

**IMPROVING CONSTRUCTION MATERIALS
MANAGEMENT PRACTICES IN
CONSTRUCTION SITES**

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DEDICATION

This thesis is sincerely dedicated to my beloved parents Hassan Ahmed, and Naima Ali Hashim, and my lovely wife Huddo Haji Hussein, and our kids (Heysam, Hiyaam, and Sumaya) and my brothers and sisters.

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In the name of Allah, Most Gracious, Most Merciful.

Alhamdulillah, with His Blessings I have finally completed this thesis.

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ABSTRACT

Construction Materials Management is a vital function for improving productivity in construction projects. Poor materials management can often affect the overall construction time, quality and budget. Currently, the construction material management practice in Somalia is believed to be poorly performed. Lack of standardized construction materials management system is one of the key issues facing by the building industry in Mogadishu-Somalia. The aim of this study was to investigate the current practices of material management at construction sites in Mogadishu-Somalia. A questionnaire survey study design was used to explore construction materials management practices. Fifty questionnaires were distributed to project managers, project engineers, site engineers, engineer, and foreman, and they were received and analysed. The following data analysis techniques were used: descriptive statistics were conducted to report sample characteristics, reliability and validity analyses were performed to confirm robustness of the instrument, graphical presentation such as bar charts were developed, and finally Average Mean Index Scale were constructed. The study results reveals that, 46.7% of respondent's organization obtain materials for sites without site requisition by site engineer provisions, while 28.9% of respondent's organization procure materials for sites with site requisition by project manager provisions and 13.3% of respondent's organization procure materials for site by engineer. The results indicated that currently there is no standardized and computerized construction materials management system applied in Somalia. The researcher concluded that all contracting companies are interested in using some techniques of managing construction materials such as creating and updating database for materials categories from local and international suppliers. Finally, researcher recommends to use computerized construction materials management systems to reduce effort and time, and to achieve more accurate results.

ABSTRAK

Pengurusan Bahan Binaan ialah fungsi penting untuk meningkatkan produktiviti dalam projek-projek pembinaan. Pengurusan bahan yang buruk sering boleh menjejaskan keseluruhan masa pembinaan, kualiti dan bajet. Pada masa ini, amalan pengurusan bahan pembinaan di Somalia dipercayai dilakukan dengan buruk. Kurangnya pengurusan bahan binaan yang seragam adalah salah satu isu utama yang dihadapi oleh industri pembinaan di Mogadishu-Somalia. Tujuan kajian ini adalah untuk mengkaji amalan semasa pengurusan bahan di tapak pembinaan Mogadishu-Somalia. Satu reka bentuk kajian tinjauan keratan rentas digunakan untuk meneroka amalan pengurusan bahan binaan. Lima puluh soal selidik telah diedarkan kepada pengurus projek, jurutera projek, jurutera tapak, jurutera, dan mandur, dan semuanya telah diterima dan dianalisis. Teknik-teknik analisis data berikut telah digunakan: statistik deskriptif telah dijalankan untuk melaporkan ciri-ciri sampel, kebolehpercayaan dan kesahihan analisis telah dijalankan untuk mengesahkan keteguhan instrumen, persembahan grafik seperti carta bar telah dibangunkan, dan akhirnya Purata Min Indeks Skala telah dibuat. Hasil kajian menunjukkan bahawa, 46.7% daripada organisasi responden mendapatkan bahan binaan tanpa permintaan lokasi mengikut peruntukan jurutera tapak, manakala 28.9% daripada organisasi responden mendapatkan bahan binaan dengan permintaan lokasi mengikut peruntukan pengurus projek dan 13.3% daripada organisasi responden mendapatkan bahan binaan oleh jurutera. Hasil kajian menunjukkan bahawa pada masa ini tidak ada sistem pembinaan pengurusan bahan yang seragam dan berkomputer yang diterapkan Somalia. Penyelidik membuat kesimpulan bahawa semua syarikat kontrak berminat untuk menggunakan beberapa teknik untuk menguruskan bahan binaan seperti mencipta dan mengemaskini pangkalan data bagi kategori bahan-bahan dari pembekal tempatan dan antarabangsa. Akhir sekali, kami mengesyorkan untuk menggunakan sistem pengurusan bahan binaan berkomputer untuk mengurangkan tenaga dan masa, dan untuk mencapai hasil yang lebih tepat.

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LIST OF ABBREVIATIONS

<i>JIT</i>	-	Just-In-Time
<i>ICT</i>	-	Information and Communication Technologies
<i>RFID</i>	-	Radio Frequency Identification
<i>SCM</i>	-	Supply Chain Management
<i>I-MATRACS</i>	-	Intelligent Materials Tracking System
<i>GPS</i>	-	Global Positioning System
<i>UWB</i>	-	Ultra-Wide Bands
<i>PDA</i>	-	Personal Digital Assistant
<i>GPRS</i>	-	General Packet Radio Service
<i>LADAR</i>	-	Laser Distance and Ranging
<i>RTK</i>	-	Real-Time Kinematic
<i>a</i>	-	Constant Weighing Factor
<i>xi</i>	-	Frequency of Respondent
<i>i</i>	-	1,2,3,4,5..... n
<i>m</i>	-	Meter
<i>Sh/S</i>	-	Somalian Money
<i>ASP</i>	-	Application service provider
<i>ERP</i>	-	Purchased as enterprise resource planning
<i>CAD</i>	-	2D, 3D, drawings
<i>CPM</i>	-	Comprehensive Project Management

CHAPTER 1

INTRODUCTION

1.1 Research Background

The construction industry is vital for the development of any nation. In many ways, the pace of the economic growth of any nation can be measured by the development of physical infrastructures, such as buildings, roads and bridges. In the construction management site, the performance of the construction practice is very essential and it has many effects, improper handling of materials during site activities and it has the potential to severely obstacle project construction performance. There are major issues, which affect materials management activities, constraints on storage areas, site logistics concerning materials handling and distribution, and also ordering and delivery of materials to the construction site. The other issue of the effect of the performance of the construction is improper storage and need large storage. Also, transportation difficulties and inappropriate materials delivery, and include manual processes, and non-compliance with specification according to (Takim, 2002).

There are numerous approaches, which was addressed materials management problem issues. There are proposed method for proper planning of materials, logistics, Just-In-Time (JIT), the method is to resolve the problems of space constraints, and the implementation of Information and Communication Technologies (ICT) such as bar-coding for automatic tracking of materials (Kasim, 2010).

1.2 Problem Statement

After decades of civil war and the collapse of the central government in 1991, Somalis and international supporters have renewed efforts – and made progress – since 2012 in re-establishing state structures and bringing stability to the country. Improved security in Somalia's capital, Mogadishu, has boosted the local economy. New housing estates are being built amid an economic boom as diaspora Somalis return and newly wealthy businessmen capitalise on the relative peace in Mogadishu. Many long-abandoned seafront villas are being rebuilt as part of a construction boom that has seen rents triple in recent months in the city's prime locations according to (Billow, 2014).

Given the construction business boom, Somalia do not have currently well-established construction material management system. The materials management practices in these countries are performed on a fragmented basis with unstructured communication and no clearly established responsibilities between the parties involved. This fragmentation creates gaps in information flow, which affects the decision making process and lead to delays in material ordering and receiving, among other problems (Thormas *et al.*, 1989). As far as we know there is no research effort that has been done to investigate the construction materials management practices of contracting companies in Mogadishu-Somalia. It is important to explore and evaluate these practices, and then offer recommendations and develop practical techniques to improve existing practices.

On the other hand, Current materials management practices in the contractor companies in construction industries are performed on a fragmented basis with unstructured communication and no clearly established responsibilities between the parties involved. This fragmentation creates gaps in information flow, which affects the decision making process and lead to delays in material ordering and receiving, among other problems. The material manager needs to realize that decisions taken at four stages in the process will certainly impact other activities and processes in the supply chain, logistic, storage, problems are not realized due to this fragmentation (Perdomo-Rivera *et al.*, 2004).

It is gathered that current manual materials management and control procedures are unsatisfactory as they are labour intensive, inaccurate and error prone. The implication leads to waste and surplus of materials, delays, decrease in productivity and lack of up-to-date and real-time information (Navon, 2005).

The initial phase of this research investigated current material management practices of contractor companies in construction industries. The investigation considered the entire range of activities necessary for procuring the needed material, starting with the estimating process and ending with site delivery, distribution and storage logistics. Research outcomes included documenting the problem bottlenecks in the supply chain, logistic, storage, and handling, as well as identifying and classifying the various criteria that influence the decision process for procuring material. A comprehensive flowchart describing the material management process was developed based on various discussions and considered many decision alternatives including material type, supplier availability and relationship, procurement options and incentives, quantities needed, delivery dates, storage alternatives, and project schedules (Robinson *et al.*, 2005).

Many challenges are encountered during the various phases of material management process including challenges with material procurement, material storage & distribution. Examples of challenges include: procurement challenges, Supplier selection challenges, Jobsite storage and handling challenges. The majority of the problems faced by contractor companies with respect to materials management are encountered at the job site and include tracking of material, storage issues, material distribution and re- handling. The material procurement (ordering and delivery), this phase is very critical to the successful execution and completion of any project. 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 ordered. They also need to verify the release dates at which the material is needed and clearly specify those delivery dates as well as the location of delivery to the supplier (Perdomo-Rivera *et al.*, 2004).

Material logistic 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, stock outs due to small quantities bought, material delivered to the wrong locations, material backordered and overall costs. The owner has to systematically follow up the status of ordered material to assure that the material

arrives to the job site in the quantities and dates specified. Expediting is one control system necessary to assure a timely equipment and materials arrival to achieve a project completion on schedule. Expediting involves monitoring all steps in the procurement cycle, with special focus on those involving the vendor or subcontractor, to assure reliable, economical, on-schedule delivery (Cutting-Decelle *et al.*, 2002).

Ensuring that material deliveries occur on a timely basis is a very difficult task. As revisions come through from material take off, it is all too easy for this to impact on material deliveries, resulting in them arriving late or in insufficient quantities. The impact of schedule changes can have a similar effect. While material may originally have been ordered in good time, this may no longer be the case. Design changes may result in a reduction in requirements for some material and an increase for others, which will also affect the delivery schedule. These changes can have a considerable impact on cost and evaluating the full impact of the changes is extremely important. Material may not arrive on time, work may have to begin out of sequence, or the fabrication process may be delayed. Effective planning and communication is required to keep costs to a minimum, to minimize errors in ordering and to increase the probability that the material is on site when needed. Constant communication and clearly specifying, without ambiguities, the material needed could help to minimize errors (Thabet *et al.* 2002).

Due to the fact that the problems in materials management will be never ending, it is plausible that ICT may be the answer to overcome the challenge of materials management in the construction industry. The dilemmas faced in materials. Management can be overcome by adapting ICT-enabled solution that can help support and effective management of materials activities. In this research, defined factors affecting material management from the opinions of managing material management practice in construction site. The main contribution of this research is to support site office system. The important of site office is material delivering, material storage, material's used.

1.3 Research Questions

- (i) What is the current practices of materials management in construction site?
- (ii) What is the problem of material management practices in the construction site?
- (iii) How to improve material management practices in the construction site?

1.4 Research Objectives

This research aims to improve material management practices in the construction site. To achieve the aim of the research, this research has the following objectives:

- (i) to investigate the current practices of material management in construction site.
- (ii) to identify the problem of material management practices in the construction site.
- (iii) to recommend the appropriate methods for improving material management practices in the construction site

1.5 Scope of Research

This research will focus on improving the performance of the material management constructions site. Major challenge at Mogadishu's construction sites is poor planning and management of resources and time among site supervisors and operational managers. Quite regularly, workers are not fully engaged for hours at a time, because construction materials have not been delivered on time or because previous work has not been completed (Secil, 2014). For data collection, this research will be using questionnaire that can be help and support effective management of materials activities. also to investigate the problems, mentioned above in problem statement of this study will focus the performance of the material management constructions from ordering, delivery handling and distributing materials to the construction site Mogadishu-Somali. Our Scope is Somalia,

especially the capital city, we will concentrate on materials management in construction site as we can see in this figure.



Figure 1.1: Location of Somalia (Map and Satellite Image, 2008)

1.6 Significance of the Study

All sectors of the industry share a common ground for material management and control. Thus, the discussion presented although it is directed towards the contractor companies in construction industry could be applied to any sector. Material management activities are required throughout a construction project and in every construction project. Moreover, the success of the project is highly dependent on the successful management of the materials required. Hence, managing the materials in an effective way is very critical to all parties involved not only in the construction industry but also in other industries. The research work is expected to provide the following benefits to the industry.

- (i) Improve the management of materials for the construction industry.
- (ii) Provide guidelines to assist in the materials management learning process.
- (iii) Standardization of the material management practices within a company.
- (iv) Investigate state of the art tools and technologies that could be helpful in managing and monitoring material and control its quality.

With the development of a structure for a material management decision support system, facilitated through a knowledge management database, the following benefits are expected:

- i) Minimization of the repetition of past failures.
- ii) Sharing of successful experiences.
- iii) Learn from other people's experiences to avoid pitfalls and to minimize the repetitions of errors
- iv) Identify specific design, process, or decision that reduces or eliminates the potential for failures.
- v) Availability of corrective actions for typical problems that might impact the cost of a project.

Based on the objective in studying of improving material management practices in construction site. Will be faced by site office considered and implementation of ICT in materials management, the main tools that are widely adopted by the contractors are the Microsoft Offices and handheld devices. Subsequently, planning and procurement are the materials management processes considered needing the highest investment of ICT implementation. Evidently, ICT tools that are hardly adopted in the materials management of each respondent's company.

1.7 Research methodology

Research methodology explains the method used in conducting the research. The steps involve are; formation of problem statement, developing research Objectives, literature review, data survey using questionnaire, data analysis, then conclusion and recommendations. This research uses quantitative approach and would be conducted in three stages, as shown in Figure 1.2. The first stage is the process to identify research issues, topic selection, problem statement and research Objectives. Second stage is the literature review to find out the previous study related to improving appropriate methods of materials management in construction projects. The third stage shows the types of data collection to be used in this research, which are literature review and questionnaire survey. The final stage discussed on data analysis process, results and findings based on the survey using questionnaire form, conclusion and recommendations for the research in order to solve the problems on materials management in construction industry.

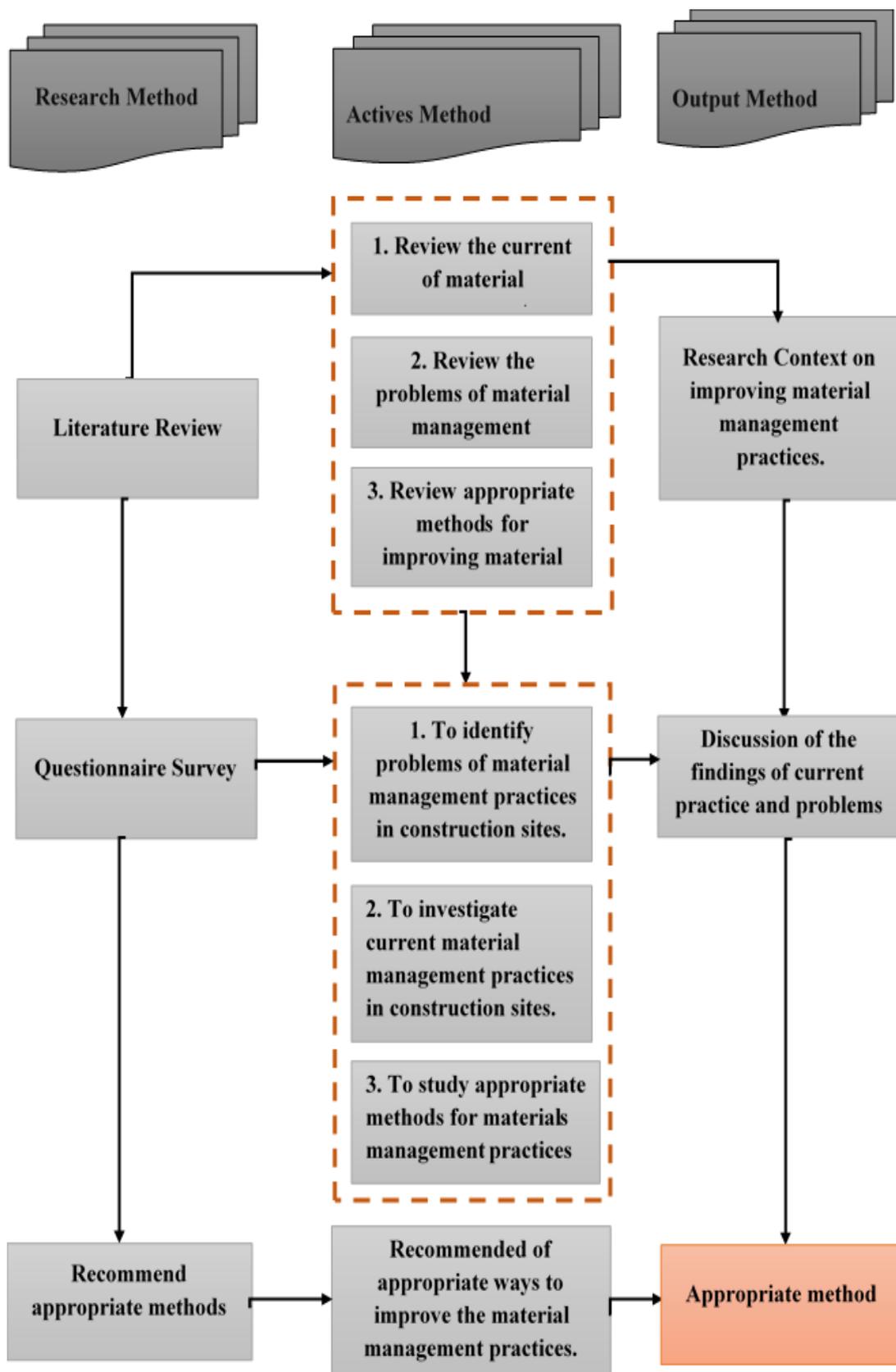


Figure 1.2: Flow Chart the of Research Method Activities and Output

1.8 Outline of Thesis

The thesis consists of five (5) main chapters. The chapter's organization and explanation to every chapter will be discussed below:

Chapter 1: *Introduction*

This section introduces the research topic. It consists of the research background, research problem, research questions, research Objectives, research scope, and research significance. Finally, the chapters' outline and summary.

Chapter 2: *Literature review*

This chapter reviews problem of material management practices in the construction site and appropriate methods for improving materials management. The chapter also focuses on identification of the research gaps that have not been discussed by previous researchers or need to be discussed more. The chapter also focuses on general suggestions to minimize interface problems.

Chapter 3: *Research methodology*

This chapter discusses the research approach and strategies, and the procedures to be adopted in conducting the research. This includes, research process and design, population and sampling techniques to be used. It also discusses the instrument of data collection and data analysis technique.

Chapter 4: *Data analysis and discussion*

This chapter presents the data obtained from questionnaires and makes analysis of the data. It also discusses the result from the survey conducted. The chapter also discusses on the findings obtained from the analysis which forms the basis of recommendations for future research.

Chapter 5: *Conclusion and recommendations*

The last chapter in the research summarizes the entire research work to be conducted where conclusion would be made. The recommendation is given based on the research subject matter for possible action to be taken. This chapter ends with highlighting the limitations in the research and conclusion.

1.9 Summary

This chapter explains the current practices of material by seeking the views of material management practices at construction site. To suggest a good method to implement material management at construction site in Mogadishu-Somalia that provides context in formulating the research approach taken to accomplish the objectives of the study. The contractors are in a strong position as they have the guidance to define the problems and to improving appropriate methods of materials management in construction projects. This aimed at enhancing materials management as a standard towards successful project productivity. In addition, the research also outlined the research scope and the methodology to be used in the research process. Therefore, further relevant information that relates to the research will be discussed in literature review in the subsequent chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Different researchers provide different definitions for material management. Therefore, different definitions can be found in different references. Material management is concerned with the planning, identification, procuring, storage, receiving and distribution of materials. The purpose of material management is to assure that the right materials are in the right place, in the right quantities when needed. The responsibility of one department (i.e. material management department) for the flow of materials from the time the materials are ordered, received, and stored until they are used is the basis of material management.

Said *et al.* (2010) suggested that the development of a new optimization model for construction logistics planning that is capable of simultaneously integrating and optimizing the critical planning decisions of material procurement and material storage on construction sites. The model utilizes genetic algorithms to minimize construction logistics costs that cover material ordering, financing, stock-out, and layout costs. The model incorporates newly developed algorithms to estimate the impact of potential material shortages on-site because of late delivery on project delays and stock-out costs. Also explained that Material procurement and storage on construction sites need to be properly planned and executed to avoid the negative impacts of material shortage or excessive material inventory on-site. There are several factors within the scope of material management and each of these factors can give rise to potential problems. The more factors are divided, the more potential problems that exist. There are many factors which contribute to poor material management in construction projects.

(Phu and Cho, 2014) Suggested that factors such as waste, transport difficulties, improper handling on site, misuse of the specifications, lack of proper work plan, inappropriate material delivery and excessive paperwork all adversely effect on material management. Factors related with material management can be mostly found in the following areas in local construction projects

- (i) Planning and Scheduling
- (ii) Monitoring and Controlling
- (iii) Organization and Personnel
- (iv) Procurement
- (v) Delivery
- (vi) Storage and Storage facilities
- (vii) Usage and Surplus and Waste control

Construction industry such as housing, infrastructure facilities use a large quantity of materials. There is a large demand in building material due to population growth and there is a gap between demand and supply management. In this situation, researchers try to find a good solution for construction material management. Valuable management of materials signifies on area with immense potential for enhancement efficiency of work and also controlling expenses. This important for building professionals and the general public because it would not only explain but also make awareness of the extent to which inadequacies in material management that can negatively affect project performance. The study aims to help the contractors, clients, consultants and all parties involved in construction projects about the ways of improving their present techniques and methods of material management. According to (Mehr *et al.*, 2014).

Developed and evaluated an automated model for management and control of materials ordering, purchasing, and supply and use. In order to evaluate the model under real conditions, the model was implemented in a prototype system and used in ongoing construction projects. The model provides a comprehensive approach, encompassing materials purchasing aspects, their delivery to the site and their dispatching for use in the building. The model can reduce the time needed for materials management, reduce wastage caused by manually ordering the materials and ensure that materials on site on time, in the right quantity and according to specifications according to (Navon, 2002).

Finally defines Materials management is an important function in order to improve productivity in construction projects. Also materials management functions include "material requirement planning and material take off, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution". This is concerned with the planning and controlling process to ensure that the right quality and quantity of materials and installed equipment are appropriately specified in a timely manner, obtained at reasonable cost and are available when needed. Materials management involves the logistics of the materials component so for a supply chain which involves the process of planning, implementing and controlling of the movement and storage of raw materials, work-in-process inventory. The management of materials should be considered from the phases of the construction process and throughout the construction period. Generally, construction materials are bulky, expensive and are supplied in large amounts to construction sites according to (Kasim, 2008).

Therefore, there is a need for an excellent management system for handling materials. The person in charge of handling materials should keep in mind the goals of the company and insure that the company is not paying extra money for materials. The goal of every company is to make a profit. This is the basis for company survival, costs should not exceed income, but keeping in mind customer's expectations.

2.2 Materials Management in Construction Site

Materials Management has been defined as the management system for planning and controlling all necessary efforts to make certain that the right quality and quantity of materials and equipment are specified in a timely manner, are obtained at a reasonable cost and are available when needed. In the past, construction managers have been more consumed with the control of labor and the control of plant. There is now a growing awareness that materials' wastage and shortages are diluting the profit to the contractors more than other reasons. Material management functions can be generally categorized as (Dawood *et al.*, 1994).

- (i) Defining material requirements for the project.
- (ii) Vendor evaluation.
- (iii) Purchasing.
- (iv) Storage on site.
- (v) Site distribution.

Currently all over the globe the main reason in cost variance and problematic management of material are due to overstocked materials because of improper planning, damaged materials due to logistics, handling or in application, loss of materials because of improper supervision, waiting of the materials to arrive in location due to improper tracking systems, frequent moving of materials due to improper site layout, inflation, material changes in buying/purchasing situation starting from the prepared cost estimation, bulk construction material, the shortages and changes of construction materials quantity required, materials inefficiency on site, stealing and loss of construction materials, material shipment, work repairing, delay in updating/posting storage system on site, inaccurate measurement of work location on construction projects, material off-take, inaccurate estimation of shipment quantity of materials, uneconomic order quantity of materials, poor shipping time, inadequate tools/equipment needed on site, increasing transportation cost of materials, material over usage in location of project, choosing the wrong materials for construction, the increasing storage cost of materials, the poor buying ability of managers, delay of payment for materials, and the poor policy in purchasing the materials (Gulghane *et al.*, 2015).

2.2.1 Site Arrangement

So as construction projects get bigger and larger and more complex then construction planning is getting more effective such as;

- (i) Planning
- (ii) Materials classification
- (iii) Ordering system

Material flow on site is the process of moving materials from the site entrance through a set of function areas to the final installation areas. This can be through a

model, which in these model six types of function area are recognized: Site entrances, lay down areas, staging areas, assembly areas, installation areas, and wastes areas. Lay down area is for the long term use for main material to their own lay down area for example steel or large panel formwork. For the frequency use of material if they are small volumes it should be shared with the same area. For short term temporary storage area is suitable. Assembly areas are the working area needed when materials are being placed when they finally remain and wastes area are also needed for the waste material. Site entrances which should be connected to the outside road system. Also non-functional area such as site offices or tools storage and worker changing rooms; and finally “Unused area” which may be used for further work (Donyavi *et al.*, 2009).

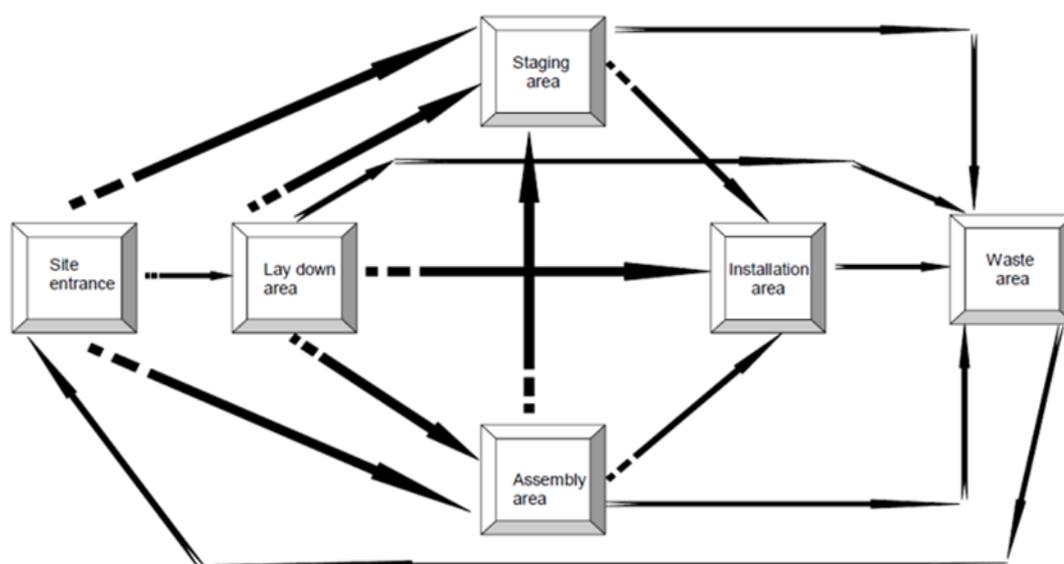


Figure 2.1: Basic Material Flow Network (Donyavi *et al.*, 2009).

2.3 Materials Management Processes

For any kind of organization to run smoothly, it needs to implement core management concepts. This necessitates that the four management functions - planning, organizing, leading and controlling be precisely understood. According to (Kondalkar, 2007). The following are the four types of management function. In order to better, understand materials management the following processes are discussed: planning, procurement, logistics, handling, stock and waste control.

2.3.1 Planning

In construction scheduling is concerned with the regulation of the flow of construction units through their preconceived plans of operations, material. Scheduling involve the establishment of time tables for the ordering of all materials requirement for maintaining the flow of materials must be schedule to coincide with the flow of all construction of activities involved in the actual construction of each project (Albert *et al.*, 2014).

The activities are pulled from each development team by the pull events. These activities represent the necessary and sufficient work to deliver the results needed to perform the pull event. The value creation activities sequencing process is divided into three steps (Pessôa *et al.*, 2008):

- i) Determine pulled activities – When a value item is on the scope of a pull event, all the teams which help deliver this item have to provide the information and/or materials needed for the event. For example, if some functional value is going to be analysed during an event, the teams should provide their designs showing how they incorporated the expected value; on the other hand, if the item will be tested, the teams should provide their prototypes for testing;
- ii) Identify dependency between activities – A dependency between activities exist whenever one needs the results (information and/or materials) from the other. In this work, these dependencies are represented through an activity-based Design Structure Matrix (DSM). An activity-based DSM is a square matrix with the same values (activities) on both rows and columns; dependencies are shown whenever results from an activity in a column are needed to perform an activity on a line. For a formal introduction to DSM, refer to (Yassine, 2004); and
- iii) Define the activity network – According to the identified dependencies, the sequence is defined and a network can be created. To reduce the possible impact of rework cycles, this work sequences activities by partitioning the DSM. The partitioning algorithm (Yassine, 2004).

2.3.2 Procurement

(i) *Material Purchase*

Purchasing is one of the basic functions common to all type of business enterprise. These functions are basic because no business can operate without them all business are administered or managed by coordinating and integrating those six functions: - Creation, the idea of design function, Finance, the capital acquisition records function, Personnel, the human resources and labor relation function, Purchasing, the buying of required equipment, material, and services, Conversion, the changing of material to economic goods, Distribution, the selling or marketing of goods produced. The good of the purchasing department then should be to avoid cheap purchase but to look for optimum purchases. Sometime good material can be purchased at lower unit cost through large order size purchases According to (Lamer, 2007).

(ii) *Purchasing Departments*

In large organization the purchasing group may include purchasing analyst, traffic expert expedites as well as management. In some cases, purchasing is expanded to include all logistics involve in the moving handling storing of material. the purchasing department on the order hand has the responsibility and authority to schedule outside production the purchasing department is an organization unit of firm whose duties include some part or all of the purchasing function (Lamer, 2007).

(iii) *Purchasing Documentations and Records*

The process is started with purchase requisition, the authorization of the firm through an approved official to buy the needed materials. Quality, quantity, and date needed are specified on a requisition form, which must be signed by an authorized person. The requisition form should also be numbered for accounting control in the case of materials that are needed periodically, a repeating requisition form may be established, where goods are ordered regularly according to a predetermined schedule. A section to include purchase order number, address should be included in the form's design for best control (Lamer, 2007).

2.3.3 Logistics

Logistics can be defined as that aspect of the supply chain process that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customers' requirements (Emuze *et al.*, 2011). In the same context, logistics management refers to the science of planning, procurement, maintenance, distribution and replacement of materials and personnel. This means having the right person, vehicle, equipment, material in the right place at the right time. The principal responsibility of a construction, project manager of a construction project revolves around the optimisation of daily operations of facilities through careful planning, organising, directing, and controlling activities before and during construction. Operational efficiencies that involve day-to-day decisions relative to logistics are directly part of the responsibilities of site management. In this context, construction logistics activities include (Jang *et al.*, 2003).

- (i) Material supply, storage, processing and handling;
- (ii) Manpower supply;
- (iii) Schedule control;
- (iv) Site infrastructure and equipment location;
- (v) Site material flow management on a job site, and
- (vi) Management of information related to all physical and services flows.

In general, construction logistics can be divided into supply logistics and site logistics. Supply logistics are related to activities in the production process that are cyclic such as the specification of supply resources such as materials, equipment, and labour, supply planning, acquisition of resources, transport to a site and delivery, and storage control. Site logistics are related to the physical flow of on-site processes such as the management of handling systems, H&S equipment, site layout, defining activity sequence, and resolving conflicts among various production teams related to the on-site activities (Jang *et al.*, 2003).

Given the above mentioned outcomes in the construction industry, it is imperative to advocate the objectives and advantages of logistics management. In other sectors of the economy, the objective of logistics management is to design,

develop, and implement an overall process that will be completely responsive to customer requirements. These merits are transferable to the construction industry that is faced with increasing demand from clients relative to performance and conformance to requirements. In this context, logistics management enable requirements that will lead to minimising the overall response time from when a need is first identified to delivery and installation of the finished product at the user's site, minimising the number of steps in the decision-making process, minimising the steps and time required in the materials purchasing process; increasing asset visibility, and minimising inventory requirements; the number of warehouses necessary and storage requirements, minimising packaging and transportation times, and minimising cost from a system life cycle perspective (Emuze *et al.*, 2011).

It follows that the realisation of the abovementioned objectives is dependent on reliable information flow and logistics requirements in Supply Chain Management (SCM) activities including the forward and reverse flows. Client's demand for improvement and new technologies makes the adoption thorough logistics practices imperative in the industry. The literature shows that efficiency gains accrue if the concept of logistics management is optimised in construction as logistics adds value to economic activities in the construction process through place and time utility. Logistics also provides place utility by moving goods from production surplus points to where demand exists and time utility by making sure the goods are available when they are needed. Logistics creates place utility primarily through transportation, and time utility through proper inventory maintenance and strategic location of goods and services (Emuze *et al.*, 2011).

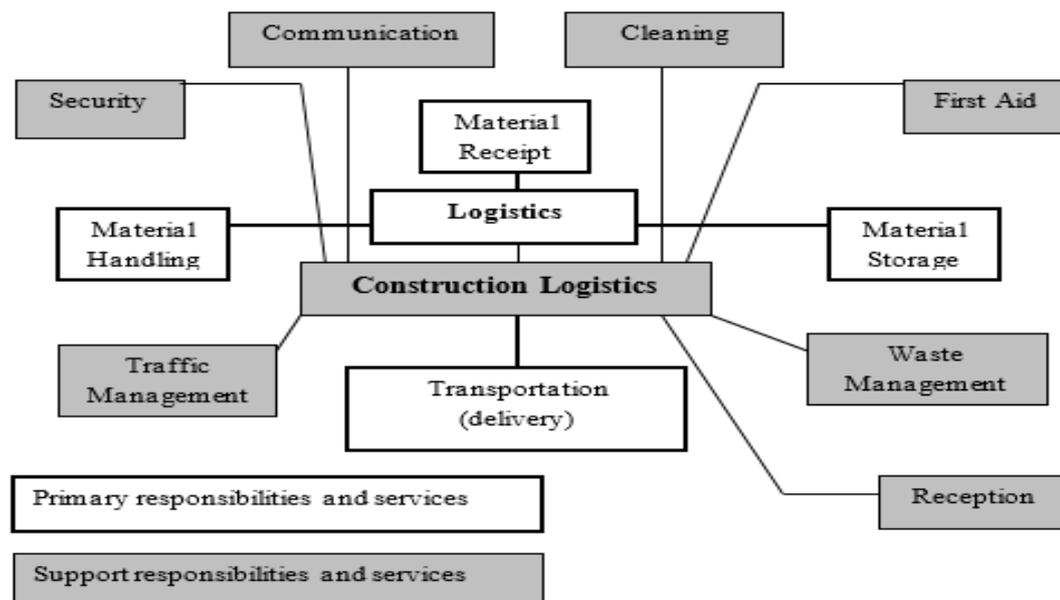


Figure 2.2: Integration of Logistics Functions in Construction Logistics System (Sullivan *et al.*, 2010)

2.3.4 Handling

Effective material handling can be describe as using the right method in providing the right amount of the right material, at the right place, time, sequence, position, condition, and cost. This involves handling, storing, and controlling of the construction materials. Therefore, materials handling provides movement to ensure that materials are located and that a systematic approach is required in designing the system. Handling of materials is the flow component that provides for their movement and placement. The importance of appropriate handling of materials is highlighted by the fact that they are expensive and engage critical decisions. Due to the frequency of handling materials there are quality considerations when designing a materials handling system. The selection of the material handling equipment is an important function as it can enhance the production process, provide effective utilization of manpower, increase production and improve system flexibility. The importance of appropriate handling of materials is highlighted by the fact that there are expensive and engages critical decisions. The materials handling equipment selection is an important function in the design of a material handling system in order

to enhance the production process, provide effective utilization of manpower, increase production, and improve system flexibility (Chan, 2002).



Figure 2.3: Handling, Storing, and Controlling of the Construction Materials (Chan, 2002)

2.3.5 Stock and Waste Control

Construction activity can generate an enormous amount of waste (Teo *et al.*, 2001) and materials waste has been recognized as a major problem in the construction industry (Formoso *et al.*, 2002). There are also mentioned that construction materials waste, in the USA contributes approximately 29%. In the UK, it contributes more than 50% and in Australia, it contributes 20-30%. This is evidence to control constructions materials in a good way during the construction process. The cause of waste in construction projects indicates that waste can arise at any stage of the construction process from inception, right through the design, construction and operation of the built facility. Therefore, waste can be reduced through the careful consideration of the need for minimization and better reuse of materials in both the design and construction phases (Dainty *et al.*, 2004). Material storage on site requires close attention in order to avoid waste, loss and any damage of materials that would affect the operations on the construction project. Problems often arise during materials supply because of improper storage and protection facilities (Canter, 1993). Previous studies have identified that building materials often require a large storage capacity, which is rarely available on site (Agapiou *et al.*, 1998). However, that there

are a few considerations to be taken into account in the planning of the storage space such as timing of the initial buy, and historical information and experience. Materials management on site should seek to reduce loss of profit due to theft, damage and wastage, as well as running out of stock. Therefore, the requirements of storing space should be taken into consideration from the initial stage of the construction process (Stukhart, 1995).

2.3.6 Storage of Materials

Construction work generally entails temporary occupation of a site, but unfortunately site storage tends to reflect this, with a carelessness shown towards materials and components which would hardly be tolerated in most other industry. Storage actually consists of more than one operation according to (Johnston *et al.*, 2016), and involved as following:

- i) Delivery of good to the site,
- ii) Offloading,
- iii) Stacking,
- iv) Protection against deterioration,
- v) Identification for future reference,
- vi) Accounting procedures,
- vii) Issue of materials to operatives for use on site,
- viii) Loading for transfer to construction areas
- ix) General movement of goods

Collectively these operations entail a great deal of organization together with the use of mechanical equipment, site labour and contract supervision. Materials may be kept on site over long or short periods of time until they are needed. Storage also means expenditure of capital, and many contractors are reluctant to purchase materials in advance, except for those needed almost immediately. Because the period between ordering and receiving materials is so uncertain, the contract must make allowances for temporary storage, and where materials are stored under the conditions laid down in the contract then the contractor is entitled to be reimbursed for this. This provides a cash flow, enabling the contractor to purchase further materials as they are needed, reducing the stocks held by suppliers and

manufacturers, and creating opportunity for continued production. Storage under proper conditions includes stacking the materials in racks and frames, retaining them in bins and boxes, protecting them from impact damage, and enclosing them from adverse weather conditions. Covered accommodation will be needed for materials which must be safely stored in open-fronted sheds or protected by temporary mobile covers. Tarpauling or loose plastic sheets are not always satisfactory; they are often blown off during heavy winds or left of by operatives withdrawing stocks (Johnston *et al.*, 2016).

2.4 Materials Management Problems in Construction Site

There are many issues, which contribute to poor materials management in construction projects. (Aibinu *et al.*, 2006) suggested that waste, transport difficulties, improper handling on site, misuse of the specification, lack of a proper work plan, inappropriate materials delivery and excessive paperwork all adversely affect materials management. Shortage of materials contributes to the cause of delay in managing materials in the construction site. Late delivery of ordered materials is also problematic in materials management. Furthermore, Dey (2001) noted that, the common issues relating to materials management are as follows:

- (i) Receiving materials before they are required, causing more inventory cost and chances of deterioration in quality
- (ii) Not receiving materials at the time. of requirement, causing loss of productivity
- (iii) Incorrect materials take-off from drawings and design documents
- (iv) Damage/loss of items
- (v) Selection of type of contract for specific materials procurement;
- (vi) Vendor evaluation criteria
- (vii) Piling up of inventory and controlling of the same, and
- (viii) Management of surplus materials

The traditional construction methods apply paper-based work during the construction process. This can produce excessive paperwork and contributes poor materials management in construction projects (Zakeri *et al.*, 1996). There is also give problematic, effort-prone and inefficient in the recording and exchanging

information of materials component within a supply chain. The implementation of smart tools such as (ICT) tools can help the management of construction activities to become more effective and faster. The emergence of smart tools system could transform conventional methods and improve materials management. The use of smart tools has also increased with new software related to the construction industry. The literature shows that smart tools can support the effective management of materials practices. Therefore, the smart tools enabled solution could help in order to overcome the problems. For example, improving materials supply management through an intelligent system to facilitate bidding, requisition and ordering of materials.

2.5 Limitations of Current Practices

In the construction management site, the performance of the construction, practice is very essential and it has many effects. Improper handling of materials during site activities and it has the potential to severely obstacle project construction performance. There are major issues, which affect materials management activities, constraints on storage areas, site logistics with regards to materials handling and distribution, and also ordering and delivery of materials to the construction site.

The other issue of effect of the performance of the construction is improper storage and need large storage. Also transportation difficulties and inappropriate materials delivery and include manual processes, and non-compliance with specification. Previous research developed prototype system, for example Intelligent Materials Tracking System (I-MATRACS) to improve on-site construction material management. This software helps to manage or handling construction material management practices in construction site (Kasim, 2012). Therefore, it is opportunity for the knowing of this software has to be for upcoming implements in construction site. It obviously smart tools and techniques currently is not in use in materials management most of them are an available with a few being used on international corporations basic, but it will help the company in the long run by providing solutions to the key problems like lack of specification, delay, improper handling.

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