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Collaborative Knowledge Management: an Emerging Theme among Construction Firms in Nigeria

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Abstract:
The increasing pressure of cost and time reduction, delivering better projects and fighting ever-increasing environmental challenges has made the effective use of intellectual capital even more important for construction firms. With these growing complexity comes an increasing need to understand how disciplines relate to each other and the value of collaboration. This research is aimed at assessing the drivers and barriers to collaborative knowledge management' as an emerging theme among construction firms in Nigeria. The research is an investigative study, in which a quantitative research method was used. The research used a purposive sampling technique that considered large building construction firms that captured in its management structure, the responsibilities of the key knowledge professionals at unit and departmental levels. These knowledge professionals were identified as Architects, Quantity Surveyors, Land Surveyors, Builders and Engineers, who are unit/departmental heads. Twenty eight (28) firms involving the five (5) knowledge professionals in each firm participated in the research, giving 140 respondents. The Cronbach's coefficient alpha was used to check the internal consistency of the data, hence ascertaining the reliability of the instrument (above 0.8), while the content validity was conducted to ascertain the relevance of the research questions as well as the tools. The Kruskal-Wallis test which is the nonparametric equivalent of a one-way ANOVA was used for testing whether samples originate from the same distribution. The availability of Collaborative KM Software was identified as the most significant driver (MS=4.31). The research also classified the barriers of CKM into process and technological barriers, with the lack of awareness of Collaborative KM practices as the most significant process barrier (M=4.21) and Poor Internet Connectivity as the most significant technological barrier (4.26). The research concludes that that all the factors (drivers and barriers) identified have significant effect on the emergence of CKM as agreed by the various professional's groups that all the drivers identified have significant effect on the emergence of CKM. The research recommends the need for a nationwide public and professional awareness of the need for collaboration as well as CKM, which can begin from involvement of professional bodies to the enforcement of construction firms and other relevant key stakeholders. It also recommends that firms should create of a dedicated collaborative knowledge management software/platforms as well as the availability of good internet services as most collaborative activities are executed over the web.

Keywords: *Collaboration, knowledge management, construction firms, professionals, Nigeria*

1. Introduction

Construction firms has realised that the biggest asset it possesses is knowledge and experience associated with its human capital (Kamara, Augenbroe, Anumba, Carrillo, 2002). The increasing pressure of cost and time reduction, delivering better projects and fighting ever increasing environmental challenges has made the effective use of intellectual capital even more important. Construction firms embark on projects that are interdisciplinary and multi-agent in behavioural processes, which continue to access, create knowledge and apply it to practical work to realize the value of knowledge. Most construction projects are unique and fast moving, so work organizations are rather dynamic as they must be restructured again and again with different professionals, management, materials, equipment, and crews (Sauer, Liu and Johnston, 2001). Traditional pattern of construction projects leads to the fragmentation which made communication an obstacle among all the professionals (Xin and Jiming, 2010). In the recent times, construction projects have turned into a more complicated, dynamic and interactive scenario. Construction firms are constantly required to speed-up reflective decision-makings on time. With this growing complexity comes an increasing need to understand how disciplines relate to each other especially with the increased intricacy of projects there is a growing need for collaboration (Bhatla&Leite, 2012; Dvir et al., 2003; Eastman et al., 2011). Knowledge therefore is noted to be one of the most important resources

contributing towards managerial decision-making and enhancing the competitive advantage of construction firms in carrying out such projects (Carrillo, 2004 and Nonaka, & Takeuchi, 1995, Almahmoud and Doloi, 2013). To achieve the construction firm goals of a typical construction project, more than one construction professional is involved (Chinyio and Olomolaiye, 2010). According to Oke, Ogunsemi, Adeeko (2013) in a developing country like Nigeria, it is constant to have architects, engineers, builders, quantity surveyors and land surveyors as primary construction professionals on contracted building projects. It is known that construction professionals commissioned on construction projects are tied to the goal of successful project delivery, especially in terms of cost, time and quality (Idris, 2017). This suggests a shared area of interest among the professionals.

Knowledge has been described as information, which has been used and becomes a part of a person's knowledge-based experience and behavioural patterns (Kaklauskas, Zavadskas, &Gargasaitė 2004, DeTienne, & Jensen, 2001). Individuals as well as professionals have different knowledge-based capacity and experience, thus leading to different problem-solving approaches and decision-making. When choosing a construction professional, knowledge and experience are significant (Ogunlana, Siddiqui, Yisa, Olomolaiye, 2001). According to Dave, and Koskela (2009), social interaction/collaboration between workers is one of the most appropriate ways to capture tacit (experiential) knowledge in construction firms. Professional must therefore be capable of knowing how to synchronize, use, manage, and utilize such knowledge in a project.

According to Muntean, (2012), Collaboration on the other hand represents a strategic alternative to the monolithic approach to business development and competition. It involves a different approach to business – focused on managing business relationships between people, within or without groups, and within and between organizations. In the present global economy, strongly influenced by IT (information technology) and information systems evolution, the modern organizations try to face the challenges by adjusting their strategies and restructuring their activities, for aligning them to the new economy requirements. It is certain, that the enterprise's performance will depend on the capacity to sustain collaborative work. It is obvious that, all collaborative environments (workgroups, practice communities, collaborative enterprises) are based on knowledge, and between collaboration and knowledge management (KM) there is a strong interdependence.

Collaboration may be seen as the combination of communication, coordination and cooperation at the total life-cycle of construction project (Xin and Jiming, 2010). Communication is related to the exchange of messages and information among people, coordination is related to the management of people their activities and resources, and cooperation is related to the production taking place on a shared space. Collaboration technology typically focuses on collaboration and group processes (cooperation, communication, coordination and coproduction). Knowledge Management (KM) technology typically focuses on content (creation, storage, sharing and use of data, information and knowledge). Yet, to achieve their common goals, teams and organizations need both KM and collaboration technology to make that more effective and efficient. Therefore, collaborative knowledge management (CKM) is considered as a process of collective resolution of problems where it is useful to memorize the process of making collective decision and to structure the group interactions to facilitate problem solving and sharing of ideas (Lewkowicz, 2000). Understanding that collaborative knowledge management deals with the management of both organisational and personal knowledge, there is the need to harness this potential. Wasko and Faraj (2000) suggest that knowledge is a private property that is exchanged in the expectation of a commensurable return. Hall (2003) also argues that knowledge is a private commodity and it is up to the owner to decide whether to share it or not. To entice people to share their knowledge as part of a social exchange transaction, they need to be persuaded it is worth doing so.

Over the last century, the view on the design and implementation of collaborative solutions has shifted from a more technology driven perspective in general to a more sociotechnical perspective used at the turn of the last century (Dix, 2017). This shift moves the focus from the technology to the people and the organizational context in which the technology is implemented in and as such moves towards a more holistic perspective. The sociotechnical system approach focuses on describing and documenting the possible as well as the actual impact of the introduction of a specific tool/system/technology in an organization (Johannesson&Perjons, 2014; Sackey, Tuuli, & Dainty, 2014). This kind of documentation also helps analysing the difficulties that are faced when implementing the tool/system/technology. As communication and collaboration are inherently social activities common in construction and as such become part of a sociotechnical system (Sackey et al., 2014), this becomes important in the development of tool/system/technology supporting these actions. Chien Wu, & Huang (2014) identified a number of challenges in construction when implementing new tool/system/technology, ranging from financial, management related and personnel related to technical risk factors (Chien et al., 2014). These factors can manifest themselves in expectations from the personnel to challenges in compatibility of the tool/system/technology with regards to current ways of working (Davies &Harty, 2013). The success of implementations of tool/system/technology in construction has mainly been research from a tool/system/technology push view (Hartmann et al., 2012; Xue et al., 2012). tool/system/technology push is defined as the development of new tool/system/technology that offers a business process change from a tool/system/technology perspective in contrast to a demand pull where demand drives the development (Chidamber&Kon, 1994; Hartmann et al., 2012) The sociotechnical system view helps consider not just the implementation of the technology tool/system/technology, but the environment that creates the context for the implementation as well, which is the management of construction firms (Arayici et al., 2011). Therefore, this research in developing a framework for collaboration, considers the management, process, people and Technology as an analytical frame.

The assessment, process, challenges etc. of adopting knowledge management in construction management are well documented, as there is a great wealth of existing literature (Anumba, Bouchlaghem, Whyte, Duke (2000), El-Gohary (2008), Lu and Issa (2005), Zhang and Tiong (2003), to list a few). In the emerging knowledge-based economy, the essence

of collaboration becomes the exchange and integration of knowledge. Thus, Knowledge management has gone beyond the integration and sharing of data to the integration of people, processes and technology within and between organizations in the implementation of project decisions and hence successful project delivery (Quirchmayr and Tagg 2002).

The research strictly focused on respondents that are knowledge workers in construction firms as described by Egbu, and Robinson, (2005) as being responsible for providing important skills and knowledge in the construction industry. These workers are unit heads in the firm who are expected to be knowledgeable about the strategic choices of their firms with regard to collaboration and hence, competitive advantage as identified by Ibem, Aduwo, Uwakonye, Tunji-Olayeni, Ayo-Vaughan (2018). A major characteristic of growing cities and city centers is the high demand for infrastructure (Ogunlana, Li and Sukhera, 2003). Hence, the research will cover large building construction firms in Abuja, the Federal Capital Territory of Nigeria, with emphasis on the management of temporary organizational setting (project based).

2. Literature Review

2.1. The Nature of the Construction Industry in Nigeria

The Nigerian construction market is reported to be among the largest construction markets in Africa, (Sunday, Olubola, & Hakeem, 2013). According to forecast by (Global, 2010) Nigeria's construction industry is growing fast and is likely to grow very large over the next decade. According to the Foci Report (2012), the Nigerian construction market is dominated by foreign companies, which is similar to most African Countries. A large number of these major constructing firms in Nigeria are subsidiaries of North American, European and Asian construction firms.

According to Onugu (2005) and AbdulAzeez (2012) firms can be classified into four major categories as seen: Micro Enterprise, Small Enterprise, Medium Enterprise and Large Enterprise.

The word construction project is generally understood to mean a series of tasks and actions by human or machineries which consume not only capital but also firm resources to build building or achieve specific objectives being planned earlier (Hanafi&Nawi, 2016). Construction projects may come in all sizes and shapes from more complex projects to smaller and simple ones. No matter the type or size of project, there are some essential components that a construction firm must get it right in order to accomplish a remarkable result. Whether a project is about enhancing a current item or administration, overseeing change or executing another system, the same essential contemplation is required when overseeing ventures. Several factors are important to be considered in determining the level of success of a project (Hanafi et al., 2016). One of such factors is Overhead costs (Chilipunde, 2010: Ogunde, et al., 2016).

2.2. The Construction Professionals

Given the focus on how the construction professionals' roles and identities are formed in construction projects, the power of position, and interaction between, actors, structures and agencies is viewed through a practice lens (Gheradi, 2009). More so, to achieve the goals of a typical construction project, more than one construction professional is involved (Chinyio and Olomolaiye, 2010). According to Owolabi and Olatunji (2014), the list of the professionals actively involved in the construction industry includes but not limited to, Architects, Builders, Estate surveyors and valuers, Land surveyors, Quantity surveyors, Town planners, Civil, Electrical, Mechanical and Structural Engineers this also agrees with Oke et al (2012).

2.3. The Evolution of Knowledge Management to Collaborative Knowledge Management

CKM is considered as a process of collective resolution of problems where it is useful to memorize the process of making collective decision and to structure the group interactions to facilitate problem solving and sharing of ideas (Lewkowicz, 2000).

Evolution Period: Main Focus	Key Theme & Focused Issues	Driving Forces	Examples of Km Systems
Development: Within an organization (1960s – 1970s) Know-what	The conceptual foundations of KM - Resource based view of the firm (Penrose, 1959) - Knowledge classification (Polanyi, 1962) - Organizational learning models (Argyris, 1976)	- Increased number of large organizations - Transaction processing systems and manufacturing automation	- Expert systems & knowledge-based systems in research labs (e.g., DENDRAL-1971; MYCIN-1975; HACKER-1975)
Consolidation: Beyond a single organization (1980s – early 1990s) Know-how	Competitive strategic framework - Organizational design and strategic fit (Mintzberg, 1980) - Strategic capability of the firm (Prahalad&Cowin, 1983)	- Globalization - Shift toward service and knowledge-based organizations	- Operational uses of DSS and GDSS - Computer Supported Cooperative Work (CSCW) (Kraemer & King, 1998) - Total quality management
Extension: Internet-based (mid 1990s - onwards) Know-where	Internet based applications & systems - Increased attention to knowledge and intellectual capital management - Industry practice and prescriptions for effective KM (Davenport, Long, & Beers, 1998)	- Web applications (Web 1.0) - Business process reengineering - Emergence of information economy	- Business intelligence - Data mining & data warehouse technologies - Workflow management systems
Elaboration: Web 2.0 & collaboration (late 1990s - onwards) E-Collaboration	Collaborative knowledge management - Conversational knowledge management - Web-based group work management - Distributed collaborative design - Distributed collaborative authoring	-Web service platform - People power, social networking, collective intelligence (Web 2.0) - Mobile technologies	- Internet based KM Services (e.g., www.askme.com, 1999) - Wikis (1995), Blogs (approximately 1994) - Intelligent and mobile agent systems

Table 1: Evolution of Knowledge Management to Collaborative Knowledge Management
Kim and Yang, (2010)

2.4. Factors Affecting the Adoption of CKM in Construction Firms

According to Abubakar (2012) in the factors affecting the adoption of Building information modeling in Nigeria, identified the following factors which were similarly identified by Ruikar*et al;* (2006) and subsequently adapted in this research. The choice of these factors in this research can be attributed to the relationship between BIM and CKM as emerging themes in the construction industry and their large dependence on technology, despite the fact that BIM seems to be gaining more awareness; the factors under study was divided into two; those that facilitate the adoption called the drivers and others that hinder the adoption called barriers. The barriers were further divided into two: process and technological barrier. These can be seen below as:

2.4. Drivers/Facilitators and Barriers

According to Tolga, Attila and Deniz (2008), Innovation is a key to competitive advantage in the construction industry, enabling firms to contend with major changes occurring in the market and to achieve the objectives in a specific project or over a range of projects. Accordingly, innovation studies have become an established part of construction management discipline with respect to the academic research undertaken and to the wide application in practice. However, knowledge base in the discipline is still developing and there is a genuine need to identify the research trends and neglected areas in the literature. This research attempts to overview and organize the many innovation drivers and barriers that have been identified in construction innovation literature and classified them as see below:
The divers are seen as

- Government support through legislation
- Company's interest in the involvement of collaborative KM practices in their projects

- Collaborative KM Software availability
- Availability of well-trained professionals to handle the Collaborative KM process Cooperation and commitment of professional bodies to its implementation
- Collaborative Procurement methods

The barriers were classified into Process Barriers and technological barriers as identified by Abubakar (2012). The process barriers are seen below as:

- Lack of Awareness of Collaborative KM practices
- Lack of knowledgeable and experienced Knowledge professionals
- High Cost of Training
- Lack of Enabling Environment (Government policies and legislations) to guide implementation
- Legal and Contractual Constraints
- Lack of Trained Professionals to handle the tools
- Social and Habitual Resistance to Change
- No proof of financial benefits
- Firms are not encouraging the use of collaborative KM tools on projects

The Technology Barriers are seen below as:

- High Cost of Collaborative/Integrated KM software/Models for all professionals
- Lack of Standards to Guide Implementation
- Poor Internet Connectivity
- Frequent Power Failure

3. Research Methodology

According to Creswell (2003), Fellow and Lui (2015) research methods can be classified into two broad classifications (qualitative and quantitative). Hanson (2008), however, argues that these sociological approaches have converged. Certainly, one can be integrated within the other (e.g., Haynes et al., 2007) in order to strengthen research design (Patton, 1990). In qualitative research, an exploration of the subject is undertaken, sometimes without prior formulations – the object may be to gain understanding and collect information and data such that theories will emerge and so, tends to be exploratory. On the other hand, the quantitative method approaches adopt 'scientific method' in which initial study of theory and literature yields precise aims and objectives with proposition (s) and hypotheses to be tested – conjecture and refutation may be adopted.

3.1. Data Collection Techniques

The primary data was obtained through field survey, using a structured questionnaire. According to Joshi Kale, Chandel& Pal (2015), the need to quantify the thing, which cannot be measured through conventional measurement techniques, has necessitated the transformation of an individual's subjectivity into an objective reality. Attitude, perceptions and opinions are such qualitative attributes amenable for quantitative transformation due to above mention reason. Qualitative research techniques do try to compensate, by depicting the complexity of human thoughts, feelings and outlooks through several social science techniques, still the quantification of these traits remains a requirement and that's how psychometric techniques come into picture. The Likert which gives definition to the psychometric techniques, is referred to as an "Evaluative continua" scales as proposed by Fowler, (2002), which are numerical or adjectival scales, where, multiple choice questions should ideally offer five to seven (5-7) response options, ranging from strongly disagree to strongly agree as the case might be. There are two (2) major constructional diversities of a Likert scale as the analytical treatment and interpretation with Likert scale largely depends upon these diversities. -Symmetric versus asymmetric Likert scale- If the position of neutrality (neutral/don't know) lies exactly in between two extremes of strongly disagree (SD) to strongly agree (SA), it provides independence to a participant to choose any response in a balanced and symmetric way in either directions (Joshi and Pal, 2015). This construction is captured in the five (5) point Likert scale as a symmetric scale, against the seven (7) and ten (10) point Likert scale, which are considered asymmetric.

3.2. Population Size

The Population for the study is registered construction firms within the Federal Capital Territory (FCT), this is due to the large concentration of construction firms within the region. The presence of a large volume of construction activities, have driven most construction firms in the country to establish a branch within the FCT. The respondents are the knowledge workers/ in the construction industry such as Engineers, Quantity Surveyors, Architects, Land Surveyors and Builders in those companies, especially those who head a unit where firm policies and decisions are made, as they are expected to know how to respond to the questions being asked and identify most of the facts that lead to reliable conclusions. The population of construction firms were obtained from Corporate Affairs Commission (CAC) as 3,126 registered Construction companies in the FCT of Nigeria, and a further classification was conducted on the basis of the firm's size, specialization and most importantly the availability of unit/departments that captures the knowledge professionals.

3.3. Sample Size and Sampling Technique

The sampling is concerned with the selection of a subset of individual, from within a statistical population to estimate characteristic of the whole population. The objective of sampling is to provide a practical means of enabling the

data collection and processing components of research to be carried out whilst ensuring that the sample provides a good representation of the population, Fellow and Lui (2015).

According to Priscilla (2005), determination of sample size depends on five factors:

- Desired degree of precision
- Statistical power required
- Ability of the researcher to gain access to the study subjects
- Degree to which the population can be stratified
- Selection of the relevant units of analysis

The following are the classification of sampling techniques as identified by Charles and Fen (2007) as: Probability Sampling, Purposive Sampling, Convenience Sampling, Mixed Methods Sampling. The research

The research focused on the purposive sampling technique. The purposive sampling technique, also called judgment sampling, is the deliberate choice of a participant due to the qualities the participant possesses (Tongco, 2007).

The following are the classifications of purposive sampling techniques: Sampling to Achieve Representativeness or Comparability, Sampling Special or Unique Cases, Sequential Sampling, and Sampling Using Combinations of Purposive Techniques as identified by Charles and Fen (2007): Kuzel (1992), LeCompte and Preissle (1993), Miles and Huberman (1994), and Patton (2002). The research used the Multiple Purposive sampling Techniques, considering the following:

- Homogeneous Sampling: The choice of a homogeneous population consisting of companies with departments/ units for the knowledge professionals such as Builders, quantity surveyors, Architects, Land surveyors and Engineers.
- Reputational Case Sampling: The firms involved are large construction firms with reputation
- Revelatory Case Sampling: the nature of the research is to reveal the true state of construction firms with respect to their readiness for the adoption of collaborative knowledge management as well as the need for a framework.
- Confirming and Disconfirming Cases: The nature of the research is also tied to Confirming and Disconfirming the state of the construction firms

Therefore, considering the population distribution of these construction firms (Large building construction firms) within the study area (Abuja) and the availability of structured units/departments that captures the knowledge professionals in these firms, the research identified a population of thirty-two (32) building construction firm.However, the research could only effectively access twenty-eight (28) construction firms.

3.4. Questionnaire Design

Good questionnaire design is crucial (Bulmer, 2004; Creswell, 2003; de Vaus, 2002; McGuirk and O'Neill, 2005; Oppenheim, 1992; Parfitt, 2005; Patton, 1990; Sarantakos, 2005) in order to generate data conducive to the goals of the research. Questionnaire format, sequence and wording, the inclusion of classification, behavioural, knowledge and perception questions, and questionnaire length and output, was considered to ensure reliability, validity and sustained engagement of the participant. The principal requirement of questionnaire format is that questions are sequenced in a logical order, allowing a smooth transition from one topic to the next (Sarantakos, 2005). This will ensure that participants understand the purpose of the research and they will carefully answer questions to the end of the survey (McGuirk and O'Neill, 2005).

The nature of the questionnaire as shown in figure 3.1 showed that the questionnaires were both open ended and close ended. Every section had provision for both closed and open-ended questions. The close ended questions were multiple choice questions, reflected in the five-pointLikert scale from section two, the multiple-choice questions in the Likert scale provides determined choices from previous literatures.

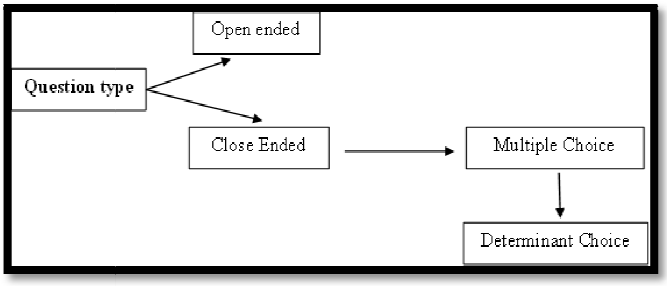

Figure 1: Questionnaire Design

The questionnaire is designed in such a way that the knowledge workers can properly articulate and respond accordingly for their firms. The questions are coined, and adapted from existing literatures that are of relevance to this research. The research implored an "Evaluative continua" scales as proposed by Fowler, (2002), which are numerical or adjectival scales, where, multiple-choice questions should ideally offer five to seven (5-7) response options, ranging from strongly disagree to strongly agree as the case might be.

3.5. Reliability Test

The most fundamental requirement of a research instrument is that it be reliable in the sense that it would yield consistent results if used repeatedly under the same conditions to test the same participants and is therefore relatively

unaffected by errors of measurement. Most researchers have focused on internal consistency, as measured by Cronbach's coefficient alpha (Cronbach, 1951). By conventional psychometric criteria, any values of coefficient alpha below .6 are regarded as poor, even for relatively heterogeneous constructs (e.g., Robinson et al., 1991). Indeed, for measures of individual differences in cognitive processing, more stringent standards of internal consistency are expected (Childers et al., 1985; McKelvie, 1994). Administering these questionnaires on a single occasion is obviously much less arduous than locating the same individuals for testing on two separate occasions. It is therefore not surprising that fewer researchers have directly evaluated the test–retest reliability of these instruments.

Therefore, the research implored the use of the internal consistency method using the Cronbach's coefficient alpha (Clarke, 1986; Entwistle and Ramsden, 1983; Watkins and Hattie, 1980). The internal consistency of the constituent scales of the questionnaire appears to as 0.853 indicating that the data is internally consistent thereby reliable for the study as seen in figure 3.2

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Figure 2: Cronbach's coefficient alpha
Source: Cronbach, (1951)

3.6. Validity Test

The other fundamental requirement of a research instrument is that it be valid in the sense that it measures the trait or traits that it purports to measure (Biggs *et al*., 2001, Richardson, 2004). Validity is arguably the most important criteria for the quality of a test. The research focused on the content validity, where the questions were subjected to professionals in both the academia and practice to validate the appropriateness of the questions as well as the tools for the research.

3.7. Data Analysis Procedure and Presentation

The analyses of data and discussion of results were based on the categories of data. Analysis of the drivers and barriers was done using descriptive statistics such as Means Score (MS) and Standard Deviation, a non-parametric Kruskal-Wallis test.

The choice of the Kruskal-Wallis test (Kruskal and Wallis 1952, 1953) which is the nonparametric equivalent of a one-way ANOVA is as a result of its use for testing whether samples originate from the same distribution. The Kruskal-Wallis test does not make assumptions about normality. However, it assumes that the observations in each group come from populations with the same shape of distribution and that the samples are random and independent. This test is a more flexible, convenient, easy to use and powerful technique similar to a parametric one-way ANOVA. For ease, Statistical Package for Social Sciences (SPSS) computer package will be used in conducting the analysis.

Nonparametric methods require less stringent assumptions than do their parametric counterparts; on the other hand, they also use less information from the data. When the assumptions of the parametric tests are not met, the nonparametric tests are the ones to be used.

The Kruskal-Wallis test is useful as a general nonparametric test for comparing more than two independent samples. It can be used to test whether such samples come from the same distribution. This test is powerful alternative to the one-way analysis of variance. Nonparametric ANOVA has no assumption of normality of random error but the independence of random error is required. If the Kruskal-Wallis statistic is significant, the nonparametric multiple comparison tests are useful methods for further analysis.

4. Data Presentation, Analysis, and Discussions

4.1. Preliminary Research Data

As earlier mentioned in the chapter three (3), a total of twenty-eight (28) construction firms were selected for the study with the knowledge professionals as a critical criterion for their selection as identified by Egbu, and Robinson, (2005) and Oke*et al*. (2013). The results of the findings are presented in the subsections below.

The data were collected from Abuja, focusing on the various construction firms within the region and the following construction knowledge professionals as the respondents: Engineers, Quantity Surveyors, Land surveyors, Architects and Builders.

4.2. Distribution of Respondents According to Profession

From figure 3, it can be seen that all the five (5) knowledge professionals in the twenty eight (28) construction firms were evenly distributed. One professional each from the construction firm, thereby forming a 20% even distribution of the population for each of the professionals.

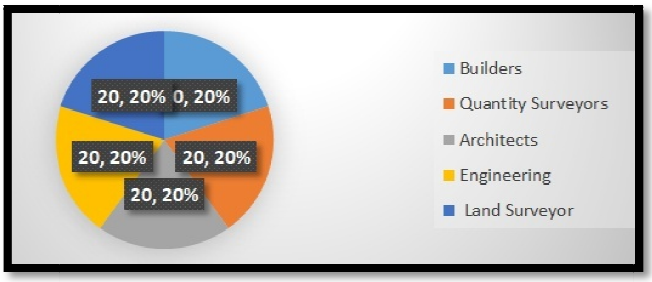

Figure 3: Distribution of Respondents According to Profession
Source: Field Survey (2019)

4.3. Factors Affecting the Implementation of CKM in Construction Firms

The section B of the questionnaire sought the opinion of the respondents as regards the existence of factors that affect the implementation of CKM in construction firms. The factors identified from literature were of two categories; those that facilitate the adoption called the drivers and others that hinder the adoption called barriers. The responses are as follows:

4.4. Drivers/Facilitators of CKM Adoption in Construction firms

The Kruskal Wallis result for the test of significant difference within and between the groups of professionals in the firms on the existence of drivers/facilitators of CKM adoption in the construction firms is presented in Table 2.

Professionals	N	Mean Rank	Test	
Builder	28	72.32	Kruskal-Wallis H	0.106
Engineer	28	70.59	Df	4
Land Surveyor	28	68.86	P-value	0.999
Architect	28	70.36		
Quantity Surveyor	28	70.38		
Total	140			

Table 2: Kruskal Wallis TestResult on the Drivers/Facilitators of CKM Adoption
Source: Field Survey (2019)

The mean rank ranged between 72.38 and 68.86 and the Chi-square value (Kruskal-Wallis H) was obtained to be 0.106 which is less than the critical value (7.779) and the p-value (0.999) is greater than 0.05. The overall results indicated no significant difference within and between all groups of knowledge professionals in the construction firms in terms of agreement with the existence of drivers/facilitators of CKM adoption in the construction firms. However, this is not to say that they are all at the same level of agreement, some variations still exist, but they are not statistically significant.

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
Government support through legislation	140	4	1	5	4.00	.080	.945	.892
Company's interest in the involvement of collaborative KM practices in their projects	140	4	1	5	4.14	.080	.949	.900
Collaborative KM Software availability	140	4	1	5	4.31	.075	.890	.793
Availability of well-trained professionals to handle the Collaborative KM process	140	4	1	5	4.11	.084	.997	.994
Cooperation and commitment of professional bodies to its implementation	140	4	1	5	4.19	.074	.872	.761
Collaborative Procurement methods	140	4	1	5	3.92	.090	1.060	1.123

Table 3: Descriptive Statistics of the Drivers of CKM Adoption
Source: Field Survey (2019)

Considering the drivers individually, from the table of descriptive statistics results (shown in Table 3) revealed 'Collaborative KM Software availability' and 'cooperation and commitment of professional bodies to its implementation' as the most important drivers of CKM adoption in the Nigerian construction industry with mean scores of 4.31 and 4.19 respectively. 'Company's interest in the involvement of collaborative KM practices in their projects' and 'Availability of well-trained professionals to handle the Collaborative KM process' also stands out as important drivers with mean score of 4.14 and 4.11 respectively.' Collaborative Procurement methods was least with mean score of 3.92, but also considered an important driver. It can be resolved here that the subjects of Collaborative KM Software availability and the cooperation and commitment of professional bodies the implementation of CKM are the most important drivers of CKM adoption as opined by the respondents. This reflects the idea propagated in the Rethinking Construction document of the United Kingdom in 2008 about software development for the transformation of the UK construction industry.

Moreover, the company's interest in the adoption is another major facilitator since the company are the executors of construction projects and their support for any innovation in the construction process has a far-reaching effect to the successful implementation of such innovation. The government as the regulator of affairs has a vital role also to play by enacting legislations that mandate or govern the implementation of initiatives such as the use of CKM in construction.

4.5. Barriers of CKM Adoption in Construction Firms

The barriers to the adoption of CKM in the Nigerian construction industry are considered under two headings as classified by Eastman *et al*; (2011) i.e., process and technology barriers.

	Professionals	**N**	**Mean Rank**	**Test**	**Process Barriers**
Process_Barriers	Builder	28	66.55	Kruskal-Wallis H	1.840
	Engineer	28	64.09	df	4
	Land Surveyor	28	76.36	Asymp. Sig.	.765
	Architect	28	73.86		
	Quantity Surveyor	28	71.64		
	Total	140			

Table 4: Kruskal Wallis TestResult on the Barriers of CKM Adoption
Source: Field Survey (2019)

The mean rank ranged between 71.64 and 66.55 and the Chi-square value (Kruskal-Wallis H) was obtained to be 1.840 which is less than the critical value (7.779) and the p-value (0.765) is greater than 0.05. The overall results indicated no significant difference within and between all groups of knowledge professionals in the construction firms in terms of agreement with the existence of process barriers to CKM adoption in the construction firms. However, this is not to say that they are all at the same level of agreement, some variations still exist, but they are not statistically significant.

	N	**Range**	**Minimum**	**Maximum**	**Mean**		**Std. Deviation**	**Variance**
	Statistic	**Statistic**	**Statistic**	**Statistic**	**Statistic**	**Std. Error**	**Statistic**	**Statistic**
Lack of Awareness of Collaborative KM practices	140	4	1	5	4.21	.075	.886	.784
Lack of knowledgeable and experienced Knowledge professionals.	140	4	1	5	4.11	.079	.935	.873
High Cost of Training	140	4	1	5	4.11	.077	.914	.836
Lack of Enabling Environment (Government policies and legislations) to guide implementation	140	4	1	5	4.15	.072	.848	.718
Legal and Contractual Constraints	140	4	1	5	4.17	.066	.777	.603
Lack of Trained Professionals to handle the tools	140	4	1	5	4.16	.078	.926	.858
Social and Habitual Resistance to Change	140	4.00	1.00	5.00	3.96	.07779	.92036	.847
No proof of financial benefits	140	3.00	2.00	5.00	4.10	.06515	.77087	.594
Firms are not encouraging the use of collaborative KM tools on projects	140	4.00	1.00	5.00	4.04	.07910	.93587	.876
Valid N (listwise)	140							

Table 5: Descriptive Statistics of Process Barriers to the Adoption of CKM in Construction Firms
Source: Field Survey (2019)

Considering the process barriers individually, from the table of descriptive statistics results (shown in Table 5) revealed 'Lack of Awareness of Collaborative KM practices', 'Legal and Contractual Constraints' and 'Lack of Trained Professionals to handle the tools' as the most important process barriers to CKM adoption in the Nigerian construction industry with mean scores of 4.21, 4.17 and 4.16 respectively. 'Lack of Enabling Environment (Government policies and legislations) to guide implementation', 'Lack of knowledgeable and experienced Knowledge professionals' and 'High Cost of Training' also stands out as important process barriers with mean score of 4.15, 4.11 and 4.11 respectively.' Social and Habitual Resistance to Change' was least with mean score of 3.96, but also considered an important process barrier.

	Professionals	**N**	**Mean Rank**	**Test**	
Technological Barriers	Builder	28	62.45	Kruskal-Wallis H	1.620
	Engineer	28	74.88	df	4
	Land Surveyor	28	71.82	Asymp. Sig.	.805
	Architect	28	71.02		
	Quantity Surveyor	28	72.34		
	Total	140			

Table 6: Kruskal-Wallis Test of Technological Barriers to the Adoption of CKM in Construction Firms
Source: Field Survey (2019)

Considering the process barriers individually, from the table of descriptive statistics results (shown in Table 4.4) revealed 'Lack of Awareness of Collaborative KM practices', 'Legal and Contractual Constraints' and 'Lack of Trained Professionals to handle the tools' as the most important process barriers to CKM adoption in the Nigerian construction industry with mean scores of 4.21, 4.17 and 4.16 respectively. 'Lack of Enabling Environment (Government policies and legislations) to guide implementation', 'Lack of knowledgeable and experienced Knowledge professionals' and 'High Cost of Training' also stands out as important process barriers with mean score of 4.15, 4.11 and 4.11 respectively.' Social and Habitual Resistance to Change' was least with mean score of 3.96, but also considered an important process barrier.

Descriptive Statistics								
	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic
High Cost of Collaborative/Integrated KM software/Models for all professionals	140	4	1	5	4.14	.083	.983	.967
Lack of Standards to Guide Implementation	140	4	1	5	4.13	.082	.973	.947
Poor Internet Connectivity	140	4	1	5	4.26	.067	.790	.624
Frequent Power Failure	140	4	1	5	4.05	.077	.908	.825
Valid N (listwise)	140							

Table 7: Descriptive Statistics of Technological Barriers tothe Adoption of CKM in Construction Firms
Source: Field Survey (2019)

Considering the technological barriers individually, from the table of descriptive statistics results (shown in Table 7) revealed 'Poor Internet Connectivity' is the most important process barriers to CKM adoption in the Nigerian construction industry with mean scores of 4.26. 'High Cost of Collaborative/Integrated KM software/Models for all professionals and 'Lack of Standards to Guide Implementation' also stand out as important Process barriers with mean score of 4.14 and 4.13 respectively. 'Frequent Power Failure' was least with mean score of 4.05, but also considered an important technological barrier.

It is important to identify the general agreement of the professionals on the subject matter, as each professional might tend to have a perspective based on the uniqueness of professional specialization, which agrees with Abubakar (2012), Idris (2017). From the six (6) drivers identified, it is obvious that all of them work towards the Facilitation of CKM Adoption in Construction firm. However, the availability of Collaborative KM Software is considered the most significant, which agrees with Stefano, Giovanna, Gobbi and Nancy (2011) who identified the need for a dedicated CKM software that is unique to a specific field. On the other hand, the lack of awareness of CKM practices has posed a major process barrier to application of CKM as also identified by Kim and Yan (2010). Poor Internet Connectivity was identified as a major technological barrier and according to Adomi (2005), it has served as a major drawback to technological adoption and adaptation in Nigeria and Africa at large.

5. Conclusion and Recommendation

The research concludes based on the agreement of the various professional's groups that all the drivers identified have significant effect on the emergence of CKM, with the availability of Collaborative KM Software as the most significant driver. The research in identifying the barriers to CKM adoption as identified by the various professional groups of the firms indicated that all the elemental factors captured under the process and technological barriers were significant. The lack of awareness of Collaborative KM practices is the most significant process barrier and Poor Internet Connectivity is the most significant technological barrier.

It is important to note that the world is gradually migrating from the traditional concept of knowledge management to integrated knowledge management and hence, collaborative knowledge management. Therefore, the need for a nationwide public and professional awareness of the need for collaboration as well as CKM, which can begin from involvement of professional bodies to the enforcement of construction firms and other relevant key stakeholders. One major role construction firm will also play will be to provide good internet services to their staffs to encourage collaborative knowledge shearing and building as the world as we know it is consistently evolving. Construction firms as well as the built industry should employ the services of web-based professionals to design and aid in the application of a dedicated and flexible web based collaborative knowledge management system/platform for knowledge professionals in construction firms to boost knowledge integration and hence collaboration.

6. Conflict of Interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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