# SUPPLY CHAIN MANAGEMENT

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**Abstract—** Supply-chain management has been defined as the "design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging worldwide logistics, synchronizing supply with demand and measuring performance globally. Management of materials and information flows are key strategic priorities for construction companies. A good performance in these areas can provide them with significant benefits and allow the adding of greater value for clients. The market of the construction company is mostly local and highly volatile. The long durability of the construction "product" contributes to the volatility. The product specification process before the customer order arrives shows different degrees of specifications: engineer to order, modify to order, configure to order, select a variant. A construction company only executes a small part of the project by its own personnel and capacity. This is a way of risk spreading and risk mitigation and to compensate for an unstable market.

**Keywords:** Supply chain management, Construction industry, Project planning.

## 1 INTRODUCTION

World construction markets are at a tipping point already with 52% of all construction activity in emerging markets today. A recent report "Global Construction 2020", Estimates that by 2025, India will be the third largest global construction market after China and USA with annual growth averaging 7.4%.This is expected to increase to 63% by 2025, with China and India contributing most to growth in emerging markets. Construction plays a key role in economic development of a country. Construction of a project requires design, and implementation of temporary production systems that incorporate temporary flows of physical resources (e.g., labor, materials, equipment, etc.) and information for the on-time completion of project milestones. These flows create 'supply systems' a supply chain may contain one or more supply systems.

### 1.1 What is supply chain management?

The supply chain is a network of organizations involved, from the supplier of the supplier until the client of the client, on the different processes and activities that produce value in the form of products and services for the final client. Its major components are the suppliers' network, the transformation unit and the clients' network. . It refers then to the coordination of the activities of all that participate in the supply chain, to knowing the production requirements with the purpose of satisfying the client, to delivering of products of higher value and to reducing the costs of the organization that apply these principles.

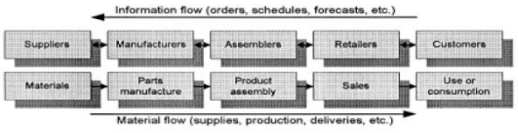



Fig.no 1 Linear configuration of SCM [(1)]

Construction management presents a lack of integration between designers, vendors, main contractors, subcontractors, suppliers, site team and finally the client. Integrated efforts are key aspects to improve performance, not only to deliver better projects on/or before completion time to the clients, but also to reduce waste and to promote cost reduction throughout the supply chain (SC).SCM is a very promising approach to successfully achieve integration between internal and external suppliers, designers, vendors, contractors, subcontractors and internal and external clients. Many people are involved in the scm process so as to run the cycle smoothly and in efficient way the mainly responsible person of our clients, suppliers, buyers, manufacturer, contractors, project manager and so on to full fill the demand of work each person is responsible in his own way.

### 1.2 Role of Supply Chain Management

1. Describe the characteristics of the site, including site access /egress, storage capacity and arrangement by programmer, labour, hoists, cranes etc
2. Use the description to produce daily, weekly and long term movements plans
3. Understand procurement arrangements
4. Control materials in and out of site.
5. Plan and integrate with key contractors to meet the needs of the planned programmer and de-confliction of onsite space and time where appropriate.
6. Assist in the evaluation of potential logistic suppliers and appropriate delivery management booking systems.
7. Be capable of managing sub-contractors to deliver their package of goods or services
8. Variation control and early communication of foreseeable change.

### 1.3 Need of Study

The aim of this research is to develop a framework for the best practice of material supply Chain process through the project phases that suits the local construction industry in order to Help contractors to have the right materials in the right quantities (at the right place) at the Right moment at minimal cost so they can improve their productivity, minimize losses and Increase competitiveness.

1.4 Research of objectives

1 To investigate the current practices of the SCM in the local construction industry.
2. To figure out detail Questionnaire survey and study key factors that may contribute in integrating the phases of supply chain management.
3. To study the current supply chain by taking the case study example and understand the process of supply management.
4. To determine the important activities that form the phases of Supply chain management.
5. To study the contractor/supplier relationship.
6. To identify the most occurred problems facing contractors in the SCP through the project phases, to diagnose the root causes of them and to develop possible solutions for them.
7. To provide solution to uncertainties and risks inherent in Supply chain management.

## 2 LITERATURE SURVEY

1) Ruben Vrijhoef,Lauri Koskela (2000) He stated that supply chain management has four specific roles in construction. Practical initiatives in each role to advance the construction supply chain are analyzed. The present status of construction supply chains is investigated by means of case studies and a comparison with prior research. Three main conclusions are drawn regarding the present status. Firstly, even in normal situations the construction supply chain has a large quantity of waste and problems. Secondly, most of these are caused in another stage of the construction supply chain than when detected. Thirdly, waste and problems are largely caused by obsolete, myopic control of the construction supply chain. These results concur with the findings made on make-to-order supply chains in general. Finally, the subjective and objective limitations of the four roles are analyzed, this being based on empirical findings and the generic theory of supply chain management.

2) Trucker.et.al (2001) He studied the construction industry in general is highly fragmented with significant negative impacts perceived low productivity, cost and time overruns, conflicts and disputes, and resulting claims and time-consuming litigation. They have been acknowledged as the major causes of performance-related problems facing the industry. The legacy of this high level of fragmentation is that the project delivery process is considered highly inefficient in comparison with other industry sectors. The construction industry in general is highly fragmented with significant negative impacts perceived low productivity, cost and time overruns, conflicts and disputes, and resulting claims and time-consuming litigation. They have been acknowledged as the major causes of performance-related problems facing the industry. The legacy of this high level of fragmentation is that the project delivery process is considered highly inefficient in comparison with other industry sectors.

3) Alfredo serpell and Boris Heredia (2004) Has been carried out the study with the general objective of proposing a generic application methodology of supply chain management (SCM) to the construction sector by adapting the manufacturing SCM experience and development to the particular characteristics of construction. The main results of the survey and highlights the problems and restrictions that exist in the local construction supply chains as well as their main causes. Also, a set of solutions is suggested to address the identified problems and improve the supply chain performance. By using the data obtained from the survey and the knowledge available in the literature, the paper proposes a framework for implementing the concepts and principles of supply chain management in construction companies and, in this way, to take advantage of the benefits that SCM can provide. One of the principal conclusions of the paper is that the application of SCM in the local construction sector will require the introduction of several changes in the way that participants of the supply chain interact currently.

4) Perdomo (2004) Different authors define the concept of materials management in different ways. However, all the researchers point out that materials management is extremely important for a successful project completion. The basic idea behind materials management is that the materials and/or equipment needed, in the quantities needed, meeting the standards of quality specified, are obtained at a reasonable cost and are available when needed on the construction site. The process of materials management should integrate purchasing, expediting, and inventory control. A well-managed materials management system can contribute to the cost effectiveness of a project.

5) Milakovich.el.al (2008) He stated that construction industry has numerous problems because of its complicated nature of operation. This industry is comprised of a multitude of occupations, professions and organizations. And this issue solved by the easy sap lap theory method and this issue solved by the easy sap lap theory method. This paper focuses more on relatively unexplored categories, as they offer potential for further exploration and research. Classification developed to show supply chains and Flexible System in TQM context from a wider perspective. Based on problem context as classification and scope for future practice and research, an evolutionary timeline has been prepared taking into account all the relevant and seminal papers published in the area of Flexible system, TQM and SCM. The definition and scope of FS in the literature from Total Quality Management to Supply Chain context classification has been undertaken. The focus on TQM, Flexible Systems and Supply Chains aspects has been done in order to facilitate further study and research.

6) Er ic Zimmer.el.al (2008) He stated that Researchers and construction professionals have adopted lean manufacturing concepts and strategies in the development of lean construction principles. Waste and inefficiency is

still evident throughout construction supply chains. A case study was conducted to achieve this goal and investigate applicability in the field. An assessment was done with a local contractor already familiar with lean. Differences between lean and non-lean fabricators and effects on construction, effective staging of materials.

7) Rowlinson and Walker (2009) He observed and stated that the construction industry is also characterized by its non-standardization. Production processes are to some extent different from each other. Hence, no universal standard or specification can be applied to the product, which leads to difficulties in quality assurance. Moreover, excessive changes to the details of the design of a project are typical throughout the construction process. They may be the result of the lack of build ability of the design produced or variations by the contractors for the sake of speed and cost of production. Further added, quality is often at risk because of the excessive changes. As a result of the changes, delays in completion of the construction project and claims by different parties to the project often occur. Hence, the relationship between the parties tends to be confrontational.

8) Schultzel and Unruh (2011) He described feasibility, development, finance, concept development and review, estimate, detailed engineering, procurement, construction and start-up. The client, consultants, contractor and sub-contractors of a construction project all have a role to play in delivering a quality project. Failure of any of the parties will seriously affect the quality of the final project. Moreover, the parties have different objectives which keep them apart. Research Project Supply Chain is one of the most complex supply networks. The management of this complex system has created new challenges for industry managers and engineers. The optimization of supply chain networks is, therefore, essential within the context of the research projects. The aims of this paper are to design the network of Supply Chain Management for research projects in an Iranian project-based organization. This model integrates strategic decisions in the whole life cycle for research projects using a mathematical approach. This model is a guideline for managers in research projects that will enable them to identify the strategic decisions of PSCM in their own organizations in order to resolve and improve them.

9) Fauzia Siddiqui & Abid Haleem (2014**)** He stated that In the global market conditions, the integrated Flexible Systems (FS) with Total Quality Management (TQM) and Supply Chain Management (SCM) is a growing field of interest for many a researchers and practitioners from the last decades. In the present paper, the ongoing integration process of aforesaid philosophies in flexible system, total quality management and supply chain has been highlighted through literature review. Many specific empirical studies have been carried out, and categories such as types of Flexibility and Total Quality Management have been studied to a great depth in the past. This paper focuses more on relatively unexplored categories, as they offer potential for further exploration and research. Classification developed to show supply chains and Flexible System in TQM context from a wider perspective. Based on problem context as classification and scope for future practice and research, an evolutionary timeline has been prepared taking into account all the relevant and seminal papers published in the area of Flexible system, TQM and SCM. The definition and scope of FS in the literature from Total Quality Management to Supply Chain context classification has been undertaken. The focus on TQM, Flexible Systems and Supply Chains aspects has been done.

10) V.Charles Duraj and K sentamilselvan (2016) He studied that construction is different from other industries because of at least following three reasons one-a-kind nature of projects, site production, and temporary organization. In spite of above fact, many efforts have been done to translate good practices from other industries especially from manufacturing to the construction industry. For last few decades, the researchers and people within the construction industry have moved towards different philosophies adopted in other industries in order to make construction industry more effective and more efficient. Supply Chain Management (SCM) is one of them. The main driver behind the adoption of this philosophy was the successes within other industry sectors. SCM can be defined as network of different organizations, linked upstream and downstream in a chain, aiming to produce quality and value in the services and products for the end consumers through integrated processes and activities.

11) Mayur A. Kalane and Prof. P. S. Dange (2017) Supply chain management (SCM) is a concept that has flourished in manufacturing, originating from Just-In-Time (JIT) production and logistics. SCM represents an autonomous managerial concept, although still largely dominated by logistics. SCM endeavors to observe the entire scope of the supply chain. All issues are viewed and resolved in a supply chain perspective; taking into account the interdependency in the supply chain. SCM offers a methodology to relieve the myopic control in the supply chain that has been reinforcing waste and problems. Construction supply chains are still full of waste and problems caused by myopic control. Comparison of case studies with prior research justifies that waste and problems in construction supply chains are extensively present and persistent, and due to interdependency largely interrelated with causes in other stages of the supply chain.

12) Dr. Ghaith Al-Werikat (2017) He stated that CSC consists of many groups, although the material and the construction chains are the largest. Integrating the construction and material chains helps in establishing more collaboration, smoother information flow and more efficient information sharing through the construction chain which assists the decision making process. SCM in the construction industry encounters many challenges linked to poor logistics planning, lack of partnerships and

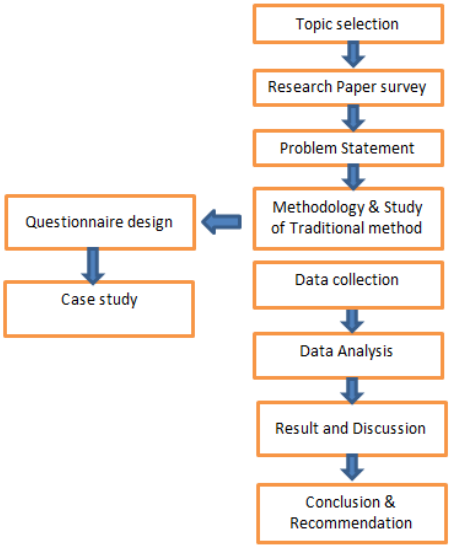
strategic alliances with suppliers, resistance to change and communication problems. In order to establish an efficient integrated supply chain, clients, suppliers, contractors and other parties in the supply chain need to establish long term partnerships, form transparent communication channels and benefit from each other‘s experience for the greater good. The Jordanian industry should make corrective actions to allow the efficient supply chain integration to take place such as: early involvement of all parties, education of project staff, fair payment, have knowledge of the benefits of integration, be familiar with and have an understanding of new contractual documents. Should all parties within the supply chain be targeted, including the main contractor, subcontractor and suppliers, overall costs of construction would reduce. In addition, early involvement of the subcontractor and supplier is as necessary as early contractor involvement. This early involvement of all parties would allow the exchange of expertise which may help to reduce costs furthermore, early involvement integration would enable suppliers to be service providers as oppose to providers of products.

2.1 Problem statement

The purpose of incorporating the principles of SCM to construction can be stated as: obtaining competitive and comparative advantages through value generation, cost reduction and the integration of all the parties that intervene in project management and construction processes, with the goal of satisfying both the internal and the external clients. The construction supply chain is affected by many problems as has been reported by several authors. Most of these problems are not generated in the conversion process but in the different interfaces that exist within the supply chain. Some of the general problems are as follows are Lack of coordination, collaboration and commitment between suppliers and clients within the supply chain. Design problems (many changes and inconsistent information). Poor quality of materials and components with deficient communication and information transfer and inadequate management within the supply chain, mainly poor planning and control.

## 3 METHODOLOGY

The research will be conducted in four major parts. The stage one included identifying the research problem, setting out the dissertation's aim and objectives and developing the research plan. The second phase included reviewing the literature related to supply chain management and construction supply chain management. In phase third developing a questionnaire to investigate the factors that form the material supply chain process, the criteria that contractors consider to select and suppliers, the factors that could help in mitigating the risks and uncertainties inherent in the material supply chain process, the problems encountering the contractors through the material supply chain process and the factors that may contribute in integrating the phases of the material supply chain process. Finally, conclusions of research and recommendations will be drafted.




Flow Diagram of work process

Based on literature paper the questionnaire survey was design. Data was collected from the reputed firms and local contractors. The questionnaire design composed of six sections to accomplish the aim of the research,

1. The first section contained information about Companies Profiles.
2. The second section contained Current Practices of Material Supply Chain Process and the important activities that form it.
3. The third section about the Contractor / Supplier Relationship.
4. The fourth section what Impact of the Policies on the Materials Supply Chain Process and the concepts that may lessen the risks and uncertainties that inherent in the construction setting and the impact of industry.
5. The fifth section about the Identification of the Most Occurred Problems Encountering the Contractors through the Supply Chain Process.
6. The sixth section was about the Key Factors Contributing in Integrating the Supply Chain Process.

Data Measurement For assessing the questionnaire factors, we required to rate these factors on a 5-point Likert scale as follows.The usage degree of the items of the SCP through the project's phases by scores 1 to 5, where "1" represents Never and "5" represents Always. The importance degree of the items of the SCP through the project's phases by scores 1 to 5, where "1" represents the Little Importance and "5" represents the Very Important. The impact of policies on the SCP by scores 1 to 5, where "1" represents the No impact and "5" represents the Very High Impact. The most occurred problems through the projects phases of the SCP by scores 1 to 5, where "1" represents the Never and "5" represents the Always. The key factors that contribute in integrating the project's phases of the MSCP through by scores 1 to 5, where "1" represents the Little Importance and "5" represents the Very Important.

To determine the relative ranking of the factors, these scores were then transformed to
1. Relative Important formula

$$\frac{\Sigma w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$$

Where w is the weighting given to each factor by the respondent, ranging from 1 to 5. For example, n1 = number of respondents for Little Important, n2 = number of respondents for Some Important, n3 = number of respondents for Quite Important, n4 = number of respondents for Important, n5 = number of respondents for Very Important). A is the highest weight (i.e. 5 in the study) and N is the total number of respondents. The relative importance index ranges from 0 to1.

## 4 DATA COLLECTION

The companies surveyed and shortlisted are given below. Basic demand of supply chain management is studied. The survey was done across the metro cities Pune and Nasik.

| Sr.no | Name of Organization |
|---|---|
| 1 | Utkarsha Group, Pune |
| 2 | GSR Group Construction, Nasik |
| 3 | Ashoka Buildcon limited, Nasik |
| 4 | Sakhre construction, Nasik |
| 5 | Kolte patil group, Pune |
| 6 | Akshay engineers consultant and services, Nasik |

Table no 1 list of companies surveyed

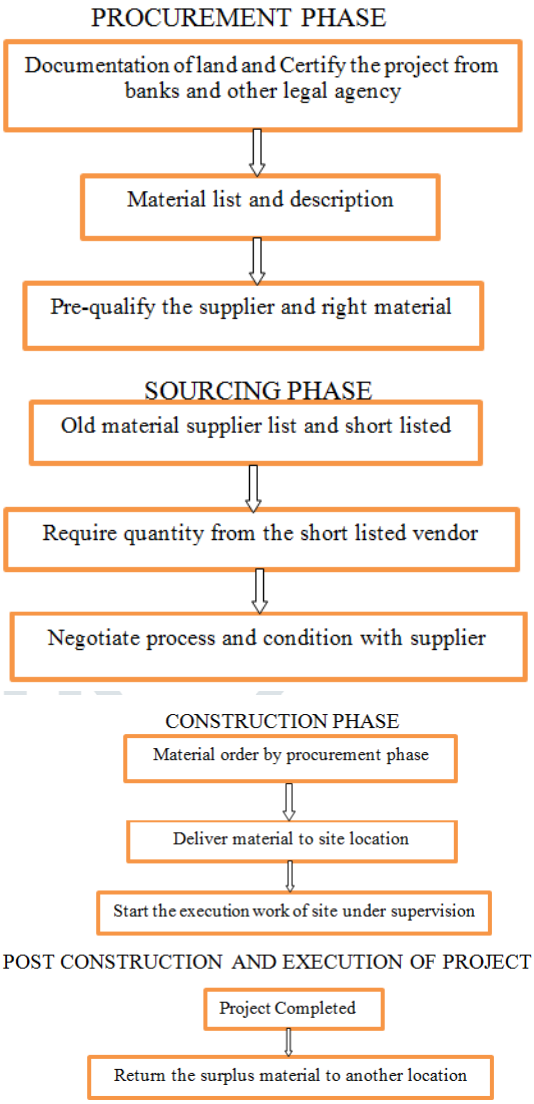
To understand there supply chain management scheme and what are problem they faced and possible outcomes are discussed so as to make the project duly timely complete and cost effective also.

4.1 Current Practices of Material Supply Chain Process and the Important Factors that Form it

The main objectives of this section is 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 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 items of the materials supply chain process used in this study are derived mainly From the material supply chain process that developed by Perdomo (2004) based on various discussions and interviews with the office and site personnel from the electrical contracting.

4.2 Case study

The purpose of example will boast the concept of frame development of scm and it will help to overcome the problem encounter by the current site and reduce the cost and save time also. The company name is Utkarsh Group since 2009 they are working on the various residential and commercial projects in pune specialized sector is building sector. The firm as very good work profile and executed more than 17 projects in last five years. The basic flow chart of the supply chain management is as follows.




Flow chart represents the Scm of case study

## 5 DATA ANALYSIS

The chapter illustrates and discusses the characteristics of the study of current construction supply chain management, the important factors that form the MSCP that are appropriate for the construction industry, contactor-supplier relationship, the impact of policy on the MSCP, some concepts that mitigate the uncertainties and risks in the construction industry, the most occurred problems facing contractors through the MSCP and the factors that may contribute to integrate the phases of the SCP.

5.1 Bidding Phase

The materials management process starts from the time that the contractor receives the drawings and specifications.

| Item No | Material Supply Chain Process | Usage Degree | | | Importance Degree | | |
|---|---|---|---|---|---|---|---|
| | | Mean | Relative index | Rank | Mean | Relative index | Rank |
| 1 | Identifying the needed materials for each item once you receive the project's drawings and specifications | 4.70 | 0.940 | 3 | 4.78 | 0.956 | 3 |
| 2 | Estimating the quantity of the needed materials per each item | 4.56 | 0.912 | 4 | 4.66 | 0.932 | 4 |
| 3 | Defining any special requirements and/or special materials to be used in the project | 4.08 | 0.816 | 9 | 4.40 | 0.880 | 7 |
| 4 | Identifying the local available materials or locally manufactured materials and the materials that are needed to be imported | 3.80 | 0.760 | 10 | 4.10 | 0.820 | 10 |
| 5 | Using software packages or computer applications such as Microsoft Excel for preparing the estimate | 4.28 | 0.856 | 7 | 4.48 | 0.896 | 6 |
| 6 | Involving the project manager or construction team in the estimation process in order to prepare a realistic estimate | 4.90 | 0.980 | 2 | 4.92 | 0.984 | 2 |
| 7 | Establishing prices database for the materials from the previous implemented projects in order to be used for preparing the estimate for the future projects | 3.90 | 0.780 | 10 | 4.10 | 0.820 | 9 |
| 8 | Depending on the prices of suppliers and manufacturers on preparing the project estimate | 3.52 | 0.704 | 10 | 3.56 | 0.712 | 10 |
| 9 | Verifying the prices used in the estimate prior to submitting the bid | 4.98 | 0.996 | 1 | 4.96 | 0.992 | 1 |
| 10 | Scheduling a meeting that includes the project manager and the construction team to re-estimate the project quantities once you win the bid | 4.10 | 0.820 | 8 | 4.16 | 0.832 | 8 |
| 11 | Generating a preliminary material requisition schedule, specifying material types, quantity needed, dates, when the material should be delivered and any additional information needed for clarification | 4.31 | 0.861 | 6 | 4.57 | 0.914 | 5 |
| | Total | 4.29 | 0.858 | | 4.43 | 0.886 | |

Table no 2 Bidding Phase

The above the figure shows their degree for various items and the importance degree from their point of view.

5.2 Sourcing (Vendor Selection) Phase

The respondents were asked about their usage degree for these items and the importance degree from their point of view.

| Item No | Material Supply Chain Process | Usage Degree | | | Importance Degree | | |
|---|---|---|---|---|---|---|---|
| | | Mean | Relative index | Rank | Mean | Relative index | Rank |
| 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 | 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 |
| 3 | Purchasing the materials from suppliers that you worked with on previous projects | 4.24 | 0.848 | 5 | 4.22 | 0.844 | 5 |
| 4 | Requesting quotations from different suppliers in order to get reasonable good prices | 4.86 | 0.972 | 1 | 4.82 | 0.964 | 1 |
| 5 | Selecting the winner supplier based on lowest prices | 3.90 | 0.780 | 6 | 3.98 | 0.796 | 7 |
| 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 |
| 7 | Negotiating the prices directly with the suppliers | 4.66 | 0.932 | 3 | 4.74 | 0.948 | 3 |
| | Total | 4.33 | 0.866 | | 4.49 | 0.897 | |

Table no 3 Sourcing Phase

5.3 Material Procurement Phase

This section contains 9 items that form the procurement phase of the SCP. The Respondents were asked about their usage degree for these items and the importance Degree from their point of view.

| | | Mean | Relative index | Rank | Mean | Relative index | Rank |
|---|---|---|---|---|---|---|---|
| 1 | Obtaining a copy 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 |
| 2 | Verifying the availability of request materials in your stocks before requesting any materials from suppliers | 4.26 | 0.852 | 5 | 4.60 | 0.920 | 6 |
| 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 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | Issuing purchase order to the winner supplier (Setting an agreement) in order to organize the relationship between the contractor and the supplier | 4.50 | 0.900 | 3 | 4.78 | 0.956 | 3 |
| 5 | Requesting materials directly by the field personnel | 2.42 | 0.484 | 8 | 2.44 | 0.488 | 9 |
| 6 | Ordering 100% of the estimated items quantities at once | 2.46 | 0.492 | 7 | 3.00 | 0.600 | 8 |
| 7 | Ordering the estimated item quantities as per the work progress on the site | 4.50 | 0.900 | 3 | 4.70 | 0.940 | 5 |
| 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 rehandling | 4.44 | 0.888 | 4 | 4.76 | 0.952 | 4 |
| 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 timeframe specified | 4.76 | 0.951 | 2 | 4.96 | 0.992 | 1 |
| | Total | 4.04 | 0.808 | | 4.30 | 0.860 | |

Table no 4 Material Procurement Phase

5.4 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.

| Item No | Material Supply Chain Process | Usage Degree | | | Importance Degree | | |
|---|---|---|---|---|---|---|---|
| | | Mean | Relative index | Rank | Mean | Relative index | Rank |
| 1 | Determining the quantities of the needed materials per each item | 4.66 | 0.932 | 3 | 4.78 | 0.956 | 2 |
| 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 |
| 3 | Determine the exact materials delivery location per each item | 4.26 | 0.852 | 4 | 4.40 | 0.880 | 5 |
| 4 | Generating a material requisition form in which the material description, quantities needed, dates when the materials are needed and the delivery locations | 4.22 | 0.844 | 5 | 4.48 | 0.896 | 4 |
| 5 | Verifying the material received against the quantity ordered | 4.90 | 0.980 | 1 | 4.94 | 0.988 | 1 |
| 6 | Inspecting the delivered materials to make sure that it meets the specifications | 4.82 | 0.964 | 2 | 4.94 | 0.988 | 1 |
| 7 | Recording any problems in the delivered materials | 4.08 | 0.816 | 7 | 4.60 | 0.920 | 3 |
| 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 |
| | Total | 4.37 | 0.873 | | 4.61 | 0.922 | |

Table no 5 Construction Phase

5.5 Post Construction Phase

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. The respondents were asked to select the scenario/s that they encountered and the percentage of occurrence.

| Item No | Material Supply Chain Process | Ranks | % of occurrence |
|---|---|---|---|
| 1 | Storing the surplus materials to be used in future projects | 2 | 39.3 |
| 2 | Returning back the surplus materials to the suppliers without penalty | 1 | 46.9 |
| 3 | Returning back the surplus materials to the suppliers with penalty | 5 | 2.68 |
| 4 | Selling the surplus materials to other contractors | 3 | 8.28 |
| 5 | Scraping the surplus materials | 4 | 2.84 |

Table no 6 Post Construction Phase

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 of the surplus materials are stored on the contractors' warehouses.

5.5 Evaluation Phase

| Item No | Supply Chain Process | Usage Degree | | | Importance Degree | | |
|---|---|---|---|---|---|---|---|
| | | Mean | Relative index | Rank | Mean | Relative index | Rank |
| 1 | Conducting a comprehensive assessment for the supply chain process through the mentioned phases to avoid the mistakes and develop this process in the future projects | 3.42 | 0.684 | | 4.44 | 0.888 | |

Table no 7 Evaluation phase

5.6 Problems Encountering Contractors through the Material Supply Chain Process

Understanding the existing problems is an absolute necessity for resolving them effectively. Many problems may be encountering the contractors during the phases of the supply chain process that hamper achieving the main objectives of the supply chain management. This section aims to determine the most occurred problems encountering the contractors during the material supply chain process through the five phases which are: the bidding phase, the sourcing phase, the procurement phase, the construction phase, the post construction phase. The section also aims at studying the root causes of these problems and then developing possible solutions for them in order to make the application of SCP goes smoothly without interruption.

5.6.1 Bidding Phase

The respondents were given 5 problems that may face contractors in the bidding phase and they were asked to mark each question as always, often, sometimes, seldom and never.

| No | Problems | Degree of Occurrence | | |
|---|---|---|---|---|
| | | Mean | Relative index | Rank |
| 1 | Lack of communication between the parties involved | 3.52 | 0.704 | 1 |
| 2 | Ambiguities between plans and specifications | 3.28 | 0.656 | 2 |
| 3 | Not a good definition of what is wanted from the owner and suppliers | 3.14 | 0.628 | 3 |
| 4 | Incomplete drawings and details are missing | 3.1 | 0.620 | 4 |
| 5 | Using specifications different from those commonly used | 2.46 | 0.492 | 5 |
| | Total | 3.1 | 0.620 | |

5.6.2 Sourcing (Vendor Selection) Phase

The respondents were given 3 problems that may face contractors in the sourcing phase and they were asked to mark each question as always, often, sometimes, seldom and never.

| No | Problems | Degree of Occurrence | | |
|---|---|---|---|---|
| | | Mean | Relative index | Rank |
| 1 | Incomplete proposals by the suppliers ( Suppliers did not include all the documents with the proposal) | 3.20 | 0.640 | 1 |
| 2 | Having too many suppliers and do not have information about them | 2.84 | 0.568 | 2 |
| 3 | Time spent investigating non-qualified suppliers | 2.50 | 0.500 | 3 |
| 4 | Total | 2.85 | 0.569 | |

Table no 8 Sourcing phase

5.6.3 Material Procurement

The respondents were given 7 problems that may face contractors in the procurement phase and they were asked to mark each question as always, often, sometimes, seldom and never.

| No | Problems | Degree of Occurrence | | |
|---|---|---|---|---|
| | | Mean | Relative index | Rank |
| 1 | Poor communication between the parties involved | 3.90 | 0.780 | 1 |
| 2 | Unavailability of required material | 3.49 | 0.698 | 2 |
| 3 | Incorrect of submittals by the suppliers | 3.32 | 0.664 | 3 |
| 4 | Late approval of submittal by the Supervisor Engineer | 3.28 | 0.656 | 4 |
| 5 | Late submittals by the contractor to be approved by the Supervisor Engineer ( Submittals are not submitted as planned) | 3.08 | 0.616 | 5 |
| 6 | The contractor sets delivery dates that are impossible to meet by the suppliers | 2.98 | 0.596 | 6 |
| 7 | The contractor does not communicate exactly what is wanted to suppliers | 2.56 | 0.513 | 7 |
| | Total | 4.48 | 0.896 | |

Table no 9 Material Procurement

To overcome this problem contractors should pre-qualify the suppliers, obtain quotations from reputable suppliers and whom they worked with on previous projects.

5.6.4 Construction Phase

The respondents were given 9 problems that may face contractors in the construction phase and they were asked to mark each question as always, often, sometimes, seldom and never.

| No | Problems | Degree of Occurrence | | |
|---|---|---|---|---|
| | | Mean | Relative index | Rank |
| 1 | Late deliveries (Materials do not arrive as scheduled) | 4.22 | 0.844 | 1 |
| 2 | The delivered materials do not comply with the required specifications | 3.32 | 0.664 | 2 |
| 3 | Poor communication between the parties involved | 3.22 | 0.644 | 3 |
| 4 | Damaging- Materials are damaged while handling or by other conditions | 2.73 | 0.547 | 4 |
| 5 | Re-handling of materials- Materials have to be moved from one place to another before being installed | 2.52 | 0.504 | 5 |
| 6 | Storage of materials- storage area are limited or far away from the working area | 2.48 | 0.496 | 6 |
| 7 | Receiving, handling and storage of the unused materials | 2.40 | 0.480 | 7 |
| 8 | Loss of materials | 2.26 | 0.452 | 8 |
| 9 | Theft of materials | 2.18 | 0.436 | 9 |
| | Total | 3.59 | 0.719 | |

Table no 10 Construction phase

To solve the problems of late deliveries and delivering materials do not comply with the required specifications, the contractors have to do the following: In the sourcing phase, they should pre-qualify the suppliers and should make sure that they are capable of delivering the right material in the right quantities in the time specified. They should not select the supplier based on the lowest prices but should consider the supplier with higher prices but who provide better services in accordance.

5.6.5 Post-Construction (Surplus materials) Phase

The respondents were given 4 problems that may face contractors in the post construction phase and they were asked to mark each question as always, often, sometimes, seldom and never.

| No | Problems | Degree of Occurrence | | |
|---|---|---|---|---|
| | | Mean | Relative index | Rank |
| 1 | Salvage losses for the surplus materials | 2.40 | 0.480 | 1 |
| 2 | No possibility that the surplus materials to be returned to the supplier | 2.38 | 0.476 | 2 |
| 3 | No storage for the surplus materials | 2.16 | 0.432 | 3 |
| 4 | Charging penalties by the suppliers for the returned materials | 1.90 | 0.380 | 4 |
| | Total | 2.21 | 0.442 | |

Table no 11 Post construction phase

5.7 Key Factors Contributing in Integrating Construction Supply Chain

Integration among the key members of the project participants: owner, main contractor, subcontractors and suppliers and also integration of the project phases will contribute in making the SCP through the project phases. The respondents were asked to mark each factor as very important, important, quite important, some important and little important.

| NO | FACTOR | Mean | Relative index | Rank |
|---|---|---|---|---|
| 1 | The design team should be expanded such that to includes contractors, subcontractors and materials suppliers | 2.66 | 0.532 | 8 |
| 2 | Using design construct arrangement between the contractor and the client | 2.80 | 0.560 | 10 |
| 3 | Entering a partnership relationship with suppliers and subcontractors based on commitment over extended time period, mutual | 3.46 | 0.692 | 8 |

| | | | | |
|---|---|---|---|---|
| | information sharing, trust, openness, dedication to common goals | | | |
| 4 | Understanding the client needs and objectives by the contractor, subcontractors and suppliers and committing for these needs and objectives | 4.82 | 0.963 | 1 |
| 5 | Executing the projects activities by the contractors own sources (Not sourcing all the project to subcontractors) | 3.36 | 0.672 | 9 |
| 6 | Negotiating contracts with the suppliers and subcontractors rather than using competitive tendering | 4.32 | 0.864 | 4 |
| 7 | The participation of the designers should not end at the design phase but continues during construction phase | 4.20 | 0.840 | 5 |
| 8 | Establishing a protocol for dealing effectively with disputes and problems that may arise among the project participants during the course of project implementation | 4.74 | 0.948 | 2 |
| 9 | Conducting workshop for suppliers and subcontractors to discuss the quality, innovation, health and safety issues | 3.16 | 0.632 | 10 |
| 10 | Aligning the system and procedures of your own company with that of the client, suppliers and subcontractors | 4.04 | 0.808 | 6 |
| 11 | Establishing a system between the project participants for communication and project information sharing in timely and accurate manner | 4.58 | 0.916 | 3 |
| 12 | Using Web Based system for information access and exchange between the project participants that include memos, request for information, transmittal, site instruction, etc. | 3.86 | 0.772 | 7 |
| | Total | 3.83 | 0.766 | |

Table no 12 Integrating Construction Supply Chain

One of the advantages of the design construct arrangement is integrating the design phase with the construction phase and minimizing the adversarial relationship inherent in the traditional arrangement.

## 6 RESULTS AND DISCUSSION

The main aim of this framework is to enable contractors to deliver the right materials, in the right quantity, in the right time with minimal cost through controlling the material supply chain through the project phases. The graphical representation is made to showcase the scm frame in which all above parameter can be achieved. The belows figure will show the details of each phase of scm to have better results in bidding phase, construction phase, sourcing phase , procuring phase and post construction phase and prosibble problem which occurred during the process is also taken into consideration and and possible outcome over it is made so as to make the process smooth and easy and ultimately the economy will made inn project.

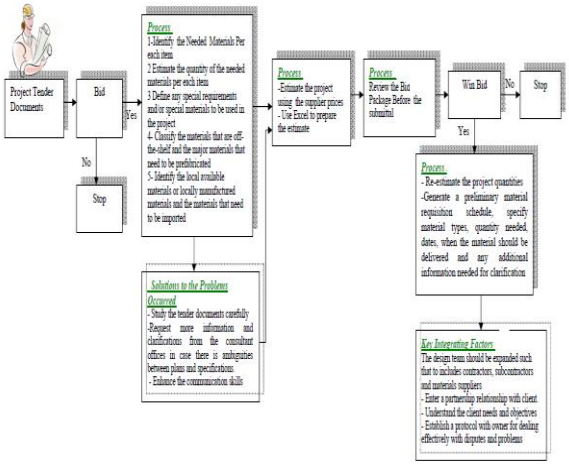



Fig. no 3 Bidding phase

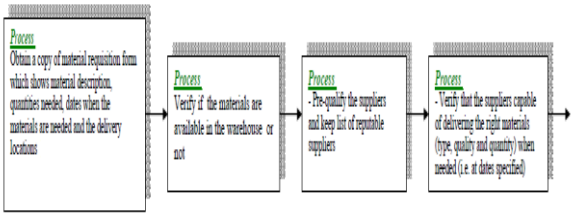



Fig. no 4 procurement and sourcing phase

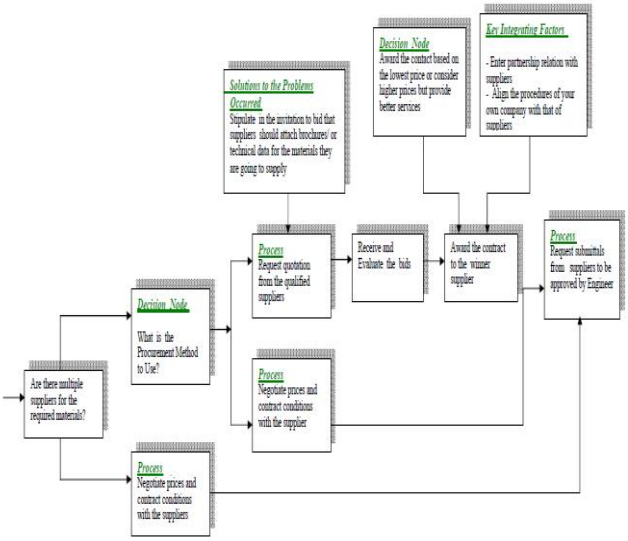



Fig. no 5 sourcing phase

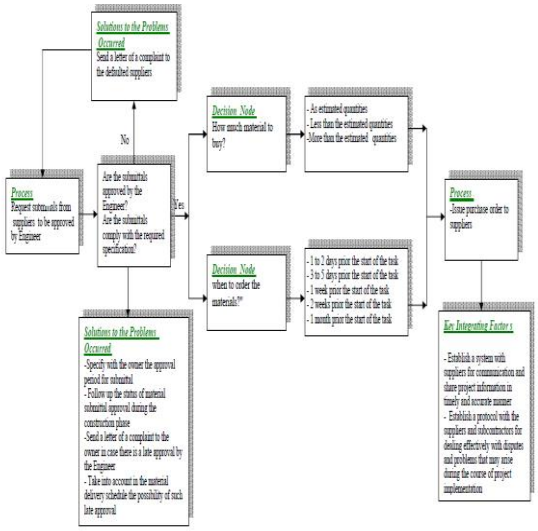



Fig.no 6 procurement phase

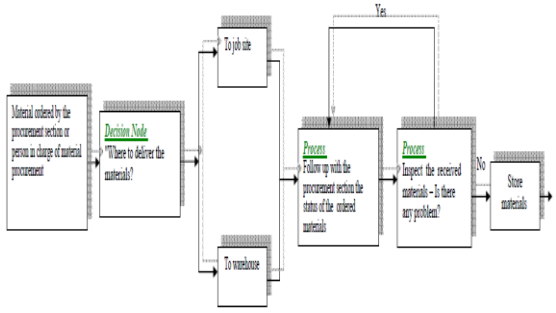



Fig.no 7 Construction phase

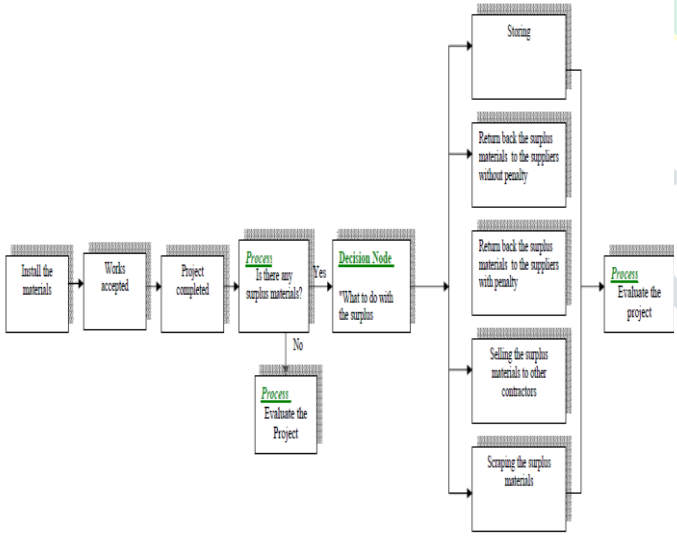



Fig.no 8 Post construction and Evaluation of project

## 7 CONCLUSIONS

Construction industry has been characterized with fragmentation and poor communication and coordination among the project participants. . Efficient 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. Studying the current practices of the SCP and the important factors that constitute it. It has been concluded that SCP 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. A graphical representation for the SCP. 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 SCP 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. It has been found the most occurred problems encountering the contractors were.

**Bidding Phase**

1. Lack of communication between the parties involved
2. Ambiguities between plans and specifications.
3. Incomplete drawings and details are missing.

**Sourcing Phase**

1. Incomplete proposals (Suppliers did not include all the documents with the proposal.

**Procurement Phase**

1. Poor communication between the parties involved
2. Unavailability of required material.
3. Incorrect of submittals by the suppliers.

**Construction Phase**

1. Late deliveries (Materials do not arrive as scheduled).
2. The delivered materials do not comply with the required specifications.
3. Poor communication between the parties involved.

SCP 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 SCP. It has been found that the most factors that contribute in integrating the project phases of the SCP are:

1. Understanding the client needs and objectives by the contractor, subcontractors and suppliers and committing for these needs and objectives.
2. Establishing a protocol for dealing effectively with disputes and problems that may arise between the project participants during the course of project implementation.
3. Establishing a system between the project participants for communication and share project information in timely and accurate manner.
4. Negotiating contracts with the suppliers and subcontractors rather than using competitive tendering.

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