

Impact of Supply Chain Management in the Construction Industry for Effective Project Delivery

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ABSTRACT

This paper evaluates the influence of supply chain management (SCM) within the United States construction industry on enhancing project delivery. It highlights the challenges faced and underscores the role of Construction Supply Chain Management (CSCM) practices in mitigating them. A survey questionnaire was administered to ninety-five (95) construction stakeholders across private and public sectors, with sixty (60) responses analyzed using statistical software. Analysis utilized Average Mean Scores (AMS) and Relative Importance Index (RII) to interpret data. Results indicate prominent challenges, including inadequate investment in information technology (IT), ineffective communication, and conflicting objectives, while issues like unfair risk allocation and poor SCM comprehension ranked lower. RII ranged from 0.82 for trust-based relationships, information flow, and financial solid flow (top ranking) to 0.69 for the Human Resource supply chain (lowest ranking). The study advocates for CSCM adoption to address industry challenges, stressing its significance in a globally competitive market. Additionally, it recommends educational initiatives by professional bodies to enhance stakeholder understanding and implementation of CSCM through workshops, seminars, and conferences.

Keywords: supply chain, construction industry, distribution dimension, and project management

I. INTRODUCTION

Supply Chain Management in construction refers to the process, systems, and practices used to manage the flow of materials; it also involves managing the relationship between all stakeholders:

suppliers, customers, contractors, owners, and manufacturers. Information across the supply chain must be coordinated, establishing all conditions to function effectively and applying and developing new technologies. Supply chain management (SCM) is a concept that has flourished in every industry. It originated from just-in-time (JIT) production and logistics; Project et al. Conference, India, 2015). It was observed that supply chain management is recognized as a leading process improvement, cost savings, and revenue-enhancing business (Aneesa et al., 2015). Therefore, it behooves all organizations involved in the delivery of construction projects to incorporate the initiative supporting strategy and tactical planning as well as systems thinking, which promotes the practice and application of supply chain management as a concept.

Construction projects require numerous agents and specialists hired by clients involved in project design (e.g., architects and structural designers), main contractors, subcontractors, suppliers, or project management consultants/third-party consultants.

They are all expected to manage the supply chain of construction processes/projects by integrating all processes and activities of different agents, as well as practical cooperation and coordination for a successful project delivery (Yadav, 2015). Supply chain management synchronizes a firm's functions and those of its suppliers to match the flow of material services and logistics in the supply chain. Therefore, construction supply chain management is the management of suppliers, subcontractors, related parties, all agents, and processes to deliver information for planning, ordering, producing,

delivering, and installing materials and services for construction projects through an organized network of organizations.

In the United States, although the concept of supply chain management is still a new area for construction stakeholders, specific elemental challenges exist that have been identified as inhibitors to the effective development of construction supply chain management practices in the construction industry. These inhibitors commonly reported in the construction industry are an inadequate investment in IT, diverse objectives, ineffective communication, poor understanding, inappropriate tendering methods, ignorance, lack of training, ineffective problem-solving mechanisms, and passive subcontractors. The challenges above have become enormous problems faced by The United States construction companies in managing the supply chain, which is the bane of successful project delivery. Also, these challenges or inhibitors of Supply Chain Management (SCM) have resulted in poor project planning, variation of project scope, faulty design, and wrong estimates, which are a direct consequence of wrong practices by construction stakeholders' contractors, consultants, and clients who are yet to fully lend credence to the conduct and practice of this management technique known as supply chain management. In dealing with these inhibitors, this study seeks to identify the common challenges construction stakeholders face in applying SCM in effective project delivery in the United States.

Construction companies, especially in The United States, are faced with enormous challenges in supply chain management, which, to a large extent, involve integrating all construction processes and activities of different agents and specialists hired by clients for successful project delivery. Construction stakeholders face inadequate investment and ignorance of build ability issues, which are commonly witnessed in the construction industry. Based on this, poor project planning, variation of project scope, faulty designs, and wrong estimates were witnessed in the past due to these inhibitors or challenges in the construction industry. These results result from not aligning its conduct and practices entirely with the SCM technique in the United States construction industry. In dealing with these challenges, this research paper seeks to identify the challenges faced by construction stakeholders in the application of SCM in practical project delivery in The United States construction industry, which is a microcosm of the United States construction industry, as well as identify standard construction supply chain management practices in

curbing/curtailing these challenges faced by construction stakeholders in the United States.

Although the concept of supply chain management is new to the United States construction industry, efforts have been made in the past to enlighten construction stakeholders. This research is not mainly to add to the subject but to bring to the fore the relevance and benefits of this pragmatic concept called supply chain management. Professional bodies like the United States Institute of Quantity Surveyors (QSI), The American Society of Professional Engineers (ASPE), The Home Builders Institute (HBI), The National Society of Professional Engineers (NSPE), Construction Management Association Inc (CMA), etc., will find it beneficial as a tool to bring awareness and educate construction professionals on the need to adopt this technique of SCM to reduce the overall construction cost by streamlining the flow of supplies to the execution process and by improving information flow between the agencies and specialists in the construction process through seminars, discussions, and workshops.

The Concept of Supply Chain Management in the Construction Industry

Mensah et al.(2014) defined it as a set of activities undertaken in an organization to promote effective management of its supply chain. In their research, Khalfan, McDermott, and Kyng (2015) defined supply chain management as a network of organizations linked upstream and downstream, aiming for products for the end consumers through integrated processes and activities. From the definition, it can be deduced that components of SCM practices include supply and material management issues, operations, information sharing, and customer service. According to Mensah et al.(2014), the latter seeks to optimize the level of integration of the whole supply chain to which the industry has responded. For this research paper, the two definitions were considered since both support the integration of the supply chain into the construction industry. However, it is noteworthy to say that there is no generally accepted definition. However, there is a substantial nexus and consensus among the various definitions that point in a similar direction, especially in the construction industry.

Several construction industries have shown interest after realizing the importance of SCM. Supply Chain Management in construction can be very complex owing to hundreds of subcontractors and suppliers involved, especially in a large-scale project. A typical construction supply

chain management involves information flow such as orders, schedules, forecasts, and materials such as supplies, production, deliveries, etc. (Vrijhoef & Koskela, 1999). Nevertheless, Saka and Mudi (2007), in their submission, asserted that construction supply chain management involved suppliers, sub-contractors, related parties, and processes to deliver information for planning, ordering, producing, delivering, and installing materials and services for construction projects through an organized network of organizations. Any problem with the flow in the supply chain will disrupt the project's performance and delivery. Below are three types of construction supply chains as follows:

- The primary supply chain that delivers the material that is needed in the final construction product.
- The support chain, which provides equipment and materials that facilitate construction.
- The human resource supply chain, which involves the supply of labor.

Though construction differs from factory production processes, supply chain management can be effective and relevant (Ojo et al., 2014). The discipline of supply chain management contrasts sharply with traditional planning, controlling, and contracting methods for projects, which seek, at best, to optimize individual activities. Therefore, supply chain, according to O'Brien (1998), currently in construction methods seeks to support the fragmented nature that plagues construction, hence promising an engineering basis to design, plan, and manage construction projects in an integral/collaborative manner.

The United States Perspective of Supply Chain Management

Statistics show that the market size of this industry is valued at around \$1.6 trillion in 2021 and is expected to grow in future years. It is also a significant contributor to the US economy. With the creation of over \$1.8 trillion worth of structures each year, we observed that construction is one of the largest customers for manufacturing, mining, and other services. It has also created over 7. million jobs in Indiana in 2020, 706,000 construction firms in the US, and 13,263 in Indiana. Are they ready to harness the full potential of this changing dynamic to benefit clients, organizations, people, communities, and the United States?

Construction is no longer building unique structures or physical infrastructures; changes in customer demand and the realities of modern

supply chains have shifted the way engineering and construction companies do business. These changes are pushing firms to seek and explore new ways of creating and capturing value. They must develop an integrated, connected, and automated operation, which comes when the supply chain is introduced into every process. This will ensure a continuous flow of information, analysis, and productivity-enhanced technologies, reduce disruptions, and work with minimal budgets.

The study, practices, and challenges of supply chain management by building contracting firms in the US metropolitan areas have shown that the management of material supply chains has taken the most practical approach to sourcing materials for their construction works. Although it was published that most contractors still suffer from a lack of creative mindset in managing their supply chain, the awareness of supply chain management is low in the United States construction industry. This awareness can be proposed to sensitize all stakeholders in the construction industry.

Inadequate infrastructure in information technology is perceived to be the most severe constraint to the involvement of quantity surveyors in supply chain management, ignorance on the part of the construction participants, and a lack of literature limited to the United States construction environment. Based on relevant research carried out thus far, there are opportunities for improvement in deploying supply chain management practices with in the United States construction industry.

Challenges of SCM in Construction Projects

The major hurdles to not implementing SCM in construction projects are the temporary nature of client-designer-contractor-subcontractor-supplier relations and the unique nature of each product. Project Management National Conference-India (2015) stressed the barriers to the construction supply chain, which hinder not only integrated supply chain but also make the execution of the projects extremely difficult, will manifest in the form of failure to share project information, fear of loss of control, lack of awareness, lack of understanding the project requirements, lack of understanding the supply chain, etc. Identifying challenges related to SCM in construction projects can be expressed in his own words:

- i. The temporary nature of the relationship between agents
- ii. Several layers of subcontracting within a single project setting
- iii. Lack of knowledge of downstream project agents about upstream project decisions.

Other challenges rocking CSCM practices in the construction industry include inadequate investment in I.T., diverse objectives, ineffective communication, passive contractors, anticipated rewards unclear; unfair risk allocation, lack of guidance for creating alliances with supply chain partners, failure to develop measures for monitoring alliances; inability to broaden the supply chain vision beyond the procurement or product distribution to encompass more extensive business processes; lack of trust inside and outside a company; organizational resistance to the concept; lack of integrated information systems and electronic commerce linking firms, lack of suitable organizational setup, and others. Finally, challenges such as developing trust and collaboration among supply chain patterns, identifying best practices that can facilitate supply chain process alignment and integration, and successfully implementing the latest collaborative information systems and internet technologies that drive efficiency and performance through the supply chain of the traditional approach to infrastructural projects which is a bent to successful project delivery

Research Design

This research paper uses Indiana as a case study to assess supply chain management in effective project delivery in the United States construction industry. The first step is to explain the concept, identify challenges/inhibitors, establish the study's objectives, and develop a research plan. Secondly, the literature on supply chain management in the construction industry was reviewed, leading to a summary supporting the survey methodology. Thirdly, the research developed a questionnaire based on the literature review. Fourthly, the research pilot study was considered; hence, a draft of the copies of the questionnaire was forwarded to professionals with in the construction industry for review, corrections, and approval. The pilot study aims to prove and achieve the questionnaire's aim, which is the instrument's validity and reliability for data collection. Modifications are affected where necessary. The fifth step of the research is data collection. The sixth step is statistical analysis. The final phase of the research included the conclusion and recommendations based on the results and discussion of findings.

This research targeted construction professionals' domiciles in Indian and Illinois.

S/N	Zones	Population
1.	West Lafayette	35
2.	Lafayette	30
3.	Zionsville	30
	Total	95

Ninety-five copies of the questionnaire were distributed to construction professionals within these states, and sixty were successfully retrieved, representing 78% of the entire population. This provided a generalized view of the concept of supply chain management in the state's construction industry.

Method of Data Analysis

Using the statistical package for socio-sciences, the data collected for rankings in the questionnaire were ordinal. This study, therefore, used average mean scores (AMS) to measure the opinions of respondents based on the extent to which they agree with the statement that the challenges pose constraints to the practical application of CSCM practices. Secondly, the Relative Importance index is used to rate the respondents' opinions on standard CSCM practices in curbing/curtailing the challenges faced by constructions take holders in the United States.

Relative Importance Index is given by:

$$RII = \frac{\sum W}{(A * N)} \dots \dots \dots (1)$$

Where W is the weight of each factor (known as the challenges) by the respondents and ranges from 1 to 5

A=the highest Weight = 5

N=the total number of respondents

This formula used was referenced by Shaban (2008)

II. RESULTS AND DISCUSSION

Section A: General Information

This section is designed to give general information about the respondents in terms of the position of respondents, years employed in an organization, years of experience, age of respondents, gender of respondents, and qualification.

Table1.1: Qualification of Respondents

Qualification	Frequency	Percentage(%)
Ph.D.	3	5
Masters	8	13
High School	32	54
Technical Studies	17	28
Total	60	100

Table 1.1 shows that 5%(3) of the respondents have a Ph.D.,13%(8)of the respondents have a master’s degree,54%(32) of respondents have a bachelor’s degree, and28%(17)of respondents have other technical

qualifications. That indicates that the qualifications of the respondents qualify them to give a good account of their opinions in the construction industry.

Table1.2: Age of Respondents

Age of Respondents	Frequency	Percentage(%)
25-30	14	23
31-35	17	28
36-40	15	26
Upto 50	14	23
Total	60	100

Table 1.2 shows that 14% (23) of the respondents ‘ages range from 25 to 30 years old;28% (17) range from 31 to 35 years old. 26% (15) of the

respondents’agesrange from36to 40, and 23% (14) are upto 50.

Table1.3:Gender of Respondents

Genderof Respondents	Frequency	Percentage(%)
Male	39	65
Female	21	35
Total	60	100

Table 1.4 shows that 32% (19) of the respondents have less than five years of experience,28% (17) of the respondents have years of experience between 5 to 10, 22% (13) of the respondents have 11 to 20 years of experience and

18% (11) of the respondents have more than20 years of experience. This indicates that the respondents, based on their various years of experience, can give good options on the subject matter.

Table1.4:Years of Experience

Years of Experience	Frequency	Percentage
Less than five years	19	32
5-10years	17	28
11-20years	13	22
Morethan20years	11	18
Total	60	100

Table 1.4 shows that 32% (19) of the respondents have less than five years of experience,28% (17) of the respondents have years of experience between 5 to 10, 22% (13) of the respondents have 11 to 20 years of experience and

18% (11) of the respondents have more than20 years of experience. This indicates that the respondents, based on their various years of experience, can give good options on the subject matter.

Objective One

To identify the common challenges construction stakeholders face in applying SCM in effective project delivery in the United States. A review of the literature yields 20 different challenges/inhibitors to the practical application of construction supply chain management in effective project delivery. Respondents were asked to rate, on a 5-point Likert Scale, the extent to which they

agree with the statement regarding the constraints of applying CSCM practices. As shown in Table 2 below, inadequate investment in I.T., ineffective communication, and diverse objectives were ranked the highest challenges constraining the practical application of supply chain management. In contrast, unfair risk allocation and poor understanding of SCM were ranked the lowest.

Table 1: Constraints to CSCM

S/N	Challenges	SA	A	NA/D	D	SD	Average Mean Score	Ranking
		5	4	3	2	1		
1	Passive contractors	23	17	6	8	6	3.7	13
2	Lack of commitment	12	25	11	5	7	3.5	17
3	Lack of Awareness	23	16	13	4	4	3.8	8
4	Fear of loss of control	32	8	12	3	5	3.9	7
5	In appropriate organizational structure	19	15	14	8	4	3.6	14
6	In adequate investment in me. T	22	26	9	2	1	4.1	1
7	Poor Understanding of SCM	16	19	9	7	9	3.4	19
8	Inappropriate Teaching Methods	23	16	13	4	4	3.8	8
9	Lack of Training	32	8	12	3	5	4.0	4
10	Lack of partnership/Collaborative skills	19	15	14	8	4	3.6	14
11	In effective communication	22	26	9	2	1	4.1	1
12	Lack of creativity	19	15	14	8	4	3.6	14
13	Diverse objectives	22	26	9	2	1	4.1	1
14	Unfair risk allocation	16	19	9	7	9	3.4	19
15	In effective problem-solving mechanism	23	16	13	4	4	3.8	8
16	Ignorance	12	25	11	5	7	3.5	17
17	Lack of understanding of the supply chain	23	16	13	4	4	3.8	8
18	Myopic thinking and strategies	32	8	12	3	5	4.0	4
19	Lack of understanding of the project requirements	23	16	13	4	4	3.8	8
20	Several layers of subcontracting within a single project settings	32	8	12	3	5	4.0	4

Objective two

To identify the standard construction supply chain management practices in curbing/curtailing the challenges faced by construction stakeholders in the United States.

Table 3 shows the relative importance indexes for the seventeen (17) supply chain management practices in curbing the challenges above in Table 2, faced by construction stakeholders in the United States. The rating scores

range from 0.82 for trust-based relationships, information flow, and financial solid flows to 0.69 for the human resources supply chain.

These indicate that construction stakeholders within the state are varyingly involved in supply chain management activities. Therefore, SCM practices are still needed to improve performance and effective project delivery in the United States construction industry.

Table2: Identification of Common CSCM Practices in Curtailing Challenges

S/N	CSCM Practices/APPLICATION	5	4	3	2	1	RII	Ranking
1	Trust based relationship	22	26	9	2	1	0.82	1
2	Long Term partnering working experience	19	15	14	8	4	0.72	11
3	Information flow	22	26	9	2	1	0.82	1
4	Supplier relationship management	16	19	9	7	9	0.69	15
5	Transparency in Financial management	23	16	13	4	4	0.77	5
6	Early appointment of key members	12	25	11	5	7	0.70	14
7	Appropriate deployment of information	23	16	13	4	4	0.77	5
8	Long-term collaboration/integration	20	15	15	6	4	0.74	9
9	Management support/Leadership	23	17	6	8	6	0.74	9
10	Relationship Development	12	25	11	5	7	0.70	14
11	Incentive-based contracting	23	16	13	4	4	0.77	5
12	Dedication to common goals	32	8	12	3	5	0.80	4
13	Supply chain Integration	19	15	14	8	4	0.72	11
14	Use of Information Technology(IT)	19	15	14	8	4	0.72	11
15	Strong financial flows	22	26	9	2	1	0.82	1
16	Human Resource supply chain	16	19	9	7	9	0.69	16
17	Equipment and material support chain.	23	16	13	4	4	0.77	5

III. CONCLUSION

This research paper used a questionnaire survey administered to professionals in the United States construction industry. This includes General Manager, Project manager, Site Engineer, Architect, Surveyor, Civil engineers, and others. This research investigated the construction industry's awareness of the challenges/inhibitors facing effective supply chain management in project delivery. It has also examined the level of perceptions of construction stakeholders in The United States regarding CSCM practices in curbing/curtailing those factors that seem to militate against the deployment of SCM. The finding reveals that inadequate investment in I.T., diverse objectives, and ineffective communication were ranked first; lack of training, myopic thinking and strategies, and several layers of subcontracting with a single project setting were ranked next; fear of losing control came last.

This study shows room for improvement in CSCM activities in the United States construction industry. Based on this research report, the relative importance index of the CSCM practices, if taken seriously by construction professionals and stakeholders, will go a long way in fostering effectived employment of SCM in the

construction industry.

IV. RECOMMENDATIONS

The research paper recommends the following based on its findings and results:

1. Construction stakeholders should embrace CSCM, a key focus area in the current scenario of the global competitive market.
2. All the Professional bodies should i form construction stakeholders of the benefits, application, and use of CSCM via workshops, seminars, and conferences.

This supply chain management technique, if adopted, will benefit constructions take holders in effective project delivery, clear visibility of the process, using data in decision making, minimizing rework on projects, identifying risks and uncertainties on time and acting accordingly, helps in the coordination and investments on quality materials, improve productivity especially in just in time procedures and avoid unnecessary adversarial delays and issues that are often associated with the construction process. Proper portfolio management and system management will assist all construction companies in being consistent in every cost savings construction measure, increasing profitability.

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