Systems, Knowledge Repository System and Wikis are significant among the Innovative Techniques and Tools for Managing Knowledge in Construction project.

Table 4: Innovative techniques and tools for managing knowledge in construction

Variables	Mean diff.	SD	*t*-value	Sig. (2 tailed)
Intranet Infrastructure - Intranet Infrastructure	0.171	0.819	2.202	0.030*
Groupware Systems - Groupware Systems	0.315	0.894	3.715	0.000*
Document Management Systems - Document Management Systems	0.396	1.003	4.166	0.000*
Decision Support Systems - Decision Support Systems	-0.081	1.153	-0.741	0.460
Artificial Intelligence Technologies - Artificial Intelligence Technologies	-0.027	0.899	-0.317	0.752
Simulation Systems - Simulation Systems	-0.315	1.458	-2.278	0.025*
Workgroup Support Systems - Workgroup Support Systems	-0.072	0.997	-0.761	0.448
Ontology/Taxonomy Based Systems – Ontology	0.207	0.926	2.359	0.020*
Knowledge Repository System - Knowledge Repository System	0.892	1.289	7.291	0.000*
Wikis – Wikis	-0.703	1.225	-6.041	0.000*
Social Media - social media	-0.144	1.249	-1.216	0.227
Mobile Devices - Mobile Devices	-0.234	1.314	-1.878	0.063
Electronic Networking - Electronic Networking	0.153	1.130	1.428	0.156
Knowledge Map - Knowledge Map	0.027	1.411	0.202	0.840
Bank of Ideas - Bank of Ideas	0.207	1.389	1.572	0.119
Weblogs – Weblogs	0.108	1.545	0.737	0.463
K-logs - K-logs	-0.216	1.467	-1.553	0.123

*Significant at the 0.05 level (2-tailed)

5. DISCUSSION OF THE FINDINGS

5.1 Innovations in knowledge management practice in construction firms

The objective here was to assess the innovative KM practices carried out by construction firms. From the findings as presented in Table 4.2, Structural Design Software, Word Editor Packages, Database Systems, Internet (websites and social platforms), Digitalized Past Project Reports, Tape/Voice Recordings, and Big Data were the innovative knowledge management practices that are most aware in construction firms. Also from Table 4.3, Electronic Mails, Word Editor Packages, Online Libraries and Applications of BIM, Robotics and Augmented were the major used Knowledge Management Practices in construction firms. This is in agreement with the findings of Lopez et al. (2015) and Afrazeh (2017). It was identified in their research that ICT has become a necessity in ensuring proper knowledge management practice by construction firms. Afrazeh (2017) concluded that to keep abreast of globalisation and the rapid changes in the world today, organisations should strive to establish knowledge management systems that utilise ICT systems to enhance the creation, acquisition, transfer, storage and application of information/knowledge.

5.2 Innovative tools and techniques used in knowledge management practices in construction firms

The objective here is to examine the Innovative tools and techniques for managing knowledge in construction firms. Table 4.4 shows that Intranet Infrastructure, Groupware Systems, Document Management Systems, Simulation Systems, Ontology/Taxonomy Systems, Knowledge Repository Systems and Wikis are significant among the Innovative Techniques and Tools for Managing Knowledge in Construction projects. This is in agreement with the findings of Albors (2015). It was concluded that, for construction companies to meet market growing needs and ensure better project delivery, construction

firms must adopt IT tools, techniques and methodologies. IT-based systems such as groupware systems, document management systems, knowledge repository systems and taxonomy-based systems that are relevant in storing information are particularly important in improving the KM process of construction firms, as this helps to record successful ideas, procedures and techniques. It also records failures in procedures, which will be discussed to ensure that such failures are not repeated.

6. CONCLUSION

This paper has assessed the innovations in knowledge management in construction firms in Lagos state, Nigeria. Furthermore, it assessed the drivers of innovations in knowledge management in construction firms, the challenges facing innovations in knowledge management in construction and the innovative tools and techniques used in knowledge management practices as identified and evaluated from Lagos state. Through a comprehensive review of pertinent literature, fifteen (15) variables were identified for innovative knowledge management practices, and seventeen (17) innovative tools and techniques used in knowledge management practice in construction firms were identified. Results showed that respondents viewed the innovative KM practices on the level of awareness and use and the innovative tools and techniques used in KM practice on the level of awareness and use. Based on the findings, it can be concluded that;

i. The innovative knowledge management practice in construction firms is centred on the development, use and exploitation of the rapidly evolving Information and Communication Technology (ICT). This indicates that the more technology advances in the world, the construction industry will incorporate these technological changes into its activities in order to meet world standards, thereby increasing awareness and use of ICT in construction management.
ii. ICT tools, platforms, gadgets and devices are vital in managing knowledge in construction firms. The development of intranet infrastructures in construction firms will continue to improve the innovative practice of knowledge management in the industry.

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