DELINEATING SUPPLY CHAIN MANAGEMENT (SCM) FEATURES IN CONSTRUCTION PROJECT DELIVERY: THE NIGERIAN CASE

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ABSTRACT

This study sought to delineate SCM features using the analytical hierarchy process (AHP) with a view to incorporating it into the delivery of construction projects in Nigeria. The study adopted an exploratory research design (quantitative and qualitative) methods. A purposive and convenient sampling technique was deployed with the aid of semi-structured interview, case study; questionnaire survey in a construction firm in Port-Harcourt, Rivers State, Nigeria. Questionnaires were used to collect primary data after being pre-tested via a pilot study for validity and reliability. The data collected were analysed using the AHP. Findings from the study shows that the following features are key; Instituting trust and long term relationships amongst supply chain partners (ITP), supply chain finance (SCF), supply chain and continuous performance measurement (SCCPM), information technology (IT), quality management (QM), supply base management (SBM), senior management's commitment (SMC) and supply chain orientation (SCO). In delivering construction projects to success using the SCM approach, adequate attention and emphasis should be accorded to the aforementioned important features in the order they appear as they would aid in effecting the much needed success. It is also expected that the features would further be beneficial to construction firms as it would enable the firms to manage, measure and evaluate the gains ensuing from the deployment of SCM techniques.

KEYWORDS: Analytical Hierarchy Process, Case Study, Delineation, Features of Supply Chain Management, Supply Chain Management.

INTRODUCTION

With the current liberal global economic order, it is challenging for the Nigerian construction industry to remain competitive. By creating an avenue for competitive advantage, good market share, maintaining high customer loyalty while also operating at a reasonable profit are evidence of good indices showing that the Nigerian construction firms can compete favourably with their counterparts. It is incumbent on the construction firms in Nigeria to strive to deliver valuable products and services at a minimum cost in order to remain relevant in business. Vrijhoef and De Ridder (2007) view supply chain as a system; comprising of social system, economic system, production system and organisational system. They further opined that the systems theory views the world in terms of a compendium of resources and

processes that exists to achieve an objective. Two distinct aspects of the systems theory that plays significant roles in supply chains are synergy and entropy. Synergy implies that the individual elements of a system can achieve results by working together in unison than if they work independently. Akintoye, McIntosh and Fitzgerald (2000 p.160) defined SCM as "the delivery of enhanced customer and economic value through synchronized management of the flow of physical goods and associated information from sourcing through consumption". while Tran and Tookey (2012 p.35) defined CSCM as "a system where suppliers, contractors, clients and their agents work together in coordination to install and utilize information in order to produce, deliver materials, plant, temporary works, equipment and labour and/or other resources for construction projects". Betts, Robinson, Burton, Leonard and Sharda (2013) made a critical assessment of the ubiquitous construction activities in Nigeria with its attendant future prospects as envisaged by the Global Forecast for the Construction Industry, as it behoves on all and sundry to come up with means of enhancing the productivity of the Nigerian construction industry which according to Hope (2012) is still taking the back seat in comparison with the manufacturing and service industries. With increasing global competition there is need for the Nigerian construction industry to form alliance with the various construction supply chain (CSC) stakeholders and influence the productivity of their industry. The outcome from this study will be of utmost importance to all and sundry. In particular, the outcome will create an enabling environment for both the public and private sector in the Nigerian construction industry to move into real construction business where the individual stakeholders within the CSC would have the opportunity of aligning themselves into providing innovative ideas that would help create the much needed value in support of the industry.

Statement of the Problem

The construction industry is characterized by complexity (Aloini, Dulmi, Mininno & Ponticelli, 2012) and constrained by time. This complex nature makes the industry more prone to the decentralization of its activities and functions thereby subjecting it to an unwholesome situation characterized by conflicts amongst the individual stakeholders. The fragmented state of the industry is a direct consequence of the poor information and goal sharing tendencies exhibited among the supply chain (SC) partners, separation of design and construction, poor coordination and integration amongst various functional units, sole dependency of main contractors on suppliers and subcontractors. The aforementioned consequences of the state of fragmentation most often leads to problems related to performance, delays, low productivity, schedule / cost overruns and thus leading to conflicts and disputes which subsequently brings the project to a halt. The inefficiencies associated with the practice of manually tracking materials, equipment and tradesmen in the construction setting often gives rise to problems of unsuccessful completion of projects (Equere & Tang 2010). According to Persson, Bengtsson and Gustad (2010), the construction industry is in dire need of a change. There exist a myriad of problems militating against the coordination and integration of the various SC partners. Most of the problems as opined by Persson *et al.* (2010) are mostly attributed to attitude related problems, myopic focus, lack of understanding between suppliers and subcontractors amongst others. Furthermore, the dearth in communication within the industry also contributes to the lack of transparency within the SC. Tight schedules and unrealistic lead-time requirements for materials and equipment further compound the problems. Most of these envisaged problems emanate at the early stage of the SC process (Persson *et al*., 2010).

According to Ayangade, Wahab and Alake (2009), the Nigerian procurement system has been bedeviled by lack of compliance with the principles of tendering amongst the various public agencies which resulted into the loss of public funds. A myriad of problems affect the construction industry most specifically during the bidding phase. For instance, an incompetent contractor may tend to introduce a cover price or lower his/her cost in order to be favourable and win the contract. Such an unwarranted act could undermine the integrity of the entire and subsequent phases of the contract leading to awarding the contract to an incompetent contractor which most often affects the entire SC linkages leading to failure of the project. The ideas of awarding contracts to the lowest qualified bidder has also created obvious problems in the industry alongside the desire to always fast track and deliver projects with minimum time which is detrimental to delivering viable and quality projects to the client. According to Akintoye *et al*. (2000) and Saad, Jones and James (2002) SCM has little impact in the construction industry and its projects given its quantifiable importance the manufacturing and other service industries have enjoyed over the years. As opined by (Saka & Mudi, 2007; Ojo, Mbohwa & Akinlabi, 2013), there is the dearth of research on the application of SCM techniques to construction projects in Nigeria. At the end of this study, the upward and downward linkages of the CSC would have been put in the right perspective with a view to propelling the Nigerian construction industry into achieving competitive advantage over their peers in the global business of construction by way of eliminating waste, increasing /continuous improvement and the deployment of modern day technologies while also creating the mind set for achieving an operational and efficient industry. The objective of the study is; to delineate SCM features for the successful deployment of SCM using the analytical hierarchy process (AHP) with a view to incorporating it into the delivery of construction projects. This study will be valuable to practitioners and all other stakeholders within the CSC and would as a matter of fact enable practitioners compare their performance and development with other key players in the industry as a whole. In addition, this study, as it is expected, would equally provide interesting implications for the fast tracking of Nigeria's globalization dream and opportunities for achieving competitive advantage in the business of construction with respect to the proper management of the various supply chains by adopting best practices.

LITERATURE REVIEW

According to Mbamali and Okotie (2012), Nigeria's independence in the 1960s brought with it a lot of businesses until towards the end of the 1960s. As at that time, most of the construction actors over stretched their bounds via contractual engagements. The industry witnessed high rate of construction activities during the era of the "oil boom" up till the end of the second republic (Amade, 2012). The same period later witness an unprecedented state of degeneration of the standard of projects delivered. Construction projects were characterized by poor planning from their conception stage through to their delivery as poorly executed projects to their clients. The state of abandonment of most construction projects can be likened to a junk-yard with projects worth billions of naira littering the entire length and breadth of the country (Akpan, Amade, Okangba & Ekweozor, 2014; Ayodele & Alabi, 2011; Ubani & Ononuju, 2013). According to Mbamali and Okotie (2012), prior to 2006, Nigeria had no laid down guidelines and standards for the regulation of the construction industry. This was as a result of the state of collapse of the industry. The industry became a field for non-professionals to practice. Oyedele (2013) further stated that there were no clear cut difference between contractors as some of them were just in business to make money not

minding the nature of work involved. The Nigerian government in 2005 established the Infrastructure Concession and Regulatory Commission (ICRC) to help streamline the activities of infrastructure provision through public private partnerships (PPPs) (Dada & Oladokun, 2012; Izuwah, 2011). The ICRC's main function is to catalyze public and private resources for purposes of developing and implementing a world class PPP framework. With the setting up of the ICRC and the Bureau of Public Procurement (BPP), has the country's procurement and infrastructural system been revolutionalised? According to Oyedele (2013), the Director General of the BPP did state that ministries, departments and agencies (MDAs) are in the habit of delaying payments meant for contractors for over 60 days contrary to what was stipulated in the Procurement Act of 2007. It was also stated that in most cases, the personal interest of Nigerian leaders override that of the entire citizenry. The BPP is known for its continuous disobedience of procurement laws as the BPP was indicted in 2010 in a contract for the construction of the second runway of the Abuja Airport in 2010. It was discovered from the outcome of the public hearing constituted by the government that the BPP manipulated the cost and bidding processes in violation of the procurement procedures (Jacob, 2010).

SCM Emergence in Construction

Prior to the introduction of the just in time (JIT) philosophy, manufacturers in the U.S. according to Manu (2014) had employed the use of mass production in the 1950s and 1960s, to lower costs and improve their productivity while also paying less to the formation of SC partnerships. SCM emerged in the early 1980s as a concept in industrial management theory and a distinct area of scientific study in SCM literature (Vrijhoef & Koskela, 1999).

SCM emerged as an important concept in the construction industry in the mid-1990s (Hai, Aminah, Syuhaida, & Wei, 2012; Wirahadikusumah & Abduh, 2010). However, (Hai *et al.*, 2012; Saad, Jones & James, 2002; Venkataraman, 2007; Viswanadham & Kumar, 2006) opined that the acceptance of SCM in the construction sector has been rather slow. Even though as the sector contributes significantly to the economic growth of most nations (Hai *et al.*, 2012). It contributes about 3 to 6 percent of GDP while also employing in excess of 111 million construction workers worldwide. The industry is bedeviled with a lot of failures hindering its performance. The recent approach to procurement according to (Hai *et al.*, 2012; Saad *et al.*, 2002) has with it some effective ingredients for collaboration and integration, while Latham and Egan in their respective reports, did recommend how the industry could alter its direction towards the most efficient destination of efficiency in their SC through partnering arrangements and innovative approaches (Egan, 1998; Latham, 1994). As (Petrovic-Lazarevic, Matanda & Worthy, 2006; Hai *et al.*,2012) puts it, partnering results in greater accuracy, speed and flexibility in responding to consumer demands, development of latest technology and products while also creating an atmosphere for maximizing profits within the SCs. Latham and Egan in their reports strongly recommend that the construction industry must adopt SCM techniques which ab initio has been applied in the manufacturing industry and as such has been proven to have increased productivity, reduce time, increase cash flows, while also minimizing risks. In a nutshell, Hai *et al.* (2012) concludes that CSC consists of firms that are involved in the upstream and downstream contractual relationships whose sole aim is to deliver a commodity, products and services that are related to the business of construction. They further stated that the key individuals not only vary from one another, but that they are linked, to achieve the aims and objectives of projects.

Features of Construction Supply Chain Management

In carrying out this study, eight (8) constructs were developed via a thorough literature review which automatically translates into the features for successful construction supply chain management. The eight (8) constructs representing the independent variables includes; supply base management, supply chain finance, quality management, instituting trust and long term relationships amongst supply chain partners, information technology, supply chain and continuous performance measurement, senior management's commitment, and supply chain orientation. The aforementioned constructs were used in delineating the SCM features for the successful delivery of construction projects using the analytical hierarchy process (AHP). Table 1 shows the various constructs/features and their individual sources as obtained from the literature.

Table 1: Features of CSCM

Constructs	Abbreviation	Sources
Instituting Trust and Long Term Relationships amongst SC Partners	ITP	Rivera, Wan, Chen and Lee (2007); Bresnen and Marshall (2000); Mistry and Davis (2009); Talavera (2013)
Supply Chain Finance	SCF	Pezza (2011); Kristofik, Kok, DeVaries and Hoff (2012)
Supply Chain and Continuous Performance Measurement	SCCPM	Cai, Liu, Xiao and Liu (2009); Venkataraman (2007)
Quality Management	QMT	Kuei, Madu, Lin and Chow (2002); Lin and Gibson (2011)
Information Technology	IT	AbTalib and Hamid (2014); Xue, Wang, Shen and Li (2007); Wang, Lin, Xiao and Lin (2007); Ribeiro and Lopes (2001)
Supply Base Management	SBM	Goffin, Szwejczewski and New (1996); Matsoso and Benedict (2014)
Senior Management's Commitment	SMC	Abdullah, Othman and Zulhumadi (2010); Cheng and Paulraj (2004); Sandberg (2007)
Supply chain orientation	SCO	Mentzer, DeWitt, Keebler, Min, Nix, Smith and Zacharia (2001); Hamid and Sukati (2011)

Instituting Trust and Long Term Relationships among Supply Chain Partners (ITP)

As opined by Rivera, Wan, Chen and Lee (2007), a mutual engagement based on trust is the bedrock for integrating all the activities in a SC. As the degree of trust between the different SC partners evolves, there is that tendency for a mutual flow of materials and information between the various individuals in a SC. According to Bresnen and Marshall (2000), studies have shown that performance in terms of cost, schedule, quality, fit-for-purpose, buildability as well as other criteria can be enhanced if partners adopt collaborative ways of working together. Trust and flexibility facilitates innovation and sharing of skills that would lead to the delivery of far reaching benefits to the SC partners (Mistry & Davis, 2009). For a successful collaboration between the various SC partners to ensue, the following according to

Talavera (2013) must be put in place. They include; management's commitment, SC mapping role and definition, information dissemination and system integration, people management and development, supply performance measurement, relationship management and trust building, as well as rationalization and simplification.

Supply Chain Finance (SCF)

As stated by Pezza (2011), SCF is a topic that hinges on the fulcrum of most enterprises with particular reference to helping out in other areas of an enterprise. It is intimately tied to credit decisions, payment collection policies, while also impacting on decisions ensuing from finance, procurement, sales and supply chain etc. Financial supply chain deals with the movement of funds along the SCs. The optimization mechanism brought by the financial supply chain management (FSCM) as opined by Kristofik, Kok, DeVaries and Hoff (2012) can be achieved by collaboration in managing accounts payable, accounts receivable, cash and risk. The final objective of FSCM is to achieve a visible purchase-to-order and order-to-cash processes that would lead to efficiency and cost savings throughout the entire chain.

Supply Chain and Continuous Performance Measurement (SCCPM)

Cai, Liu, Xiao and Liu (2009) opined that there are different metrics used in supply chain performance evaluation which has been designed to measure operational performance, evaluate improved effectiveness as well as examine strategic alignment of the whole SCM. In order to address the problems, Cai *et al.* (2009) further opined that some researchers adopted the balanced score card (BSC) and activity based costing (ABC) methods in evaluating SC performance. The Supply Chain Operations Reference (SCOR) model developed by the SC Council in 1996, provided a comprehensive framework in tracking performance and as such has been adopted as the basis for SC improvement in terms of global and site specific projects. By integrating well known concepts of business process re-engineering (BPR), benchmarking and process measurement, the SCOR model provides a medium for cross functional framework for improving SC performance. The SCOR model according to Venkataraman (2007), uses five (5) key aspects of SCs viz: plan, source, make, deliver and return (PSMDR) as building blocks in describing SC.

Quality Management (QM)

Successful SCM according to Kuei, Madu, Lin and Chow (2002) depends on how well quality and technology are introduced and managed within the framework of a social and technical system of a SC. Kuei *et al*. (2002) further opined that the social and technical systems are normally built on the interactions of many different variables in the areas of quality and technology management. In other to implement quality in a SC, there is need to streamline all efforts towards the various areas in order to enhance quality from a client's perspective (Lin & Gibson, 2011). Kuei *et al.* (2002) opined that Hong Kong's critical competitive advantage is hinged on low cost production capabilities in China. As a result of this development, Hong Kong companies are highly dependent on suppliers in China. They further opined that the adoption and implementation of ISO 9000 systems in the early 1990s had a significant impact on rekindling the quality management mantra in Hong Kong.

Information Technology (IT)

The importance of IT according to AbTalib and Hamid (2014) in SCM cannot be over emphasized as information has always been the pivot in the efficient management of logistics. According to Xue, Wang, Shen and Li (2007), the construction industry is adjudged to be an information dependant industry given its diversity in terms of information generated procedures that are associated with detailed drawings and photos, cost analysis sheets, budget reports, risk analysis, charts, contract documents, and planning schedules. In the construction sector, computer aided design (CAD) has consistently helped in reducing cycle time, productivity and accuracy whenever there is need for a change in design. Furthermore, Wang, Lin, Xiao and Lin (2007) opined that with the integration of promising technologies like the radio frequency identification (RFID) technology, mobile devices like personal digital assistants (PDA) and web portals could help in improving the effectiveness and convenience of information flow in CSC control systems. Ribeiro and Lopes (2001) reiterated that internet applications and web based technologies have emerged as the most effective means of achieving supply chain integration in the delivery of construction projects.

Supply Base Management (SBM)

Supply base management (SBM) or supply management (SM) as it is sometimes called, deals with the organisation of the optimal flow of high-quality, value-for-money, materials or components from a suitable few set of innovative suppliers. To be able to achieve a competitive advantage, Goffin, Szwejczewski & New, (1996) argued that organisations need to streamline the number of suppliers from which their purchase can be made. The reduced supplier base implies the tendency for a close and long-term relationship being achieved with a few set of suppliers who are critical in playing a significant role in contributing to new products while also minimizing cost and continuous improvement in quality. Matsoso and Benedict (2014), opined that the use of few suppliers enables effective communication and supplier relationship thus leading to SCM performance.

Senior Management's Commitment (SMC)

Abdullah, Othman and Zulhumadi (2010) stated the need for managers to understand the dynamics of SCM well before the re-engineering of SC and logistics related activities. They further argued that management's involvement and support is usually required to promote harmony between suppliers and customers for the value chain to be flexible. According to Cheng and Paulraj (2004), one of the key functions of top management executives in any organisation is to stimulate the setting up of organisational values and come up with suitable management styles that would improve the organisation's performance. As opined by Sandberg (2007), top management should be seen as a function rather than being an individual that possesses a domineering influence on an organisation's SC performance.

Supply Chain Orientation (SCO)

Mentzer, DeWitt, Keebler, Min, Nix, Smith and Zacharia (2001) opined that an organisation possesses an element of SCO if its management can detect the implications of managing the upstream and downstream flows of its products, services, finances and information flow across their suppliers and customers. According to Hamid and Sukati (2011), SCO serves as a

strategic capability for most organisations. They opined that an organisation with a strong SCO is likely to have its members as an integrated entity and satisfy their needs. Trust, commitment, sharing of common relationship-building foundations, compatibility between organisations and the support of top management all contributes to a firm's SCO. In order words, SCM according to Mentzer *et al.* (2001) is the implementation of a SCO across suppliers and customers.

Research Gap/Empirical Insights into SCM in the Nigerian Construction Industry

According to Akintoye *et al.* (2000), the construction industry has been reluctant in adopting and applying SCM principles. In Nigeria, for instance, there is a dearth of the application of the concept of SCM in the Nigerian construction industry. A few authors have been able to carry out studies in the area of CSCM. According to Akintoye *et al*. (2000), the construction industry has been reluctant in adopting and applying SCM principles. In Nigeria, for instance, there is a dearth of the application of the concept of SCM in the Nigerian construction industry. A few authors have been able to carry out studies in the area of CSCM. Ojo *et al*. (2013), did a study on the analysis of green supply chain management (GSCM) comparing with South Africa and Nigeria. This aspect of GSCM deals with the integration of environmental thinking into CSCM. It is interesting to note that previous studies on CSCM have been carried out to a greater extent in South Africa, while none was carried out in Nigeria (Ojo *et al.*, 2013). Saka and Mudi (2007) undertook a study, evaluating the challenges of SCM by building contracting firms in the Lagos metropolitan area. The result of the findings shows that most building contractors in the study area source for their materials locally and there are no formal relationship existing between suppliers. Other key findings show the absence of using information and communication technology (ICT) for tracking suppliers and in inventory management. And finally, the major problems of material SC includes; import tariff and security, foreign exchange, sharp practices, and late delivery, bad roads and freight cost amongst others. Yet the study by Saka and Mudi (2007) is one of the visible works conducted in the area of SCM in the Nigerian construction industry. Even though, there are other studies conducted in SCM related areas like partnering and collaborative as well as integrated means of executing construction related works.

Several authors have developed frameworks for application in construction project related studies that are not specifically related to SCM. A cursory look at some SCM frameworks developed for purposes of delivering projects to fruition is presented. Hernandez, Poler, Mula and Peidro (2008) developed a collaborative knowledge management framework for SC. The study centered on how knowledge management and information technology could be incorporated into SCM processes. The framework known as the UML-based framework mainly looked at collaborative mechanism in SCM processes using IT in Spain. One of the drawbacks of the framework is that it laid more emphasis to other sectors of SCM generally other than the construction industry where the framework we are developing hinges on. Aloini *et al.* (2012) developed a conceptual framework that would be adapted for use in the construction industry. The framework depicts the relationship between contextual, antecedent and benefits as key features of implementing CSCM. The study adapted a literature review procedure of various articles on the subject matter to come up with the framework. The procedure so adopted may not be adequate as there was no other method of collating the information viz: quantitative and analytical means and as such the framework so developed lacks any scientific application. The geographical location were the framework so developed

could be tested was not even mentioned in their work. Xue, Li, Sheng and Wang (2005) developed an agent-based framework for SC coordination in construction in China. The study adopted agent technology, multi-attribute negotiation and multi-attribute utility theory as the mechanism for coordinating construction activities. The framework adopted a multi-attribute utility technique that is akin to the AHP. The framework developed by Xue *et al.* (2005) has features for rekindling a CSC environment, but one of its drawbacks is that it may not be applicable/feasible to the Nigerian construction industry at the moment due to the fact that the extent of application of SCM concept is still at its lowest ebb. The framework would be most appropriate for use in China and other developed climes where the SCM concept has fully been in operation. Perdomo (2004) in his study developed a framework for a decision support model for SCM in the construction industry with specific reference to the procurement of electrical. The framework has in built checks for electrical materials requisition by a contractor, it has some notable drawbacks in the sense that the framework was developed for a peculiar type of SC, that is, the electrical material part components which we feel is immaterial compared to the various enlarged SCM components. Another drawback noticed in the framework is that there was no mention of where the framework would be domesticated talks less of solving the needs of a particular geographic location. Magalhaes-Mendes, Rodrigues and Ferreira (2010) developed a framework for assessing the impact of delays in CSC in the Portuguese. The framework deployed the use of the critical path method (CPM) in articulating the key components of the framework. The framework specifically looked at delays confronting CSC which is critical in CSC realization. The framework has a lot of shortcomings in the sense that there was no network shown to portray how the issues bordering on delay could be nipped at the bud. The framework also lacks the necessary ingredients for its replication elsewhere. Manu (2014) in his work on SCM practices in construction and inter-organisational trust dynamics developed a framework for engendering inter-organisational trust in construction projects in the U.K. The framework provided a means of benchmarking SCM in the main contract and promoting trust amongst the SC partners. The framework primarily centered on one key component of the SCM which is trust. Although the framework has other key elements of trust and behavioral consequences that are needed to propagate SCM in the construction industry, but certain drawbacks exists. There was no evidence of the deployment of quantitative variables in developing the framework. The framework may not perfectly suit a developing country like Nigeria where the SCM concept is still at its infancy.

It is against this background that this study deploys the AHP approach in delineating SCM features. The rationale for choosing AHP is that recent trends have been directed towards the application of multi criteria decision making approaches (MCDM) of which AHP is one of them (Dalalah, Al-Oqla & Hayajneh, 2010). AHP deploys both qualitative and quantitative approaches in solving complex decision making problems. In the qualitative aspect, AHP structures the issues in question through decomposition into a hierarchy of components and levels viz: objectives, criteria, and sub-criteria. While from the quantitative angle, AHP prioritizes a set of attributes distinguishing them into important factors from the less important ones.

AHP helps to capture both the subjective and objective assessment measures of an alternative options thus leading to reduction in bias as regards decision making. AHP was introduced as an effective tool for dealing with complex decision making, it helps a decision maker in setting priorities and making the best decision. Reliable and accurate forecast are needed for

making sound decision by incorporating scientific procedures with a view to achieving the desired result. The analytical hierarchy process (AHP) was used to delineate the key features of SCM for incorporating it into the successful delivery of construction projects in Nigeria. This study seems to be unique in the sense that SCM principles will be explored in relation to delineating its features with the aid of AHP applications into the delivery of construction projects.

RESEARCH METHODOLOGY

This study adopted an exploratory research design approach and case study method. The following categories of respondents formed part of the study. They include project managers, quantity surveyors, architects, engineers, builders, etc. The sample for the study was conveniently and purposefully selected to capture the required group of respondents. The researcher's years of practical work experience in construction project related activities was an added advantage in the selection of the participants. Port-Harcourt, Rivers State of Nigeria formed part of the location for the study. Questionnaires and semi-structured interviews were used to collate data from the sampled respondents from case study organisation. In the questionnaire, closed-ended questions were used for the purpose of facilitating data collection and analysis. The researchers used the questionnaire in collating the data needed for conducting a pair-wise comparison that is based on a specific scale adopted by Saaty in developing the framework using AHP (Saaty, 2008). The questionnaire targeted groups consisting of long-experienced persons in the field of SCM related activities in the Nigerian construction industry. To ensure the collection of reliable data, the researchers adopted the interviewee administered questionnaire method to help respondents with any ambiguity with respect to the questions. In pilot testing the questionnaires, they were first distributed to a small sample, targeting professional colleagues with a view to achieving data quality and accuracy, thus achieving reliability to a greater extent. Of the 113 questionnaires sent 102 were retrieved out of which 94 were found usable. The reliability of the scale of measurement used in the questionnaire was inbuilt in the AHP method of determining consistency as arrived at in the constrained matrix table. The three (3) project architects and four (4) site engineers who happened to have handled the project management aspect of the project right from the inception were interviewed based on their responses to the questionnaires as is the practice with AHP. With a vast experience in project management spanning over twenty five (25) years with additional postgraduate qualifications and registered professionals in their various fields of endeavour were found to be appropriate for the interview.

In analyzing the data, the analytical hierarchy process (AHP) was used with the aid of a Microsoft Excel. The rationale for choosing AHP is that recent trends have been directed towards the application of multi criteria decision making which AHP is one (Dalalah *et al.*, 2011). AHP helps to capture both subjective and objective assessment measures of an alternative option available thus leading to the reduction in bias as regards decision making. Dalalah *et al.* (2011) further opined that the application of AHP is a step towards eliminating bias or prejudice in the judgment of an expert since the procedure leading to the judgment are made explicit through relational assessment which also helps in exposing any gap in the expert's thinking with regards to qualitative factors which may not have been considered initially. Lin and Chen (2011) are of the view that one of the key reasons for the popularity of AHP as a multi criteria decision making approach is the fact that it takes into cognizance not just the tangible criteria but also the intangible ones. The AHP was used to delineate SCM

features in this study for successful delivery of construction projects. In this study, AHP was used to calculate the pair-wise and constrained matrices, weighted scores and Eigen vector using Microsoft Excel. In the iteration process, the relative priorities of the criteria or alternatives implied by the comparisons are computed. The relative priorities are usually computed using the theory of Eigen vector and the consistency check carried out at the stage of selection. In order to evaluate the consistency of the results, three (3) vital components are required. The vital components are; Consistency Index (CI), Random Index (RI), and Consistency Ratio (CR). For a consistent reciprocal matrix to ensue, the largest eigenvalue must be equal to the number of comparisons. After computing the CI, the next iteration is to use the index and comparing it with the required random consistency index by selecting randomly generated reciprocal matrix using the different scales of 1/9, 1/8…….1,8,9 as propounded by Saaty (Dalalah *et al.*, 2011; Saaty, 2008). The Random Index (RI), is the average CI value of randomly generated comparison matrices using the Saaty's preference table sorted by the number of items being considered and then getting the random consistency index. The Random Index (RI) from the Saaty's preference scale for factors is used in the decision making process. See Amade (2016); Dalalah *et al.* (2011); Saaty (2008) and Wong and Li (2008) for details on the Saaty's preference scale. A Consistency Ratio (CR), is a comparison between the CI and RI, and it shows the amount of allowed inconsistency, that is,

$$CR=CI/RI \qquad \text{……..(1)}$$

If the value of the CR is smaller or equal to 10 percent (0.1), the level of consistency is within the acceptable threshold and the decision is accepted. But, if the CR is greater than 10 percent, the outcome of the subjective judgment should be revisited and reviewed.

ANALYSIS AND PRESENTATION OF RESULTS

The study population consists of professionals from a construction firm named CCA. Questionnaires were self-administered to the professionals in this construction firm. According to Wong and Li (2008), the AHP is a subjective method of analysis that does not require the involvement of large samples and as such it is better appreciated on researches that focus on a specific issue where the use of a large sample may not be necessary. They further opined that the AHP method may not be feasible for a survey with a proportionately large sample size as the respondents may have a tendency of providing arbitrary answers which may lead to the realization of very high degree of inconsistency. This study therefore deduced that the eight (8) criteria/main features for successful supply chain management in construction project delivery are reliable and are used for further analysis.

Description of the Case Study Project

CCA was involved in the construction of a "Centre of Excellence Building Project", as part of the Central Bank of Nigeria's (CBN) intervention scheme for teaching and learning in the Management sciences. The site for the project was initially a water-logged area and there was concerted effort to reclaim the site by the contractor. After the site preparation and layout design, a tower crane and other equipment were deployed. Pile foundation was designed to carry and stabilize the sub-structural components of the project giving the swampy nature of the area. The project commenced in June, 2012 and has gulped over ₦10 billion Naira with about 90% of work completed. Sub-contractors works is about 68% completed. CCA won the

contract bid via a keen competitive tendering process. A face-to-face semi structured and recorded interview, walk throughs/observations and discussion sessions was conducted at CCA's project site as part of the data collection process.

Delineating the Features of SCM for Sucessful Construction Project Delivery

To delineate the SCM features into the successful delivery of construction projects, the earlier identified constructs that were identified from the literature were articulated into *delineating the SCM features*. The key features of successful SCM construction project delivery are viz; Quality management (QM), Senior management's commitment (SMC), Instituting trust and long term relationships among SC partners (ITP), Supply chain finance (SCF), Supply chain orientation (SCO), Supply chain and continuous performance measurement (SCCPM), Supply base management (SBM) and Information technology (IT). The weights of the aforementioned main criteria were used in *delineating the SCM features*. Table 2 shows the pair-wise comparison matrix of the eight (8) key features after they were synthesized from the interview outcomes with the professionals based on the Saaty's scale of indicating the level of dominance of one element over the other. See Amade (2016) and Saaty (2008) for details of the Saaty's scale of preference.

Table 2. Pair-wise comparison matrix of SCM features for project delivery

	ITP	SCF	SCCPM	QMT	IT	SBM	SMC	SCO
ITP	1	3	2	5	2.01	5.03	3	3
SCF	0.33	1	2	3	2.01	3.01	4	3
SCCPM	0.5	0.5	1	2	3.01	2.01	3	3
QMT	0.2	0.33	0.5	1	2.01	1	3	2
IT	0.5	0.5	0.34	0.51	1	2.01	2	3
SBM	0.2	0.33	0.5	1	0.5	1	2	3
SMC	0.33	0.25	0.34	0.33	0.5	0.51	1	2
SCO	0.33	0.33	0.34	0.51	0.33	0.33	0.5	1

The consistency ratio (CR) as shown in table 3 was computed using MS Excel at each stage in order to be sure that CR does not exceed 10% according to AHP principle for sound judgment. However, in a situation where the CR exceeds the 10% limit, the entries are further reviewed for consistency. Since the value of CR in table 3 is less than 0.1 (0.064), the judgments from the findings are deemed acceptable. The criteria were further ranked according to their individual weights as shown in the last column of table 3, and thereafter listed from the highest to lowest value below:

1. Instituting trust and long term relationships among SC partners (ITP) has a weight of 28.26%.

2. Supply chain finance (SCF) has a weight of 18.93%.

3. Supply chain and continuous performance measurement (SCCPM) has a weight of 15.4%.

4. Information technology (IT) has a weight of 9.92%.
5. Quality management (QMT) has a weight of 9.55%.
6. Supply base management (SBM) has a weight of 7.84%.
7. Senior management's commitment (SMC) has a weight of 5.54%.
8. Supply chain orientation (SCO) has a weight of 4.56%.

Table 3. Synthesized /Constrained matrix of SCM features for project delivery

	ITP	SCF	SCCPM	QMT	IT	SBM	SMC	SCO	Priority Vector
ITP	0.294	0.48	0.286	0.375	0.177	0.337	0.162	0.15	0.282625
SCF	0.098	0.16	0.286	0.225	0.177	0.202	0.216	0.15	0.18925
SCCPM	0.147	0.08	0.143	0.15	0.265	0.135	0.162	0.15	0.154
QMT	0.059	0.053	0.071	0.075	0.177	0.067	0.162	0.1	0.0955
IT	0.147	0.08	0.048	0.038	0.088	0.135	0.108	0.15	0.09925
SBM	0.059	0.053	0.071	0.075	0.044	0.067	0.108	0.15	0.078375
SMC	0.098	0.04	0.048	0.025	0.044	0.034	0.054	0.1	0.055375
SCO	0.098	0.053	0.048	0.038	0.029	0.022	0.027	0.05	0.045625
									∑ = 1.0

λ max = 8.629 , CI= 0.09 , RI= 1.41 , CR= 0.064 < 0.1 OK.

Findings from the outcomes of the questionnaire, as it was initially stated, were integrated based on the opinions of the professionals interviewed in this study. The respondents were asked to indicate their preference for each of the criterion relative to the pair-wise comparison as the basis for the delineating the SCM features.

The features depict clearly the priority vector value criterion and the most important criterion that should be accorded priority when applying SCM in the delivery of construction projects as 'instituting Trust and Long Term Relationships amongst SC Partners' ITP. This feature had the highest PV value of 28.26%. This implies that trust is key and fundamental in the deployment of SCM principle in the Nigerian construction industry. This is followed by SCF, SCCPM, IT, QMT, SBM, SMC and SCO, in that order.

Discussion of Findings

The finding from the study show that instituting trust and long term relationships among SC partners (ITP) has a weight of 28.26% and was ranked high based on its priority vector value. In relationship development, trust is critical as it tends to eliminate tension while helping to build confidence. Trust and flexibility, according to Mistry and Davis (2009), precipitates innovation and skills sharing that would lead to some benefits to the SC entities. Bresnen and Marshal (2000) in their study identified performance in terms of cost, schedule, quality, fit-for-purpose, buildability as well other criteria could be enhanced if the various entities within a chain can adopt a collaborative method of working together. While for effective

collaboration to ensue amongst the various SC partners, Talavera (2013) recommends relationship management and trust building as one amongst other key variables to be considered in entrenching a successful outcome. These findings demonstrated that relationship management and trust are vital amongst the various SC partners if they must achieve their objective of delivering their construction projects via SCM hence benefiting from the outcome of the project. The findings from this study agrees with that of AbTalib and Hamid (2014) who opined that the issue of trust is a major hindrance if not addressed prior to engaging in any collaborative commitment amongst SC partners. A mutual agreement based on trust is key to the integration of the activities of the various SC entities. Talavera (2013) further stated that for collaboration to ensue amongst SC parties, one of the key ingredients to be considered must include relationship management and trust building. The issue of trust is key and fundamental in every interaction. Given the Nigerian situation, most investors would prefer dealing with someone they can trust. Without any element of trust, definitely no concrete agreement can be reached in terms of any contractual engagement.

The next in the line is supply chain finance (SCF) with a weight of 18.93% and was ranked next after ITP. The ability to deploy an order-to-cash process as well as the tendency to achieve a visible purchase-to-order corroborates with that of Kristofik *et al*. (2012) who stated that putting certain conditions on ground would assist to a greater extent to the successful delivery of a project. One of such conditions is the outlining of trade finance facilities as a precondition to achieving a successful SC. SCF hinges on the activities of most organisations as well as it specifically also hinges on credit decisions, payment collections, financing, procurements and sales. This finding agrees with that of Pezza (2011). Finance as we all know is the life wire of every entity. Lack of the appropriate finance and its proper management would definitely spell doom to an organisation. This may be the reason why SCF came second after ITP.

The next is supply chain and continuous performance measurement (SCCPM) with a weight of 15.4% and was ranked after SCF. Continuous performance measurement is a fundamental ingredient for success in most organisations. It consists mainly of defect elimination, waste reduction, improving productivity and performance while also managing production time effectively. Cai *et al*. (2009) argued further that applying activity based costing and management as a performance measure via the elimination of non-value adding activities across the chain helps in achieving performance. The next is information technology (IT) with a weight of 9.92% and ranked after SCCPM. The use of Internet applications and web based technologies as well as the deploying of web based and other software and portals has contributed in improving the effectiveness of construction activities (Ribeiro & Lopes, 2001). These findings are in tandem with Ribeiro and Lopes (2009) who argued that web based technologies are the most effective means of integrating effective SC in the delivery of most construction projects. The importance of IT in SCM cannot be over emphasized as information has consistently been the fulcrum of most management entities (AbTalib & Hamid, 2014). IT is a key driver of SCM enabled activities in aiding information sharing which is a key component of SCM.

On the aspect of quality management, Lin and Gibson (2011) opined that for quality projects to ensue in a SC environment there is need for the proper streamlining all efforts towards the individual constituents of the SC with a view to achieving enhanced quality to end users. The outcome of this exercise often leads to cost reduction, improved delivery time, improved

quality and reduced inventory. Integrating the concept of quality management system throughout the entire supply chain and maintaining and sustaining an IT based and quality driven capability also contribute to achieving quality in a SC driven entity.

Supply base management (SBM) with a weight of 7.84% next QMT. The service level and price of suppliers plays a significant role in relationship between customers and suppliers. Laying more emphasis on delivery records of suppliers and also selecting few suppliers with a view to enabling effective communication and supplier relationship are also key to achieving SBM. This findings corroborates with that of Goffin *et al*. (1996) who are of the view that the type of service and price at which services are rendered contributes in no small measure in producing high quality components that would be needed in the delivery of a project.

Senior management's commitment (SMC) with a weight of 5.54% followed suit after SBM. The findings indicate that top management needs to continually implement policies that would stimulate interests of all and sundry. Chen and Paulraj (2004) opined that one of the vital functions of top management in any organisation is to stimulate the entrenchment of values that would improve on an organisation's performance.

The findings indicate that supply chain orientation (SCO) with a weight of 4.56% was ranked least amongst the eight (8) features. SCO which is a management philosophy *per se*, if implemented in an organisation, would definitely lead to the manifestation of SCM philosophy within such an organisation, thereby enhancing the delivery and performance of an organisation.

CONCLUSION

The study delineated SCM features for successful deployment of SCM using AHP with a view to incorporating it into the delivery of construction projects. From the results obtained, analysed and discussed, we now conclude that; the eight (8) main criteria were delineated based on the weighted Eigen vector/priority vector value using AHP. The study further concludes that in delineating the features into the delivery of construction projects, the weights of the main criteria based on the AHP priority as well as the most important factors should be followed and accorded the necessary attention if the application of SCM into construction project delivery must be achieved in that order beginning with instituting trust and long term relationship among SC partners (28.26%), supply chain financing (18.93%), supply chain continuous performance measurement (15.40%), information technology (9.92%), quality management (9.55%), supply base management (7.84%), senior management's commitment (5.54%) and finally supply chain orientation (4.56%). Limited research also exists in the areas of application of SCM in the Nigerian construction industry. The findings from this study via the delineation of SCM features would help to bridge the gap by providing a clear understanding of how the concept could be used to deliver construction projects to fruition.

The delineated features provides a comprehensive guide by showing the key elements necessary for the successful delivery of construction projects using the SCM technique with a view to achieving a competitive advantage by construction firms. Furthermore, a significant improvement in the delivery of construction projects can be achieved through the judicious

application of the features by construction professionals. The study further recommends that effort should be made by the professionals and the likes to adopt the features in the delivery of their construction projects to schedule, cost and quality objectives. The delineation of the features which is first of a kind would help the Nigerian construction professionals deliver their projects successfully while also creating a platform for launching into the international construction business and create a niche for themselves. It is expected that the delineated features will further be beneficial to construction firms as it would enable the firms to manage, measure, and evaluate the gains ensuing from the deployment of SCM techniques as this would ensure a drastic increase and improvement in the business of construction.

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