

Material Supply Chain Practices in the Construction Industry

Sahil Kaushik

M. Tech (Construction & Real Estate Management), DCRUST University

Abstract: Materials require special attention while creating a project plan, since it forms a large portion of the total cost of a construction project. Materials are essential for the daily progress of a construction project. The nonattendance of materials when required is one of the primary drivers of loss of profitability in a jobsite. Current materials administration honed in the development business are performed on divided premise with unstructured correspondence and no plainly settled obligations between the parties included. The very fracture is an after-effect of the detachment of outline and development, absence of coordination and reconciliation between different useful controls, poor correspondence, and so on. These are the imperative components causing execution related issues, for example, delay in material requesting and accepting, low profitability, cost and time invade, struggle and question. To realize the research aim, a survey questionnaire was used to achieve the following objectives: exploring the current practices of material supply chain process, identifying the important activities that form the material supply chain process, studying the contractor/ supplier relationship, studying the impact of the Indian closure on the material supply chain process, identifying the most occurred problems facing the contractors through the project phases and finally identifying the key factors that may contribute in integrating the phases of the material supply chain process. 135 questionnaires were distributed to the stakeholders of the construction industry. 105 were received back and analyzed.

Introduction: Supply Chain Management (SCM) is a concept originating from the supply system by which Toyota was seen to coordinate its supplies and manages its suppliers. The basic concept of the SCM includes tools like Just-In-Time (JIT) and logistics management. The present idea of the SCM is fairly more extensive yet at the same time generally overwhelmed by coordinations. SCM manages the administration of materials and data assets over a system of associations that are engaged with the outline and the generation procedure. It perceives the between association amongst materials and data assets inside and over the association limits and looks for methodical change in the way these assets are organized and controlled. The goal of store network administration is to have the capacity to have the correct items in the correct amounts at the opportune place at the correct minute at negligible cost.

Construction Supply Chain (CSC) is all the development procedure, from the requests by the customer, applied outline, development and support and associations, which are engaged with the development procedure, for example, proprietor, planner, general contractual workers, subcontractors, providers, specialists, and so on. CSC isn't a chain of development business with business-to-business connections yet a system of different associations and connections, which incorporates the stream of data, the stream of material administrations or items, and the stream of assets between customer, planner, temporary worker and provider.

The focus and attention in this research are given to the materials since it forms a large portion of the total cost of a construction project. In addition, materials are essential for the daily progress of a construction project. The absence of materials when needed is one of the main causes of loss of productivity in a jobsite. Therefore, contractors have to manage their materials efficiently to lower cost in order to remain in business. They should select reputable suppliers, tracking the materials to identify when materials need to be ordered based on the actual usage of materials on site and progress of the work, dealing on site with materials handling, storage, misplacement and handling of materials surplus. This research investigates current material management practices and develops Material Supply Chain Process (MSCP) that suits the local construction industry. The investigation considered all the activities starting with the estimating process and ending up with surplus materials at the end of the project. The supplier / contractor relationship was studied. Furthermore, the investigation included the effect of Indian Closure on MSCP.

Aim & Objectives: The aim of this research was realized through the following objectives:

- To investigate the current practices of the MSCP in the local construction industry
- To determine the important activities that form the phases of MSCP
- To study the contractor/supplier relationship
- To explore the impact of the Indian closure on the MSCP.

Concept of Material Management: Efficient management of materials plays a key role in the successful completion of a project. The control of materials is an essential and indispensable subject for each organization and ought to be taken care of adequately for fruitful finish of a task. Materials represent a major piece of undertaking cost. A few examinations reasoned that materials represent around half 60% of the undertaking cost (Bernold and Treseler, 1991).

Distinctive authors characterize the idea of materials administration in various ways. Notwithstanding, every one of the specialists call attention to that materials administration is critical for an effective task culmination. The fundamental thought behind materials administration is that the materials as well as hardware required, in the amounts required, meeting the principles of value indicated, are acquired at a sensible cost and are accessible when required on the building site. The procedure of materials administration ought to incorporate obtaining, speeding up, and stock control. An all-around oversaw materials administration framework can add to the cost viability of a task (Perdomo, 2004).

Benefits of the Materials Management:

A powerful material administration framework can bring numerous advantages for an organization. Past investigations by the Construction Industry Institute (CII) reasoned that work profitability could be enhanced by six percent and can create 4-6% extra funds (Bernold and Treseler, 1991). Among these advantages are:

- Reducing the general expenses of materials
- Better treatment/handling of materials
- Materials will be nearby when required and in amounts required
- Improvement in labor profitability
- Improvement in venture plan
- Better connection with providers
- Reduce of surplus materials
- Reduce stockpiling of materials on location
- Labor investment funds
- Stock lessening

Construction Supply Chain

Construction is a multi-association process, which includes owner, designer, temporary worker provider, expert, and so forth. It is likewise a multi-organize process, which incorporates theoretical, plan, development, support, substitution. Starting here of view, Construction Supply Chain (CSC) is all the development procedure, from the requests by the customer, reasonable, plan, development and upkeep and associations, which are engaged with the development procedure, for example, proprietor, fashioner, general temporary workers, subcontractors, providers, experts, and so on. CSC isn't a chain of development business with business-to business connections yet a system of various associations and connections, which incorporates the stream of data, the stream of materials administrations or items, and the stream of assets between customer, planner, temporary worker and provider.

Construction Supply Chain Management

Agapiou et al (1998) noticed that no investigations have characterized what is SCM in the construction procedure. Be that as it may, in light of the comprehension of SCM, Construction Supply Chain Management (CSCM) can be characterized as: the coordination of key development business forms, from the requests of customer, plan to development, and key individuals from development production network, including customer/proprietor, fashioner, contractual worker, subcontractor and provider. CSCM centers around how firms use their providers' procedures, innovation and capacity to improve upper hand. It is an administration theory that broadens conventional intra-endeavor exercises by uniting exchanging accomplices with the shared objective of streamlining and productivity. CSCM underscores on long haul win-win, helpful connections between partners in foundational viewpoint. Its definitive objective is to enhance development execution and include customer esteem at less cost (Xue, et al., 2007). Trucker et al. (2001) characterize the CSCM as the vital administration of data stream, undertakings and process, including different systems of associations and linkages (upstream and downstream), all through a task life cycle. The upstream exercises inside development in connection to the situation of a principle temporary worker, comprises of the exercises and undertakings prompting the readiness of the generation on location including development

customers and configuration groups. The downstream comprises of exercises and errands in the conveyance of development item including development providers, subcontractors, and expert contractual worker interrelating with the main contractor.

Material Supply Chain Process

Perdomo (2004) developed a conceptual framework for the Material Supply Chain Process (MSCP). The framework was based on various discussions and interviews with office and site personnel in Northern Region i.e. NCR India. From the information acquired from the interviews, five distinct phases that comprise the MSCP were identified which are: 1-Bidding Phase, 2-Sourcing Phase, 3- Materials Procurement, 4-Costruction Phase, 5- Post Construction Phase.

The following subsections will briefly discuss the five phases:

Bidding Phase: The materials management process starts from the time that the contractor receives the drawings and specifications. The materials takeoff and identification process is the first step in this phase and involves identifying the materials needed as well as any special requirements or special materials to be used in the project.

Sourcing Phase: This phase includes the selection of reputable suppliers and manufacturers. The selection of suppliers is critical and the contractor needs to verify that the supplier is capable of delivering the right material (i.e. type, quality and quantity) when needed (i.e. at dates specified).

Material Procurement Phase: this phase includes material requisition and expediting and it is considered very critical to the success of a material management process. The person in charge of procuring materials or the purchasing department, in the case of a large company, needs to ensure that the correct materials in the correct quantities are delivered.

This person also needs to verify the release dates at which the material is needed and to clearly specify those delivery dates and the location of delivery to the supplier.

Construction Phase: material delivery usually occurs during the construction phase. Material is generally requested for delivery to the jobsite. In some instance material delivery to the jobsite may not be feasible due to storage or access limitations. In this case, the material is delivered to other locations such as the contractor's warehouse, a prefabrication shop or another subcontractor storage area. Material requisition problems greatly affect the construction stage and failure to manage this phase effectively could result in project disruption and possible delays due to late deliveries, stockouts due to small quantities bought, material delivered to the wrong locations, material backordered and effects in overall costs. The requisition process for miscellaneous material starts in the construction phase and is focused on how much material to buy, when to buy this material, where to deliver this material, when to deliver, which supplier to buy from, where to store on site.

Post-Construction Phase: after installation of the materials on the structure, the contractor has to manage any surplus material. The surplus is handled differently depending on the type of material and also whether or not the contractor has a warehouse. If the company has a warehouse, the surplus material is stored in the warehouse for use in future projects. Other companies return surplus material to the supplier for reimbursement.

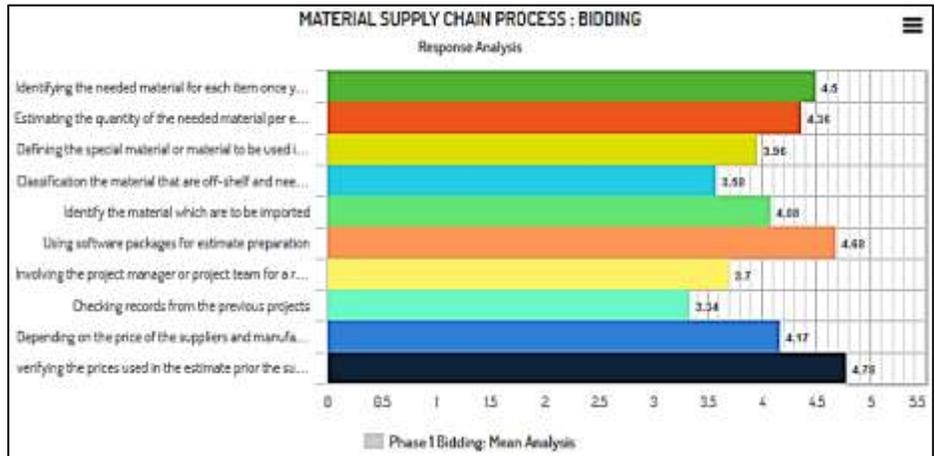
Result:

Current practices of material supply chain process and the important factors that form it.

The main objectives of this section are to study the current practices of the construction material supply chain practices in the Construction Industry as well as the important factors that are appropriate for the same industry. This section contains six phases of the materials supply chain process which are: the bidding phase, the sourcing phase, the procurement phase, the construction phase, the post construction phase and the assessment and evaluation phase. The respondents were given a group of questions in each phase to achieve the said two objectives. The rating of these questions consists of two main scales. The first one is the usage degree that aims at studying the current practices of the material supply chain in the local construction industry and the second one is the importance degree which aims at paving the ground for developing the construction materials supply chain process. The respondents were asked to mark each question as always, often, sometimes, seldom and never for the usage degree scale and very important, important, quite important, some important and little important for the importance degree scale.

Bidding Phase (Estimating, Preparation, Submission and Winning) :

This section contains 10 items that form bidding phase of the MSCP. The respondents were asked about their usage degree for these items and the importance degree from their point of view. Below Fig 5.8: Material Supply chain Process : Bidding Analysis



S.no	Material Supply Chain process	Usage Degree			Importance Degree		
		Mean	Relative Index	Rank	Mean	Relative Index	Rank
1.1	Identifying the needed materials for each item once you receive the project's drawings and specifications	4.50	0.922	3	4.58	0.936	3
1.2	Estimating the quantity of the needed materials per each item (quantity take off)	4.36	0.890	4	4.46	0.915	4
1.3	Defining any special requirements and/or special materials to be used in the project	3.96	0.797	7	4.21	0.862	7
1.4	Classifying the materials that are off-the-shelf and are to be pre-fabricated	3.58	0.740	9	3.95	0.798	8
1.5	Identifying the local available materials or locally manufactured materials and the materials that are needed to be imported.	4.08	0.838	6	4.25	0.876	6
1.6	Using software packages or computer applications such as Microsoft Excel for preparing the estimate	4.68	0.960	2	4.72	0.964	2
1.7	Involving the project manager or the project team in the estimation process for a realistic estimate.	3.70	0.760	8	3.92	0.800	9

1.8	Establishing the price databases for the materials from the previous implemented projects in order to be used for preparing the estimate for future projects.	3.34	0.684	10	3.36	0.692	10
1.9	Depending on the price of the suppliers and manufactures for preparing the estimate	4.17	0.852	5	4.28	0.876	5
1.10	Verifying the prices used in the estimate prior the submission of bid.	4.78	0.975	1	4.74	0.974	1

Sourcing (Vendor Selection) Phase:

This section contains 7 items that form the sourcing phase of the MSCP. The respondents were asked about their usage degree for these items and the importance degree from their point of view. Table 5.8 below presents the results.

In general, the results show that the most common usage & most important method for selecting the suppliers is requesting quotations from different suppliers. Negotiation is the second used and second important technique used for selecting the suppliers & finally contractors select suppliers whom they worked with in previous project. Contractors decision which method to use depend on many criteria such as cost, availability of the materials, and capability of the suppliers to deliver the right materials in the right time.

It can be stated that the first stage in the sourcing phase is the selection of reputable suppliers and manufacturers. Most of contractors prefer to buy materials from suppliers that they worked with on previous projects and the contractor needs to verify that theses suppliers are capable of delivering the right materials (type, quality and quantity) when needed (i.e. at dates specified). He added, in order to get reasonably good prices for the materials, they request quotations from different suppliers. Suppliers are usually selected based on the lowest prices, however, contractors may consider suppliers with higher prices but that will provide better services or that have a record to supply the right materials in the quantities needed at the times specified. He further added, for major materials contractor often negotiates prices directly with the suppliers.

S.no	Material Supply Chain process	Usage Degree			Importance Degree		
		Mean	Relative Index	Rank	Mean	Relative Index	Rank
2.1	Pre-qualify the suppliers and manufacturers and keeping a list of reputable ones in order to obtain quotations from them	4.62	0.924	4	4.68	0.936	4
2.2	Verifying that the supplier is capable of delivering the right materials (type, quality and quantity) when needed (i.e. at dates specified)	4.76	0.952	2	4.80	0.960	2
2.3	Purchasing the material from the supplier that you worked with on previous project.	4.24	0.848	5	4.22	0.844	5
2.4	Requesting quotations from the different suppliers in order to get reasonable good prices	4.86	0.972	1	4.82	0.964	1
2.5	Selecting the winner supplier from the lowest prices	3.90	0.780	6	3.98	0.796	7

2.6	Considering suppliers with higher prices but that will provide better services or that have a record to supply the right materials in the quantities needed at the times specified	3.26	0.652	7	4.16	0.832	6
2.7	Negotiating the prices directly with the suppliers	4.66	0.932	3	4.74	0.948	3

Material Procurement Phase:

This section contains 9 items that form the procurement phase of the MSCP. The respondents were asked about their usage degree for these items and the importance degree from their point of view. Table 5.9 presents the results.

The relative importance index for item "Following up the status of the ordered materials to make sure that the delivered materials comply with the specifications, in the quantities needed and within the timeframe specified" is very high (0.951) for Usage Degree with rank equals (2) and very high (0.992) for Importance Degree with rank equals (1). Contractors gave this item very high degree for both the usage and the importance. The procurement section or the person in charge of procurement should coordinate with the construction team on the site and the suppliers to make sure that the right materials are delivered to the site within the time specified.

It is stated that the procurement process starts with the generation of material requisition schedule that usually starts by the site staff and then is sent to the purchasing department for material request from the suppliers under contract. In smaller jobs, materials may be requisitioned directly by the field personnel. The material requisition schedule specifying material types, quantity needed, dates, when the material should be delivered. In companies that have warehouse, the purchasing department first verifies the availability of the materials in the warehouse before ordering the materials from the suppliers. He further added, once a release form is generated, suppliers are contracted for procuring the material needed. The type of material needed, quantities and the time when the material is needed is specified to the supplier.

S.no	Material Supply Chain process	Usage Degree			Importance Degree		
		Mean	Relative Index	Rank	Mean	Relative Index	Rank
3.1	Obtaining a copy of the material requisition schedule, specifying material types, quantity needed, dates, when the material should be delivered that prepared by site personnel (such schedule prepared by the site staff on the construction phase)	4.20	0.840	6	4.58	0.916	7
3.2	Verifying the availability of requested materials in your stocks before requesting any materials from suppliers	4.26	0.852	5	4.60	0.920	6
3.3	Requesting a submittal (material sample) from the supplier or manufacturer and approving it by the Engineer prior to materials delivery	4.84	0.968	1	4.88	0.976	2
3.4	Issuing purchase order to the winner supplier (Setting an agreement) in order to organize the relationship between the	4.50	0.900	3	4.78	0.956	3

	contractor and the supplier						
3.5	Requesting materials directly by the field personnel	2.42	0.484	8	2.44	0.488	9
3.6	Ordering the estimated item quantities as per the work progress on the site	2.46	0.492	7	3.00	0.600	8
3.7	Ordering 100% of the estimated items quantities at once	4.50	0.900	3	4.70	0.940	5
3.8	Specifying to the suppliers the release dates at which the material is needed supplier and the exact location of materials delivery to avoid materials re-handling	4.44	0.888	4	4.76	0.952	4
3.9	Following up the status of the ordered materials to make sure that the delivered materials comply with the specifications, in the quantities needed and within the time frame specified	4.76	0.951	2	4.96	0.992	1

Construction Phase:

This section contains 8 items that form the construction phase of the MSCP. The respondents were asked about their usage degree for these items and the importance degree from their point of view. Table 5.10 presents the results.

It is illustrated that whenever materials are needed at the construction site, a material requisition process is initiated by site personnel (Foreman or the project manager). This process involves generating a material requisition form in which the material description, quantities needed, dates when the materials are needed and the delivery locations are specified. In the case that the material is delivered to the job site, the designated site personnel verify the material received against the requisition form. Actual quantities received are recorded. If there are discrepancies in the material quantities, damages to the material or items not delivered, the foreman fills a problem sheet form and forwards a copy of this form to the purchasing department for follow up with the concerned supplier.

S.no	Material Supply Chain process	Usage Degree			Importance Degree		
		Mean	Relative Index	Rank	Mean	Relative Index	Rank
4.1	Determining the quantities of the needed materials per each item	4.66	0.932	3	4.78	0.956	2
4.2	Determining dates in which the materials per each item are needed to be available	4.14	0.828	6	4.38	0.876	6
4.3	Determine the exact materials delivery location per each item	4.26	0.852	4	4.40	0.880	5
4.4	Generating a material requisition form in which the material description, quantities needed, dates when the materials are	4.22	0.844	5	4.48	0.896	4

	needed and the delivery locations						
4.5	Verifying the material received against the quantity ordered	4.90	0.980	1	4.94	0.988	1
4.6	Inspecting the delivered materials to make sure that it meets the specifications	4.82	0.964	2	4.94	0.988	1
4.7	Recording any problems in the delivered materials	4.08	0.816	7	4.60	0.920	3
4.8	Keeping a track record of the supplied materials, remaining balance and the installed materials	3.84	0.768	8	4.36	0.872	7

Post Construction Phase (Surplus Materials):

Reducing the surplus materials to the minimum is one of the fundamental concepts of the supply chain management in the construction industry that related to the quantity attribute. This section contains five scenarios for dealing with surplus materials at the end of the project. The respondents were asked to select the scenario/s that they encountered and the percentage of occurrence.

Table 5.11 presents the results.

Item No	Material Supply Chain Process	% of Occurrence	Ranks
6.1	Storing the surplus materials to be used in future projects	39.3	2
6.2	Returning back the surplus materials to the suppliers without penalty	46.9	1
6.3	Returning back the surplus materials to the suppliers with penalty	2.68	5
6.4	Selling the surplus materials to other contractors	8.28	3
6.5	Scraping the surplus materials	2.84	4
	Total	100%	

Table 5.11 shows that (46.9%) of the surplus materials are returned to the suppliers without penalty at the end of the project, (2.68%) of the surplus materials are returned to the suppliers with penalty. These results indicate that the suppliers are very flexible and the contractors may keep some kind of good relationships with them. Keeping good relationships with the suppliers is very important for achieving integration between them. The result also shows that (39.6%) of the surplus materials are stored on the contractors' warehouses. Such materials may be subject to deterioration, damage, loss, theft and more importantly it will tie down the capital of the contractors. Thus, contractors should prepare good materials take off in order to avoid the material surplus.

Contractor / Supplier Relationship: The relationship of a contractor with his suppliers is critical for the successful of any construction project. This section aims at studying the contractor / supplier relationships. It is divided into two subsections. The first subsection shows the criteria that the contractors adopt to select the suppliers. The second subsection shows the likely or preferred course of action that contractors use when the supplier deliver materials late or deliver materials do not meet the required specifications.

Criteria for Selection the Suppliers: A long-term relationship with the suppliers is one of the fundamental concepts of the construction supply chain management. Such relation should be built on cooperation, trust, fairness, commitment and done in win-win basis for all the parties involved. In this subsection the respondents were given nine criteria and they were requested to rank it in accordance with their concerns to select the suppliers. Fig. Ranking the criteria to select the supplier

Criteria	Percentages	Rank
Competitive pricing- Cost	78.44	1
Reliable delivery	65.33	2
Good Quality	64.22	3
Availability	49.56	4
Flexibility in accommodating contractor's changes/request	38.67	5
Financial facilities	32.89	6
Sign long term agreement/enter into partnership	31.56	7
Personal relationship	25.33	8
Mutual interests	13.33	9

Most of the contractors believe that the reliable delivery, good quality and availability are very important criteria for selecting the suppliers as these criteria was ranked second, third and fourth respectively. Such criteria are considered the main attributes of the construction supply chain management. The results also reveal that competitive pricing is the most important criteria to select suppliers. This is may be due to the fact that the contractors believe that they can get lowest prices by competitive bidding. However, using competitive bidding to select the suppliers will make the suppliers to reduce their profit to the minimum in order to win the contract.

This in turn may create adversarial relationships between them during the course of project implementation and consequently affect the project's success. Furthermore, reliable delivery, good quality and availability of the materials when needed will not be guaranteed in a relationship based on a competitive bidding. The results also show that the contractors do not depend on the personal relation and mutual interest in selecting the suppliers as these two criteria was ranked eighth and ninth respectively.

Impact of the Indian closure and policies on the construction materials supply chain.

The Indian closure to the borders and its policies works against the objectives of the supply chain management. As it is expected, the results show that all the respondents agree that the Indian closure and the its policies highly impacted the materials supply chain process; it leads to increase the material prices, project total cost, late delivery of the materials, delaying the project completion and unavailability of the construction materials.

Table 5.20 presents the impact of the Indian closure as expressed by the respondents.

S.no	Indian Closure Impact	Mean	Relative Index	Rank
1.	Increasing the material prices	4.96	0.992	1
2.	Increasing the project total cost	4.78	0.956	2
3.	Late material deliveries to the job site	4.78	0.956	2
4.	Delay in the project completion	4.60	0.920	3
5.	Unavailability of the main materials	4.54	0.908	4
	TOTAL	4.73	0.946	

Conclusion:

Construction industry has been characterized with fragmentation and poor communication and coordination among the project participants. There are many inter-organizational problems, such as late deliveries of materials, wrong deliveries and inaccurate information transfer in materials supply chain process, which result in miss performance. Efficient material supply chain process is crucial for the success of any construction project and can be the deciding factor between a successful project and a project full of delays and claims. The primary aim of this research was to develop a material supply chain process framework that enables contractors to have the materials needed, in the right quantities, with the quality and time required. This was accomplished through achieving the following objectives:

- Studying the current practices of the MSCP and the important factors that constitute it. It has been concluded that MSCP comprises six phases which are bidding phase, sourcing phase, procurement phase, construction phase and evaluation phase. Each phase contains a set of activities that should be viewed as integrated activities rather than only a series of individual activities.
- Studying contractor/supplier relationship. It has been found that the contractor/supplier relationship is based on project by project basis. Most of the contractors do not form long term agreement or partnership with the suppliers. Competitive pricing is the most important criteria adopted for selection of the suppliers and it is primarily based on the lowest price. Contractors are obscured by price and have generally overlooked the bigger picture of the total costs. Selection of supplier based on long term agreement or relationship is one of the fundamentals of MSCP concept. Furthermore, contractors prefer to send a letter of complaint in case suppliers deliver wrong materials or make late deliveries, and they do not prefer imposing penalty charges.
- Studying the impact of Indian closure and its policies on the MSCP. All surveyed contractors believe that Indian closure has negative impact on MSCP. The closure lead to increasing the material prices, increasing the project total cost, delaying materials deliveries to the job site and delaying the project completion and unavailability of the main materials. The consequences of Indian closure hinder the application of the MSCP.
- Identifying the most occurred problems facing contractors through the MSCP, diagnosing the root causes of these problems and developing possible solutions for them. It has been found the most occurred problems encountering the contractors were:
 1. Bidding Phase: Lack of communication between the parties involved, Ambiguities between plans and specifications, Incomplete drawings and details are missing
 2. Sourcing Phase: Incomplete proposals (Suppliers did not include all the documents with the proposal)
 3. Procurement Phase: Poor communication between the parties involved, Unavailability of required material, Incorrect of submittals by the suppliers, Late approvals of submittals by the Supervisor Engineer
 4. Construction Phase: Late deliveries (Materials do not arrive as scheduled), The delivered materials do not comply with the required specifications, Poor communication between the parties involved

It has been found that most of the problems are caused in another (i.e. earlier) stage of the MSCP other than where they are detected. The root causes of the most occurred problems are found in previous activity executed by a prior actor. Determining the key factors that may contribute in integrating the project phases of MSCP. It has been found that the most factors that contribute in integrating the project phases of the MSCP are:

- Understanding the client needs and objectives by the contractor, subcontractors and suppliers and committing for these needs and objectives
- Establishing a protocol for dealing effectively with disputes and problems that may arise between the project participants during the course of project implementation

- Establishing a system between the project participants for communication and share project information in timely and accurate manner
- Negotiating contracts with the suppliers and subcontractors rather than using competitive tendering
- The participation of the designers should not end at the design phase but continues during construction phase.

References:

- Al-bazi A and Dawood N. (2012). Simulation-based genetic algorithms for construction supply chain management: Off-site precast concrete production as a case study. *OR Insight, Special Issue*, 25(3): 165-184.
- Aloini D, Dulmin R, Mininno V and Ponticelli S. (2012). Supply chain management: a review of implementation risks in the construction industry. *Business Process Management Journal*, 18(5): 735-748
- Arantes A, Ferreira LDF and Costa AA. (2015). Is the construction industry aware of supply chain management? The Portuguese contractors' perspective. *Supply Chain Management*, 20(4): 404-414.
- Balasubramanian S. (2012). A Hierarchical Framework of Barriers to Green Supply Chain Management in the Construction Sector. *Journal of Sustainable Development*, 5(10): 15-27.
- Bankvall L, Bygballe LE, Dubois A and Jahre M. (2010). Interdependence in supply chains and projects in construction. *Supply Chain Management*, 15(5): 385-393
- Christopher M. (1992). *Logistics and Supply Chain Management: Strategies for Reducing Costs and Improving Service*. Pitman Publishing: London, UK.
- Cox A and Ireland P. (2001). Managing Construction Supply Chains: the common-sense approach for project-based procurement. In *Proceedings of the 10th International Annual IPSERA Conference*, 9-11 April, Jönköping, Sweden, 201-214.
- Cox A, Ireland P and Townsend M. (2006). *Managing in Construction Supply Chains and Markets*. Thomas Telford: London, UK.
- Cus-Babic N, Rebolj D, Nekrep-Perc M, Podbreznik P. (2014). Supply - chain transparency within industrialized construction projects. *Computers in Industry*, 65(2): 345-353.
- Dadhich P, Genovese A, Kumar N, Acquaye A. (2015). Developing sustainable supply chains in the UK construction industry: A case study. *International Journal of Production Economics*, 164: 271-284.
- Deraman R, Salleh H, Beksin AM, Alashwal AM, Abdullahi BC. et al. (2012). The roles of information and communication technology (ICT) systems in construction supply chain management and barriers to their implementation. *African Journal of Business Management*, 6(7): 2403-2411.
- Dim NU, Ezeabasili ACC. (2015). Strategic supply chain framework as an effective approach to procurement of public construction projects in Nigeria. *International Journal of Management and Sustainability*, 4(7): 163-172.
- Doran D, Giannakis M. (2011). An examination of a modular supply chain: a construction sector perspective. *Supply Chain Management*, 16(4): 260-270.
- Ebrahimi Y, AbouRizk SM, Siri F, Mohamed Y. (2011). Simulation modeling and sensitivity analysis of a tunneling construction project's supply chain. *Engineering, Construction and Architectural Management*, 18(5): 462-480.

- Edum-Fotwe FT, Thorpe A, McCaffer R. (1999). Organisational relationships within the construction supply-chain. In Proceedings of a Joint CIB Triennial Symposium, Cape Town, vol.1, 5-10 September 1999, 186-194.
- Eriksson PE. (2010). Improving construction supply chain collaboration and performance: a lean construction pilot project. *Supply Chain Management*, 15(5): 394-403.
- Gosling J, Towill DR, Naim MM, Dainty, ARJ. (2015). Principles for the design and operation of engineer-to-order supply chains in the construction sector. *Production Planning & Control*, 26(3): 203-218.
- Tennant S and Fernie S. (2013). Organizational learning in construction supply chains. *Engineering, Construction and Architectural Management*, 20(1): 83-98.