A Supply Chain Management (SCM) Framework for Construction Project Delivery in Nigeria: An Analytical Hierarchy Process (AHP) Approach

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ABSTRACT

This study sought to analyze the results of a survey that aims to develop a SCM framework for the successful delivery of construction projects using the analytical hierarchy process (AHP). The study adopted an exploratory research design with the aid of both quantitative and qualitative methods of research. Purposive and convenient sampling techniques were utilized with the aid of semi-structured interview, case study and questionnaire in selecting respondents from a construction firm in Port-Harcourt, Rivers State, Nigeria. Structured questionnaires were used as instrument for primary data collection after it was pre-tested via a pilot study for purposes of validity and reliability. The data collected were later analyzed using the AHP. Findings from the study shows that the following main factors; trust and long term relationships (TLR=0.283), supply chain finance (SCF=0.189), continuous performance measurement (CPM=0.154), information technology (IFT=0.099), quality (QTY=0.096), supplier management (SMT=0.078), top management's support (TMS=0.055) and supply chain orientation (SCO=0.046) are key to the successful delivery of construction projects using the SCM approach. The findings indicates that when delivering construction projects via the SCM approach, more emphasis should be skewed towards the eight (8) (critical) factors in the hierarchy as they would drive the critical ingredient to achieving success in the delivery of projects using SCM. In a nutshell, the framework would kick start the drive to ensuring a drastic increase and improvement in the business of construction in Nigeria.

Keywords*:* Analytical hierarchy process, Construction projects, Case study, Framework, Supply chain management

INTRODUCTION

SCM according to Shakerian *et al*.(2016) has become one of the important features through which the global industry can compete and as such is likely to remain a major element in worldwide competition. Given the current economic crisis engulfing nations and coupled with the competitive nature of most environments, there is the need to optimize supply chain activities of most organizations to help stem the tide of this recent upsurge. The term "supply chain" as stated by Irizarry *et al.*(2013), entails the delineation of the stages through which construction resources viz materials, equipment, and personnel proceed from supply (source) points to the constructions site.

Tamošaitienė *et al*.(2017) stated that the main objective of SCM is to maximize value in the supply chain (SC) environment. SC in construction is concerned primarily with the planning and directing discrete quantities of materials to the construction site where the proposed project is articulated from incoming (raw) material components. A look at the industry indicates that a large proportion of waste generated ensues as a result of the poor management of the material SC viz; service delivery, inventory, communications.

SCM as opined by Tamošaitienė *et al.*(2017) was initially used in the 1980s, and is described by Ab Talib and Hamid (2014) as a systematic and strategic means of integrating business functions, from an end user perspective through to the original supplier by adding value to end products, services and information for users and other key stakeholders. A SC consists of all activities, functions, and facilities that are involved in the flow and transformation of goods and services from the material stage (raw state) to the end user (final stage). In this era of globalization and innovation, the delivery of construction projects needs to be achieved with the aid of technical skills and techniques that would contribute to an effective and efficient production of construction project and its sustainability in the nearest future (Mohammad *et al.*, 2014). Hence, there is need for the construction industry to shifts its attention towards addressing the manufacturing of their products/deliverables in relation to keeping abreast with sustainability issues and waste generation within the construction environment. As opined by Albaloushi and Skitmore (2008), SC within the context of the construction industry, consists of all construction processes that starts from the initial demands made by the client/owner, through to the design and construction, to maintenance, replacement and subsequent demolition of projects. It further consists of firms involved in the construction process, viz the client/owner, designer, main contractor, subcontractor, and suppliers. Albaloushi and Skitmore (2008) further stated that, construction SCM is adjudged to be a group of firms, individuals working collaboratively in a network of interrelated processes that is structured in such a way that the end users needs are satisfied while also rewarding the entire constituents of the chain.

According to Aloini *et al.*(2012), the construction industry differs a great deal from the SCs noticeable within the goods and services sectors per se, largely as a result of the high complexity and uncertainty associated with the production process; the transitory state of its site during construction configuration; the high rate of customer influence on the deliverable; the fragmented state of its operations; and the complex state of its network of stakeholders involving multiple organizations and relationships amongst others. The peculiar nature of the industry alongside other cultural ties is some of the causes of the encumbrances militating against its inability to replicate some of the positive gains being experienced from other industries. From the information acquisition point of view, some of the problems associated with construction projects usually emanate from the aspect of data and information generation from construction sites. The effectiveness and efficiency of information and data flow between the office and the construction site is most time affected generally by the use of written documents, drawings, specifications and shop drawings causing the duplication of data and information, lack of data and information, and subsequent confusion. The means of processing information and data accumulation are not only time-consuming, but rather expensive thus leading to a compromise on project management performance in information acquisition process (Wang *et al.,*2007). With the advent of technology and culture, a lot of changes have been witnessed in the construction industry in recent time. Studies have shown that the industry is still not effective as a lot of problems bedeviling construction supply chain (CSC) could be identified easily. Majority of these problems to a greater extent are SC related that originate at the interface between the individual actors or stages involved in the CSC activity (Wang & Xue, 2004).

The broad objective of the research reported in this paper, therefore, was to develop a SCM framework for the successful delivery of construction projects to fruition using the AHP. More specifically, the aim was to obtain an insight into the applicability of SCM practices in construction project delivery in Nigeria, with a view to gaining insights into the business of modern day use of cutting edge technology associated with SCM adoption on project performance and delivery in the Nigerian construction industry.

LITERATURE REVIEW

SCM as opined by Vrijhoef and Koskela (1999) is a concept that originated from the supply systems of Toyota motors, where it was seen as a means of coordinating and management of supplies. It is sometimes closely related to lean production. Its basic concept according to Vrijhoef and Koskela (1999), includes other tools like the Just-In-Time (JIT) delivery and logistics management. Ahmed *et al.*(2002) defined SC as a network consisting of facilities and distribution entities that conducts the functions of procuring materials, transforming the materials into partly finished and finished products and the subsequent distribution of the finished products to the end users. SC activities are noticeable in both service and manufacturing industries and as such, the complexity of such chains may vary to a greater extent from one industry to another.

As reiterated by Croom *et al*.(2000), SCM has received due attention in the early 1980s, but up till date, its management has not been conceptually and particularly being understood, and as such a lot of authors have highlighted the necessity of succinct definitional constructs and conceptual frameworks on SCM. The reasons for the dearth of a universal definition of SCM as opined by Croom *et al*.(2000), is it's multidisciplinary nature and state of its evolution. From a construction industry's perspective, Akintoye *et al*. (2000) defined construction supply chain management (CSCM) as a set of practices geared towards the management and coordination of an entire chain from raw material suppliers to end users. Benton and McHenry (2010, p.8) defined "CSCM as the strategic management of information flows, activities, tasks, and processes, involving various networks of independent organizations and linkages (upstream and downstream) which produce value that is delivered to the owner in the form of a finished project". The upstream activities within CSCM from the point of view of a prime contractor as stated by Benton and McHenry (2010) consist of the client and engineering/design teams as they involve in the preparation of the construction process. The downstream activities consist of material suppliers and subcontractors who engage with the prime contractor to execute the task of actual construction, while also soliciting for coordination among the various partners on the project. In other to synchronize the activities of the downstream and upstream elements of the SC, the prime contractor must come up with an enabling structure and efficient communication system with a view to achieving an effective relationship management that is part and parcel of an overall and effective project management.

Eight (8) constructs and their forty (40) sub-parts that are factors for successful incorporation of SCM in construction project delivery were identified from the literature (Amade, 2016). The constructs include; supply chain finance (SCF) (Steeman, 2014), supply chain orientation (SCO), trust and long term relationships (TLR) (AbTalib & Hamid, 2014;Quesada *et al.*,2010), quality (QTY) (Ronchi, 2006), information technology (IFT) (Pal & Karakostas, 2014; Yu, 2015), supplier management (SMT) (Lemke *et al.*,1999), top management's support (TMS) (Chen & Paulraj, 2004) and continuous performance measurement (CPM) (Bani Ismail, 2012; Ntabe *et al.*,2014). Table 1 shows the summary of the SCM factors for successful construction project delivery.

The key factors for successful SCM construction project delivery and their sub-criteria are shown in details in table 1.

Table 1: Factors for CSCM

Factors	**Sub criterion (factors)**	**Authors**
Supply Chain Finance (SCF)	1. Tendency to achieve a visible purchase-to-order (SCF) 2. Ability to deploy an order-to-cash process (SCF) 3. Getting organization's stakeholders on board via the bank's financial assistance (SCF) 4. Outlined trade finance as a pre-condition for a successful supply chain finance (SCF)	Pezza (2011); Kristofik, Kok, DeVaries and Hoff (2012)
Quality (QTY)	1. Disseminate quality information across the various chains (QTY) 2. Minimize the number of contractors/subcontractors to a sizeable number (QTY) 3. Adopt and implement ISO 9000 systems in improving the quality of our projects (QTY) 4. Integrate the concept of quality management system throughout the entire supply chain (QTY)	Kuei, Madu, Lin and Chow (2002); Lin and Gibson (2011)

	5. Maintain and sustain an IT based and quality driven capability (QTY)	
Supply chain orientation (SCO)	1.Top management support is needed in SCM orientation (SCO) 2. Commitment from employers and employees in achieving SCM (SCO) 3. Credibility on the part of all and sundry in orientating employees in our organization (SCO) 4. Benevolence (SCO) 5. Communication of the concept (SCO) 6. Environmental pressure from specialists and other professionals about the benefits of SCM (SCO)	Mentzer, DeWitt, Keebler, Min, Nix, Smith and Zacharia (2001); Hamid and Sukati (2011)
Trust and Long Term Relationships (TLR)	1. Relationship management and trust building (TLR) 2. Collaborative commitment (TLR) 3. Goal congruency (TLR) 4. Trust amongst supply chain partners (TLR) 5. Integrated information sharing (TLR)	Rivera, Wan, Chen and Lee (2007); Bresnen and Marshall (2000); Mistry and Davis (2009); Talavera (2013)
Top Management's Support (TMS)	1. Top management needs to continually implement policies that would stimulate interests of all and sundry (TMS) 2. We believe top management needs to motivate its employees towards the realization of the objectives (TMS) 3. We believe top management needs to communicate effectively its policy directions (TMS) 4. Top management needs to commit to the achievement of the concept (TMS)	Pezza (2011); Kristofik, Kok, DeVaries and Hoff (2012)
Continuous Performance Measurement (CPM)	1. Apply different quality standards such as ISO 9000 in achieving project objectives (CPM) 2. Apply activity based costing and management as a performance measure via the elimination of non-value adding activities across the chain (CPM) 3. Holistically define the solutions and scope of resolving supply chain issues (CPM) 4. Avoid unintended consequences by approaching our supply chain as an interactive system (CPM) 5. Deploy Just-in-time and lean techniques in achieving our performance targets (CPM) 6. Deploy earned value management metrics in our schedule and cost performance (CPM)	Cai, Liu, Xiao and Liu (2009); Venkataraman (2007)
Information Technology (IFT)	1. Use of Internet applications and web based technologies (IFT) 2. Integrate radio frequency and identification (RFID) technology in fast tracking construction activities on site (IFT) 3. Use of mobile devices & personal digital assistants in supporting our activities (IFT) 4. Deploy web based and other software and portals in improving the effectiveness of our construction activities (IFT)	AbTalib and Hamid (2014); Xue, Wang, Shen and Li (2007); Wang, Lin, Xiao and Lin (2007); Ribeiro and Lopes (2001)
Supplier Management (SMT)	1. Select few suppliers with a view to enabling effective communication and supplier relationship (SMT) 2. Often conduct a regular and comprehensive quality appraisal on our suppliers (SMT) 3. Monitor our suppliers more closely (SMT) 4. Lay more emphasis on Delivery records of our suppliers (SMT) 5. Deploy technological capabilities in our supply base management (SMT) 6. Also ensure that the service level and price of our suppliers are better (SMT)	Goffin, Szwejczewski and New (1996); Matsoso and Benedict (2014)

Gap in the literature

SCM as an emerging area of study in the construction industry the world over is based on similar concepts that have been widely and successfully deployed in the manufacturing sector. A handful of studies have been carried out where attempts were made to apply the SCM concept to the construction industry. In as much as there have been a number of attempts to develop frameworks for SCM in the delivery of construction projects, none of such frameworks has been able to be developed for the Nigerian environment in particular. In other advanced climes of the world, various frameworks for SCM construction project delivery have been developed (Hernandez *et al*.(2008), Aloini *et al.* (2012), Xue *et al.*(2005), Perdomo (2004), Manu (2014) and Magalhaes-Mendes *et al*.(2010).

Majority of these studies were not based on any theoretical and quantitative variables that are inherent with the AHP process nor have they produced any significant results which can potentially lead to a successful formation of a tangible framework that is a replica of AHP. As a consequence, the results produced by some of these studies are not coherent at best. Furthermore, most of these studies do not fully consider the quantitative and qualitative tools of solving complex decision making problems that incorporates scientific reasoning which is a common phenomenon with the AHP (Dalalah, Al-Oqla and Hayajneh, 2010; Wong and Li, 2007; Saaty, 2008). This study is unique in the sense that SCM factors were explored in detail and used in developing the SCM framework via the AHP in the delivery of construction projects in Nigeria.

RESEARCH METHOD

The study deployed an exploratory research and case study design approach. Quantity surveyors (24), project managers (19), engineers (18), builders (22), architects (20) formed part of the study respondents. Convenient and purposive sampling technique was deployed in selecting the respondents. The study was carried out in Port-Harcourt; Rivers State, Nigeria. Port-Harcourt in Rivers State was chosen for this study as one of the area/location that constitutes the hub of most construction related activities SCM principles and techniques are believed to be practiced to a greater extent. Sampled questionnaires and semi-structured interviews were deployed in eliciting data from the respondents from the case study organization. Closed-ended questions were deployed for purposes of eliciting data collection and further analysis. In collating the data needed for the pair-wise comparison, questionnaires were used based on a specific scale as stated by Thomas Saaty in developing the framework using the AHP (Wong and Li, 2007; Saaty, 2008).

The closed-ended questionnaires were sent to experienced professionals who had ample experience in the construction industry. In a bid to ensure the retrieval of reliable data from the respondents, the researchers deployed the method of interviewee administered questionnaire method to help clarify with the respondents on any perceived ambiguity that may arise with regards to the questions. The questionnaires were pilot-tested before they were distributed to some professional colleagues and seasoned academics drawn from the built environment industry. A total of 123 questionnaires were distributed based on the Krejcie and Morgan method of determining sample size while 114 were collated out of which 103 were found adequate for further analysis. The questionnaire has an already in built reliability scale of measurement which is common with the AHP method of consistency determination as shown in the constrained matrix tables. Three (3) project managers, five (5) architects and four (4) site engineers formed part of the interviewees who were interviewed. Their vast years of experience in construction project management gave them the opportunity to respond perfectly to the questions.

In the data analysis aspect of this work, the AHP was deployed in arriving at the results of the study. The reasons for deploying the AHP tool is that most multi criteria decision making techniques like AHP helps in arriving at an informed decision (Dalalah *et al.,* 2011; Saaty, 2008). In developing the framework via AHP, the key factors for successful SCM were alongside deployed to achieve the purpose. The AHP was used in computing the pair-wise and constrained matrices, weighted scores and Eigen vector. During the iteration process proper, the relative priorities of the factors or alternatives were determined. In computing the relative priorities, the theory of eigen vector was applied while the consistency check was conducted at the stage of selection. In a bid to evaluate the consistency of the results, some critical components were required. They include; the Consistency Index (CI), Random Index (RI), and Consistency Ratio (CR). To get the consistent reciprocal matrix, the largest eigenvalue must be equal to the number of comparisons. When the computation of the CI is done, the index value is then used in comparing it with the required random consistency index by selecting the randomly generated reciprocal matrix value using the various scales of 1/9, 1/8…….1,8,9 as contained in the Saaty's table of preference (Dalalah *et al.*,2011; Saaty, 2008).

The Random Index (RI), consist of the randomly generated average CI value matrix using the Saaty's preference table, this was later sorted by the number of items being considered and then we get the random consistency index. The RI from the Saaty's preference scale for factors is then deployed in the decision making process. While the CR value, is the ratio of the CI and RI, and this indicates the extent of allowed inconsistency permitted by AHP, that is,

CR=CI/RI………..(1)

Whenever the value of the CR is lower or equal to 0.1, the level of consistency is deemed to be within the acceptable threshold and such a decision will be accepted. On the other hand, if the CR is higher than 0.1, it means that the outcome of the subjective judgment needs to be revisited and reviewed.

RESULTS

In developing the framework for SCM in the delivery of construction projects, the developed constructs identified from the literature were later fused into developing the framework. Tables 2-17 depict the pair-wise comparison matrix of the eight (8) key factors and forty (40) sub key factors after being synthesized from the results of the interview with the respondents based on the Saaty's preference scale (Saaty, 2008).

The respondents indicated their preferences regarding each of the sub criterion (factor) as shown from tables 2 to 17. The tables show the various weights of each sub criterion as applicable to the construction firm. The sub criteria were ranked according to their weights from highest to least as indicated in the tables.

Table 2. Pair-wise Comparison Matrix of SCO

	SCO1	SCO2	SCO3	SCO4	SCO5	SCO6
SCO1	1	0.33	0.5	2	3.02	5.05
SCO2	3.01	1	2	3.01	5.02	7.08
SCO3	2	0.5	1	2	4.02	5.05
SCO4	0.5	0.33	0.5	1	3.02	5.05
SCO5	0.33	0.2	0.25	0.33	1	3.03
SCO6	0.2	0.14	0.2	0.2	0.33	1

Table 3. Synthesized/Constrained matrix of SCO

	SCO1	SCO2	SCO3	SCO4	SCO5	SCO6	Priority Vector
SCO1	0.142	0.133	0.112	0.234	0.184	0.192	0.166167
SCO2	0.427	0.398	0.449	0.352	0.306	0.269	0.366833
SCO3	0.284	0.199	0.225	0.234	0.245	0.192	0.229833
SCO4	0.071	0.133	0.112	0.117	0.184	0.192	0.134833
SCO5	0.047	0.08	0.056	0.039	0.061	0.115	0.066333
SCO6	0.028	0.057	0.045	0.023	0.02	0.038	0.035167
							$\sum = 1.0$

λ max = 6.188 , CI= 0.038 , RI= 1.24 , CR= 0.030 < 0.1 OK.

Table 4. Pair-wise comparison matrix of TLR

	TLR1	TLR2	TLR3	TLR4	TLR5
TLR1	1	2	3	2	1
TLR2	0.5	1	2	1	0.5
TLR3	0.33	0.5	1	1	0.25
TLR4	0.5	1	1	1	0.5
TLR5	1	2	4	2	1

Table 5. Synthesized/Constrained matrix of TLR

	TLR1	TLR2	TLR3	TLR4	TLR5	Priority Vector
TLR1	0.3	0.307692	0.272727	0.285714	0.307692	0.2947652
TLR2	0.15	0.153846	0.181818	0.142857	0.153846	0.1564735
TLR3	0.1	0.076923	0.090909	0.142857	0.076923	0.0975225
TLR4	0.15	0.153846	0.090909	0.142857	0.153846	0.1382917
TLR5	0.3	0.307692	0.363636	0.285714	0.307692	0.3129471
						$\sum = 1.0$

λ max = 5.052 , CI= 0.013 , RI= 1.12 , CR= 0.012 < 0.1 OK.

Table 6. Pair-wise comparison matrix of SMT

	SMT1	SMT2	SMT3	SMT4	SMT5	SMT6
SMT1	1	3.01	3.01	4	2.01	3.96
SMT2	0.33	1	3.01	2	3.01	4.96
SMT3	0.33	0.33	1	3	2.01	2.98
SMT4	0.25	0.5	0.33	1	0.5	1.98
SMT5	0.5	0.33	0.5	2	1	2.98
SMT6	0.25	0.2	0.33	0.5	0.33	1

Table 7. Synthesized/Constrained matrix of SMT

	SMT1	SMT2	SMT3	SMT4	SMT5	SMT6	Priority Vector
SMT1	0.375	0.559	0.367	0.32	0.227	0.222	0.345
SMT2	0.124	0.186	0.367	0.16	0.34	0.278	0.2425
SMT3	0.124	0.061	0.122	0.24	0.227	0.167	0.156833
SMT4	0.094	0.093	0.04	0.08	0.057	0.111	0.079167
SMT5	0.187	0.061	0.061	0.16	0.113	0.167	0.124833
SMT6	0.094	0.037	0.04	0.04	0.037	0.056	0.050667
							$\sum = 1.0$

λ max = 6.413 , CI= 0.083 , RI= 1.24 , CR= 0.067 < 0.1 OK.

Table 8. Pair-wise comparison matrix of CPM

	CPM1	CPM2	CPM3	CPM4	CPM5	CPM6
CPM1	1	2	0.5	2	0.5	2
CPM2	0.5	1	0.5	2	0.5	2
CPM3	2	2	1	3.01	2	3
CPM4	0.5	0.5	0.33	1	0.5	2
CPM5	2	2	0.5	2	1	3
CPM6	0.5	0.5	0.33	0.51	0.33	1

Table 9. Synthesized/Constrained matrix of CPM

	CPM1	CPM2	CPM3	CPM4	CPM5	CPM6	Priority Vector
CPM1	0.154	0.25	0.158	0.19	0.104	0.154	0.168333
CPM2	0.077	0.125	0.158	0.19	0.104	0.154	0.134667
CPM3	0.308	0.25	0.316	0.286	0.414	0.231	0.300833
CPM4	0.077	0.063	0.104	0.095	0.104	0.154	0.0995
CPM5	0.308	0.25	0.158	0.19	0.207	0.231	0.224
CPM6	0.077	0.063	0.104	0.048	0.068	0.077	0.072833
							∑ = 1.0

λ max = 6.187 , CI= 0.037 , RI= 1.24 , CR= 0.03 < 0.1 OK.

Table 10. Pair-wise comparison matrix of QTY

	QTY1	QTY2	QTY3	QTY4	QTY5
QTY1	1	0.33	3	0.5	2
QTY2	3.03	1	3	2	3
QTY3	0.33	0.33	1	0.33	0.5
QTY4	2	0.5	3.03	1	3
QTY5	0.5	0.33	2	0.33	1

Table 11. Synthesized/Constrained matrix of QTY

	QTY1	QTY2	QTY3	QTY4	QTY5	Priority Vector
QTY1	0.145695	0.132176	0.24937	0.120096	0.210526	0.1715729
QTY2	0.441501	0.400534	0.24937	0.480384	0.315789	0.3775158
QTY3	0.048565	0.133511	0.083123	0.079263	0.052632	0.079419
QTY4	0.291391	0.200267	0.251889	0.240192	0.315789	0.2599057
QTY5	0.072848	0.133511	0.166247	0.080064	0.105263	0.1115866
						∑ = 1.0

λ max = 5.176 , CI= 0.044 , RI= 1.12 , CR= 0.039 < 0.1 OK.

Table 12. Pair-wise comparison matrix of SCF

	SCF1	SCF2	SCF3	SCF4
SCF1	1	2	0.25	0.33
SCF2	0.5	1	0.25	0.33
SCF3	3.99	4	1	3
SCF4	2.99	3	0.33	1

Table 13. Synthesized/Constrained matrix of SCF

	SCF1	SCF2	SCF3	SCF4	Priority Vector
SCF1	0.118	0.2	0.137	0.071	0.1315
SCF2	0.059	0.1	0.137	0.071	0.09175
SCF3	0.471	0.4	0.546	0.642	0.51475
SCF4	0.353	0.3	0.182	0.214	0.26225
					$\sum = 1.0$

λ max = 4.125 , CI= 0.042 , RI= 0.9 , CR= 0.046 < 0.1 OK.

Table 14. Pair-wise comparison matrix of IFT

	IFT1	IFT2	IFT3	IFT4
IFT1	1	2.01	2	0.5
IFT2	0.5	1	2	0.25
IFT3	0.5	0.5	1	0.5
IFT4	2	4.01	2	1

Table 15. Synthesized/Constrained matrix of IFT

	IFT1	IFT2	IFT3	IFT4	Priority Vector
IFT1	0.25	0.267	0.286	0.2	0.25075
IFT2	0.125	0.133	0.286	0.1	0.161
IFT3	0.125	0.067	0.143	0.2	0.13375
IFT4	0.5	0.533	0.286	0.4	0.42975
					$\sum = 1.0$

λ max = 4.18 , CI= 0.06 , RI= 0.9 , CR= 0.067 < 0.1 OK.

Table 16. Pair-wise comparison matrix of TMS

	TMS1	TMS2	TMS3	TMS4
TMS1	1	0.5	2	0.5
TMS2	2	1	3	0.5
TMS3	0.5	0.33	1	0.33
TMS4	2	2	3	1

Table 17. Synthesized/Constrained matrix of TMS

	TMS1	TMS2	TMS3	TMS4	Priority Vector
TMS1	0.182	0.131	0.222	0.215	0.1875
TMS2	0.364	0.261	0.333	0.215	0.29325
TMS3	0.091	0.086	0.111	0.142	0.1075
TMS4	0.364	0.522	0.333	0.429	0.412
					$\sum = 1.0$

λ max = 4.068 , CI= 0.023 , RI= 0.9 , CR= 0.025 < 0.1 OK.

Figure 1 depicts the framework for successful SCM in construction project delivery using the AHP.

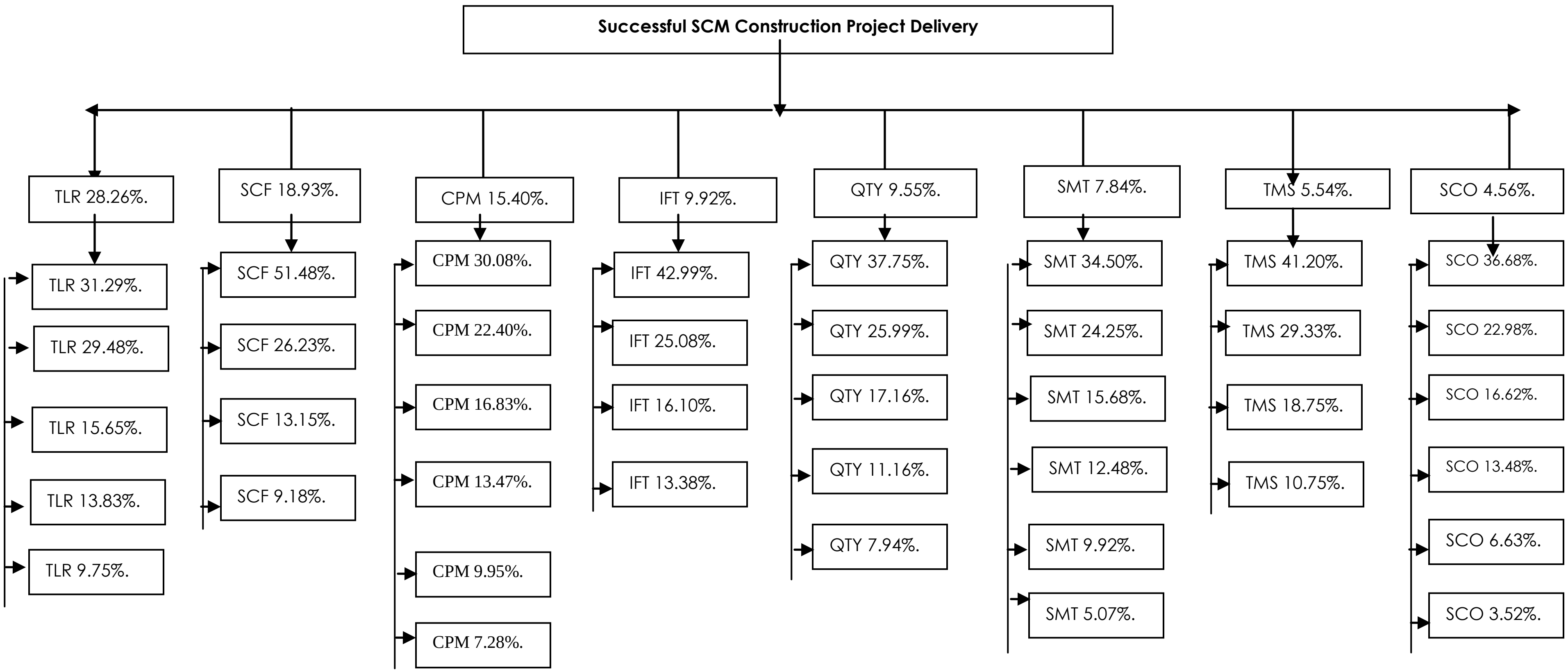

Figure 1: Framework for Successful SCM in Construction Project Delivery

Figure 1 clearly depicts the framework for successful SCM construction project delivery using the AHP. The key main criterion "Successful SCM Construction Project Delivery" was identified at the first level of the hierarchy, while at the second level, the eight (8) main criteria (factors) were ranked based on their individual weights as was obtained from their priority vector (PV) values shown from tables 2 to 17. The framework shows clearly based on the priority vector value criterion the most important criterion (factor) that should be accorded priority when deploying SCM in the delivery of construction projects. TLR with a PV value of 28.26% was adjudged as having the highest weight. This implies that trust is a fundamental ingredient when deployment SCM in the delivery of construction projects in the Nigerian construction industry. This is followed in that order by SCF, CPM, IFT, QTY, SMT, TMS and SCO.

Discussions

This research explored the major factors for successful SCM construction project delivery using the AHP to come up with a framework for the delivery of construction projects to fruition. The results showed that trust and long term relationships (TLR) was ranked highest based on its priority vector value of 0.283. SCM aims to improve trust and collaboration among SC partners, hence increasing inventory visibility and velocity is an innovative tendency that seems to be appropriate for successful delivery of construction projects (Albaloushi & Skitmore, 2008). Trust plays a significant role in relationship building and development, it is critical in the reducing tension and hostility to a greater extent, while also creating a conducive atmosphere for confidence building. As stated by Mistry and Davis (2009), trust and flexibility often gives rise to enhanced skills and innovation amongst the individual SC partners thus culminating into an overall benefit to an organization. Achieving performance on cost, quality, schedule, buildability and fitness-for-purpose can lead to the enhancement of the various constituents of a SC by adopting collaboration (Bresnen & Marshal, 2000).

The outcome of this finding corroborates that of AbTalib and Hamid (2014) and (Bresnen & Marshal, 2000) who were of the view that trust is a critical element for any partnering arrangement to ensue which SCM is all about. If adequate attention is not accorded this critical element, the tendency of achieving fruition at the end of the whole exercise would be a mirage. Trust and long term relationships are key and fundamental in every interaction and as such they form the critical ingredient on which other issues bordering on project delivery emanates from. With the state of mistrust and associated with doing business in most developing countries of the world, most serious minded investors would want to go into a business deal with persons who they can trust and have proven to be reliable in all ramifications. In the absence of this critical element, your guess is as good as mine as to what would come out of any such envisaged contractual engagement that lacks this critical ingredient.

Supply chain finance (SCF) was ranked next after TLR with a weight of 0.189 as determined by the priority vector value**.** The tendency to deploy an order-to-cash process and also achieving a visible purchase-to-order agrees to a large extent with the findings of Kristofik *et al*.(2012) who reiterated that articulating the necessary conditions needed for success would culminate into the successful delivery of a project to fruition. Outlining of trade finance facilities as a prior condition to achieving a successful SC is one of such conditions. As a pivot for most organizations, SCF relies more on decisions regarding credits, collection of payments, sales, financing and procurement. This assertion is in tandem with Pezza's (2011) findings as finance is the critical and inevitable resource that any organization can't do without. The dearth of funds and its management can be one of the vital reasons that would undermine the proper functioning of any entity.

Continuous performance measurement (CPM) with the next high priority vector value of 0.154 was ranked after SCF. Continuous performance measurement is one of the critical ingredients for achieving success in any organization. CPM has to do with the elimination of defects, minimizing waste, enhancing productivity and performance while at the same time managing production time. The tendency to deploy activity based costing and management as a means of measuring performance through the elimination of non-value adding activities amongst the chains aids in achieving performance to a greater extent (Cai *et al.*,2009). The essence of performance measurement is to continually check for reliability and consistency of any given system for optimum performance. Information technology (IFT) with a priority vector value of 0.099 was ranked high after CPM. As stated by (Ribeiro & Lopes, 2001), the use of internet resources and web based technologies, and the use of web-enabled software and portals has to a larger extent led to the improvement and effectiveness of construction activities of recent.

The findings corroborate those of Ribeiro and Lopes (2009) who were of the view that web enabled technologies have been the key to effective means of achieving success in the delivery of most construction projects via the SCM approach. According to AbTalib and Hamid (2014), the indispensability of IT in SCM is unequalled as IT has always been the driver of most modern day conglomerations. Quality with a priority vector value of 0.096 was ranked next after IFT. In a bid to ensure the realization of projects that meets the required quality by all standards, all the necessary components needed for the realization of such objectives must be properly articulated. This entails that the SC entities must work according to specification while also observing other key critical components for achieving quality for the end users satisfaction (Lin & Gibson, 2011). In a nutshell, this action leads to improved project delivery time, improved reduction in cost, quality improvement and minimum inventory. The outcome of this finding agrees with that of (Lin & Gibson, 2011). Supplier management (SMT) with a priority vector value of 0.078 was ranked high after QTY.

As stated by Goffin *et al*.(1996), dwelling on the records of delivery, while also relying on a few selected and trusted suppliers is critical in achieving an effective supplier/SCM within an entity. This action is often precipitated by efficient and effective communication as well as effective supplier relationships. The outcome of this findings agrees with that of Goffin *et al*.(1996) to a larger extent. They opined that the nature of services being rendered and the price at which such services are delivered all contributes to the production of quality parts/components that contributes to the overall delivery of the project's deliverable. Top management's support (TMS) with a priority vector value of 0.055 was ranked high after SMT, this implies that the top management of most organizations should as a matter of necessity come up with policies that would reinvigorate and motivate all the facets of the organization and its employees with the sole aim of achieving competitive advantage in the industry. The outcome of this finding agrees with that of Chen and Paulraj (2004), who were of the view that one of the important functions of top management in any organization is to see to the entrenchment of the right attitude and values that would culminate into the improvement of an organization's performance.

The study findings show that supply chain orientation (SCO) with a priority vector value of 0.046 was ranked the least amongst the eight (8) factors. As one of the factors for successful SCM, as well as a critical ingredient that if it is deployed in an organization, would in no small measure create the much needed awareness that would culminate into the manifestation of SCM's ideology in an organization, thereby leading to the realization of the key objectives of an organization.

This work has made some contributions to knowledge in the sense that a lot of studies focused extensively mainly on SCM in the manufacturing sector. Hence, there is limited empirical support for activities in the Nigerian context with regards to the construction sector. Data obtained from the case study firm have been used to come up with the key factors that constitute SCM in the delivery of construction projects using the AHP. The syntheses of these SCM factors contribute to the body of knowledge on SCM implementation by providing a structured and coherent framework of the factors that should be incorporated into the successful delivery of construction projects to fruition in Nigeria.

CONCLUSION

In developing the framework for the successful deployment of SCM, the study deployed the AHP and incorporating it into the successful delivery of construction projects. The findings emanating from the study shows that the results obtained as well as the analyses, and discussions so far indicates that the eight (8) key factors were developed into a SCM framework based on the weight of their respective priority vector value as shown from tables 1 to 16. From the findings so far, the study thereafter concludes that in developing the framework into the delivery of construction projects, the individual weights of the key factors as obtained by the priority vector (Eigen vector) value based on the AHP process, the factor with the highest priority vector value be given due and adequate priority when deploying SCM into the delivery of construction projects. In delivering the project using the SCM approach, the eight (8) factors should be articulated in their order of priory vector value from the highest to the lowest commencing with trust and long term relationship (TLR=0.283), supply chain financing (SCF=0.189), continuous performance measurement (CPM=0.154), information technology (IFT=0.099), quality (QTY=0.096), supplier management (SMT=0.078), top management's support (TMS=0.055) and finally supply chain orientation (SCO=0.046). There is a dearth of studies in this aspect of the deployment of SCM using AHP in the delivery of projects in the Nigerian construction industry. The outcomes from this study would aid in bridging the much needed gap by creating an avenue for understanding how the AHP framework could be deployed using the SCM concept in the successful delivery of construction projects to cost, schedule and performance. The study finally recommends the deployment of this framework by all professionals and the likes within the built environment by adopting and deploying the framework into the delivery of their construction projects to fruition amongst others.

Acknowledgements

The authors are grateful to the professionals who actively participated in sharing their experiences at the construction site visited as well as their generosity in providing the much needed support by engaging the authors in valuable discussions pertaining to the study.

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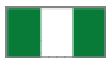

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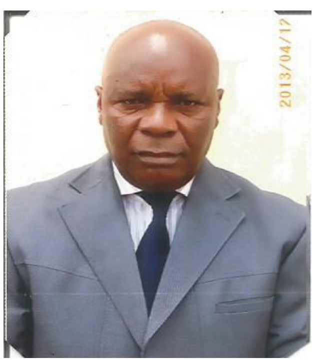

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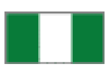

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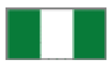

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