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### Performance Management in Construction Supply Chain: Review, Implication, and Direction for Future Research

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**Abstract:** The purpose of this paper is to critically examine the available literature in the field of performance management of construction supply chains. By doing so, it seeks to analyze and highlight the research gap in the current body of knowledge and identify the promising areas of future research and propose a performance management framework for managing construction supply chains. Research papers on performance management of supply chain published in last 10 years were reviewed. The current paper provides an innovative and useful framework to manage the performance in construction supply chain, which can be helpful for effective management of construction supply chain.

**Key words:** Construction supply chain, Performance management, Supply chain concern, Logistics, Literature review

**JEL Classification Codes:** M 110, O 320

#### INTRODUCTION

The term construction projects emanate from the background that all building objects takes the shape of a project. Compared to a static firm, a project is defined by a clear start and end time (PMI 2013). The life of a construction organization is therefore as long as the construction project in itself. This means, that the organizational structure for the project is born and dies with the project itself. Like many other industries the goal for a construction industry is to meet customer expectations and on cost, time, and quality. This is what some authors call the 'iron triangle' (Toor and Ogunlana 2010).

It is often claimed that the temporary nature and other uncertainties in the industry has a negative impact on the cost and time (Son and Rojas 2011). Hence performance management issues are needed to be well addressed in construction supply chain. At present, there are many construction industries following the systems and procedures to improve the operational efficiency through an adequate and effective construction supply chain management practices which become the new success stories in the global market place. The failure to deliver the project in time and cost is worrying today. Construction industry has been treated now as high cost industry with low productivity and low operational efficiency.

With the increasing understanding of the need for managing supply chain and its outcome become one of the key factors for enhancing profitability and increasing operational efficiency of construction company. With growth in national economy, the expenditure and focus has shifted to infrastructure; resulting in mushrooming of many new Indian construction companies. Tough competition has resulted in low and unreliable rates of profitability and margins have been reduced drastically. In controlling the cost, Construction Supply Chain Management (CSCM) plays a very important role since this is the function which not only keeps lower cost but also enhances competitive position in efficient work completion. Therefore, to be profitable and competitive, construction companies need to have performance measurements, performance evaluation system and efficiency analysis of construction supply chain.

Improvements in construction supply chain are reported to have a great benefit to construction industries. Various researchers also in opinion that reduction in inventory, improvement in on-time deliveries; reduction in cumulative cycle time and control on cost, increases the revenue of the industry. An effective supply chain performance management system has the potential to reduce costs, reduce finances committed to holding inventory, reduce lead/delivery time and enhance performance, productivity, quality, customer satisfaction as well as market access.

Literature survey indicates development of a number of performance measurement models since 1980s. Most of the models have gone through some empirical testing and some have only theoretical developments. The most widely cited performance measurement systems are the SMART (1988), the performance measurement matrix (1989), the Balanced Scorecard (1992), and the integrated dynamic PMS (1997). In the Indian context, there have been many attempts to measure the performance at the organizational level, but very few attempts have been made to measure the performance at inter-organizational level (Saad and Patel, 2006). The performance management system of the supply chain is based on its strategy, value drivers and important goals and objective of the companies. The management's main interest is to know efficiency of the supply chain management and the value addition for the entire business process.

In this context, the purpose of this paper was to critically review the literature in the field of performance management of construction supply chains. By doing so, it seeks to analyze and highlight the research gap in the current body of knowledge and identify the promising areas of future research. An innovative and useful framework to manage the performance in construction supply chain, has been designed which can be of great use to both the research community and industrial practitioners.

## **METHODS OF STUDY**

Various literatures in academic journals, books, models and case studies were reviewed in the current study. The primary aim was to collect and organize the existing knowledge relating to performance management

of construction supply chain management. Review of existing models was carried out in sufficient detail to find out the issues and practices of performance management of construction supply chain management and the manner in which many of them have been studied and addressed. Inputs from prominent academicians and researchers in the field of construction supply chains were also provoked. Varieties of information were also obtained mainly through discussions with various corporate professionals of reputed construction companies. The collected information was investigated to determine current performance management practices and major aspects of construction supply chains of their industries. The strengths and weaknesses of most previous management & measurement frameworks, techniques and models were investigated. Performance information that each can generate was analyzed in the context of supply chain management of the construction industry.

### **REVIEW OF PERFORMANCE MANAGEMENT IN CONSTRUCTION SUPPLY CHAIN**

Supply chain management is an incipient area of exercise in the construction industry world-wide. It is based on comparable notion that has been widely and successfully used in the manufacturing industry. Construction Supply Chain Management (CSCM) is defined 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 labor and/or other resources for construction project (Hatmoko & Scott, 2010). CSCM is primarily concerned with the coordination of discrete quantities of materials (and associated specialty engineering services) that must be delivered to specific construction projects (O'Brien *et al.*, 2008).

Nowadays construction industries are suffering from many problems, i.e. low profit margin, delays and budget overruns. As Profit of the Construction Industry is very low and unreliable, margins of the industries are very less. It was also reported that the typical contractor subcontractor relationship is still traditional, cost-driven and potentially adversarial (Greenwood, 2001). Delays which are common problems in construction are reported to result in lower productivity (Christian and Hachey, 1995) and increase in costs (Alkass *et al.*, 1995). Waste is also identified in many construction projects as a result of ineffective construction processes. Some important performance drivers identified as concerns for CSCM are as follows:

- **Low productivity:** There are several factors responsible for the low productivity in construction supply chain project. As construction process is complex, fragmented and involved by large number of actors/ players, the chances of inefficiency is high at every stage. Major factors involved for low productivity are lack of proper attention towards buildable design, frequent change of clients' requirement, ineffective procurement system, poor site management and inadequate mechanization.
- **Cost overruns:** A cost overruns or budget overrun generally known as a cost increase due to unexpected costs incurred in excess of budgeted amounts . Cost overrun may be occurred due to technical factor like imperfect forecasting technique, inadequate data, psychological factors like increase of scope and target and political-economic factors.
- **Time overruns:** Time overrun occur when project is not completed within the specified time as per project plan. Some reasons of time overruns are shortage of material, shortage of labor, and shortage of funds.

- **Inadequate design specifications:** A complete and buildable design improves the project performance. Incomplete design and its change increase the significant waste by creating the disruption to progress of the project work. Finally inadequate design specification produce inefficiency and increases the work pressure of supply chain management while ordering the materials and doing other supply chain management activities.
- **Liability claims:** Construction industry generally involves large number of parties and acts in collaborative nature results in shared liability for claims resulting from construction process. Cases involving third party claims against construction liability is difficult and complicated.
- **Conflicts & disputes:** Disputes between the parties to construction projects are of great concern to the industry.
- **Adversarial culture.** This has been a recognized problem for many years and may result in disadvantages for both clients and contractors and discourage the adoption of the best modern procurement processes.
- **Fragmented industry structure.** The fragmentation is not only in terms of the number and size of construction firms, but also the diversity of professions and trades. Many main contractors no longer undertake work directly. This leads the main contractors to subcontract the work to specialist subcontractors, hire plant, use labor-only subcontractors and use many suppliers.
- **Lack of investment in research and development:** This is damaging the industry's ability to maintain innovation in processes/services and technology. Hence in house R&D is required within the industry.
- **Crisis in training.** The proportion of trainees in the workforce has been reduced and there is concern about skill shortages in the industry. Few people are being trained to replace the retired skilled workforce. Construction also lacks a proper career structure to develop supervisory and management grades.

Problems in the construction supply chains are in line with the existing problems in the construction industry. Supply chain in the construction industry is very complex, as maximum numbers of subcontractors and vendors are involved, especially in a large-scale project. In a construction project, any delay of the materials delivery may have serious effects on delaying the works and, if they are critical, the project completion will be delayed adversely. The same situation will also happen for the late completion of the subcontractors' works. It needs special attention for everybody associated in the construction industry to manage their supply chains well so that the best result can be achieved. Therefore, as stated by O'Brien and Fischer (1993), there is an opportunity to make significant improvement in construction supply chain performance. The world's construction industry has undergone considerable change recently because of heavy pressure due to low margins and many industry initiatives aimed at improving supplier performance and customer satisfaction. However, these initiatives have not addressed the fundamental root causes of the inherent problems of the industry. Construction supply chains are always becoming contested, fragmented and highly adversarial because of the conflicting nature of demand and supply.

Performance management (PM) includes activities which ensure goals and objectives are met in an effective and efficient manner. PM also known as a process by which organizations align their resources,

systems and manpower's to strategic objective and priorities to achieve the operational goals. Performance management systems (PMS) should answer two simple questions:

- Are functions and departments doing the right things?
- Are they doing them well?

Supply chain performance management is defined as the multiple measures of performance developed by the organization to gauge the ability of a supply chain to meet an organization's long-term and short-term objectives (Anant Deshpande, 2012). According to (Tejas faldy, Srikanth Krishna, 2006), supply chain performance management (SCPM) is a process centered approach towards business decision making. It helps to manage supply chain performance using metrics framework for stake holders, managers and employees within an integrated management environment. Performance measurement in construction focuses on project performance in terms of time, cost, and quality (Ward *et al.*, 1991; Kagioglou *et al.*, 2001). The focus of performance measurement has also changed. In recent years, the most important performance indicators include client satisfaction, business performance, health, safety, environment, and so on (Yu *et al.*, 2007).

Construction supply chain performance management (CSCPM) should be a business critical process driven by metrics and supported by business intelligence. Neelay *et al.* (1995) define performance measurement as the process of quantifying effectiveness and efficiency of an action. The quantification of an action is required since we cannot manage what we cannot measure. Performance measurement can provide important feedback to enable managers to monitor performance reveal progress, enhance motivation and communication and diagnose problems (Waggoner *et al.* 1999). It provides necessary assistance for performance improvement in pursuit of supply chain excellence. Managing supply chain performance in construction is a complicated process now days. There are very few researchers who have focused their research specifically on managing construction supply chain performance in the construction industry. In terms of construction performance at company level, individual project performance and performance focused on contractor, subcontractor and material suppliers are monitored.

By doing rigorous review of literatures, it was found that the most popular criterion for evaluating and managing performance of construction supply chain are cost/finance, followed by customer satisfaction, then output quality and at lead time. But now day's maximum industries are managing the performance of construction supply chain comprises of 3 phases; namely, procurement, construction process, and order fulfillment.

Procurement of construction materials: This is about selecting suppliers, purchasing materials and gets the materials to the construction site. The important matter to evaluate here is supplier performance, material quality, lead times, inventory level etc. In order to reduce lead times and costs it is advisable to pay attention to evaluate the procurement part.

Construction process/Building process: Common measurements suitable for evaluating the building process are concern about waste levels, subcontractor's performance, safety, assembly times etc. According to Karim et al (2006) about 90% of the work performed on the site is allocated to subcontractors and thus evaluating subcontractors work and the relationship with subcontractors is become important.

Order fulfillment/Client or customer satisfaction: The main aspects covered here are whether project is completed within agreed time, within the budget and within the quality frames having the zero defects.

It is however agreed in the literature that cost, quality, time and client satisfaction are four important aspects in assessing project performance. Therefore, to manage overall performance of construction supply chain, it is mandatory to measure cost, quality, time, and client satisfaction in each phase of construction supply chain.

### THE GAP ANALYSIS FOR RESEARCH ISSUE ITEMS IN PERFORMANCE MANAGEMENT OF CSC

Past literature review showed that previous researches had attempted to cover various aspects related to construction supply chain but still there are several areas which are unexplored or little attention had been paid by researchers, few of such areas are; green practices in Construction supply chain, health and safety, agile practices and so on. As we know competitive advantage is the extent to which an organization is able to create a defensible position over its competitors, hence variables like price/cost, quality, delivery, and flexibility have to be identified as important competitive capabilities of an organisation. From the literature review it was found that these variables are not addressed by researchers completely in many cases. On the basis of literature study through models, research framework for competitive advantages and organisational performance can be addressed through above mentioned dimensions as mentioned in the proposed model.

The theoretical model developed on the basis past literature review, is shown in Fig. 1. This theoretical model depicts various antecedents to Performance Measurement in Construction Supply Chain, which are highlighted in table 1.

Along with above mentioned activities, a set of supporting activities are also there, namely, Supply chain (CSCM) concern, CSCM Competence, CSCM Performance and CSCM Practice. With the fact that

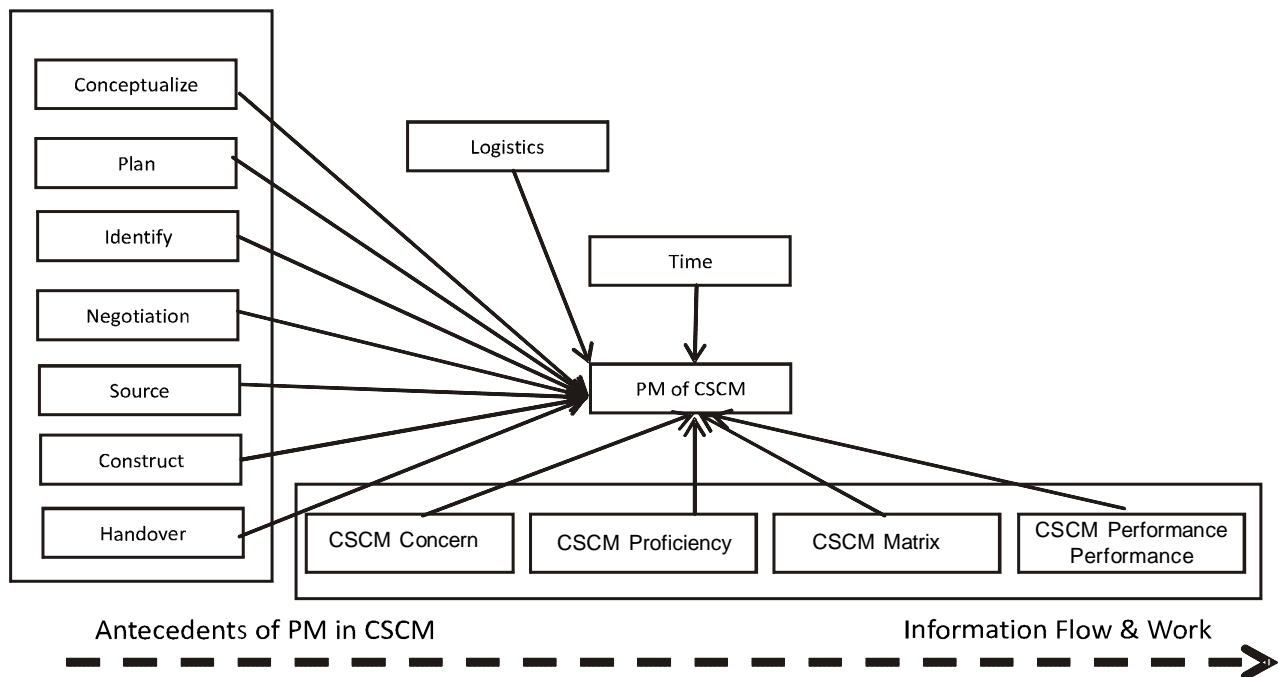


Figure 1: Theoretical framework derived from literature review

**Table 1**  
**Antecedents to Performance Measurement in Construction Supply Chain**

<i>Activity</i>	<i>Measure</i>
Conceptualize	Tendering process, selection of main contractors, Mobilization activity of plant and machinery and flow of work force to project site
Planning	Planning in construction are basically meant for supply chain planning activities, such as material requirement planning, master production planning, capacity planning, quality planning, variances against budget, order lead time, information processing cost, inventory planning, net profit vs productivity ratio, total cycle time, etc.
Identify Vendor	Vendor selection procedure based on cost, quality and delivery, reverse auction etc
Negotiation	Target price, Target delivery date, Required material specification and prescribed guide lines of management.
Source	Supplier delivery performance, supplier lead time against industry norm, supplier pricing against market, Efficiency of purchase order cycle time, Efficiency of cash flow method, Supplier booking in procedures
Construct	Percentage of defects, cost per operation hour, capacity utilization, utilization of economic order quantity
Deliver/handover	Flexibility of service system to meet customer needs, timely delivery of project to avoid client dissatisfaction, effectiveness of project planning schedule

observed in literature that problems occurred in construction supply chain is synchronization of activities throughout the life cycle of the construction projects. As there is very less literature available in construction supply chain performance management, integrating different functional division of construction supply chain is difficult task. The performance of CSCM can be depicted from the figure 1. As time schedule and logistics forming are integral parts of CSCM performance, so it is important to note the other aspects. The performance of CSCM commences from the conceptualizing and planning stage of any construction. Once the initial plan is developed, SCM starts identifying vendors and negotiating to strike an optimum deal for the services. Once the vendor is finalized, it starts sourcing it materials and the project team commences the construction, which are the building blocks of a project. Finally, the product after its completion is handed over. In all these steps CSCM plays a crucial role where the concerns, proficiency, matrix and performance of SCM are put to test.

### **IMPLICATIONS**

The research has informed a better understanding of the fragmented structure of the construction industry, highlighting the factors which influence construction supply chain performance. The proposed research framework can bring out a well-defined process mechanism can help the supply chain management team to address the issues and minimizes the concerns of the performance drivers to achieve sustainable competitive advantage. This paper has brought out understanding of the construction industry in respect of supply chain management to contribute with respect to project performance and outcomes. The overall findings of this study will reveal significant positive relationships between various performance drivers of construction supply chain management highlighted in the proposed frame and same will improve the construction industries' operational performance.

Current study also proposes the projects participants to identify any bottleneck in construction supply chain and offer the basis for supply chain process evaluation and improvement. Therefore, construction supply chain performance management can help contractors and other stake holders to evaluate suppliers' information for use in future projects. As proposed in the current study, managing delivery flexibility can in turn have a positive impact on inventory cost reduction and customer responsiveness time. Supply chain Managers can reconfigure the supply chains to accommodate the flexibility component to fulfill the aim of achieving reduced inventory and improved customer responsiveness. The framework presented in the study can be useful when motivating employees or partners to improve the performance of construction supply chain. Secondly, this study will expand the traditional concept CSCM performance into both tangible and intangible performance by highlighting output and outcome. We are trying to focus on output oriented performance, such as price, delivery, and quality. It should be noted that a comprehensive management of performance is one of the ways to understand the invisible roles and impacts of CSCM.

### CONCLUSION AND DIRECTIONS FOR FUTURE RESEARCH

Performance management is important and critical to have the effectiveness of construction supply chain management practices. Literature review indicated that very few amount of work is done in the area of Performance measurement in the past decade. A comprehensive construction supply chain performance management systems incorporating specific requirement of organizations and which are implementable are yet to be finalised. Selection of appropriate PMS suitable to the construction industry and its implementation strategy are important and vital for enhancing the profitability of construction industries.

The current study is purely based on literature review. There is still scope for studying the relationship between components of construction supply chain practices and components of construction supply chain performance. Studies may be carried out for evaluating the performance of successful construction industries whose profit margins are above 10% with the help of objective data. Examining the link and relationship among individual factors of construction supply chain management practices and individual factors of construction supply chain management performance, the managers can identify the proper CSCM practices to strengthen and improve their performance in needed areas is another good area of study. Theoretical framework developed in the study can be empirically tested in construction supply chain. Same framework can be used in other supply chains also to measure their performance.

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