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Survey on Application of Supply Chain Tools for Improvement in Construction Material Management

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ABSTRACT: Supply chain management (SCM) is a concept that has flourished in manufacturing, originating from Just-In-Time (JIT) production and logistics. Today, SCM represents an autonomous managerial concept, although still largely dominated by logistics. Previous initiatives to advance the construction supply chain have been somewhat partial. The generic methodology offered by SCM contributes to better understanding and resolution of basic problems in construction supply chains, and gives directions for construction supply chain development. The practical solutions offered by SCM, however, have to be developed in construction practice itself, taking into account the specific characteristics and local conditions of construction supply chains. Construction supply chain management's potential for contributing to profitability. Construction supply chain has gained significance because of the increasing number of potential complex private and public sector construction projects. In the construction process costly delays in materials, equipment's, and services erode profits. Construction supply chain management through the integration and coordination of materials, information, and money flows between the various project partners resolves delays and offers a new means of increasing profitability. CSCM's emphasis on information sharing and communications fosters cooperation and collaboration among supply chain members. This study on assessment of supply Chain Management (SCM) in improving material management in the Indian Construction Industry in Pune district is focused on identifying the challenges of construction supply chain management (CSCM) for effective project delivery and also to identify the CSCM practiced in curtailing challenges in the construction industry in Pune.

KEYWORDS: CSCM, Construction Supply chain management, material supply, profitability, under-budget

I. INTRODUCTION

1.1 GENERAL:

The construction industry has become increasingly more complex. There has been significant growth in construction projects in domestic markets and in emerging free market economies throughout the world. Horizontal and vertical construction projects are increasing at an impressive rate. The construction of bridges, highways, schools, housing developments, hospitals, apartment buildings, manufacturing facilities, and levies has led to an explosion in construction knowledge.

Supply Chain Management can be defined as the management of flow of products and services, which begins from the origin of products and ends at the product's consumption. It also comprises movement and storage of raw materials that are involved in work in progress, inventory and fully furnished goods.

The main objective of supply chain management is to monitor and relate production, distribution, and shipment of products and services. This can be done by companies with a very good and tight hold over internal inventories, production, distribution, internal productions and sales.

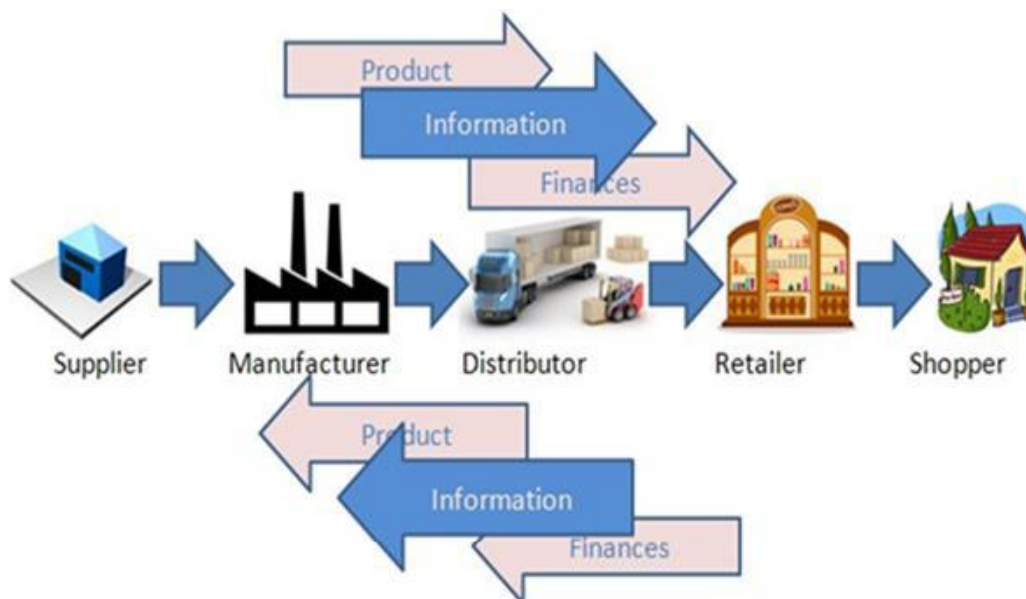


Fig 1: Supply Chain management in construction

In the above figure, we can see the flow of goods, services and information from the producer to the consumer. The picture depicts the movement of a product from the producer to the manufacturer, who forwards it to the distributor for shipment. The distributor in turn ships it to the wholesaler or retailer, who further distributes the products to various shops from where the customers can easily get the product.

1.1.1 Background:

Supply chain management (SCM) is a concept originating from the supply system by which Toyota was seen to coordinate its supplies, and manage its suppliers (Womack et al. 1990). In terms of lean production, SCM is closely related to lean supply (Lamming 1996). The basic concept of SCM includes tools like Just-In-Time delivery (JIT) and logistics Management. The current concept of SCM is somewhat broader but still largely dominated by logistics. Until now, in construction, initiatives belonging to the domain of SCM have been rather Partial covering a subset of issues (e.g., transportation costs) in a limited part of the construction supply chain (e.g., the construction site). In most cases, the issues are regarded from a main contractor's point of view (e.g., Asplund and Danielson 1991, Wegelius- Lehtonen et al. 1996). Statistical figures show that main contractors are purchasing more labour and material than previously.

1.1.2 What is supply chain? What is supply chain management?

The term "supply chain" refers to a series of interdependent steps of activities or processes (sometimes sequential and sometimes overlapping) as well as flows between them, supported by infrastructure (people, equipment, buildings, software, etc.) [e.g., Simchi-Levietal. 2007; Fine and Whitney 1996]. These flows express real or forecast customer demand going in one direction, and supply going in the other direction in order to fulfil that demand. Figure 1.1 outlines the general directions of these flows. Demand and supply flow in opposite directions but may follow different routes (they are not necessarily one-on-one opposites of each other). Information flows both ways. Products and services also may flow both ways (e.g., a fabricator may ship products to a galvanizer and then incorporate returned products into larger assemblies). Accordingly, the term supply "network" might be a better characterization of this system than supply "chain" is, but the latter term is used more commonly and will thus be used throughout this paper. Supply chain management (SCM) refers to managing the flows of physical products and services, information, and money between the activities or process steps that companies perform, while aiming for customer service as the goal (i.e., get the right product to the right place at the right time for the right cost). Defined in this way, SCM applies to the delivery of capital projects (so-called "project supply chains") as it does to the delivery of products or services in other industries (supply chains that deliver products are sometimes referred to as "product supply chains").

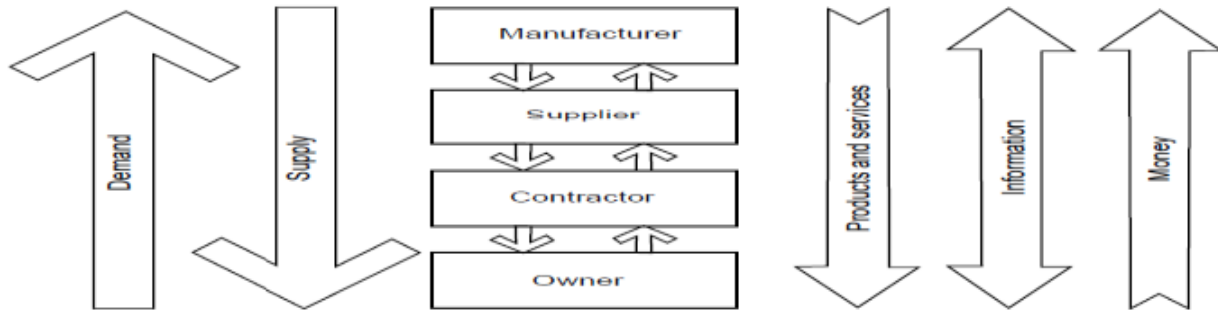


Figure 1.2: shows examples of supply & demand with flow of product/services, information & money in supply chain (Philip kamensky, Glenn barad, iris D. Tommenlion)

Supply chain management is the combination of art and science that goes into improving the way your company finds the raw components it needs to make a product or service, manufactures that product or service and delivers it to customers.

“Supply chain management is a set of approaches used to efficiently integrate suppliers, manufacturers, warehouses, and customers so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time in order to minimize system wide costs while satisfying service-level requirements.” A prime contractor may be able to position a firm as a market leader through exploitation of best practice operations, but the nature of the linked firms in the supply chain necessitates that subcontractors and material suppliers must be part of this strategy. The prime contractor cannot become an industry leader without supply chain support, and, thus, supply chain management is a prerequisite for developing a competitive advantage for successful construction operations. Intense competition forced Chrysler and General Motors to bankruptcy.

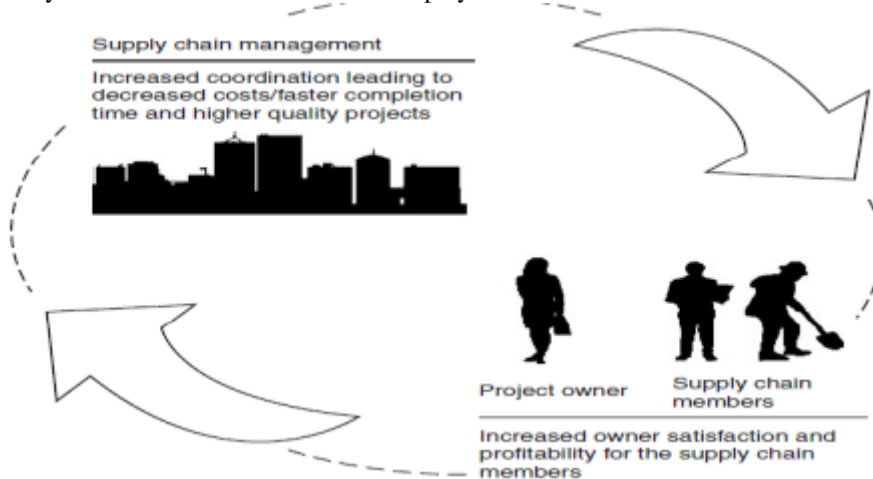


Figure 1.3: shows circular benefits of construction supply chain management (W.C. Benton, Jr. & Linda F. Mchenry)

1.1.3 Benefits of using Supply Chain Management-

Following are the major advantages of supply chain. The key benefits of supply chain management are as follows:

- Develops better customer relationship and service.
- Creates better delivery mechanisms for products and services in demand with minimum delay.
- Improves productivity and business functions.
- Minimizes warehouse and transportation costs.
- Minimizes direct and indirect costs.
- Assists in achieving shipping of right products to the right place at the right time
- Enhances inventory management, supporting the successful execution of just-in-time stock models.



- Assists companies in adapting to the challenges of globalization, economic upheaval, expanding consumer expectations, and related differences.
- Assists companies in minimizing waste, driving out costs, and achieving efficiencies throughout the supply chain process.

These were some of the major advantages of supply chain management.

1.2 MATERIALS MANAGEMENT can be defined as a system responsible for the planning and controlling the flow of materials. Materials management is a system for planning and controlling to ensure the right quality and quantity of material and equipment are specified in a timely manner. Materials Management is a key business function that is responsible for co-ordination of planning, sourcing, purchasing, moving, storing and controlling materials in an optimum manner so as to provide a pre-decided service to the customer at a minimum cost. Materials management comprises of series of processes of which a storage management is part. These processes include planning, purchasing, logistics, handle and stock and waste control.

Planning

Planning is a very major factor in the management of material. It takes care of all the process and at the same time coordinates the rest of the processes. Material planning includes measuring, ordering and scheduling which helps to increase productivity. Most construction firms tend to be costly when proper planning is not implemented.

Purchasing

Purchasing of the materials and services from outside the firm to support the operations of the firm to marketing, sales and logistics (Hendrickson, 2008). A detailed material schedule and coordination of purchasing and order of materials are important in assuring material availability.

Logistics

Is the concept that deals with the delivery of materials to site and also involve the planning, implementation and controlling the movement and storage of all the things from raw materials to finish product. The routing of the materials also affects the cost and time to completion of the project.

Handling

Handling of materials deals with the flow of materials from the suppliers to the site. Due to the rate of handling materials, there are considerations that are used in the materials handling system. The selection of material handling most at times depends on it weight or the center of gravity of the material and which enhance the production process, provide effective operation of manpower, increase production and advance the system to be more flexible.

Stock and waste control

Stock control is the technique planned to ensure that materials or equipment are available at all time. It includes raw materials, processed materials, assembly components, consumable stores, general stores, maintenance materials and spares, work in progress and finished products. Construction activities generate a lot of waste and cause difficulty to the construction industry. The implementation of materials management which is effective will help to minimize waste of materials and increase profit for the firm.

1.3 SITE STORAGE

As storage being the first step in material management and failure to accommodate materials result in poor productivity and waste. Effective site and space utilization is a fundamental to material management. Materials stored on site can either be small or valuable and large or bulk storage item. All these items have the means of storing them on site. Small and valuable items are stored on racks or bin systems and similar items are kept together in a lockable store.

1.3.1 Functional stores

The one which depends on the use of which the material is put. They are normally named by the purpose of the material. Eg. Raw materials store, production store, general stores, tool stores, transit sheds, open yard, etc. .

Open yard store; the type which is normally used in the constructional fields, the items are stored in the open space. The surface of the ground are cover with sheets or steel mats or lean concrete and are normally used to store bulk items which do not required specialized storage.



1.3.2 Physical stores

The stores that depend on the size and location. The naming is in respect to how big or small the store is and the place where is located or the distance from the point of usage. Eg. Central stores, sub-stores, transit stores, site stores, etc. .

Site store; this is usually at the project site containing building or construction materials like cement, steel, tools, etc.

1.4 STORAGE OF CONCRETE MATERIALS

Storage of material as the provision of adequate space, protection and control for building materials and components held in the site during the construction process, defines storage of materials by including the handling of the materials as part. Handling and storage of materials involve the unloading of materials such as steel with a crane, driving a truck loaded with concrete blocks, carrying bays or materials manually; and other materials such as drums, barrels and timber. It provides a continuous flow of parts and assemblies through the workplace and ensures that the materials are available when need. Improper handling and storage of materials always results in cost increment and may sometimes cause accidents at the work place. Proper training and education should be adhering to in the stores since most of them cause accident when moving, handling and storing.

Materials which are to be used on site should be carefully planned before brought to the site for storage.

1.5 CLASSIFICATION OF CONSTRUCTION MATERIALS

Studies have categorized construction materials in terms of how they appear, thus either in their raw state or finished product. These classifications are as follows;

i. Raw materials: These categories represent the original state of the materials and are the materials which are normally in its natural process. They are not affected so much by the weather and pilferage; and most at times bulky in nature. Consumes a lot of space when not properly planned well at the site. Chippings (gravels) and sand are examples;

ii. Factory goods: These categories deal with those items which have passed a series of processes and the end point are to pick and install. They are normally well packaged and most of them are off the shelf items. Examples include cement, ceramic items (closets, bath, basin, tiles) and ironmongery;

ii. Workshop finished items: They are the semi-finished product, thus slight works will be done on them before using. They are normally with their standard measurements and those materials are normally expensive since any default on it will create for it replacement. Examples include glass, timber, roofing materials, etc.

1.6 EFFECTS OF IMPROPER STORAGE AND HANDLING

The effect of improper storage location is also an issue and that can lead to poor productivity and waste. The effect of purchasing materials early may lead to capital tied up and interest charges incurred on the excess inventory of materials and to top it all, materials will deteriorate during storage and be stolen shows that an effective storage system should be operated with the planned activities of construction and revealed the building projects, procurement of materials should be well documented while location for materials should be made in good time; and materials should be delivered according to the programme of work.

1.7 GUIDELINES FOR THE STORAGE OF CONCRETE MATERIALS

There are number of building materials used in the construction industry, most of them go waste during the storing process that materials form the bases of every project and occupying about 50% -60% of the cost of the entire project. Wastage in the storing of these materials have very big negative impact on the project.

1.8 RESEARCH PROBLEM:

Supply chain management (SCM) is a great opportunity for the construction industry primarily to reduce cost and time, and thus improve profitability. SCM principles seem to have much strength to smoothen and integrate the



construction processes. The supply chains in construction could be divided into two major groups as materials chain and the construction chain, which would help to separate the procurement and management operations. However, both chains are linked through a SCM database, which is further linked with the central project database. This would ensure the smooth flow of information within the different chains and results in increased collaboration within the supply chain partners. Hence to adopt these benefits of SCM, this study is aimed to apply SCM tools for material management on a site selected for case study analysis.

1.9 RESEARCH AIM AND OBJECTIVES:

The main aim of this research was to study the effect of poor storage of concrete materials on construction firms in Pune and to develop guidelines for the proper storage of such materials in the building industries
To fulfil this aim the following objectives will be achieved:

- To identify the problems while transferring the materials from place of origin to place of usage.
- To identify the materials resources management practice that the contractors use
- To identify the mode of storage of concrete materials on site
- To identify the effect of poor storage of concrete materials on the contractor in the construction firms in the Pune.
- To find out the way of cost reduction of materials.

1.10 LIMITATIONS OF THE STUDY:

The work for application of SCM tools is carried out only in the construction industry of Pune. A case study site is selected for Analysis The work is limited to the residential real estate sector only and the results will depend on the data obtained after pursuing interviews with the professionals engaged in this industry.

1.11 NEED FOR STUDY:

Effective Supply Chain Management is the next logical step towards increased profits and market share. Construction supply chain management through the integration and coordination of materials, information, and money flows between the various project partners resolves delays and offers a new means of increasing profitability. CSCM's emphasis on information sharing and communications fosters cooperation and collaboration among supply chain members. Contract arrangements that promote core values across all levels of the supply chain depart from traditional practices by advancing successful project outcomes instead of individual firm's successes. Project management and execution are the final tests of how well the supply chain is working. Tracking progress in the field ensures that a project will be on-time and under budget and within specifications. Sharing field measurements with all members in accordance with supply chain values is the final predictor of a profitable project.

Despite the benefits, supply chain strategy remains relatively low:

- Current supply chain strategies are still fairly new.
- Most people do not perceive a difference between supply chain strategy and supply chain management
- Managers often fail to explain major changes to the supply chain in terms of either supply chain strategy or tactics
- professionals don't view the supply chain as a genuine competitive advantage

II. LITERATURE REVIEW

2.1 Overview of the literature:

Supply chain Management has assumed a significant role in firm's performance and has attracted serious research attention over the last few years. In this paper attempt has been made to review the literature on Supply Chain Management. A literature review reveals a considerable spurt in research in theory and practice of SCM. We have presented a literature review for 15 research reports for the period between 2005 and 2019. The aim of this study is to provide an up-to-date and brief review of the SCM literature that was focused on broad areas of the SCM concept.

2.2 The Research Carried Out by Various Researchers-

The extensive literature review was carried out by referring standard journals, reference books, I.S. Code and conference proceeding. The major work carried out by different researchers is summarized below:



1) SulafaBadi , Niamh Murtagh (2019), Green supply chain management in construction: A systematic literature review and future research agenda:

The author researched on the green supply chain management in construction. The main aim of the author is to described in terms of publication outlet, date of publication, geographic setting, methods used, tools and techniques, conceptual definition, the role of stakeholders and practical implications. Research on green supply chain management in construction has been growing in recent times but to date has not been systematically brought together. A systematic literature review (SLR) is presented, applying the high standards of rigour and transparency required by the methodology.

2) Zhaojing Wang , Hao Hu, Jie Gong , Xiaoping Ma , WuyueXiong (2019), Precast supply chain management in off-site construction: A critical literature review:

The author studied on the precast supply chain management in off-site construction. The study done by the author was to create a taxonomy to properly classify existing studies in precast supply chain management so as to reveal research gaps and suggest future research opportunities. Precast supply chain, as a vital connection between construction sites and off-site plants, is the focus of many recent studies. While these studies have greatly advanced precast supply chain management (PSCM), a critical analysis to summarize the recent research, to identify research gaps.

3) Po-Han Chen*, ThanhChuong Nguyen (2019), A BIM-WMS integrated decision support tool for supply chain management in construction:

The author researched on the supply chain management in construction using BIM-WMS integrated decision support tool. Author aimed to support tool that integrates building information modeling (BIM) and web map service (WMS) for the source selection of sustainable construction materials. Selection of construction material sources is an important issue in construction supply chain management. This affects not only the shipping cost and schedule of a construction project, but also its environmental impact.

4) Hassan Younis , BalanSundarakani , Barry O'Mahony, Green Supply Chain Management and Corporate Performance: Developing a Roadmap for Future Research Using a Mixed Method Approach:

The literature is reviewed on green supply chain management and corporate performance for developing the roadmap for future research using a mixed method. The author investigates the relationship between green supply chain management (GSCM) practices and corporate performance (CP) using a sequential mixed methods research design. Research. on the impact of the implementation of green supply chain management practices on corporate performance is still inconclusive. a quantitative survey was conducted with 140 respondents to test a series of hypotheses.

5) YueZhai, RunyangZhong, George Q. Huang (2018), Buffer space hedging and coordination in prefabricated construction supply chain management:

The author researched on the construction supply chain management by buffer space hedging and coordination in prefabricated. The aim of the author is to coordinate scheme and to solve a buffer space hedging (BSH) issue in the prefabricated construction supply chain management (PCSCM). To hedge against unfavorable impacts caused by improper delivery of prefab, the project contractor requires the transportation company to reserve some buffer space in its intermediate warehouse for contingent use. A balance must be kept through a BSH coordination mechanism. Two terms are involved in this mechanism: a BSH amount related cost term is charged by the transportation company to the project contractor and a constant transfer term is used to fairly allocate the system surplus.

6) Muhammad Farooque , Abraham Zhang , Matthias Thüerer , Ting Qu ,Donald Huisingh(2019), Circular supply chain management: A definition and structured literature review:

The author researched on the circular chain management which integrates the philosophy of the circular economy into supply chain management, offers a new and compelling perspective to the supply chain sustainability domain. There is increasing research interest. However, a review of the extant literature shows that a comprehensive integrated view of CSCM is still absent in the extant literature.

7) Mochamadagungwiowo, elizar, (2017), supply chain management strategy for recycled materials to support sustainable construction:

The main of the author was to determine supply chain management strategy for recycled materials to support sustainable construction. The concept of sustainable construction is the wise use of resources, the fulfillment of the future needs. This study by the author shows the strategies of field implementation. Thus attested by the low scores



attained in green building certification. To support the sustainable construction in relation to supply chain management for materials, which have not been implemented well in Indonesia.

8) FabíolaNegreiros de Oliveira , Adriana Leiras , Paula Ceryno (2019), Environmental risk management in supply chains: A taxonomy, a framework and future research avenues:

The author researched on the chain supply management risk to environment. The main aim of the author was analyses both external and internal factors of environmental risk and their impact on supply chain management, as well as the mitigation strategies through the literature study. Where the recent environmental scandals and accidents bring to light the negligence of the environmental issues by supply chains.

9) Zhaojing Wang, Tengyu Wang, Hao Hu, Jie Gong, XuRen, Qiyong Xiao, Blockchain-based framework for improving supply chain traceability and information sharing in precast construction:

The author researched on the blockchain based framework for improving the supply chain management in precast construction. The author determines the framework to extend the applications of blockchain in the domain of construction supply chains. As precast supply chain management often faces challenges such as fragmentation, poor traceability, and lack of real-time information.

10) Alda Yoshi UemuraReche, Osiris Canciglieri Junior, Integrated Product Development Process and Green Supply Chain Management: contributions, limitations and applications:

The literature is reviewed on the Product Development Process and Green Supply Chain Management. The main focus of the author was to identify the main bibliographical references that deal with integrated product development process (IPDP) models for the green supply chain management (GSCM).

This study starts by identifying some keywords and the main academic journals databases. Author selects the peer-reviewed articles from journals with high impact factor (SJR> 1; Q1), resulting in 9430 articles. Next, the search selects the articles of greater relevance on the studied subject by verifying the titles and abstracts, as well as considering inclusion and exclusion criteria, resulting in 355 articles.

III. CONCLUSION

The paper concludes with recommendations for further research that can be conducted based on the conclusions and limitations of the study. This research was initiated with the primary aim of identifying the effect of poor storage of concrete materials on construction firms in Pune and to develop a guidelines for the proper storage such materials in the building industries. In order to achieve the stated aim, three research objectives were set in Section 1.4. Objective 1 was achieved mainly through literature reviews. Objectives 2 and 3 were achieved through the literature reviews and the survey questionnaires, which were conducted. Below are discussions on how the objectives were achieved. The report demonstrated that with effective material management, firms can save a substantial amount of money and makes more profits out of it. The storage of concrete materials is very important since it forms about 25% - 35% of the entire materials needed in the construction. Therefore proper management of this material will go a long way to benefit both the client and the contractor and the economy as a whole.

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