THE DEVELOPMENT OF A FRAMEWORK TO IMPROVE MATERIALS MANAGEMENT ON LIBYAN CONSTRUCTION SITES

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DEDICATION

With all my heart, I thank Allah (my God), for his blessing, support, Guidance and love, this work would not have been possible.

This piece of work is especially dedicated to my wife for her love and encouragement; she has never ceased supporting me.

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DECLARATION

I declare that this thesis has been composed by myself. It has not been accepted in any previous application for a higher degree than the work it is a record has been performed by myself. All sources of information have been specifically acknowledging.

Naser Maauf

ABBREVIATIONS

AVE	Average Variance Extracted.
BTS	Bartlett's Test of Sphericity.
CII	Construction Industry Institute.
CCM	Construction Material Management.
ICT	Information Communication Technology.
JIT	Just-in-time method.
KMO	Kaiser-Meyer-Olkin.
LC	Lean Construction.
MM	Materials Management.
SCM	Supply Chain Management

ABSTRACT

Materials management is crucial in construction projects specially in developing countries. It contributes very important role to the achievement of the project on time and, as such, affects the overall economy of any country. The research aims to develop a framework to improve material management on the Libyan construction sites. This could be achieved by examining the Libyan construction context and its characteristics from the Libyan professional construction experts' perspectives. Although several studies have recognised the importance of managing the material in the project site, there is still a gap in knowledge with respect to designing a holistic model that could satisfy the construction practitioners.

A mixed-method approach was applied to analysing material management in the Libyan construction companies. The study adopted a quantitative questionnaire to identify the perceptions and attitudes of the Libyan construction authority because many responses from different companies and regions were required to determine differences in the perceptions of construction stakeholders. Semi-structured interviews were conducted to collate data from other stakeholders who were not involved the questionnaire to explore the functions involved in the material management process. The present study findings displayed that the Libyan construction companies have a system for managing the procurement process and for ordering materials. However, contractors and project managers lack experience, and most of them know nothing about managing material. Besides, they lack knowledge on management material waste which is one of the significant issues facing the Libyan construction sector.

It is anticipated that the model will help Libyan construction authorities to improve their performance and to understand the process of material management. The proposed approach will be helpful to other countries which need to develop their material management processes.

CHAPTER ONE: INTRODUCTION

This chapter presents the context for this research. It starts with a brief background to the research and then justifies the need for the research. Research questions are presented together with the research's aim and objectives, research methodology adopted, and a brief remark on the research contribution. The chapter concludes by outlining the structure of the thesis.

1.1 Background

The construction industry is vital for the development of the country's economy. In many ways, any nation's economic growth rate is measured by developing physical infrastructures, e.g., buildings, roads, tunnels, and bridges (Oke et al., 2016). In the construction management site, the materials management process is key to a construction project's success. However, many problems affect it, such as improper handling of materials during site activities (Kasim, 2011). The inappropriate handling and management of the materials on the construction sites can hinder project performance (Gulghane & Khandve, 2015).

Material is the main component in the construction projects. Therefore, if the material management is not in a controllable state; it will create project cost overruns. Construction management can control the project cost by taking corrective actions towards the cost variance (Kulkarni et al., 2017). Consequently, construction companies need efficient materials management measures to control productivity and cost in the construction projects (Ahmad et al., 2018).

Materials management is a crucial function that improves construction projects' productivity (Ahmad et al., 2018). However, many problems impact the materials management functions, e.g., constraints on storage areas, site logistics regarding materials handling and distribution,

and ordering and delivering materials to the construction site. Other issues include waste material management, proper planning of logistics (Kasim, 2011), transportation obstacles, inappropriate materials delivery (Tedla, 2018), manual processes, non-compliance with specifications (Dey, 2001), and late delivery (Aibinu and Odeyinka, 2006). According to the Libya's Public Project Authority (PPA) (2010), construction projects started under trying conditions and then went into an evolution process at the time of oil discovery in 1951. Construction projects mainly depended on oil revenue. Over the last four decades, there has been an improvement in the Libya's public construction, which became a vital business contributing 5.2% to the gross domestic product (GDP).

The role construction projects play in the Libyan economy is huge; they create jobs and wealth. According to Omran et al., (2012), the construction projects constitute an important business that makes a contribution of 5.2% to the national Gross Domestic Product (GDP). On the other hand, construction projects in Libya encounter numerous difficulties that hinder realizing their goals; these include labor, machinery, materials and the market. What negatively impacts construction projects' implementation is the inappropriate dealing with materials while performing site activities. Yap et al., (2017) confirmed that the improper handling and the mismanagement of materials on construction sites relentlessly hinder project performance. What significantly affect materials management activities are issues such as restrictions on storage areas, delivery of materials to the construction site, site logistics and materials mishandling, distribution and ordering.

Earlier research studies also highlighted certain materials management issues, such as inappropriate storage (Ahmed, 2017), transportation problems and improper materials delivery (Tedla, 2018); proper storage requires large storage capacity (Agapiou et al., 1998). Other related issues comprise nonconformity with specifications and manual processes (Dey,

2001); besides materials shortage (Alfakhri, 2017) and late delivery (Aibinu and Odeyinka, 2006).

Considering the accessibility of raw materials, Libya possesses the biggest cement factories in North Africa; they are located in Derna to the east of the country; besides, other factories situated in Benghazi, Tripoli, and Sabha, together with an iron steel factory in Misrata (Nagab, 2007). However, Salah and Bloomer (2013) stressed that the sources of building materials and construction in Libya are rein steel, blocks, cement, and finishing mat. This means that there is a dire need to make use of materials management practises to deliver materials to the site projects when needed since the main aim of materials management in construction projects is to reduce delivery time (Handfield et al., 2005). Murali and Yau (2007) agreed with Handfield and added that any delay would increase cost, reduce the feasibility of the project, and fail to contribute to the society's development.

Libyan researchers have conducted several studies during the last few years, although most discussed construction delays without recommending the need for materials management (Shebob et al., 2012; Abdullah et al., 2002; Abdelnaser et al., 2005). The exception is Mustafa (2009), who observed that most of the delay factors are related to materials management which plays an essential role in saving time and reducing costs while retaining quality. One of the difficulties facing construction project staff in Libya is that they mainly depend on foreign experts. Currently, the projects need improvement and development to meet the national housing supply and infrastructure needs: new homes, airports, seaports, railways, and roads. Hotels, office buildings, and resorts are also required to meet the potential tourism needs (Ngab, 2007; Mostafa, 2009 and Shebob et al., 2012).

There are several varieties of approaches, which address the materials management issues. These comprise Just-In-Time (JIT) concepts and appropriate planning of materials logistics to

determine space restrictions along with the Implementation of Information and Communication Technologies (ICT) such as bar-coding which is used for tracking materials automatically. Nonetheless, there are no positive examples on how such tools productively improved materials management on construction sites.

1.1.1 Geography of Libya

Libya located in the North Africa; it extends over 1,759,540 square kilometres. It is the 4th largest country in Africa and the 17th in the world. 90% of Libya is a desert. Libya also has the longest Mediterranean coastline, 1770 kilometres (1100 miles), and its climate is mostly dry, desert-like except in the north (Mediterranean climate). Libyan's population is growing by 3.5% annually. With half of the people under the age of 20 and more than 85% living in cities, there is an urgent need for new homes, schools, hospitals, and infrastructure facilities. In the next decade, there is a need for approximately 500,000 homes. (See Figure 1.1: Infrastructure of Libya)

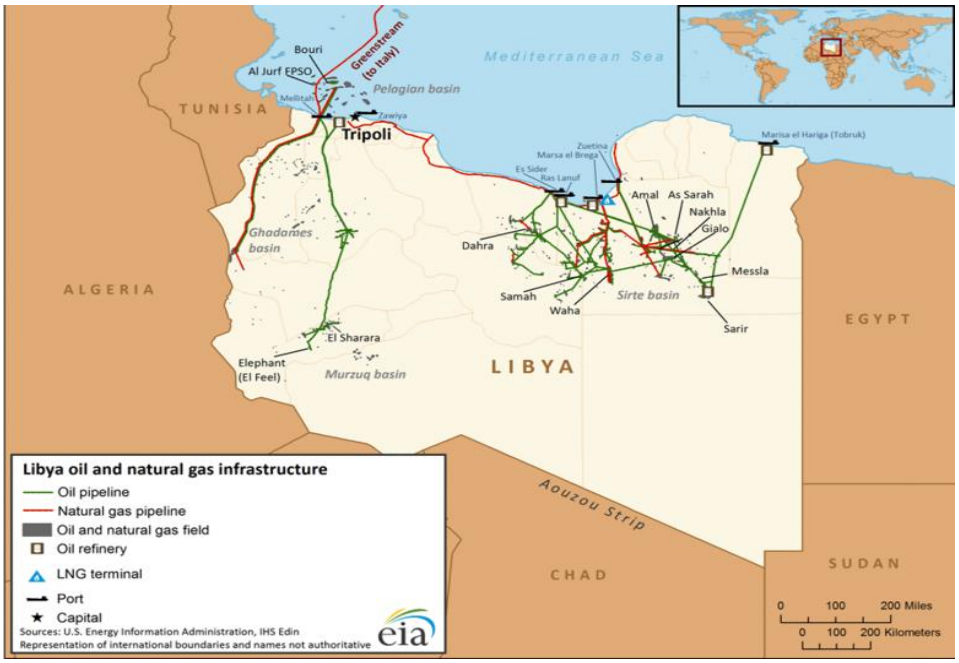

Figure 1.1: Infrastructure of Libya

1.1.2 Construction material management in Libyan projects

Numerous construction projects of the 1970s sponsored by government created a flourishing industry to the extent that by the end of the decade, Libya turned into the world's leading position with respect to the consumption of cement per capita. This was a vital economic achievement for Libya; particularly since the 1978 housing law effectively eliminated the private 112 residential construction project in 1986. Construction contributed almost 11 percent of GDP´; it comes next only to the public services in the non-petroleum area (http://countrystudies.us/libya/61.htm).

As with many developing countries, inappropriate material management of the construction projects in Libya is a common issue and it is often considered as a significant source of poor performance. This current issue is one of the main reasons that contribute to the cost and time of overruns (Ngab, 2007). The Libyan construction industry and its associated processes and operations appear to be restricted by many issues. The time and cost overrun were the significant issues associated with Libyan projects. As a result, hundreds of construction projects have become worn out during the construction stage. When delayed, the activities comprising construction projects had often totally stopped. The public has consequently lost hope of a few being successful. Furthermore, the high demand on construction projects is expected in future years (Shebob et al., 2012). The Libyan construction industry has a poor image in the construction market due to its low performance over the past few years.

Libya is considered less advanced in construction management than other developing countries due to a lack of knowledge, financial training, effective managerial strategies, technical capabilities, and experience within the Libyan construction companies. Also, the lack of commitment on the part of foreign companies has negatively affected construction

projects in Libya (PPA, 2010). Thus, the construction sector needs to adopt a new strategy to improve its performance.

Material management is an important function for enhancing productivity in construction projects (Ahmad et al., 2018). Like any developing country, the lack of computer technology use in the Libyan construction material management process impacts projects' execution in terms of time, cost, effort, and quality. Libya suffered from a lack of appropriate infrastructure and buildings in almost all sectors before the Arab Spring of 2011. Reconstruction resulting from this war has been estimated at over (£200 billion); more than half of this amount will be spent on concrete (cement, steel, aggregates, and sand), blocks, glass, timber, metals, and finishing materials (Salah & Bloomer, 2014).

A key factor in constraining construction activities is the scarcity of critical building materials and basic materials (Veraart, 2018). Libya has a severe problem; it is unable to produce the materials and components needed by the construction industry, and many are sourced from outside the country. The Libya construction industry spends more than half of the projects cost on materials. With a lack of experience in the procurement of materials process, the Libyan construction companies have not given due attention to this aspect. Experience, visual survey, and observations have confirmed that the materials used do not live up to the required standards in production, storage, and transport (Salah & Bloomer, 2014). On the other hand, countless projects have been delayed and failed in Libya because of a lack of the contractors' efficiency and expertise (Elsayah, 2016).

Stakeholders involved in the material management process are essential for the project's success (Nguyen et al., 2009). However, after 2011, Libya increased the number of foreign workers who came to live and work in Libya; they occupied highly skilled jobs due to the limitations experienced by the Libya's human resources. The number of immigrants has

augmented in recent years; most of them have come from different countries such as Egypt, Syria, Bangladesh, India, and Pakistan due to the changes in the country's political and economic scenarios. Most of these people work in construction companies; they are unqualified, and they lack skills and experience https://publications.iom.int/system/files/pdf/ch24-labour-migration-dynamics-in-libya.pdf.

Therefore, to improve the Libyan construction industry functions, it is necessary to understand the material management strategies. All the above problems affect the project management process and subsequently impact the construction project's profitability.

1.2 Research gaps

Construction stakeholders are those people involved in the project. It is vital to identify all the project stakeholders upfront. As individuals who are crucial for an organisation's survival, the stakeholders can affect the achievement of the organization objectives (Eyiah-Botwe et al., 2016). The list of possible stakeholders is extensive; it may include contractors, clients, designers, planners, consultants, employees, subcontractors, suppliers, and project managers who are significant participants in many construction projects. Olander, (2007) and Jin et al., (2017) defined stakeholders as any group of people who can impact or are impacted by achieving the company's objective (Olander, 2007). However, a small number of studies adopted the stakeholders' perceptions to understand the kinds of strategies stockholders use to impact companies and their decision-making (Frooman, 1999: 193: Aaltonen et al., 2008: 509).

It is crucial to identify and analyse those stakeholders' perceptions of project decisions (Olander, 2007: 278). Researchers in construction building theory should be concerned with people who contribute to decision making and who benefit from the outcomes of such a decision (Olander, 2007: Aaltonen et al., 2008: Jin et al., 2017). Also, Nguyen et al., (2009)

affirmed the necessity to scrutinize and assess the stakeholder impact index application in construction project management in diverse places and stages.

Material management functions include planning, material take-off, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution (Bell and Stukhart,1986: Jusoh & Kasim, 2017). It is crucial to manage all materials from the design stage to the construction stage (Kasim, 2010). There is extensive literature on handling material management on site; however, one needs to consider the material management process in detail. Each of the following studies focuses on a different function process (Plemmons & Bell, 1995; Kasim & Ern,2010; Mehr & Omran, 2013); Gulghane & Khandve, 2015: Kulkarn et al., 2017; Jusoh & Kasim,2017; Tedla & Patel,2018).

In developing countries, the construction industry's material management process is still in its infancy (Kar & Jha, 2020). Besides, there is limited research in the literature related to material management in developing countries, and little research investigates the material management process (Kar & Jha, 2020). Despite the importance of material management, few research types considered Libya (Salah & Bloomer, 2014).

There are various factors that impacted material management, and each of these factors can give rise to potential problems. Many of these factors contribute to poor material management in construction project performance. Some of the crucial factors that impact material management from the project stakeholders' perspective are inadequate knowledge and experience (Ahmad et al., 2018). These factors include lack of planning, transport and waste improper handling, lack of resources, procurement, storage, technology, and inappropriate equipment (Phu & Cho, 2014). Construction material management suffers from external factors, (factors outside stakeholder control), such as the weather and political

situation. There are many studies on material management; however, little research was conducted by the researchers and practitioners investigating the problems faced by the construction industry (Jusoh & Kasim, 2017).

1.3 Research Questions

Q1: What are the professional stakeholders' perceptions (contractors, consultants, and project managers) regarding the material management process activities?

Q2: What techniques are used by practitioners to determine the significant construction functions that improve the material management process?

Q3: What factors currently influence the Libyan construction projects' material management process?

1.4 Research Aim and Objectives

The study aims to develop a framework that improves materials management on the Libyan construction sites. The goals will be achieved by examining the Libyan construction context and its characteristics from the Libyan professional construction experts' perspectives.

The objectives of this research are to:

- Critically review the existing literature on the materials management process in the construction industry
- Identify the perceptions of the professional stakeholders (contractors, consultants, and project managers) currently involved in the material management process,
- Evaluate the current situation to determine the functions that can be used to improve the material management process.
- Determine the factors that currently influence the Libyan construction projects' material management process.

- To develop framework for material management in Libyan construction industry.
- To provide recommendation for improvement of Libyan construction industry in material management on sites.

1.5 Research Justification

Libyan researchers, over the last twenty years, have focused their research on the causes of delay in the construction projects; however, a few studies have touched on the materials management role in overcoming these problems through implementing processes such as coordination, planning, and monitoring with the aim of controlling quality and optimising the use of materials (Shebob, 2012 and Salah, 2014). Consequently, this study will be the first of its kind to display the current material management techniques and strategies. Comparing the diverse approaches will offer the professions deeper insight into these strategies. Furthermore, this study will illustrate the causes for unsuccessful material management practices applied to control the current and future projects.

Additionally, the study will clarify how these causes are related to the current material management practices making the stakeholders more cautious. The stakeholders are weak with respect to the most concerning issues such as cost overrun and the delay of the project delivery materials. Apart from the fact that this research is beneficial to the field professionals, the study is also precious to the academicians.

This study findings support those arrived at by other researchers who have investigated material management in construction projects. Moreover, the study will provide valuable information to researchers interested in probing into this definite case or one similar to it. The research findings will serve as a general framework to the Libyan construction industry stakeholders. This study will also highlight the importance of training workers on-site, making them aware of the newest techniques. The machinery has to be well-operated

regularly to evade any breakdown. This will definitely result in an increase in productivity. Tedla et al., (2018) observed that laborers and contractors should be properly trained to accomplish a specific task.

1.6. Contribution to Knowledge

According to the literature, several studies are conducted on material management (Plemmons & Bell, 1995; Kasim & Ern, 2010; Mehr & Omran, 2013; Gulghane & Khandve, 2015: Kulkarn et al., 2017; Jusoh & Kasim, 2017; Tedla & Patel, 2018; Kar & Jha,, 2020); however, each study viewed the topic from a different angle. None of the models cited above gives details on how to improve the construction material management of a specific country.

Most of the current research related to material management has been conducted in developed countries. Little research has been carried out on construction material management in the Middle East. Therefore, the field of construction needs a study that presents information about a developing country, particularly after the Arab Spring. This study about Libya, a developing country, adds to the existing body of knowledge.

This study contributes to knowledge by understanding the process of material management of construction projects. This study addresses the gap in the construction industry literature by considering the practitioners involved in the current situation related to material management in Libya construction companies to recognise their perceptions. It also defines the input attributes offered by providers and highlights the importance of considering other aspects related to material management, such as skills, experience and staff training. The findings also reveal Libya's failure to choose a project manager and contractor with experience and skills.

Another significant contribution is that this study highlights the importance of communication between the team members, one of the leading components in developing

material management. This study suggests that the contractor and project manager should focus on cooperation and relationship between the project team members to create awareness and to help the staff understand the construction project process.

Additionally, it provides information on the type of adjustments that need to be incorporated into the Libyan construction to mitigate the mistakes made and their impacts on the work. Although this research was carried out in Libya, the results can be generalised to other countries with slight modifications considering the similar construction characteristics.

This study designed a model to ensure that the entire material management activities are included. The model is straightforward and practical; it is appropriate for developing Libya's construction material management. This model can be applied to any project, company, or country to improve its material management processes. The proposed model will help the Libyan construction practitioners develop their project material process; it may also help them change their strategy and improve their work.

This study is a valuable resource for academic researchers and students interested in understanding the process of improving construction material management. It will contribute to knowledge by providing a significant database for another researcher in this area, helping the reader to understand the factors that would impact the material management process. It makes another practical contribution by using a mixed-method approach to help Libyan construction authorities address their construction sector's issues, particularly the negative factors.

1.7 Methodology and Methods

The explanatory sequential mixed-method approach is adopted (see Figure1.2) to analyse the Libyan construction material management and process activities. It makes use of the quantitative and qualitative data collection techniques and analysis procedures; an online

questionnaire is used to collect the views of the Libyan construction stakeholders, 120 respondents (Chapter 5).

Semi-structured interviews were conducted to collect data from the Libyan construction project critical authorities; the interviews focussed on the material management process, involving project managers, contractors, consultants and site managers (Chapter Six). The qualitative approach provides the researcher with in-depth information on the research issues.

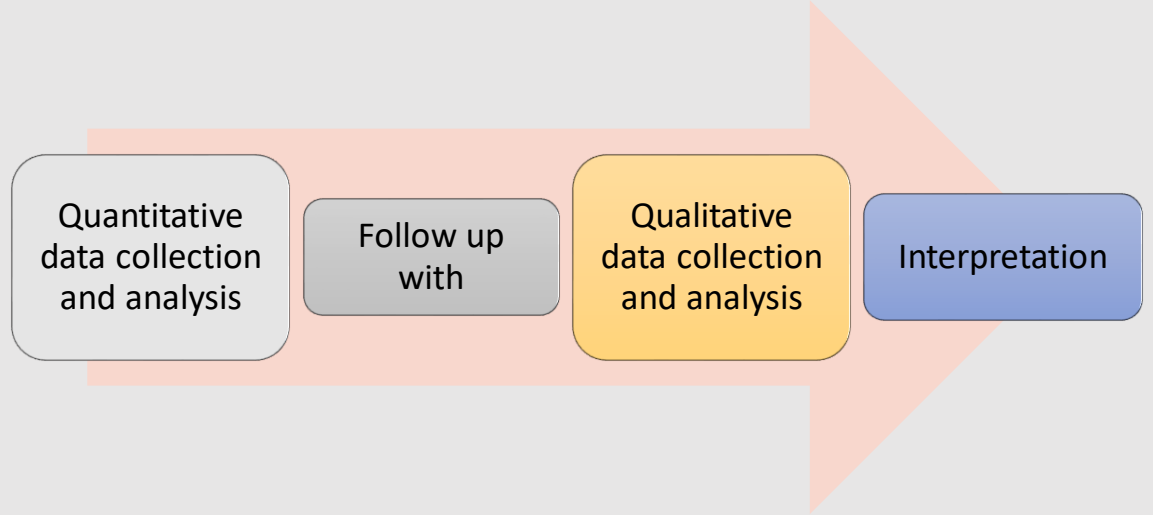

Figure1.2 Basic Mixed Method Design (explanatory sequential mixed method)

Source: Creswell (2014:220) &Saunders et al (2015:170)

The pragmatist's view is adopted in the current study, together with the qualitative and quantitative approaches and the inductive and deductive logic. Its epistemology combines both the interpretive and the positivist positions. Its ontology combines both subjective and objective points of view to help interpret data.

A single case study is selected since it helps the researcher gain deep understanding of the research phenomenon. To realise the study primary aim, a model for the construction of material management is developed.

First, data are collected and analysed separately; then, they are compared and combined. The comparison aims to identify the material management process and to determine the model's elements; the comparison is highlighted in the discussion chapter (Chapter Seven).

1.8 Thesis Structure

Chapter One: introduction. This chapter presents the context for this research. It starts with a brief background to the research and then justifies the need for the research. The research questions are presented; they address the research aim and objectives; the chapter also presents the research methodology adopted, and a brief remark on the research contribution. It concludes with outlining the structure of the thesis.

Chapter Two: the literature review. This chapter provides a critical review of the literature related to the construction projects to define the factors and moves on to the factors that contribute to the construction projects' success. It begins with presenting a definition of material management in construction; it also discusses the role of supply chain management (SCM) and lean construction (LC) as related to the construction sites and concludes with the presentation of a theoretical framework.

Chapter Three: Conceptual Framework. This chapter makes use of the information presented in the Chapter Two to introduce a conceptual framework that would contribute to minimising the wastage of materials and control cost and quality within the Libyan construction site. It will subsequently be modified in line with the analysis chapters' results and converted into a final framework in the discussion chapter.

Chapter Four: Methodology. It defines and determines the methods used for conducting a research investigation as an integral part of the whole research process. The readers can understand the different methods and techniques used for conducting the research work.

Moreover, the researcher can use this chapter to ensure that the study is carried out efficiently and effectively.

Chapter Five: quantitative data analysis. The chapter starts by presenting the analysis and research findings of the questionnaire. It falls into three parts: the first part presents the position of material management and its relation to the Libyan construction site, the second part identifies the factors that mostly affect material management, and the third part presents the whole sample, applying factor analysis to identify the important factors that should improve material management. All these techniques were undertaken using the statistical package SPSS, version 23.

Chapter Six: Qualitative data analysis. This chapter presents the qualitative findings of the interview data to establish a rich, in-depth picture of the issues explored in this study. The chapter describes the data gathered via the use of semi-structured interviews. Semi-structured interviews are regarded appropriate, as they offer an opportunity to ask more follow-up questions. This would make it possible to explore the viewpoints of the construction company professionals when required.

Chapter Seven: dissection chapter. This chapter aims to triangulate and discuss the results of Chapters Five and Six and to link them to the literature review in Chapter Two. A model is then proposed for improving material constructions management, the main research aim.

Chapter Eight: Conclusion and recommendations. This chapter wraps up the main points in the discussion chapter and presents the research contribution with recommendations to the Libyan construction authorities and other countries. It acknowledges the limitations and makes suggestions for further study.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter provides a critical review of literature related to the construction projects; it aims to define factors that contribute to the success of the construction projects. It first defines the material management in construction and then it discusses the role of the supply chain management (SCM) and lean construction (LC) in the construction sites and concludes with the presentation of a theoretical framework. The literature review is based on the acknowledged literary sources, the evaluation of the proceedings of the various seminars and conferences and the written articles that deal with the subject matter as well as those published online. In the meantime, all the factors of postponement that might be experienced during the construction project completion scenario were focused on. This led to the recognition of the probable elements which precipitate the time schedule of the project.

2.1 Materials Management (MM)

Materials management is the process, which links supplies and organisations in order to obtain a high standard of service ensuring that the right materials are available on the construction site at the right time and at the lowest cost possible (Safa, 2014). Madhavi et al., (2008) identified materials management as a process of planning, implementing and controlling the right source of equipment of a specific quality at the right place and time for an optimised cost-construction process. Agapiou et al., (1998) added that successful materials management and reduction of the project cost involve three critical phases: purchasing, storing and using.

Ayegba (2013) examined the materials management as applied to building construction sites in Niger, focusing on the methods of procurement and the factors affecting the management of the construction site, suggesting measures for effective materials management. The present

researcher also highlighted delays either caused by the materials supplier, or they are the result of unskilled supervision, poor site security, weather among other natural occurrences, such as alterations of designs, theft, over-ordering of materials and vandalism. This all leads to the wastage of materials on building construction sites in Malaysia. However, Abdul-Rahman et al., (2006) identified the shortage of materials as an important factor in the Libyan construction projects.

Hannure and Kulkarni (2014) observed that the materials management is a scientific technique concerned with preparing, organising and control of the flow of materials from their initial purchase to the end users. They recommended carrying out materials management processes to minimise wastage and damage to the material, and to overcome shortages, lack of storage space, and delays in supply. In Libya, Amar et al., (2015) observed that building materials in construction projects have to be properly managed and made suitable to the project; besides, they have to be cheap with good quality and delivered on time.

In Afghanistan, Ghulam and Kassim (2012) identified the high price of materials, the fluctuation in availability and the estimation of quantity as major problems in the construction projects, leading to cost overrun. In Libya, Shebob et al., (2011) specified the most critical delay factors in the construction projects as those involving delays in materials delivery together with the increased cost of materials. Furthermore, materials management in Libya is required to control the waste of material on site (Bennett et al., 2011).

Abdelnaser (2012) concluded that in Libya good material management could safely improve labour productivity. For instance, work time can become unproductive or idle time due to the lack or shortage of equipment and tools in the right place at the right time. Also, double handling, due to the distance of storage from the site, can affect the availability of materials. Materials quality and availability, therefore, can impact critically the project's success. As for

labour- and productivity-related factors, a United Nations report (1995) stated that two broad sets of factors affect the site worker's productivity requirements: organisational continuity and execution continuity. Abdulbagei et al., (2012) and Kasim (2008) agreed that materials management is essential to manage productivity and cost efficiency because these two parameters contribute to the major portion of expenses in the construction projects. Moreover, it can reduce the total project costs and help to complete the project on time by controlling procurement, carrying value.

2.1.1 What is material management?

Distinctive researchers tend to provide different definitions to the process of material management. This leads to the diversification of the various referencing points concerning diverging definitions. Fundamentally, management of construction material is related to arrangement, plan formulation, information and material acquisition, stockpiling and ensuring the flow of material. The reason for indulging into the material management is to guarantee that the correct materials are in the perfect place and in the correct amount when required. The duty of the material management officer is to make sure that the construction material is procured, received, stored and distributed on site in accordance with the established guidelines.

According to Mouton (2013), proper management of construction material refers to the methodical procedure of plan formulation, acquisition, preservation and transportation of such materials which could be necessary for construction purposes. It is oriented towards the judicious utilisation of resources such as capital, workforce personnel and even technical facilities.

Doleeb (2016) defined the process of managing construction material as the sequential procedure utilized to arrange the necessary material and equipment at the appropriate moment

to the place where it is necessitated. It is performed to minimise the cost incurrence of the production process and to control the supply of materials in an effective manner. According to Wild (2017), the structure of the material management requires organising procedures in such a manner that they take into account the necessities of co-ordination, and supervision of the necessary supply chain of materials, with a specific end goal, utilizing the assets in a judicious manner and keeping the expenditure down to the bare minimum extent. Mogalli and Hussein (2017) pointed out that the structure of management of materials is necessary to the design and planning procedures and to the arrangement of resources, ensuring the qualitative warehousing and preservation along with the supervision of the utilisation of materials, and ultimately bearing the material costs; all these efforts have to be interdependent and related to each other.

The responsibilties of a manager regarding the supervision of materials in an association are entirely specific regarding cost reduction under the prevailing circumstances. The individual accountable for dealing with materials should bear in mind the objectives of the organization guaranteeing that the organization does not be pay additional cash for materials. The objective of each organization is to make profit. This is the reason for the organization survival; the expenses ought not surpass the revenues incurred (Tersine and Campbell, 1977; Ammer 1980 and Stukhart 1995).

The responsibilties of the mateiral management offcial include:

- Purchasing materials and procruement of the necessary equipment

- Fast-pacing the development efforts

- Planning material management

- Handling the procured management

- Distributing the procured material

- Controlling the cost incurrence

- Managing the product inventories and the material storage

- Utilising the mateirals after finalising proper purchase, transportation and procurement.

The essential responsibilities of undertaking the acquisition and purchase of the materials are meant to be effective processes to achieve cost reduction and to maintain quality considerations. The process of expedition involves the relentless supervision of suppliers to obtain the necessary resources in a timely manner. The reason for material management is to acquire and provide the necessary materials on time and to keep the stock ready to take care of the prerequisites. The essential capability for handling the materials in the most effective manner involves maintaining the flow of materials at a consistent pace for the organisations.

The administrator or manager requires ensuring that the expenses related to the management of materials are kept to a minimum. Regarding cost control, the business administrator needs to ensure that the expenses to purchase materials are kept to a base. At the end of the day, the business administrator needs to secure that he could purchase the items at the bare minimum conceivable cost.

2.1.2 Importance of Materials Management

Materials management is the process that links supplies and organisations in order to obtain a standard of service guaranteeing that the right materials are available on the construction site at the right time and at the lowest cost (Safa, 2014). The criterion of successfully completing any construction project is always incumbent on the management of materials in an efficacious manner. Patil and Pataskar (2013) and Gulghane and Khandve (2015) agreed that the fluctuation of costs of such material, concerning the completion of the projects, could

amount to any extent between 20-70% of the complete construction project expenditure and on occasions, this could exceed the general cost ceiling of 70 %. The sustainable management of material generally yields several advantages. Many authors highlighted the importance of material management (see Table1 2.1 below).

Table 2.1: **Important of materials management. Source: Author**

Authors	The Importance of Material Management
Hannure and Kulkarni (2014)	Materials management is a scientific technique concerned with preparing, organising and control of the flow of materials from their initial purchase to the end.
Safa, (2014)	Materials management is the process, which links supplies and organisations in order to obtain a standard of service ensuring that the right materials are available on the construction site at the right time and at the lowest cost.
Abdulbagei et al. ,(2012)	Materials management is essential to manage productivity and cost efficiency which contribute to the major portion of expenses in construction projects. Moreover, it can reduce the total project costs and help complete the project on time by controlling, procurement and carrying value.
Mouton, (2013)	Proper management of construction material could be defined as the methodical procedure of plans formulation, acquisition and preservation and transportation of such materials which could be necessary for construction purposes.
Doleeb, (2016)	Materials management is a sequential procedure applied to arrange the availability of the necessary material and equipment at the appropriate moment to the place where it is necessitated.
Mogalli & Hussein (2017)	The structure of materials management is necessary to design and planning procedures, and arrangement of resources, ensuring the qualitative warehousing and preservation, supervision of the utilisation of materials, ultimately bearing the material costs.
Salah and Bloomer (2014)	The associated factors material management are inventory management, store operations, handling of purchased materials and transportation of the finalised

	products and components.
Abdelnaser (2012)	Proper material management improves labour productivity. For instance, work time can become unproductive or idle time due to the lack or shortage of equipment and tools in the right place at the right time.

In their study on material management techniques and their effect on construction projects, Adita and Sabihuddin (2013**)** demonstrated that following functions: planning and material take off, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution are the most important ones in construction industry. They conducted a survey of the industry, determining various formats for materials management and tracking systems and software technology developed for the management of construction materials. They estimated that the total cost of material might be 52% of the total costs; so, it is important for the contractor to consider the timely availability of material as one that contributes to the successful completion of the project. Materials management is thus essential to successful project management.

Kabede et al., (2018) examined the problems of construction materials management in residential projects, addressing current practices to identify issues and to apply better control (ABC) analysis and S-Curve analysis. However, there is a problem with introducing new technologies such as RFID, ICT and bar coding for material tracking and management. Therefore, the researcher recommends further study in this area. Caldas (2014) stated that the programme of comprehensive materials management could contribute to reducing cost, improving productivity, and securing better quality and more predictable project outcomes. The author concluded that although the role of materials management is expanding in the early phases of capital project planning, IT systems continue to improve real-time coordination and course correction. The study recommended that materials management

should influence IT system selection and integration during project planning, and that training programmes should be integrated to improve the use of materials management IT systems.

2.1.3 Environmental Benefits

Environmental benefits entail the processes of conserving the existing natural resources, mitigating energy consumption and curtailing the impact of such projects on the environment so that they do not negatively impact the life cycle of virgin products with the purpose of reducing the demand of such products; the ultimate objective is to conserve the spaces where landfill could have taken place.

2.1.4 Economic Benefit

This involves the curtailment of the disposal costs and the costs associated with the transportation mechanism of the construction material which generally could achieve the pruning of the costs of purchase as well. This could occur regardless of the fact that construction materials, which are non-virgin regarding their sources, are generally less prone to incur costs similar to those of the virgin recourses. Such benefits could enable the contractors to become more competitive as they could place their bids at reduced costs. They also formulate various opportunities of employment and extend the horizon of financial activities, which could contribute to the expansion of the industry of recycled and reusable products.

2.1.5 The use of materials on construction site

Bailey and Farmer (2002) observed that construction materials are primarily sourced and purchased from the organisations which generally furnish manufactured products. According

to Chandler (2001) the materials of construction could be categorised on the basis of the measures of their constitution as well as the process of their handling, regarding the construction sites. Such process could include:

Bulk materials which are generally transported and delivered in large bulks through cargo containers,

Bagged materials which are specific materials generally transported and delivered in various bags for the purpose of control, proper utilisation and easy handling,

Pelleted material which are bagged and transported in pellets to the delivery stations,

Packaged material which are mostly related to the immediate onsite construction operations and are packaged carefully to prevent the occurrence of any damage during the course of transportation to the construction sites; packaging is also necessary to properly store the materials and to ensure that deterioration and decay of the valuable materials never occur,

Loose materials which are unique concerning their partial fabrication; these can be handled on individual basis.

Construction materials could be envisaged as the core constituents regarding the various applications of the modern technological processes; they could be visualised as the most effective formation concerning the construction activities. Each engineering sector is closely associated with such construction material and the industry related to the construction material which is closely responsible for the increment of the national output, regarding the rates and the qualitative measures of the construction projects. Such construction materials are mostly purchased through the standard lengths and bulk quantities. Such materials could be identified as cables, pipes and wires. These are primarily complicated with respect to the necessities of planning as the uncertainties are associated with the quantity of construction

material which could be necessary for the completion of any construction project. Such engineering and construction materials are generally constituted on a project specific basis, regarding the particularities associated with such projects. Apart from this, these are also manufactured, keeping in mind the specifications of the industry, at particular production facilities which are generally removed from the construction sites.

Such construction materials are principally utilised for various purposes. They could be envisaged as ones that are formulated on the basis of minute engineering data; they have to be assembled from different ingredients to construct finished products or components necessary for the construction projects. As instances, steel beams with perforation s and beam seats, cement blocks, bricks, reinforcement bars and glass products could be considered in this regard.

2.1.6 Materials purchasing

Material management is closely related to the functions related to purchasing which reflects the authoritative responsibilities concerning the commitment of project related funds for the purpose of the acquisition of materials, services, equipment and personnel. Such responsibilities are shouldered more or less by either the field office or by the home office. A combination of both could be occasionally utilised as well. It completely depends upon the extent, scope and size of the construction project. This is necessary to ensure the consistency of the purchase undertakings (Stukhart and Bell, 2007). It is incumbent on the home office to undertake the various planning, the related policy implantation and the procedural direction issuance regarding the operations which are generally performed in the construction fields. This is necessary to maintain consistency concerning the pricing of purchased products. The acquisition and procurement efforts involve activities such as organising the procurement of

the construction materials and services such as those associated with equipment arrangement making use of the necessary measure of labour forces.

The underlying rationale of the entire process of material management could be understood as the effort of provisioning the construction materials, which have to be qualitative in nature, at the opportune and necessary moment at the construction site. The budgetary considerations should be maintained in any such material management procedure. The other related factors of the procurement procedures could be envisaged as aligning the necessary arrangement mechanisms to the direction of the expedited completion of the purchasing of materials and formulation of the schedules of the delivery of supplies and of the follow-up operations. Such procedures are meant to ensure that the spare parts supplies could be provided to the construction sites on a timely basis.

2.1.7 Transportation of materials

Material management could reflect the most unique perspective of transporting the necessary equipment, materials and construction personnel to the construction sites, a process which requires certain specialised operations elements to be implemented. The transportation aspect of such vast quantities of components should also be handled by most experienced and specialised personnel so as to minimise the cost incurrence in this regard. The project could be executed without any unpleasant delay (Ahuja and Dozzi 1994). In this regard, the most effective logistical movement encompasses the utilisation of the minimum amount of the construction material, which could be stationed at the construction site prior to assembly, and utilisation in the construction process.

The benefits of such endeavours could be understood as the maintenance of the hygiene and cleanliness of the construction site as well as the minimisation of the storage costs. Apart

from this, the benefits comprise the reduction in the incidences of any constructional risk of accident occurrence at the construction site. For this reason, a team of logistic experts is needed to undertake proper planning and maintenance of the construction sites, the production plants, and the equipment as well. To this end, the expertise related to transportation and traffic handling of such large quantities of materials and of the personnel who could be associated with the logistics team could be assistive to the project especially handling various categories of loads. These could involve products within an extensive rage ranging from sensitive electronics to enormous modules of equipment (Bailey and Farmer, 2002).

2.1.8 Materials Handling

Inappropriate handling of materials on site is a significant issue that badly affects the performance of construction projects (Kasim et al., 2008) and can hamper project achievement (Ogun, 1996). Shebob et al. (2012) identified significant issues which affect the management of materials activities, such as restricted storage areas, site logistics in relation to materials handling and delivery, and also arranging and posting of materials on the building site. Previous studies have discussed further issues of materials management, such as unsuitable storage (Canter, 1993; Agapiou et al., 1998); difficulties of transportation, and untimely delivery of materials (Zakeri et al., 1996); non-compliance with specifications (Dey, 2001); late delivery (Aibinu and Odeyinka, 2006); and lack of materials (Abdul-Rahman et al., 2006). However, Akbar et al. (2013) stated that there are many approaches to addressing materials management problems, including proper planning of materials, and the Just-In-Time (JIT) concept. Tompkins and White (1984) define effective material handling as using the right method, amount, material, place, time, sequence, position, condition, and cost. This

involves handling, storing, and controlling of the construction materials. 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 material handling system. Material handling equipment selection is an important function as it can enhance the production process, provide effective utilization of manpower, increase production and improve system flexibility (Chan 2002). Sadiwala (2007), affirmed the following improvement of materials handling system which are: Motion which implies that materials movement from one place to another should be handled efficiently to eliminate avoidable movements so as to minimize cost, Time which indicate that materials handling officer must ensure materials get to, or remove from production unit at the right time, Place that materials should be at the right place at the right time to enhance smooth operations, Quantity: which means that materials supply to, or remove from the right place should be according to operating unit demands and Space: which means efficient storage space is paramount to achieving the objectives of materials handling system and overall organization goals.

Tompkins and White (1984) identified that efficacious handling of construction material could be inclusive of the factors such as proper methods, accurate amount of construction materials, conformation of the time schedules and sequences of material delivery at the construction sites, positioning of purchase bid, construction project conditionality maintenance and cost incurrence control. This entire process also involves the operations such as storing the purchased material, handling of the same and controlling of the entire lot of purchased construction materials in a suitable and effective manner.

The movement and placement of the materials for the purpose of construction could as well be envisaged to be related to the components of the flow of logistics for the project performance completion. The significance of proper and meticulous utilisation as well as handling of materials is featured by the way that they could be purchased and by the fact that these materials are utilised to complete the critical operational sections of the project undertakings. Because of the recurrence of the frequency necessity of handling of materials, the contemplations and considerations of quality maintenance are as well undertaken when outlining the material handling processes and frameworks.

Material handling and the selection of the hardware for the same could be considered as critically significant as it can upgrade the production procedures, enhance the capacity of labour quality improvement, increment of delivery capacity and could improve the adaptability of the project framework to inclusion of different working processes (Chan 2002). Sadiwala (2007), averred that material handling mechanism could be inclusive of a range of improvement potentials.

The first one could be identified as Motion which could insinuate to the movement of the construction material from various points of initiation to the destination points. This could be improvement on part of the efficiency enhancement to weed out redundant movements which could lead to the minimisation of cost incurrence. The second one could be envisioned as cost which could imply that it is always the prerogative for the responsible officials of material handling to assist the process of transportation of the construction materials to their destination points. This also involves the removal of all the material from their production units at the opportune moment. The third is associated with the Place where the construction materials could be deposited to or could be transported to. It is necessary for the maintenance of the time schedule of the construction operations.

The next category is associated with the Quantity of the materials which involves the demands of the supplied material as per the necessity of the unit operating specifications and the cost incurrence which could be outlined in the project budgetary management. The final one is directly associated with the Space factor of the material storage areas. This is significant from the perspective that efficient storage handling procedures could be tantamount to achievement of the necessary project objectives regarding the overall systematic handling of the purchased and available construction material.

2.1.9 Waste of Materials

Waste material is one of the most serious problems in construction projects; it makes a difference between the estimated and actual consumption of individual items (Kambiz et al., 2016; Gulghane and Khandve, 2015). Kulatunga et al., (2006) noted that by implementing waste materials practices, construction projects improve and achieve economic, quality and sustainability goals. Vivan et al., (2007) and Lingard et al., (1997) argued that by implementing waste materials practices, contractors can reduce the cost of construction projects. Construction waste materials planning also helps to achieve benefits such as cost reduction in purchasing materials (Nilupa et al., 2015; Guthrie, 1998; Jaillon et al., 2009). However, Formoso et al., (1999) and Mohammed and Anumba (2006) explained that although waste material is a loss that incurs various costs, it does not add any worth to production.

Stock control is classified as a technique devised to cover and ensure that all items are available when required. Stock control can include raw materials, processed materials, and components for assembly; besides, consumable stores, general stores, maintenance materials and spares, work in progress and finished products (Prabu, 1986). It is of great importance that the bulk of the construction materials delivery requires proper management of stock

control. Meanwhile, construction activities can generate an enormous amount of waste (Teo, 2001); it has been recognized as a major problem in the construction industry (Formoso, 2002). However, tighter materials planning can reduce waste and directly contribute to profit-improvement and productivity. Reduction of waste can be carried out by practicing attitude towards Zero wastage, proper decisions at the design stage, site management, proper standardization of construction materials, and codification of the same construction waste, which can also be reduced by using a waste management system on project. The project activities are to be planned at every stage by every construction personnel, who are involved, in minimising the overall waste generation at project (Thomas, 2013).

2.1.10 Material waste control

Controlling the stock of construction material could be identified as the utilised mechanism to ensure the possibility of encompassing the entire range of building or construction materials as per the requirement of the construction operations. Controlling the stock of the material generally includes the processed or raw materials, assembly components and stores which are utilised for general purpose operations at the project construction sites, materials which could be consumable in nature, spare parts and other materials which are necessary for maintenance purposes and ultimately the products which could be under progression or completion (Prabu, 1986). It is of incredible significance that the main part of the construction materials requires appropriate administration of stock control regarding their transportation and delivery. In the interim period, construction undertakings and related exercises can create a tremendous measure of industrial waste material (Teo, 2001). It is perceived as a noteworthy issue in the construction sector (Formoso, 2002).

In any case, additional research in integration management could provide higher standards of material handling and management planning which could lead to the reduction of waste

material. This could be performed through the adoption and stringent practice of Zero waste-based principles. It could primarily contribute to the enhancement and multiplication of productivity and quality management of the construction material. Another prospect for achieving reduction of construction waste could be interpreted as the codification of the construction materials into specific categories. This involves consistent and pre-meditated planning process at every phase of the project operations. The engagement of every construction person into such planning process is necessary and the minimisation of the complete generation of waste at the entire project undertaking could be the outcome in this regard (Thomas, 2013).

2.1.11 Just-in-time method (JIT)

The acronym JIT has been exceedingly obvious since late 1980 as the manufacturing processes endeavoured to address aggressive difficulties by receiving recently developing administration hypotheses and methods, alluded to as Lean Production (Akintoye, 2005). Stock (2001) expressed that Just in Time (JIT) manufacturing is depicted as a framework that aids in making fitting request of materials accessible to each working unit at the ideal time in the correct amount. JIT is a deliberate idea comprising of JIT, JIT transportation and JIT creation. The aforementioned elements, three in number, could be combined to formulate the system which could handle the materials to avoid any occurrence of wastages and to minimize the cost investment requirements.

The resultant technique generally takes into consideration the attitude, habits and belief mechanism of the employees and their awareness measures regarding the evaluation of the quality assurance prospects associated with such project undertakings. This could be identified as the operating procedural philosophical management which envisages persistent and consistent improvement. This could take place with respect to the identification and

removal of the non-value adding incidences, which could be termed as the industrial wastages. According to Ocheoha (2013), JIT is formed around the objectives of reducing time necessary for processing the construction material, complete preclusion of any emergence of production wastage and ultimately the minimisation of costs. Such prospective objectives are only achievable with the utilisation of zero inventory based lean supply chain management.

The synopsis of the objectives of lean supply chain management related associations is to enhance profitability by limiting the cost of the qualitative product. The accompanying variables can be considered for the required quality enhancements. These could be identified as process and product configuration, utilizing cutting edge gear and innovation, holding zero stock, lessening lead-time of supply of materials, diminishing the batch volumes and sizes, utilizing pull generation framework, and simplifying the layout of the factories**.**

2.2 Materials Management (MM) Key Factors

The review of the available literature is based on acknowledged literary sources, evaluation of the proceedings of various seminars and conferences, articles that deal with the subject matter and on online information. In the following stage, all the factors of postponement that might be experienced during the construction project completion scenario were focused on; a definite survey of the literary sources was undertaken. This led to the recognition of the probable factors which precipitate the time schedule of the project.

2.2.1 Factors related to contractor

The contractor has the greatest obligation to complete an undertaking on time, amongst the parties involved into the construction projects, (Hughes, 2015). On the other hand, Shabbar et al. (2017) stated that time schedule overruns and excessive cost incurrence make the

constructors culpable as well. As a general rule, contractual contraction is a burdensome and often a difficult venture which reflects complications. Besides the necessity to maintain a strategic distance from any overruns, be it costs or time, the contractors have to regularly shoulder the complete liability regarding the outcomes of the efforts and work performances invested by the sub-contractors and other workforce personnel (Leung, 2014; Salloom et al. (2017).

Fundamentally, the process through which the contractor manages the specific responsibilities exhibits the actual nature of the work (Shi and Arditi, 2001). Walker (2015), remarked that the ability of the contractor to complete the task as per the arranged timetable chiefly relies upon two aspects: accessibility of assets (consolidating cash, labour, materials, and hardware and mechanical apparatus); besides, the administrative capability is utilized to the greatest extent. There are two kinds of sources from which the contractor procures the necessary amount of working personnel: the sub-contractors and the direct recruitments. In the event that the sub-contractual sources of labour could contribute to delays of the agreed upon time schedules then both the project and property owner and the primary contractor are responsible for providing an answer to the issue. However, Mpofu et al., (2017) argued that numerous different variables might prompt schedule overruns. These could be categorized into 4 sections such as construction material, machinery, labour force management and performance management.

In a construction company, a contractor is responsible for the time plan of the entire project from the beginning to the end; he is in charge of planning, leading, executing, controlling, and inspecting a building construction project (Mohammed and Varouqa, 2020). Also, his responsibility includes the budget, and project cost reduction (Ghulam and Kassim 2012).

2.2.2 Factors related materials

Accorrding to Myers (2016), construction materials are one of the basic segments of any construction process undertaking; furthermore, such a segment highlights the actual extent of the expenses which any business owner could have to contend with. From the point of view of the contractor, it also forms a significant perspective. As a general rule, material obtainment and arrangement of effective transportation are crucial for the contractor at the various phases of the construction process undertaking (Ibrahim, I. I, 2015). The inability to deliver an appropriate obtainment design or poor material storage facilities may bring about postponements and time overruns and could as well result in numerous different issues, for example, robbery or dilapidation of materials.

To Odeh and Bataineh (2002), the consistent provision of materials is an essential obligation on the part of the contractor on the grounds. Koushkiet et al., (2005) observed that this forms another key viewpoint with respect to material costs. The current researcher noted that an expansion in material costs might hinder the ability of the owner to procure more materials, particularly on account of extensive building ventures where ascends in costs have a genuine effect. The choice to sit tight for a fall in material costs is critical, in light of the fact that it might prompt postponements in the entire construction projects. Also, changes in the particular undertakings at times happen because of the infrastructural shortcomings.

These alterations fail to influence the nature of the actual materials which are generally utilised. However, securing new materials may take quite a while because of many factors, such as negotiations of prices (Wiguna and Scott, 2005).

2.2.3 Factors related Labour

Human resources and the availability of manpower could be ascertained as ones of the most significant factors regarding the operations and procedures of the construction services worldwide (Noe, 2013; Bailey, 2018). Such factors incorporate foremen, reviewers, technical specialists and architects of various denominations (Muhammad, 2016; Ravi, 2015). Such resources could be categorised into three sections based on the aptitude levels such as being partially skilled, highly skilled and/or unskilled. The astute choice and productive administration of labour can be the way to the accomplishment of a project development undertaking. Hendrickson (1998) reported that output based on labour unit basis is often deemed to be the definition of production capacity.

In generalised prospects, the contractor is in charge of distinguishing the better work possibilities and doling out specific work contracts of the project undertakings together with the associated obligations to the sub-contractors and the hired specialists into the entire architecture of the project. Drewin (1998) opined that those shortcomings in the identification of the exact required number and classification of the labour force personnel would be of prime influence on the quality, the cost and the work progression scenario in the construction sector. Any adverse situation could lead to the cancellation or failure in such endeavours regarding the above-mentioned perspectives.

In the construction sector of Libya, the greatest extent of construction organisations and contractors import numerous foreign working personnel for the construction project purposes. Various issues arise for contactors regarding the outsourcing of working personnel from outside nations since this process includes numerous intricate procedures, for example, recruitment of personnel, training, medical coverage, and travel and convenience costs (Salah, 2014). These procedures are frequently tedious and they fall beyond the ability to

control the contractor. Likewise, because of the association of various nationalities, more issues may emerge through social contrasts, for example, dialect hindrances and distinctive techniques for working.

Additionally, the effective use of task management requires numerous different abilities. These could be identified as arranging process management, collaboration and effective as well as uninterrupted communication. In any case, the contractor more often than not, encounters multiple obstructions in actualising effective undertaking administration. The project development and administration scenario necessitate that the contractor performs different obligations, adding to the existing task performance scenario. These obligations and duties ordinarily incorporate arranging and coordinating the task execution processes with other parties of the construction projects. Apart from this, supervising and evaluating the performance of the sub-contractual workers are also necessary regarding such processes (Shebob, 2012).

2.2.4 Factors related to consultant

The client could hold discussions and consultations with other specialists. These can assist him to organise the complete undertaking. These assisting specialists could be viewed as advisors. The primary obligations and liabilities of such a specialist could involve the work procedures such as planning the framework of the construction undertakings through incorporating structural, mechanical, architecture-based as well as electrical set up designs (Long et al., 2004). Some different duties may incorporate the planning of report processes of the construction projects which could include factors such as charges, illustrations, documentations and communications (Enshassi et al., 2010).

Additionally, consultants lead the process of planning and designing the project and they also contribute to cost control and the estimation of resource structure necessities as well as quality control mechanisms. Under various circumstances, postponements related to the issues generated by the consultants could occur during the design selection and approval phase, amid the reception of construction blueprints, while accepting plan endorsements from contractors or from the clientele and while performing the evaluation of the best management methodology.

There are numerous conceivable rationales which underscore these sorts of postponements. They could include the relative lack of experience on the part of the staff of the consultancies, shortcomings of necessary qualifications, inappropriate communication scenarios and/or shortfalls in the planning and execution capabilities of the necessary co-ordination processes for the achievement of success in such management ventures (Gunlana and Krit, 1996). According to Odeh and Battaineh (2002), the inspections and research studies that could be generated by the consultants could lead to slowing down the entire undertaking.

Accordingly, the contractors could develop resolutions to such problems from multiple angles. The probability of these arrangements leading to the fulfilment of the expectations of the consultants is not always expected. This could as well lead to the re-engagement of the work. Effective supervision and management of the operations of the construction site could be noteworthy components that add to the accomplishment of project completion. Apart from this, impediments in the implementation of the entire range of resolutions can lead to the development of adverse situations which could precipitate greater delays.

2.2.5 Factors related to owner

The key participatory elements of the entire process of construction projects could be comprehended as the clientele and the owners. Kwakye (1998) delineated the obligations and

duties of the owners which are mostly burdensome. This contributes to the development of a situation where the association with other professional sources of assistance could become necessary for the clients and owners regarding the project ventures. As for a range of matters, project owners first approach the management groups and units available to them to derive assistance from the entire range of skill sets of such personnel regarding the management responsibilities. Owners also prefer to employ central administrators to deal with the management control necessities (Odeh and Battaineh, 2002).

One of the most significant decisions in this respect is to determine the span of the agreement; the owners need to focus on resolving this first. Numerous owners lean towards quick finishing of work. Careful deliberations ought to be considered to choose the terms of the agreements. Another main consideration involves demonstrating the initialisation of the project undertaking; the owner might be unable to hand over the site to the contractor. In this case, the individual inclusion and brisk basic leadership on different issues by the owner in the underlying periods of the task may quicken the pace of the project undertaking.

Kimmons and Loweree (1989) hold that interdependence between the owners and the working personnel is one of the most significant determinants of undertaking achievement. Likewise, such relationship creates trust between the two sections of the stakeholders. The owners must take an interest in the development venture on horizontal as well as lateral platforms, without interfering with the working procedures of the contractor.

Similarly, monetary issues ought to be considered, and the owners must guarantee accessibility to the assets on a timely manner. Apart from this, the absence of stable budgetary conditions may cause numerous issues. One such factor could be highlighted as the broad context in which time schedule overruns could occur because of work strikes or improper management of the concerned material (Chan and Kumaraswamy, 1997).

2.2.6 Factors related to planning and design

According to Newman (2017), the early arrangement and configuration stage may decidedly or unfavourably influence the life cycle of the whole undertaking. Precise and sufficient plan formulation can bring about smooth advance of development exercises and at last accomplish the work on time, yet it requires a lot of consideration and broad data about the venture and interrelated issues. Carnell (2000) observed that information provision and the utilisation of the same procedure regarding the various tools and components of planning are required to facilitate the diverse involved parties to fulfil their obligations. It is imperative to perceive the vital part of the construction designs in the early outline stages. For this reason, an appropriate regime of correspondence and frequent cooperation amongst different sections of the work groups is necessary.

Odeh and Battaineh (2002) outline the available data which is fundamental for the planning and blueprint formulation, including the size, area, shape, framework and materials identified with the outline of the task. Review of the existing information sources could reveal that 4 specific components of delay can be recognized. These could be identified as early phases of planning.

2.2.7 External factors

Various aspects of constructions could be identified beyond the control of the operational elements associated with the entire construction projects. The case study of Libya is an example. One could understand that the summer season in the country is extremely hot, with the average temperature exceeding that of 40 degrees of Centigrade. In opposition to this, the seasonal circumstances in the United Kingdom are characterized extremely cold during winter when the temperature could fall to -5 or -8 degrees Centigrade. In such conditions, the

constructors could encounter greater complications which contribute to the reduction in the pace of the construction process. This could as well lead to the complete postponement of the work involving the obstructions which could inhibit the utility services, such as electricity supply, water and gas provisions and other amenities.

As reported by Ogunlana and Krit (1996), the socio-cultural environment and the perspectives could definitely influence the readiness of the labour forces to access the site of construction and the time required for such an undertaking on a daily basis. This could contribute to imparting negative effects on the construction schedule and could result in various measures of delays and time overruns for the project to be concluded. The hike in the price structure of purchasing construction of the raw material could as well affect the project time overrun factor although it is beyond the capability of any contractor or owner to influence such price oscillations in the open market. The current case in Libya proved that the multiplicities of construction endeavour ceased because of the costs of steel getting multiplied in 2011. These outer components may likewise make conflicts between the construction participants, which will additionally expand the time and cost of the undertaking (Odeh and Battaineh, 2002).

2.2.8 Factors related to technology

ICT is implemented in materials management and its operation has facilitated the efficient and effective materials control on site. Sun and Howard, (2004) noted that its common use in management is evident in the process of cost estimation making use of software such as Lotus 1-2-3 and Microsoft Excel. Harris and McCaffer, (2001) affirmed that the internet is extensively used for sending and receiving e-mails and carrying out electronic commerce comprising payments and receipt of materials process as well as electronic invoicing. It is feasible for suppliers and contractors to alter their activities from conventional to more

innovative or sophisticated techniques and tools to promote productivity in quotation and ordering activities. According to Faniran et al., (1998) one can make better use of computer-based systems to enhance materials management on construction sites. For instance, for this purpose, applications developed by several researchers incorporate the following:

- * Expert System Advisor for Concrete Placing (ESCAP) which aids in controlling and planning concrete-placing operations that do not require highly experienced staff (Alkass et al., 1993); besides, Pen-Based Computer which automates the process of collecting construction field-data.
- Construction Materials Planning System (CMPS) which assists in planning how the construction materials could be utilized to attain the most suitable materials as far as quantities, and time are concerned to meet the work program requirements (Wong and Norman, 1997 and McCulloch and Gunn, 1993);
- * Construction Materials Exchange (COME) (E-Commerce system) which aims to improve the effectiveness and efficiency of materials acquisition in construction (Kong and Li, 2001);
- * Internet-based Electronic Product Catalogue (IEPQ which delivers product information like product category among other data associated with a certain product by searching or browsing online (Kong et aL, 2001);
- 9 Virtual Construction Material Router (VCMR) which intends to supply the decision support system for materials movement assisting site planners and managers working on complex construction site (Mahjoubi and Yang, 2001);
- " Material Handling Equipment Selection Advisor (MHESA) who serves to select material handling equipment (Chan, 2002);

- “Bar-code system” which is designed for material storage management (Chen et al., 2002), Geographical Information System (GIS) and "E-Commerce intended for trading construction materials (Li et al., 2003).

Most recently, a need arises to make extensive use of more computer-based systems to advance material management in construction sites (Olusegun et aL, 1998). The construction materials planning system serves as an example of the instruments applied to manage construction materials (CMPS). Wong and Norman, (1997) defined CMPS as a computer-assisted planning system that aims to integrate the management and scheduling of construction materials providing the most appropriate materials at the right time with the right quantities to satisfy the increasing demand for construction activities that are scheduled ahead. A smart material handling equipment selection system is another development which is referred to as MHESA (Material Handling Equipment Selection Advisor) (Chan, 2002). Such types of tools rather than checklists are urgently needed to help engineers select the most suitable cost effective material handling equipment to tackle monotonous and complex tasks. Harris and MacCaffer, (2001) observed that numerous computer Information Technology and software in Construction (ITC) tools have been recently developed and are extensively applied in construction, such as the bar codes used for managing materials on site to preserve inventory records purposes; besides, the extensive use of the internet for communicating via e-mails and for electronic commerce purposes such as payments and receipts of materials and electronic invoicing.

2.3 Improve Materials Management

2.3.1 Supply Chain Management (SCM)

SCM is a tool used to describe the relationship between companies in converting a series of required materials or services into the final product for the customer (Koskela, 2000). Christopher (1992, p.26) identified the supply chain as a "network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer". In construction projects, Subramani and Tamizhanban (2016) suggested that the main contractors/ subcontractors, designer and surveyor are all part of a supply chain (see Figure2.1).

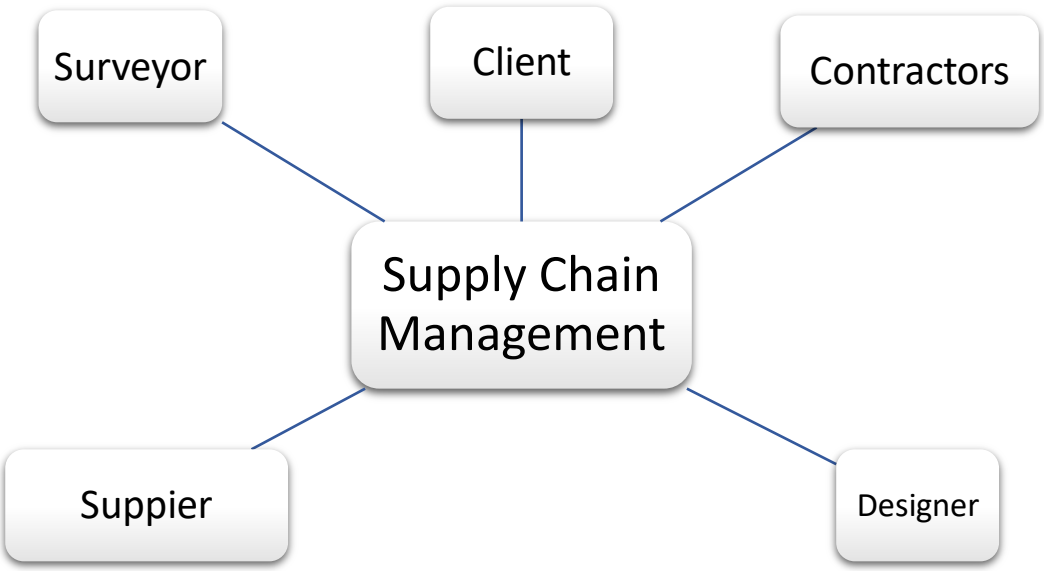

Figure 2.1: The Supply Chain Management Five Parts of in Construction. Source: Author

On the other hand, Mulla et al. (2015) identified that the benefit of SCM is that clients are better able to identify strengths and weaknesses. The contractor will be in communication with the client and offering the skills and expertise of the sub-contractors. About 90% of the

work in construction is done by sub-contractors while the main contractor is involved in management and coordination (Commonwealth of Australia, 1999; Khalid, et al., 2006). Within the chain, each company has a client to provide services; however, incorporated SCM aims to work wholly in the interests of the project client (Construction Excellence, 2004). There is a relationship between the main contractor's position, and the activities and errands leading to the preparation of the SCM on site, including that of clients and the design team, which also need consideration (Saad et al., 1999; Akintoye et al., 2000; Kaschola, 2000). This means that there is a relationship between the delay of construction projects and the supply chain. Moreover, the process of reducing the real cost and removing waste from projects is one of the benefits of the supply chain in construction. Vrijhoef and Koskela (2000) have identified four roles of SCM in construction (see Figure 2.2).

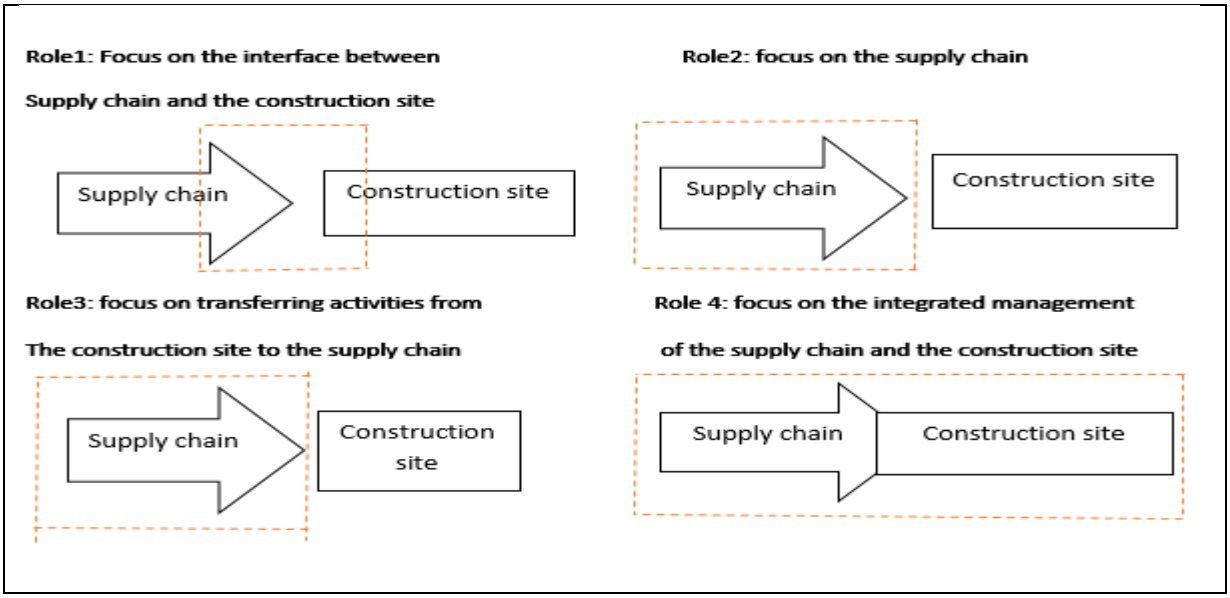

Figure 2.2 Four Roles of Supply Chain Management (SCM) in Construction.

Source: Vrijhoef and Koskela (2000: 7)

Role 1: Improving the interface between site activities and the supply chain.

In the field of construction logistics, SCM has the clearest roles related to co-operation between suppliers and contractors in order to improve materials management (Asplundh and Danielson, 1991; Wegelius-Lehtonen and Pahkala, 1998, cited in Koskela, 2000). However, traditional treatment of construction and handling of materials has concentrated on site activities. On the other hand, Salah (2014) stressed that the weak connection between suppliers and contractors is a key problem in Libya and leads to non-delivery of materials at the specified time.

Role 2: Improving the supply chain.

This is the main aim for the development of particular supply chains, such as prefabricated concrete elements or elevators (Koskela, 2000; Laitinen, 1993). It necessitates analysis of cost and time to identify specific improvement for the development of the supply chain; and when the supply chain has been developed, a comparison should be made between transportation and production costs in order to achieve overall improvement, because productivity and supply chain performance may decrease with changing site conditions (Al-hajj, 2011).

Role 3: Transferring activities from the site to the supply chain.

Oyedele et al. (2013) conducted a study in the UK and pointed out that JIT production in construction requires SCM. Therefore, the focus should be on redesigning the supply chain by transferring on-site activities off site. Industrialisation of materials, especially prefabrication, can be observed as a structural means for eliminating on-site activities from the total production chain (Warszaswki, 1990). Thus, these earlier, and still relevant, initiatives towards industrialisation of construction must also be seen as a form of SCM concentrating on the design of the supply chain (Sarja, 1998).

Role 4: Integration of site and supply chain.

Van Randen (1990) presented a number of suggestions for management of a supply chain such as open building to enable users to defer decisions regarding the interior of the building. The idea is to structure the site work as successive realisations of autonomous sequences (this resembles group technology as developed in manufacturing). On the other hand, Koskela (2000) explaining the relationship between SCM and LC, stated that LC improves the downstream of supply chain for on-site projects; moreover, open building aims to optimise the quality of the built environment, by improving the relationship between the customer and the building industry. Meanwhile, the aim of LC is to optimise building and construction. Both have the benefit of improving supply chain on-site projects.

On the other hand, Saad and Jones (1999) recommended the need to improve SCM downstream because it is the weaker link in construction. Erik et al. (2010) conducted a study to improve the supply chain in construction and concluded that in order to improve downstream, there is a need to apply lean thinking to construction. This means improving activity on the construction site by defining units of production and using tools such as visual control of processes. Design teams work exclusively on one design from beginning to end, supporting sub-contractors in developing tools for improving processes (Kaschola, 2000; Construction Excellence, 2004).

2.3.2 Supply Chain management and construction projects

In connection to the inventory network, basic on location issues concern conveyance unwavering quality (Agapiou et al., 1998a; Akintoye et al., 2000), arranging of material streams (Bankvallet et al., 2010; Wickramatillakeet et al., 2007) and correspondence and

association (Briscoe et al., 2001; Colleagues, 2009; Titus and Bröchner, 2005; Vidalakis et al., 2011). The intricate internal linkages between the research requirements of the construction project planning and management and the processes and the supply chain management are consistently overlooked. Problems, which take place at the various on-site production processes, could be considered to be the primary impediments of the construction projects. These issues normally begin from either the development venture process or the production network (Friblick, 2000). Basic cases of on location issues getting from the development venture process are absence of data sharing (Kelsey et al., 2001; Laufer and Tucker, 1987), poor correspondence between venture performing artists and between venture stages (Dainty et al., 2006; Emmitt and Gorse, 2006; Karrbom Gustavssonet al., 2012) and vulnerabilities (Bankvallet al., 2010; Dubois and Gadde, 2002).

The effect of such ignorance could lead to serious consequences as well. The various decisions such as the selection of specific technological and material-based inventories could directly affect the progression of the construction project completion process. In this respect, it could be contemplated that the process of supply chain management could encompass the entire range of activities regarding the material management commencing from the refinement of the raw materials and culminating at the finalised product delivery (Council of Supply Chain Management Professionals, 2013). On the other hand, the operations associated with the construction project entail the three core activities of the entire working architecture of any construction project undertaking which could be identified as plan formulation, design process completion and finally the production of the actual product on the site of constructions (Winch, 2010). This is a process that encompasses the preconstruction as well as the on the construction site activities (Johansen and Wilson, 2006). The similarity of involving the site based and pre-construction scenarios between these two processes lead to the amalgamation of the two processes as has been delineated in the following (Figure 2.3).

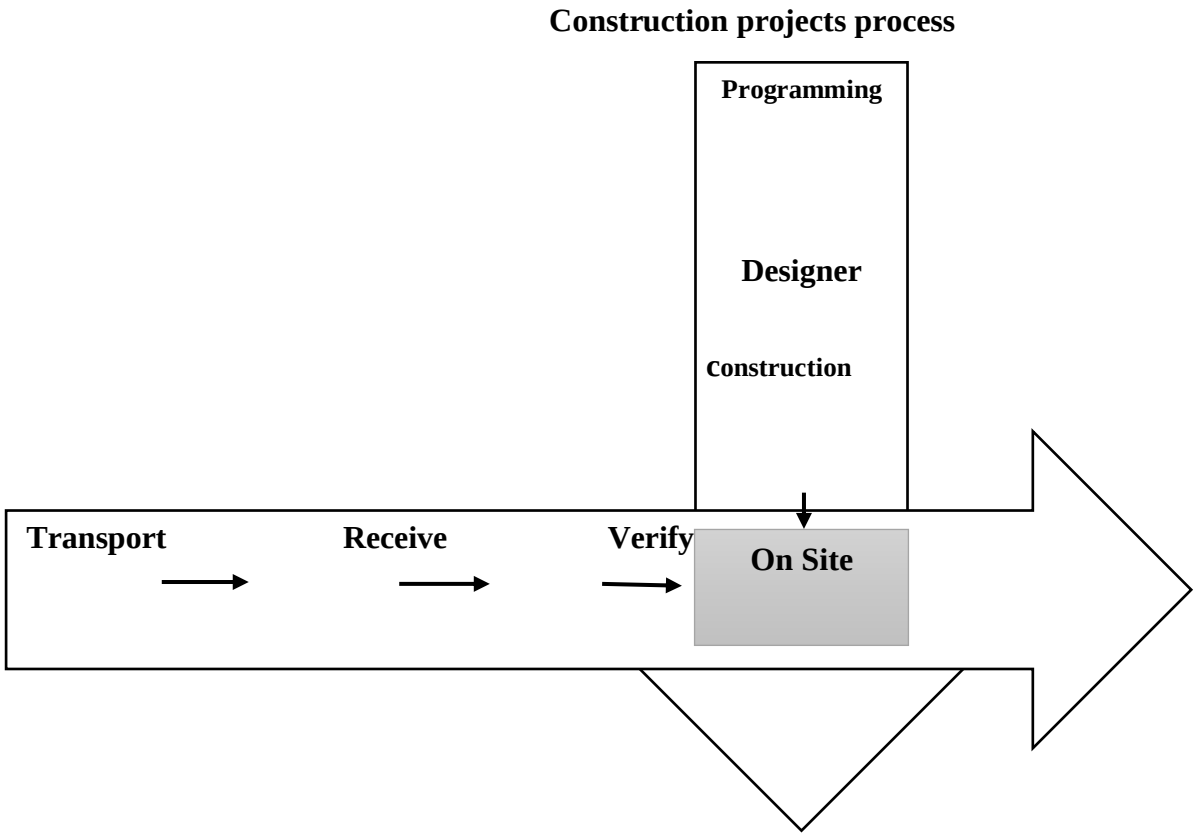

Figure 2.3: The intersection between the supply chain and construction process

Source: Olsson (2000)

The exact construction project could be considered to be the central unit of analysis. It comprises two specific components of the construction project such as the procedures and the supply chain management undertaking. Bankvall*et al.* (2010) and Dubois and Gadde(2002), have discussed the intricate interdependencies regarding the processes of the construction projects and those of the supply chain operations. They have highlighted that the prime necessity in this regard is concerned with the addressing of the various problems which occur at the construction site related to the Supply Chain Management operations and the activities

regarding the Construction Project Management. Reduction of the costs of construction could be achieved regarding the combining of the Supply Chain Management operations to manage the construction projects in a proper manner (Vrijhoef and Koskela, 2000).

Vrijhoef and Koskela (2000) has evaluated that 50% of the material pricing structure consists of material handling based expenditures. However, the study does not provide any clear indication of how the entire concept of Supply Chain Management could contribute in the addressing of all the problems which could be encountered during any construction undertaking at the related sites. This stems from the relative void of understanding regarding the actualities of the problems which could arise from the construction sites and the measures of the Supply Chain Management which could mitigate such problems (Tennant and Fernie, 2014).

2.3.3 SCM in construction

The term of SCM (Supply Chain Management) is a concept, which could be understood to be relatively a novel one in the construction sectors. There have been formative works, in this regard, two in number, which have been published by Egan (1998) and Latham (1994). These have asserted the fact that the factors which lead to the curtailment of the productivity and cost increment in the construction projects could be understood to be the issues related to the functioning of the operational procedures, defects in the construction material as well as processes, necessities of having to undertake works which could have been completed previously and many more. Egan (1998), Latham (1994), and Vrijhoef and Koskela (2000) have averred that increased coordination between the components and the supply chain members could lead to the situations where the existing problems could be solved.

Akintoye *et al* (2000) have opined that the primary objective of the construction operation specialists could be contemplated to be the implementation of the Supply Chain Management. Principles for the attaining of the benefits and advantages, which could satisfy the existing and the potential customers and could thus lead to the improvement in the customer service potential of the organisations, which could be operating in the field of construction. This could, in turn provide the necessary explanations regarding the propensity of the construction contractors to engage in the collaboration with the clientele. This is specifically meant to exclude the suppliers from such arrangements (Akintoye *et al.* 2000). However, the necessity of having to focus to a greater extent on the collaboration with the suppliers could never be ruled out as well.

As per the research of Vrijhoef and Koskela (2000), various issues concerning the logistical management at the construction sites and related to specifically the delays which take place in the execution of the material management responsibilities, could be traced back to the inefficient supply chain management processes and in the lack of communication between the project management administration and those of the suppliers. The projection of the focus has been on the four different categories related with the operational implications of the construction sectors. The first one could be identified as the interface between the activities which take place at the construction sites and those of the supply chain-based operations. The second category is the improvement of the operations of supply chain and delivery of logistic supports for the construction project. The third one is the transferring of the responsibilities of material related site-based activities completely to the supply chains. The final one is the improvement of the site-based construction operations and co-ordination between various different segments of the entire construction process.

According to the research of Saad *et al* (2002), the building of the proper understanding regarding the concept of Supply Chain Management, as a method of overcoming of various

challenges at the construction industry, is still of developed. Both CSCMP (2013) and Mentzer *et al* (2001), have suggested the factors such as trust, professional relationship and commitment to be the significant constituents in terms of proper Supply Chain Management procedures. It is thus a philosophical concept rather than an operational tool. Trust could be considered to be the most significant aspect regarding Supply Chain Management. According to the research of Akintoye *et al* (2000), the efficacious and qualitative implementation of Supply Chain Management principles could only be possible on part of the existence of the institutional trust amongst the members of any organisational project.

On the other hand, the dearth of the necessary measure of commitment on part of the various administrative sections of such project undertakings could be considered as the primary reason for the poor implementation of the principles of the Supply Chain Management related success attainment. The lack of trust in the construction industry is well acknowledged (Dainty et al. 2001a). Tennant and Fernie (2013) has highlighted that the managerial hierarchy could become deficient to lead to such situations and this stems from the fundamental poor understanding regarding the facets of the Supply Chain Management operational process. The improvement in the coordination of the construction project management could only be possible through the efficacious organisation of the supply chain management operations within a specific period of time. According to the research of Karim *et al* (2006), the extent of necessity regarding the improvement of the management of the sub-contractors by the contractors and the existing operations of the supply chain management is significant. The subcontractors primarily represent the execution of the responsibilities of the working operations at the construction sites and the measures of defects and shortfalls in the project progression could thus be associated with the sub-contractors also.

2.3.2 Lean Construction (LC)

The minimisation of the necessary investment of time and effort with the generation potential realisation of the maximum extent of dividend or value over production could be the other two factors which are intricately associated with the Lean Construction methodology According to the research of Koskela *et al* (2002), Lean Construction could be understood to be the process of systematic designing of the construction project based production operations which could entail the bare minimum emanation of industrial or construction wastage material.

Sacks et al. (2010) identified that lean construction is a project delivery approach based on production management, with the purpose of minimising waste. Hoop and Spearman (1996) identified that LC aims to achieve the objective of the project and meet customer requirements using fewer resources. Koskela et al. (2002) identified it is a system to minimise waste of materials, time and effort to generate the maximum possible amount of value. Womack and Jones (2003) defined LC as a philosophy that depends on the notion of lean manufacturing, concerning control and improving the construction process to meet the customer's needs on time (Creswell et al., 2013). On the other hand, Sarhan et al. (2017) conducted a study in Saudi Arabia and reported that LC improved the quality and productivity of Saudi construction projects by about 77%. They identified specific results of LC in on-site projects, such as improved working conditions through decreasing physical and psychological stress. Dave and Koskela (2013) focused on implementing LC and considered the client, contractor and designer. They identified that by using LC, the owners could realise significant benefits on projects, such as increased building performance, reduced financial risk, reliable cost estimates and optimised facility management.

Howell (2001) stated that the construction sector is often described as having many problems, including lack of efficiency, and recommended using the LC concept as a solution. Murman et al. (2002) added that the principles of LC include waste minimisation. LC concepts have also received attention as a modern way to improve performance and labour productivity (Abdel-Razek et al., 2007; Koskela, 1992; Construction Excellence 2004). Abdelhamid and Salem (2005) presented five principles of lean production in the construction sector: "1. reduce variability; 2. reduce cycle times; 3. minimise the number of steps, parts and linkages; 4. focus control on the complete process; and 5. balance flow improvement with conversion improvement, benchmarking, increased output flexibility and improved process transparency".

According to Salem and Zimmer (2005), this concept of Lean Construction could as well be described as a process under continuation that is oriented towards the complete removal of any possibility of waste formation at the construction sites and towards the meeting and exceeding of very customer expectation. This process ardently has to focus on the stream of value addition to the existing operation and has to undertake the inculcation of the maximum level of perfection in the execution of the projects.

Abdel hamid and Salem (2004), a generally utilized definition is that Lean Development is a method for planning developmental frameworks of construction to limit the misuse of materials, time and additional cost incurrence with a specific end goal to produce the most extreme conceivable measure of significant worth for the customer. As indicated by Fewings (2013), the definition which could be associated with the Lean Construction process could be closely reflective of the waste elimination design necessities related to the production or the construction process of any such structural engineering project undertaking. The utilisation of the lean principles had been advocated for the first time by Ohno.

Lean Construction primarily retains the momentum of the continuous pursuit of inculcation of the improvement potentials in the designing and construction operations processes as well as ensuring the maintenance of the construction project based requirements fulfilment to meet and exceed the demands of the customers. This is generally performed from the perspective of addition of value to the existing operations and by abjuring the non-productive or non-performing practices in this regard of project criteria fulfilment. Creation of greater time for the value addition as well as service quality improvement could be understood to be such factors which assist the process of Lean Production.

The Lean Construction methods not only make the construction procedures into greater effective ones, these also improve the efficiency and profitability of the operations and it minimises further, the operational risks which could lead to the hampering of smooth operational tempo of the construction projects. Such construction philosophy contributes in the overcoming of the perception that lean management of time, quality and costs could not be pursued in a simultaneous manner in any project performance scenario (Dulaimi and Tanamas, 2005).

2.3.2.1 Lean Construction Principles

The number of basic principles, which could be associated with the Lean Construction management operations, could be understood to be five in number and these are critical in terms of their significance to enable the project undertaking to achieve greater excellence and acceptance in the operational field. These have been identified by Womack and Jones (1996). These could be recognised as the identification of the value propositions from the perspectives of the customers, the building of the proper understanding concerning the value stream process, the achievement of the flow of materials from the various approaches related with the working processes, the achievement of the customer pull at the opportune moment

and ultimately, sustaining the drive of infusing the most effective measure of quality improvement and consistent development (Cullen *et al*. 2005; Hook and Stehn,2008; Suresh *et al*. 2012; Fewings 2013). These standard principles, as drivers for continuous improvement and the advantages of Lean Construction, could only be accomplished through their all holistic and overarching execution regarding the construction sectors (Dulaimi and Tanamas, 2005). In any case, as indicated by Green (2001) and Bertelsen (2004), the variations of the various construction sectors ensure that not every principle could be applied to the construction projects in general.

According to the recommendations of Forbes and Ahmed (2011), each and every one of the five principles could be relevant to every business organisation. In a similar manner, Salem and Zimmer (2005) have observed that the vast majority of the principles have become pertinent to the construction industry, Koskela (2004) has researched that such principles have not been successful in completely covering value generation prospects of any particular production procedure. Moreover, Snare and Stehn (2008) have opined that the principles are more or less deficient regarding the cultural perspectives of the existing and involved working forces and this could be a serious shortcoming since the lean construction and production practice could be seriously influenced by the cultural aspects of any working force which could be intricately associated with the production procedures.

The Construction Industry Institute (CII) has outlined five different Lean Construction principles as well. These could be understood to be the retention of the focus on the customers, taking into notice the culture and the people associated with that of the entire production and construction process, organisational co-ordination at the workplace and at the site of operations, standardisation of performance, waste elimination completion and ultimately the persistent improvement of the qualitative aspects of the construction

undertaking (Forbes and Ahmed 2011). To improve a comprehension of Lean Construction, it is necessary to undertake a proper enumeration of the associated essential standardisation and principles. Regarding the wide-ranging variations associated with the nature and development criteria of construction processes, Koskela (1992) has indicated that the principles of Lean Construction are multiple in natures. These could be identified as transparency of the processes, minimisation of variability, reduction of the necessary time cycle, benchmarking of criteria, simplification of the involved operational processes, the management of the work and material flows, maintaining the flexibility of the output processes and finally maintaining of the focus of process management on the entire construction structure.

realize what the customer needs and generally presume whatever the clientele could be expecting to receive in return (Fewings 2013). In this way, the supply groups must be aware of the necessities of the customers and the specifications of the end users so that the delivering of the value could be achieved (Bjornfot and Stehn 2007; Mossman 2009).

process of value addition could be understood to be inclusive of all the steps required to configure, formulate and deliver the necessary outcomes (Fewings 2013).

In the project construction undertakings, the stream of values could be identified as the grouping of exercises extending from the idea of handing the project outcomes over to the client with the objective that the customer could be compelled to make further requests (Pull) for the addition of value to the buildings or administrations. The process of identification of the stream of values could involve the establishment of the time and place related measures through which the decisions generally take place and the primary strategy which could emerge out of such undertakings for furthering the value addition potentials into the entire aspect of the project undertaking. The map of the value stream, thus, delineates accordingly a

framework of tasks that prompt significant accomplishment of quality infusing into the entire prospect of product development and recognizes differentiated and alterative courses of actions to augment execution in the development procedures (Dulaimi and Tanamas 2005; Forbes and Ahmed 2011).

2.3.2.1.1 Flows

The number of various factors that could pose as impediments to the value and resource management within the construction project could generally include accidents, executive meetings, poor communication, approval cycles, improper site based administration, variations and management interference and waste (Mascitelli 2002, Abdelhamid and Salem 2005).

Lean Construction process intends to accomplish a comprehensive measure of efficacious stream of information, data and asset based resources. Such a flow could be considered to be the central procedure of introduction of perfection and adjustment of the interconnected exercises through which a product could be created (Fewings 2013). Nonetheless, there are various elements that could become impediments regarding the completion of the asset development process and the realisation of the worth of the business ventures. These include accidents, official gatherings, poor correspondence, endorsement cycles, poor welfare on site, variations and administration impedance and waste among others. Therefore, the minimisation and complete removal of the previously mentioned impediments are necessary for the achievement of the coveted success concerning the delivery of the created value to the end users. Creation of value which could be formulated on the basis of the elimination of complete wastage could be the cornerstone regarding the meeting of the objective of satisfying the clientele since the entire sector of construction is primarily extensively prone to suffer from industrial wastage (Latham 1994; Forbes and Ahmed 2011).

Therefore, the minimisation of the various obstacles, which have been mentioned, previously is necessary to achieve the successful delivery of values to the customer. In the current era, construction practices are prone to become wasteful to some extent and the elimination of the waste incurrence regarding the undertaken tasks and activities could be the primary requirement to formulate greater value for the end users across the spectrum. To this effect, the application and development of various techniques which could remove the work processes which hinder the workflows could be hindered from adding the necessary value to the project development processes of construction could be deemed necessary concerning the improvement of the entire perspective of construction project (Bennett 1998; Farrar *et al.* 2004). The underlying factors are generally minimisation of uncertainties, accident risk management and reduction of any incidence which could result in the accidents taking place at the workstations at the sites, avoidance of any variation from the ideal work process so that various work processes could progress under the certain and ideal working conditions.

2.3.2.1.2 Pull

The process of Pull could be identified as the capacity of achievement of earliest delivery of the finished products to the customer and being the most punctual regarding the conceivable operational dimensions (Bicheno2000). The process of delivering the project outcomes could be conceived to be fraught with various vulnerabilities, risks, uncertainties and dangers. These generally preclude the delivery of any finished product or project undertaking outcome to the customer or the end-user within the predetermined time schedule (Dulaimi and Tanamas 2005). These also jeopardise the prospects of minimum resource utilisation as well. Notwithstanding such considerations, such effects could be resolved through the prompt emphasis on the necessities of the customers and the defining of the same through detailed methodical approaches.

This ensures that the improved product outcomes can be delivered to the customers inside the most limited time frame through the utilisation of the most spurious measures of materials, working personnel, planning necessities and other required assets. The building construction materials should likewise be provided when these could be utilised to keep the construction project-based ventures afloat and could preserve the necessary pace of the operations (Farrar *et al.*2004). To accomplish an effective Pull, the project undertaking teams are primarily required to clearly and pointedly influence the customer to see how the deliverables could be transported and provided to the end users and how the customer could make the Pull of the delivered products into a successful one (Mascitelli2002; Farrar *et al.* 2004).

2.3.2.1.3 Perfection

To accomplish flawlessness and work perfection, enhancing task execution capacity in any business association and persistent change management are to be made the working cultures. This process requires persevering distinguishing proof of what significant undertakings have been undertaken, how they ought to be done and coordinating of assignments with the correct groups to execute them. Flawlessness and perfection can be accomplished through a persistent change in dispensing with all types of impediments and non-value adding systems and work processes along the working streams in the project operations management structures (Dulaimi and Tanamas 2005). The meeting of the customer specifications in the product outcomes regarding the quality and quantity could be explained to be the principle of perfection. The maintenance of the exact time and minimisation of the pricing could be envisioned to be the primary necessities associated with the same and this also involves minimisation of waste materials as well (Bicheno, 2000). This principle highlights the opinion that elimination of construction waste could never be completed, and this is the reason that Lean Construction process is considered to be divergent from that of an actual process. Therefore, it is considered as a journey.

2.3.2.1.4 Process Transparency

The factor of transparency of the construction and material management process could be alternatively identified as the visibility of the incidences which take place within the structure of any such project undertaking (Klotz and Horman 2007). The concept of lean production could be achieved through the application of such process transparency. The underscoring rationale of such a process is oriented towards the facilitation of the communication between the production process and the people who would be availing the outcomes of such parts or the complete outcomes of such processes (Formoso *et al.*, 2002). It is necessary for both the working personnel and the administrative management to take notice of the ongoing processes and activities within the extent of the construction site so as to make sense out of every operation which could be suitable for the completion of the entire project (Tzortzopoulos and Formoso 1999).

Visual gadgets, signage, house-keeping processes and great formats could all be utilized to make the whole procedures in a straight forward manner which could be discernible to the specialists, administration and all partners on the site (Tezel *et al.*, 2010; Forbes and Ahmed 2011). The settings and procedures related to the work requirements and operations requirements ought to be made clear as crystal. Process straightforwardness diminishes chances for mistakes to take place and could assist in the improvement of the visibility or ability to identify the proof of blunders and deformities in both the working processes and in the end products (Koskela 2000). Continuous change and quality enhancement over the distinctive categories and sections of the production processes could be perfectly accomplished when the close proximity of waste and variations from the norms or issues as well as the problems of production are distinguished by individuals operating at the construction sites. The procedure ought to be straightforward and informative for everybody to recognize, modify of stay away from a problematic issue or preclude the re-occurrence of

such problems in a sustained manner. Moreover, it is just when the procedure is straightforward that value addition exercises can be produced and devaluating works could be minimised to the most extended measure.

2.3.2.1.5 Benchmarking

This is a methodical and legitimate method for enhancing the execution of the production system by estimating and contrasting execution of the tasks of different associations, so that lessons can be learnt from the best framework to facilitate change (Constructing Excellence 2012). It distinguishes and outlines the best possible approaches and recognises the more profitable ventures which could be undertaken to complete the achievement of better performances. Comparisons could be drawn with the other construction undertakings, organisations as well as other business ventures from different fields of operations (Koskela 1992; Costa *et al*., 2004). Lessons learnt could be utilised to reflect change in working society, procedures, execution and efficiency. This could include building up a program to accomplish upgrades over the diverse business sectors and responsibilities. Benchmarking empowers the association to look remotely past its own particular inward change procedures (Alarcon *et al* 2001). The guideline stresses that organizations should talk about and share their accepted procedures in task administration structures and asset-based administration, with the goal that they can gain from each other in terms of experiences.

2.3.2.1.6 Cycle time reduction

At the point when an association takes part in ceaseless change exercises, the time taken to perform exercises and undertakings ought to be lessened. This could be accomplished by decreasing the overlapping of roles between exercises, holding up times, movement-based transportation times, waiting in line times and the duration which is necessary to outline the activities themselves. With a specific end goal to accomplish these curtailments, the

specialists ought to be as effective as would be could be reasonably expected (Koskela 1992; Ballard 2001). Moreover, the unwavering quality of work process should be boosted as well. Be that as it may, to amplify the work process unwavering quality, the variations must be limited (Ballard 2001).

2.3.2.1.7 Flexibility

An existence of various levels of flexibility within the systematic production mechanism of any business organisation could lend the corporate entities, their working personnel and even the clientele with greater capability to formulate adequate responses towards unforeseen changes and demands which could never have been predicted earlier. Such changes and demands could arise due to the fact that the changing technologies and market based circumstances and necessities could contribute in the emergence of the requirements of the efficiency levels which could be much different from those which could have been adhered to earlier with certainty (Lane and Woodman 2012). Notwithstanding the levels of absence of variations and presence of certainty, the element of flexibility is necessary to be put in place within the working architecture of any business organisation.

The variation of the level of flexibility could be ascertained to be pertinent with the systems of production undertaken. The nature of the construction process is reflective of the determination and provisioning of such variations as well. The measure of predictability, which could be included in a possible manner with the construction project undertaking also, determines the flexibility of any material management process. The level of predictability and the efficiency and flexibility are divergent to each other (Lane and Woodman 2012). However, Tzortzopoulos and Formoso (1999) have included the opinion in their research conclusion that adequate measures should be invested in the process of ensuring the facts that

no disruption or impediment should ever be caused to the delivery of the completion phases of construction projects on part of improvement efforts of project procedural flexibility.

2.3.2.1.8 Balance Flow Improvement with Continuous Improvement

Lean Construction process classifies development exercises into change and flow-based exercises (Koskela 1992). The flow-based exercises incorporate flows of materials, work process, data stream amongst many others. The efficient and accurate administration of these streams could make a more secure, more proficient and profitable outcome of the project undertaking into a possibility. Along these lines, flow-based project administration is an extremely noteworthy part of Lean Construction process. Accentuation ought to be centred on enhancing change forms and on the upgrading efforts along with flow based working processes. Both the activities associated with the management of conversion and flow, are necessary to be integrated into a single operational structure (Tzortzopoulos and Formoso 1999). This could be useful to enable the construction undertaking to achieve the balancing of both the activities regarding the aforementioned perspectives (Chen *et al*., 2004). Apart from this, in the undertaking of the flow management, the redundant flows and the underlying conflicts have to be completely avoided so that resources could be saved.

2.3.2.1.9 Process Simplification

The reduction of the numbers of steps and linkages, which are directly related to the material as well as the information supply systems, could lead to the minimisation of the activities, which are of redundant in nature. The simplification of the tasks could be performed from the perspective of utilisation of the most advanced technologies, the facilitation of the responsibility execution could be achieved through the amalgamation of the management procedures of the conversion, and flow-based operations (Chen *et al*., 2004).

2.3.2.1.10 Minimise Variability

Variation could be understood to be the primary activity which does not add any value and could result in the wastage of the resources, incurrence of high project cost and the duration of project completion could be extended as well as the unreliability of workflow (Kraemer *et al*., 2005). In spite of the fact that variations are probably not going to be stayed away from in venture conveyance, it ought to be limited as much could be expected because of its extraordinary negative effect of the execution undertaking. Variations could influence the project undertaking accomplishments by bringing about greater loss of output, increment in lead time, capacity wastage and abnormal state of work-in-process. The negative effect of fluctuation on the undertaking is higher at later phases of the task contrasted with beginning times. Therefore, more endeavours ought to be put to forestall variations as the venture moves towards fulfilment (Koskela 2000). The clients could become greater satisfied with the focussed and consistent approaches regarding the project operations and task execution. The workers could experience lesser measures of stress regarding the early completion of the project as well. The factors of planning in detail as the tasks could imply, could prevent variations from rising within the working structures as well (Tzortzopoulos*et al*., 1999**).** The week based planning of work procedures and the operations meeting on daily basis could be such methods.

2.3.2.1.11 Focus on Complete Process

The attention ought to be on the overall process and not just on parts of it. Despite the fact that project progression and advance are checked across the distinctive exercises which could be occurring at the site, the advance check, assessments and monitoring should be done in a spontaneous manner over all parts of the project (Tzortzopoulos*et al.,* 1999). However, singular parts and undertakings ought to be arranged and composed in points of interest so that appropriate assets will be apportioned to limit wastage and amplify proficiency.

2.3.2.1.12 Build Continuous Improvement into the Process

A culture of ceaseless development, improvement, and enhancement of capacity ought to be ingrained in the labourers. The process-based principles are generally pursuant of the managerial staff and the working personnel to engage themselves in such persistent continuity of the activities and operations both inside and outside of the organisations (Separate and Wijesiri 2008). The rule seeks after directors and specialists, to partake in persistent enhancements exercises of the association. The employers and the working personnel ought to continually be associated with an all-around development procedure that could be proficiently organised, methodical, ceaseless and imaginative in terms of diminishing the incurrence of industrial and construction project related wastes (Abdelhamid and Salem 2005; Forbes and Ahmed 2011).

2.4 Summary of the chapter

In the operation of on-site construction projects not only materials and the environment but also human errors should be considered. The main contractors, subcontractors, designer, and surveyor have a direct effect on delivering the project on time. The contractor reports to the client before any work starts, and manages and monitors, checking the skills, knowledge and experience of all workers on the site and choosing experienced sub-contractors and labour. The contractors and sub-contractors are parts of SCM supply chain management, but they are downstream. Therefore, LC has to be involved, with the goal of removing waste as the one benefit of SCM. SCM has four roles in construction: improving the interface between site activities and the supply chain, improving the supply chain, transferring activities from the site to the supply chain, and integration of site and supply.

There is another goal, to improve activities on the construction site. In conclusion, the goal of this study is to improve materials management on construction sites, to reduce cost and

remove waste. Materials management improves productivity, involving people and systems. SCM has five players in construction, whose roles are weaker in construction (SCM downstream), so LC counteracts this weaker and reduces financial risk with reliable cost estimates and optimising facility management. LC also improves quality and productivity. All of these problems in Libyan construction projects identified from the literature review will presented in the framework chapter.The literature review shows that many studies have been conducted in different countries (see table2.2).

Table2.2: Factors related to materials management. Source: Author

Related to Contractors	**References**
- Inadequate contractor experience - Inappropriate construction methods - Inaccurate time estimates - Inaccurate cost estimates - Poor site management and supervision - Improper project planning and scheduling - Incompetent project team - Unreliable subcontractor - Obsolete technology	- Hughes et all 2015. - Leung, et all 2014. Salloom et all, 2017. Shabbar et all 2017.
Related to Material	**References**
- Shortage of required materials - Delay in materials delivery - Changes in materials prices - Changes in materials specifications	Ibrahim, I. I, 2015. Myers, D, 2016.
Related to Labour	**References**
- Slow mobilisation of labour - Shortage of skilled labour - Manpower productivity - Manpower supply - Absenteeism - Strikes - Low motivation and morale	Muhammad 2016. Ravi, 2015.
Related to Consultant	**References**
- Poor qualification of consultant engineer's staff assigned to the project - Delay in the preparation of drawings -Delay in the approval of contractor submissions by the consultant - Poor communication between the consultant engineer and other parties involved - Poor planning and coordination by the consultant engineer with other parties involved	Leunget all 2014. Odeh et all 2002.

- Delays in performing inspection and testing by the consultant engineer - Slow response from the consultant engineer to contractor inquiries - Inadequate design specifications - Poor contract management	

Internal Factors	**References**
- Unforeseen ground conditions - Unexpected geological conditions - Problems with neighbours - Unusually severe weather - Conflict, war, and public enemy - Poor weather conditions on the job site - Traffic control and restrictions on the job site - Rises in the price of materials	Pawanhari et all 2016. Sambasivan et all 2017.
Factors related to early planning and design	**References**
- Changes in the scope of the project - Ambiguities, mistakes and inconsistencies in specifications and drawings - Subsurface site conditions materially differing from contract documents - Original contract duration is too short	Newman, 2017 Carnell, 2000 Odeh and Battaineh 2002
Factors related to owner	**References**
- Delay in furnishing and delivering the site to the contractor - Unrealistic contract duration - Delay in the settlement of contractor claims by the owner - Suspension of work by the owner's organisation - Delay in issuing of change orders by the owner - Slow decision-making by the owner's organisation - Interference by the owner in the construction operations - Uncooperative owner with the contractor complicating contract administration - Delay in progress payments by the owner - Owner's poor communication with the construction parties and government authorities - Owner's failure to coordinate with government authorities during planning - Poor coordination by the owner with the various parties during construction - Excessive bureaucracy in the owner's administration	Hendrickson et all 1989. Hughes et all 2015. Ibrahim, 2015. Okorocha, 2013.

CHAPTER THREE: CONCEPTUAL FRAMEWORK

3.1- Introduction

This chapter makes use of the information presented in the previous chapter to put forward a conceptual framework that would help minimise the wastage of materials and control the cost and quality within the Libyan construction site. This will subsequently be modified in line with the results reported in the analysis chapters and converted into a final framework in the discussion chapter. The purpose of a framework is to improve material management on the construction site. This framework, together with the literature review, focuses on the pre-material management phase. Actions in this phase aim to improve the construction community and to highlight the impact of contractors, owners, consultants, and engineers on the construction operation on site.

3.2. Building Construction Material Management (CMM) process

It can be concluded from the research studies presented earlier that the management of construction materials is a process that includes various activities which exceed the organisational boundaries of a construction project. This conclusion supports the perspective of Phani and Methew, (2019) that project materials management should be thought of as a process rather than an organisation. In fact, the activities of materials cycle across all organisation lines of the project begin with the specification of the material which is primarily the responsibility of the owner and engineer (Mouchi et al, 2011).

Material management processes and functions consist of multi-organisations and integrated processes of material definitions and acquisition and field disposition (Gurmu, 2020). Studies conducted by Stukhart (1995), Hampson & Brandon, (2004), Jusoh and Kasim, (2017), Silva et al., (2017), and Harris et al., (2021) deal with the constructs relating to construction

material management; the researchers envisaged the construction materials management processes. Stukhart (1995:29) justified the necessity for this vision; it is very important that materials management be recognised as a system or process, rather than a function or organisation, because systems and processes imply a common set of goals, distinct from just some commonality in activities". He added that the use of this approach (a system or process) to construction materials management provides a means of looking at assumptions that govern existing techniques and enable one to think in terms of innovations that affect the entire system. Thomas et al., (1989 and Bernold and Treseler, (1991) among others agree with Bell and Stukhart (1987) that construction professionals recognise the need to focus on the materials management process as a proactive, identifiable entity that has a significant impact on the cost of construction.

Jusoh and Kasim, (2017) stated that materials management in a construction project consists of seven integrated processes and functions. They include: project planning, materials take-off, supplier's enquiry, purchasing materials control, warehousing, expediting and shipping. On the other hand, Gulghane & Khandve (2015) suggested that materiel management process involves five functions: planning, procurement, logistics, handling, and waste control process. Kasim and Ern (2010) illustrated the importance of managing all materials from the design stage to the construction stage. Poor handling of construction materials affects the overall performance of construction projects in terms of time, budget (cost), quality and productivity.

Plemmons and Bell, (1995**)** introduced a model for material management process in construction industry. In his model, he explained the communicating functional boundaries of the CMM process; the model also illustrated the flow of data, information, and materials activities between the primary and secondary suppliers and customers (see Figure 3.1 below).

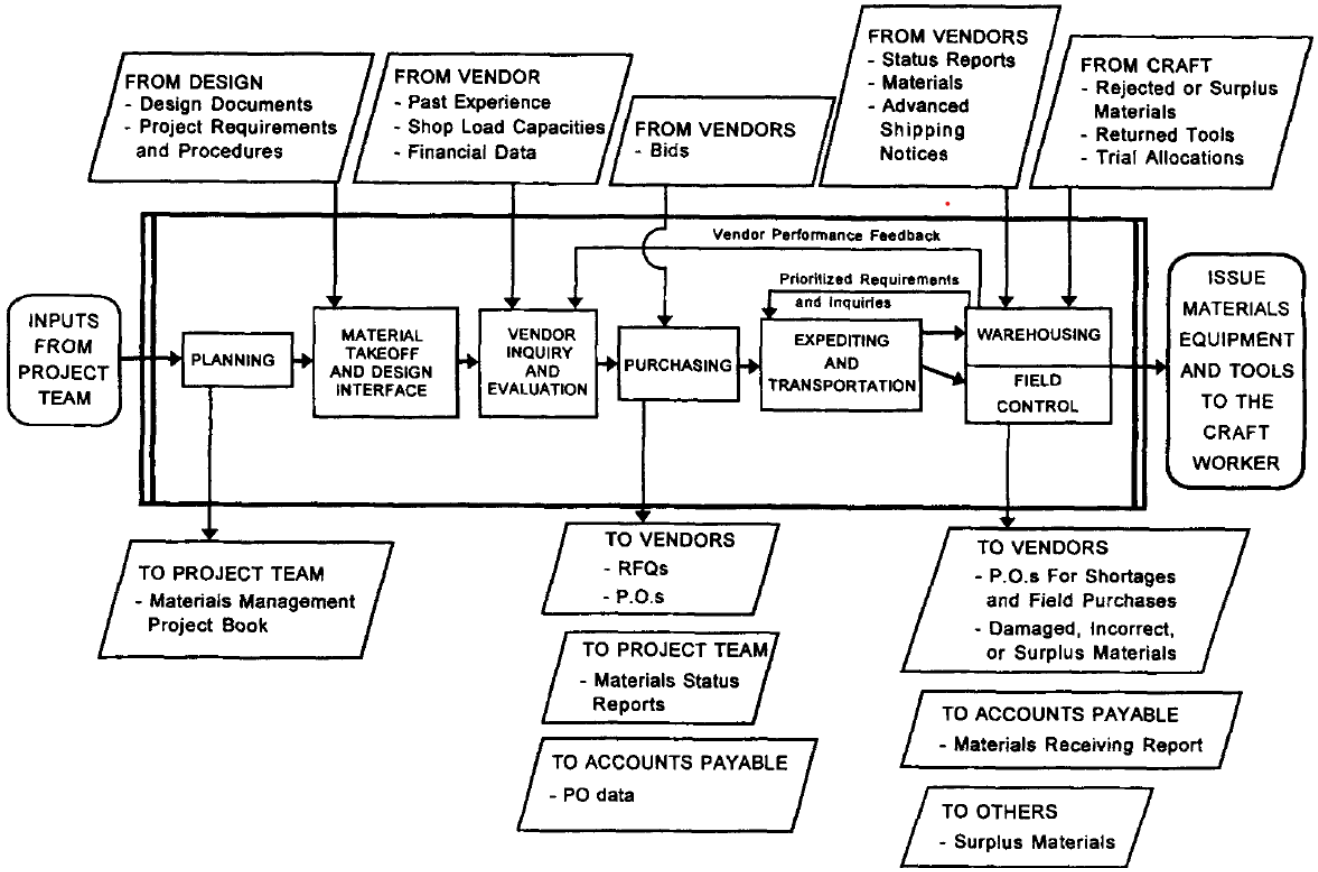

Figure3.1: Construction materials management process

Source: (Plemmons& Bell, 1995: 28)

Mehr & Omran (2013) suggested six stages for material management process in construction Mehr and Omran (2013) suggested six stages for material management process in the construction project: planning, procurement, handling, stocking and waste control, and the logistics surrounding materials. These components include the connection and amalgamation of the activities in each stage. Therefore, successful implementation of a materials management system needs to consider the different decisions made at various steps of the material management process. Figure 3.2 clearly describes this process.

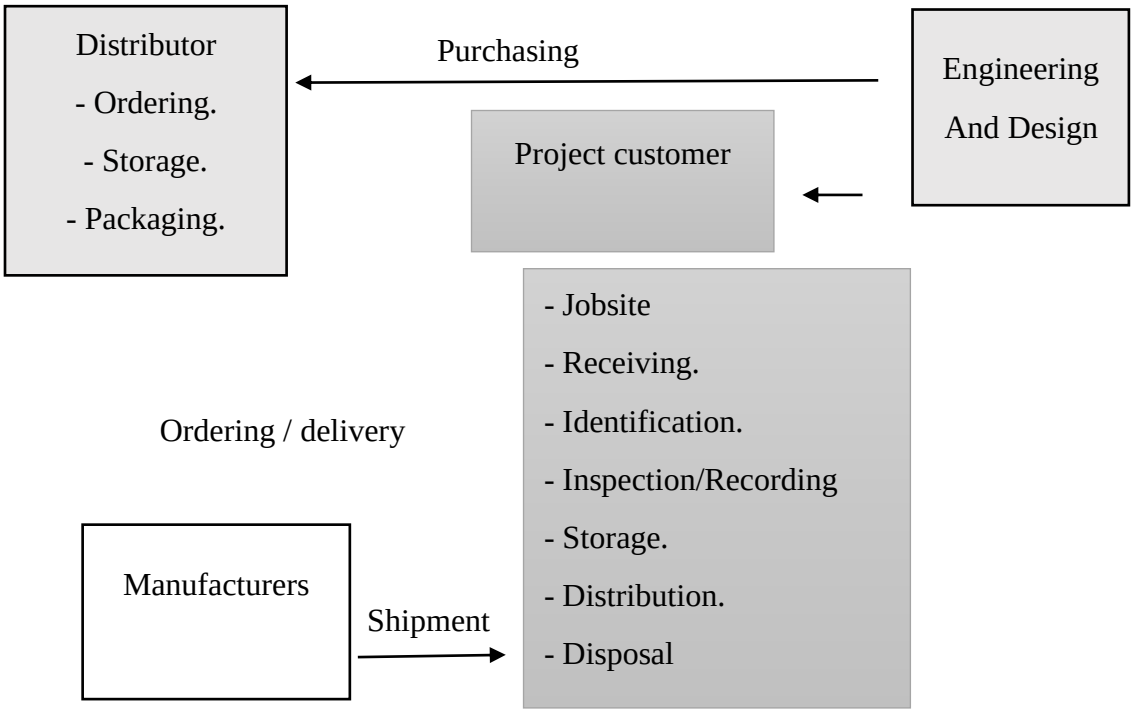

Figure 3.2: Typical Materials Management in Construction

Sources: Mehr & Omran (2013:57)

In addition, Kulkarn et al., (2017) believe that management should pay due attention to the most important material management phases such as value analysis, purchasing, material

handling, store keeping, recycling/ disposal, highlighting three essential stages for successful material management: materials purchasing, materials usages, and storage. Material management aims at reducing cost and increasing profitability (see Figure 3.3).

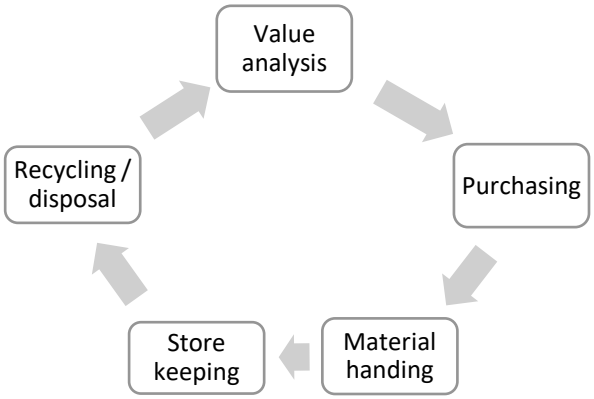

Figure 3.3: Component of material management process. Source: Author

On the other hand, Tedla and Patel, (2018: 147) describe the material management components as illustrated in Figure (3.4)

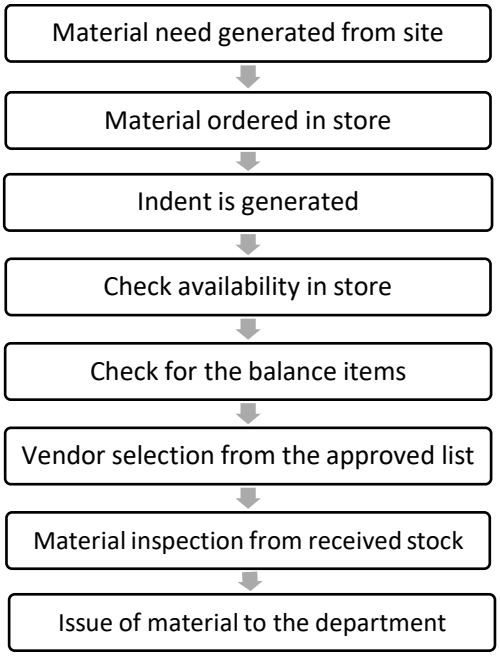

Figure 3.4: Material Management Process

Sourcess (Tedla& Patel ,2018: 147)

Ashika (2019) noted that in the construction project operation, there is often a project cost variance in terms of the material, equipment, manpower, subcontractor overhead cost, and general conditions. Therefore, one should properly consider material management because if it is not appropriately managed it will create a major variation in the cost. Kumar and Tadesse, (2020) maintained that construction management should consider the timely availability of contractor material as a factor involved in the successful completion of any project. Improving material management should be based on management recognition of material management's significance, combined with extensive pressure on costs and efficiency functions, making up the material management process (Kasim, 2010).

3.3. Measurement of the effectiveness of the CMM performance in construction industry

Plemmons and Bell (1995) carried out a basic study on the measurement of the effectiveness of the CMM, which becomes a basic reference for most researchers as reported in the literature on the industrial construction projects. In their research, Plemmons and Bell, (ibid: 27) identified key effectiveness measures of the industrial construction materials specifying the mechanism that can be used for the effectiveness of materials management systems. The main aim of his research was to determine the effective measures currently applied in the construction industry, which might be benchmarked between the projects and companies. Table 3.1 provides a summary of the key measures of material management effectiveness; it includes six attributes for the performance of material management: accuracy, quality, quantity, timelines, cost, and availability.

Table 3.1: Key Measures of Material Management Effectiveness

Source: Plemmons and Bell, (1995: 26 and 27)

Attribute	**key measures of material- management effectiveness**
Accuracy	Material receipt and problem. Warehouse inventory accuracy.
quality	Job-site Rejections of Tagged Equipment.
quantity	
timelines	Procument lead time. Purchase Orders to Material Receipt Duration. Commodity Vendor Timeliness. Commodity Timeliness.
Cost	Construction Time lost. Total Surplus
Availability	Material availabilty.

3.4. Integration Function

The functions of construction materials management are often performed on fragmented basis with minimal communication and no clearly established responsibilities among the parties involved. This fragmentation creates gaps in information flow, which does not lead to implementing the collaboration required among departments, and in turn, it leads to project failure (Cheng el at., 2010: Thomas et al., 1989). However, Yusuf et al., (2004) state that in certain instances, specifically on large projects, the whole scope of materials functions may be combined into one unit. Hans et al: (2007), McCarthy and Gordon, (2011) argue that a proactive integrated system approach is the only successful means to ensure that materials are considered in project planning, controlling and directing project activities.

Bemporad and Morari, (1999) suggest that the integration system must satisfy the control and reporting requirements for each function of the material management process exposed. The successful implementation of the integration system requires that the organisation engage in an excellent project management. This includes a clear definition of objectives, development of both a work plan and a resource plan, and careful tracking of project progress (Umble et

al., 2003; Langenwalter, 2020). Executives must interface with many different functional areas in the firm, such as marketing and distribution management, to perform jobs such as handling packaging issues, new product design, materials management, and warehousing (Gupta and Kohli, 2006). However, integrating the management system with documentation is difficult due to the variety of organisational goals and characteristics; besides, the uncertainty of management, which is influenced by a changing external environment (Raisienė, 2011).

The basis of integration can therefore be characterized by cooperation, information sharing, partnerships, shared information, shared technology and a fundamental shift away from managing individual functional processes to managing integrated chains of processes (Power, 2005). Integration can begin with product design, and incorporate all steps leading to tracking the material (Lee and Billington, 1993). The coordination and supervision of management systems should be marked because such activity is complex, requiring constant redesigning and innovation in separate management areas. Besides, long-term united efforts of the strategic level leaders and high level of organisational maturity are required to ensure the fluent stages of planning, preparing the documentations (policies, procedures, orders), implementing social technologies and realising the integrated management system (Raisienė, 2011).

Identifying integration is the primary step for developing the construction material management process (Kagioglou et al., 2000). Using integrated materials management systems, the project staff was able to improve the overall labour productivity (Gulghane and Khandve, 2015). Increasing labour productivity is the aim of all project managers. Therefore, many managers design training courses for the employees to join because training improves productivity and reduces cost; well-trained staff are more efficient and productive compared to the untrained ones (Tedla and Patel, 2018).

3.5 The CMM process boundaries and the integrated functions adopted

As opposed to the advantages and the importance of using a system approach to constructing materials management (CMM) as a process, the system approach has its own disadvantages; the most tangible ones are the following;

Before the system is applied, the designer must determine its boundaries. Unless management specifically defines materials management, there is likelihood that the system will be defined differently in each term by the different organisations. As a result, some functions and personnel will not believe that their goal remains the same as that for the materials management system (Safa et al., 2014).

Damij et al., (2008) defined system or improvement management process as a collection of activities that take one or more kinds of input and create an output that is valuable to the customer. However, Datta (2003) stressed that the improvement management process as any group of interrelated parts or elements function together to achieve the goals of the enterprise. To facilitate identifying the CMM process boundaries, Plemmons and Bell, (1995) suggest a process model to communicate or combine input to create output.

Koontz and Weihrich, (1993) and Plemmons and Bell, (1995) postulated three bases for the essential ingredients of a process (see Figure 3.5): the first is the input. In construction industry, this could comprise machinery, natural resources, raw materials, human resources and other materials input. While, the second ingredient involves the process, which means the basic input is broken down into one or more output products for the customer or market, which a series of operations performed by people and machinery. This actually provides an understanding of the CMM process and its integrated functions and activities.

The third ingredient is the output, which is the finished product; finally, comes the control which gives rise to the need of management. In our case, the model includes input consisting of the labour or staff, raw material and information transformed into output embodied by the performance indicators of price, time, quality and place.

As open does not exist in a vacuum but in an environment, which has a little or no control, this control element is always present and works through a feedback loop.

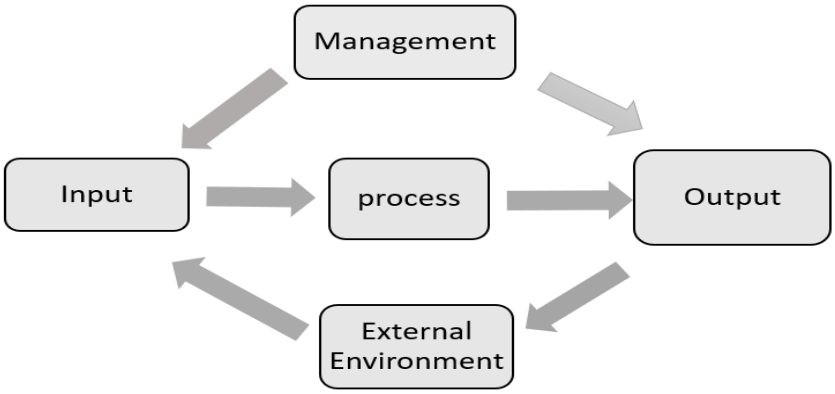

Figure (3.5): Systems Approach Management

Source: Koontz and Weihrich (1993:23)

3.2 Research model guide

Figure (3.6) is used as a guide to collect the relevant data for this study; it attempts to combine all components and factors required for improving the material management process. The guide model is based on extracts from the literature pinpointing the major impacts in the related areas. It is based on the views expressed by Koontz and Weihrich (1993), Plemmons and Bell (1995), Kasim and Ern (2010), Mehr and Omran (2013), Kulkarn et al., (2017) and Kumar and Tadesse (2020). These views are discussed earlier in the literature review. The guide model adopts Koontz and Weihrich (1993) and Plemmons and Bell (1995) perspectives on the management process.

The guide model aims to explain the relationship between construction material management functions and the construct (such as contractor, project management, labour). It will help the researcher develop a theory for the improved material management process in a Libyan construction company, which is the main aim of this study.

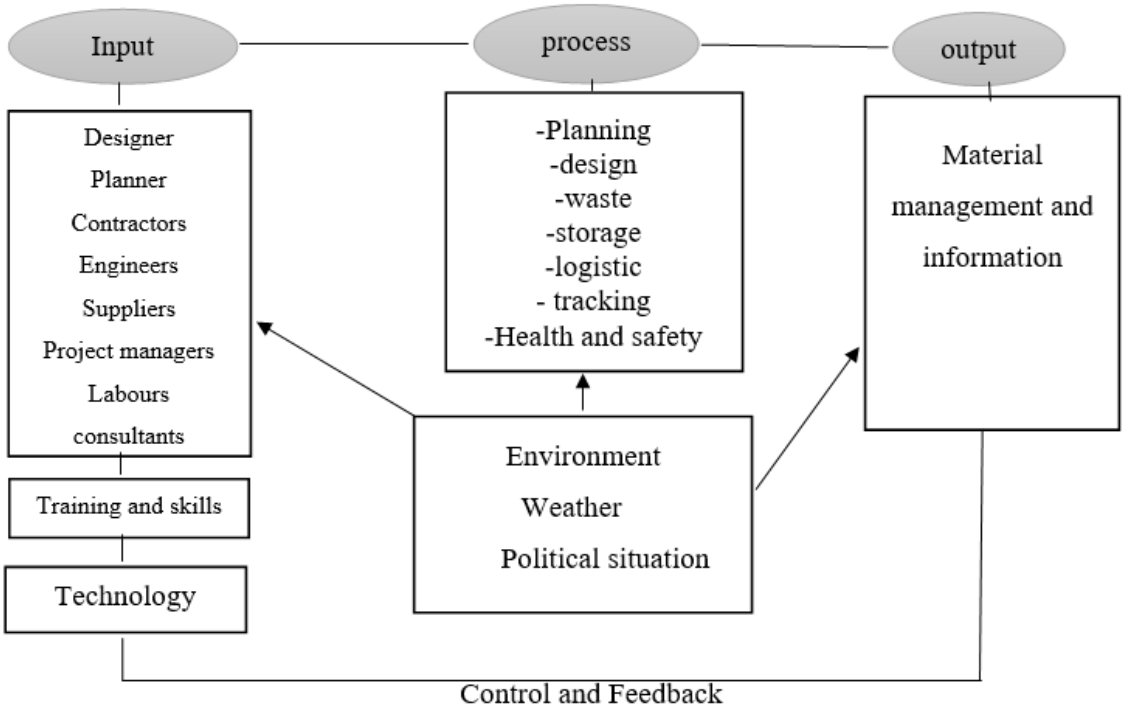

Figure 3.6: Research Model Guide. Source: Auther

The input included the construct groups (planners, design contractors, engineers, consultants, suppliers, project managers and labours) because they are all responsible for improving the material management process. Skills are vital for all people, particularly the contractors and project managers; the training courses are paid due attention because most of the staff members in construction need them. Technology will make the workers in the construction sites more efficient. It helps them to increase productivity and tackle more complex projects. Technology has brought comprehensive improvement to the construction process performance in terms of quality, time, and client satisfaction (Ruddock, 2006). Job site

materials personnel must be trained in all aspects of material classification, inspection and computer data entry (Bell and Stukhart, 1986).

The second part is the process, the functions of the material management applied by the people who are in the input stages in an effective and efficient manner into the output. The external environment variables such as weather, political situation may be impacted by the process. The output is the material management information and recommendations to be used by the construction site people. Feedback, output information and recommendations help the stakeholders fix any mistake in the process; some output variables, such as new skills of labour become important input, next time.

3.3. Research questions and Research gap

3.3.1. Perception of Stakeholders

Q1- What are the professional's stakeholders' perceptions (contractors, consultants and project managers) regarding the material management process activities?

objective 1- To identify the perceptions of the professional's stakeholders (contractors, consultants and project managers) currently involved in the material management process.

Construction stakeholders are people involved in the project. It is important to identify all the project stakeholders upfront. Stakeholders as groups or individuals are crucial for organisations survival and they can affect the achievement of its objectives (Eyiah-Botwe et al., 2016). The list of possible stakeholders is extensive; it may include contractors, clients, designers, planners, consultants, employees, subcontractors, suppliers and project managers who are major participants in many construction projects. Olander, (2007) and Jin et al., (2017) defined stakeholders as any group of people who can impact or are impacted by achieving the company's objective (Olander, 2007). However, few studies adopted the

stakeholders' perceptions to understand the kinds of strategies stockholders use to impact companies and their decision making (Frooman, 1999: 193: Aaltonen et al., 2008: 509).

It is important to identify and analyse the stakeholders' perceptions of the project decisions (Olander, 2007:278). Researchers in the construction building theory should be concerned with people who contribute to decision making and who benefit from the outcomes of such decisions (Olander, 2007, Aaltonen et al., 2008 and Jin et al., 2017). Nguyen et al., (2009) also affirmed that it is necessary to examine and evaluate the implications of the stakeholder impact index in construction project management across different stages and places.

3.3.2. Construction activity

Q2- What are the techniques used by the practitioners to determine the significant construction functions that can be used to improve the material management process?

Objective 2- To evaluate the current situation in order to determine the functions that can be used to improve the material management process

Material management functions include planning and material take off, vendor evaluation and selection, purchasing, expenditure, shipping, material receiving, warehousing and inventory, and material distribution (Bell and Stukhart, 1986 and Jusoh and Kasim, 2017). It is important to manage all materials from the design stage to the construction stage (Kasim, 2010). There is abundant literature on managing material management on site, but there is no detailed focus on the material management process; each study focuses on different functions or processes (Plemmons and Bell, 1995; Kasim and Ern, 2010; Mehr and Omran, 2013); Gulghane and Khandve, 2015: Kulkarn et al., 2017; Jusoh and Kasim,2017 and Tedla and Patel ,2018).

In developing countries, the material management process in the construction industry is still in its infancy (Kar and Jha, 2020). In addition, there are limited research studies in the literature related to material management in developing countries, and to material management processes in general (Kar and Jha, 2020).

3.3.3. Factors affect construction material management

Q (3): What factors currently influence Libyan construction projects' material management process?

Objective (3): To determine the factors that currently influence Libyan construction projects' material management process.

Various factors impact material management and each of these factors can give rise to potential problems. Many of these factors contribute to poor material management in construction project performance. Some of the crucial factors that impact material management from project stakeholders are due to inadequate knowledge and experience (Ahmad et al., 2018). These are factors such as lack of planning, waste, transport, improper handling, lack of resources, procurement, storage, and improper equipment among others (Phu and Cho, 2014). However, construction material management suffers from external factors beyond the stakeholder control, such as the weather and the political situation. There are many studies on material management; however, little research has been undertaken by researchers and practitioners on the problems facing the material management in the construction industry (Jusoh and Kasim, 2017).

3.4 Summary

This chapter has introduced and discussed the guide model that will be utilized in this study. The model is based on previous models and theories of construction management system. Some elements are discussed in more detail than others due to their importance and usefulness in serving the aims of the fieldwork. As discussed in the literature review, several models of the material management highlight the diverse elements of material management, (Plemmons and Bell, 1995, Kasim and Ern,2010, Mehr and Omran, 2013), Gulghane and Khandve, 2015, Kulkarn et al., 2017, Jusoh and Kasim,2017, Tedla and Patel, 2018). However, none of the models cited above gives details on how to improve the material management process. Also, the research gap and research questions are highlighted.

CHAPTER FOUR: METHODOLOGY AND METHODS

4.1 Introduction

Defining and determining the methods that can be used for conducting a research investigation is an integral part of the whole research process. It acts as a control mechanism and enables the researcher to conduct the study in a thorough manner (Quinlan et al., 2019). In this chapter, the scholar has presented a discussion and justification of different aspects of a research study that have been used in the current study. Areas such as research philosophy, approach, strategies, techniques, ethics and many others have been discussed in the following sections. By reading through this chapter, the readers can understand different methods and techniques that were used in conducting the research work. Moreover, the researcher can also use this chapter in order to ensure that the study is carried out efficiently and effectively.

4.2 Research Definition

Flick (2015) defines research as the process of systematically and methodological collection of knowledge or information about a particular topic. The main aim of conducting research is to increase the knowledge and help in expanding on a specified topic or subject area. Specific characteristics make research different from the process of just gathering data and knowledge. Research generally has an apparent purpose, and it provides a proper justification for the way the data is collected and used. According to Mackey and Gass (2015), the role of research in modern-day society is vital. It helps in exploring and understanding different aspects about a given topic and expand human understanding.

A significant part of any research study is Saunder's Research Onion. It was developed by Saunders in 2007 and presented the various stages and processes involved in conducting any research investigation. According to McCusker and Gunaydin (2015), it is one of the critical parts of a research study, as it helps in developing a strategy through which the study can be

carried out efficiently and effectively. Each layer on the onion describes details about each stage of the research process. Thus, it may be said that the research onion provides for an effective progression to develop an appropriate research design well-suited according to the requirements of the study. The main reason for its widespread popularity among the researchers is that it can be used and applied in almost any type of research. It can be easily used in a variety of contexts and situations (Wahyuni, 2012). Each layer of the onion has an impact on the following layers.

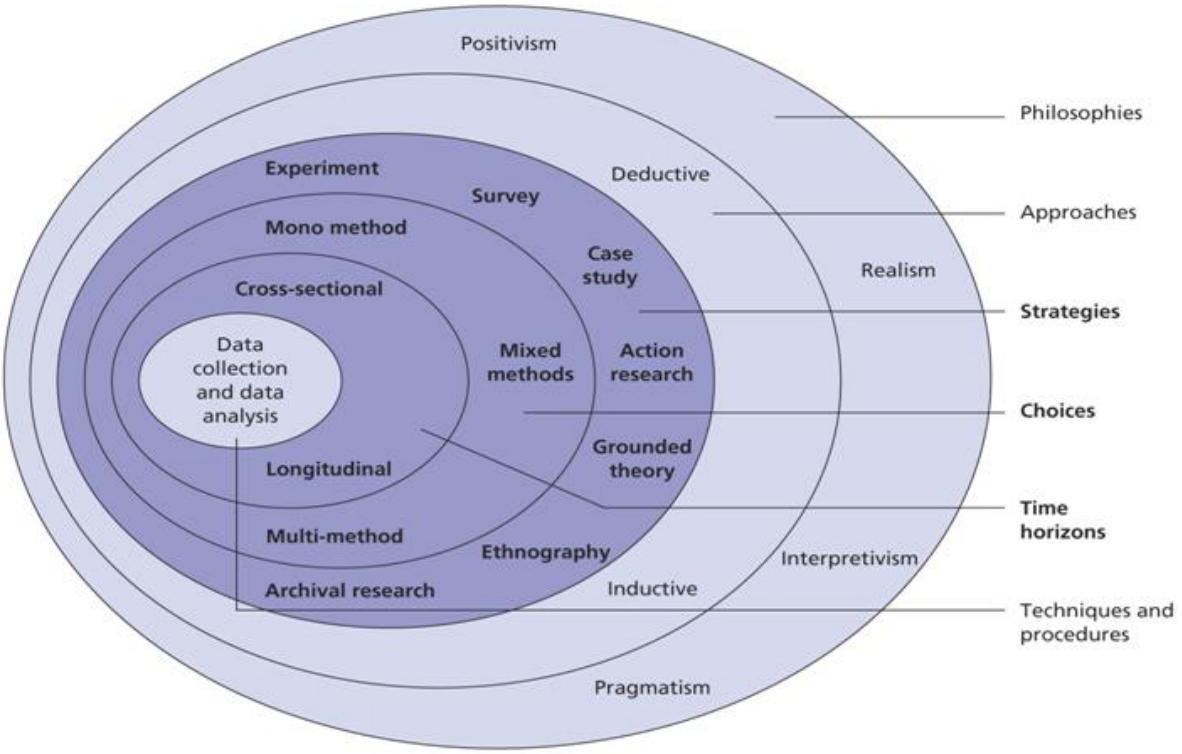

Figure 4.1: Research Onion

Source: (Wahyuni, 2012)

Research philosophy is the first stage as per the research onion. It defines the type of knowledge and information that the researcher uses while conducting the investigation. The assumption developed from the research philosophy plays a crucial role in determining how the whole research study will be undertaken (Tuohy et al., 2013). While selecting the type of philosophy to be used in the investigation, the researcher needs to pay attention to the type of

knowledge being investigated in the research project. There are four types of research philosophies – *pragmatism, interpretivism, realism* and *positivism*.

The second layer of the onion is the research approach. It highlights the various steps that needed to be taken in order to conduct the study and to ensure that the aim and objectives of the study are fulfilled. Selection of the research approach is primarily dependent on the type of philosophy used by the researcher (Jamshed, 2014). There two types of research approach – *inductive and deductive*.

The third layer is the research strategies. It describes how the researcher intends to carry out the research work. The strategy selected tends to define the process of the whole study. Therefore, the utmost attention must be given to the way the strategy is selected and implemented (Bauer, 2014). Any mistake in this part can have a significant negative impact on the whole study. It can be of many different types – archival research, ethnographic research, grounded theory, action research, case study, survey or experimental.

The fourth layer of the research onion shows the choices that the researcher has in terms of the methods and techniques that can be used by the researcher (Lather and St. Pierre, 2013). There are three main choices available to the researcher – *mono methods, mixed methods* and *multi-method*. As the name suggests, these methods utilise different techniques in order to conduct the study efficiently and effectively.

The fifth layer describes time horizons that is the time available and used in conducting the research work (Gale et al., 2013). There are two types of time horizons – *cross-sectional* and *longitudinal*. Attention must be given to the way the researcher selects the time horizon. It is mainly dependent on the type of data being collected by the scholar.

The last layer of the onion is that of techniques and procedures to be used while carrying out the research work. Herein the researcher describes and justifies the method used for

collecting and analysing the data. The process used and described at this stage tends to have a significant impact on the overall reliability and validity of the whole research project (Isaacs, 2014). Two types of data can be collected in any investigation, regardless of the approach – *primary* and *secondary*.

4.3 Research Philosophy

It is the first step in conducting any research investigation. Due to this very reason, this stage holds significant importance and tends to have the most significant impact on the way the study is carried out. If any mistake is made at this stage, then it can have a significant negative impact on the whole research process. According to Mackenzie et al. (2012), understanding research, philosophy is fundamental in determining the best possible way of conducting the research work. In view of Daudt et al. (2013), research philosophy works in three ways. It extends support to the researcher in identifying and selecting the data to be used during the study; in determining the best and highly effective methods for data collection and analysis; and thirdly in informing the researcher about the appropriateness of the research design. The following paragraphs describe and define different types of research philosophies.

4.3.1 Positivism

The philosophy of positivism states that the researcher should view the world as a single entity, as it exists even if no individual exists in it (Mukhopadhyay and Gupta, 2014). Thus, according to this philosophy, the best way to study is that the world is through independent scientific and objective methods. Its further states that a research study should not be carried out using subject methods, as they entail a chance of biases and partiality because of the

direct involvement of the researcher. Use of this philosophy entails developing theory and formulating a hypothesis that can be utilised during the research study.

The researcher should be passive, with attention to quantifiable observations that can be analysed through objectively used statistical procedures (Saunders et al., 2015). Positivist researchers utilise more scientific methods, such as experiments and surveys, as they demonstrate facts measured in numbers (Sekran and Bougie, 2016).

4.3.2 Interpretivism

Interpretivism can read and interpret people that is the participants in their social and cultural lives. By using this philosophy, a researcher can focus on explaining the actions of different individuals and also analyse their actions. For the interpretivists, the reality is subjective, and it is based on different social constructs (Krishna Jasti and Kodali, 2014). Due to this, subjective meanings and judgements play a crucial role in the way the data is collected and interpreted. According to Tong et al. (2012), researchers are very subjective during the data collection process. Therefore, to be able to analyse the data effectively, the researcher usually resorts to using inductive research approach.

The researcher's role is significant because he provides an interpretive understanding of a phenomenon from his subjective perspective (Bryman and Bell, 2015). So, the researcher and his beliefs and views are integral to interpretive research (Creswell, 2013). Interpretivism generally incorporates qualitative research techniques, which can include observations from participatory individuals (Cohen et al., 2013). However, the qualitative method through the interpretive approach may result in a case of uncertainty, which is marked for less interest with the need of generalisation (Saunders et al., 2015).

4.3.3 Realism

It is another widely used research philosophy. Riedl, Davis and Hevner (2014) state that realism is a philosophical concept that provides information with regards to the nature of scientific practices. According to this philosophy, several real-world objects exist regardless of human knowledge regarding them. Herein it should be noted that this philosophy is based on the viewpoint which states that there are chances that the researcher does not have the information or knowledge about a particular aspect, but even then, it exists. Therefore, it can be said that the philosophy of realism can enable the researcher to explore different aspects of a particular topic and thereby ensure that the study is carried out in the most effective manner possible. Realism as a philosophical paradigm has elements that belong to both positivism and constructivism (Ryan,2018).

4.3.4 Pragmatism

This philosophy helps in explaining the concepts that are used in different actions and processes. Herein main focus of the researcher is on the practical consequences instead of just explaining the abstract and vague ideas. In studies that use the pragmatist philosophy, research question or problems form the core part (Dumay and Cai, 2015). Such investigations are developed in such a manner that they either discuss the problem or that they provide an effective solution for resolving the problem. These guides the researcher in either developing or determining a practical solution for the research question, so that a particular issue can be resolved to the highest possible extent. Furthermore, by using this philosophy, a researcher can bridge the gap between the positivism and interpretivism philosophies (Saunders et al., 2015). It is an attempt to reconcile objectivism and subjectivism, facts and values and different contextualised experiences. This is achieved by considering theories, ideas, hypotheses, concepts as well as research findings, not as abstract entities, but as instruments

of thoughts and action and practical outcomes. Pragmatists view research from the perspective of a problem which needs a practical solution. Research is initiated when a researcher has a doubt about something; then the researcher's values drive the process of inquiry. A new belief is recreated when the research has been resolved (Saunders et al., 2015).

According to Creswell (2014), pragmatism is a philosophical foundation for the mixed method approach and plays an important role in conducting research and interpreting results. It can be applied to yield a better result (Saunders et al., 2015).

4.3.5 Selected Research Philosophy

The current study cannot be carried out by adopting one philosophy: positivist or Interpretivism. Positivism cannot be used alone because of the participants' views and perceptions, and their experience plays an essential role in the research. The research cannot be purely interpretive because quantified facts are required for objectivity. Moreover, the present research starts with people's engagement with construction companies' site to improve their skills and identify the material management process activities. Therefore, interpretivism is required for this study because it helps to understand the Libyan construction stakeholders' views. The researcher wants to find a solution through the present research and explore better ways to improve material management in the project site.

At the same time, positivism was needed to identify the factors that impact the material management process. This required the researcher to identify the construction professionals' staff attitudes to using material management in the project site. Quantifying data is essential for an objective insight, with reliable mathematical procedures, which reflect the phenomenon objectively. These descriptions are typical of pragmatist research, where the

ultimate purpose is to find a practical solution to the research problem (Collis and Hussey, 2014).

So, the research problem adopts the pragmatism philosophy, where positivist and interpretive philosophies are combined to explain the approaches to the problems and understanding the research phenomena.

4.4 Research Approach

The research provides information on the various stages and steps required to conduct the study efficiently and effectively. A transparent research approach helps to carry out the research work better and to ensure that its aims and objectives are fulfilled by answering questions to the given research questions. In any research work, the role of philosophy is vital (Soni and Kodali, 2012). It enables the researcher to highlight, present and discuss different steps that are required to conduct the study. There are two main types of research approaches: inductive and deductive. Well-defined approaches help the researcher to move from broader aspects of the study to particular ones that will have the most significant impact on its progress and success and on the overall effectiveness on the readers (Saunders et al., 2015).

The deductive approach starts with a general theory applied to a research-specific case or context while the inductive approach observes some phenomena and collects data, which may lead to develop a theory (Sekaran and Bougie, 2016).

Through this approach combination, the researcher was able to develop thorough understanding of the various factors that lead to either the success or failure of the techniques used for material management at the construction sites in Libya. Both deductive and inductive approaches are beneficial even when used in isolation, but they can be instrumental when they are used together as well. The deductive approach characteristics include: search for causal relationships between variables, quantitative data, highly structured methodology,

facilitation of measurement, generalisation of results and large sample size (Saunders et al., 2015). The inductive approach does not start with a pre-established theory; rather, the researcher collects data and observes phenomena, and only then establishes a theory based on the given data.

Another approach that combines detective and inductive data is the abductive approach. It aims to find the most likely explanation of the subject under investigation and involves a cyclical process in the sense that the researcher establishes a dialogue at every stage between theory, data and the social context (Saunders et al., 2015). The abductive approach helps the researcher modify an existing theory as it involves developing theories based on social actors' language, meaning and accounts. Research starts with describing these activities and then derives concepts that support the understanding of the problem of research (Eriksson and Kovalainen, 2015).

In this study, the researcher applies an abductive approach which includes both inductive and deductive reasoning, allowing more explanation of the phenomenon to identify and explore themes and patterns regarding the stakeholders' perceptions; that will definitely help develop theory.

4.5 Methodology

Creswell (2013: 12) defines research designs as "types of inquiry within qualitative, quantitative and mixed-methods approaches that provide specific direction for procedures in a research design". These methods are quantitative in the case of positivist research and qualitative in interpretivist research.

4.5.1 Quantitative Research Design

Quantitative research is always linked with figures and statistics; it is referred to as positivist and deductive (Sekaran and Bougie, 2016). The main quantitative research focus is concentrated on examining the causal relationships between research variables in a highly structured manner (Creswell, 2013), such as experimental research and survey (Saunders et al., 2015).

The quantitative research designs are more suited to the deductive approach and logical integration of a natural science model (Wahyuni, 2012). It consists of appropriate and precise measurement methods. By applying such type of design, the researcher can easily quantify the data collected from different sources and analyze the data efficiently and effectively. The quantitative method is more suited for conducting statistical analysis of the data; thereby enabling the researcher to thoroughly analyse the responses of the participants. The research requires larger sample sizes, implying investigation of broader issues related theoretically to the population. It does not provide an in-depth insight into the topic (Saunders et al., 2015).

4.5.2 Qualitative Research Design

Qualitative research describes any data collection instrument and analysis procedure that uses non-numerical data. It is associated with the interpretivism paradigm and inductive approach. The focus here is on finding the relationships between the research variables and gaining a rich insight into the topic under study (Bryman and Bell, 2015). In qualitative research designs, the researcher tends to focus more on analysing data through qualitative means; thereby interpreting responses of the participants in a better manner. The use of such research design entails analysing and presenting the data which is easily readable and understandable by the readers (Mukhopadhyay and Gupta, 2014). This way, their overall understanding of the subject matter can be realized. Qualitative research would help the readers comprehend

the way the study was carried out and the means whereby the data was collected from different sources and how the participants' answers were dealt with (Bryman and Bell, 2015).

4.5.3. Mixed methods research design

The mixed-method research design is composed of both quantitative and qualitative data collection techniques and of analytical procedures (Creswell, 2013). Mixed-method design is compatible with pragmatism since it posits that the adoption of a single philosophy in research is unhelpful; moreover, it considers that a choice of a mixture of positions will aid in achieving the research goals and objectives (Bryman and Bell, 2015). What determines the most appropriate methodological choice is the nature of the research, the research context, and the research outcome (Saunders et al., 2015). Pragmatists value both qualitative and quantitative design, considering that the extent to which they are appropriate depends on the research nature and goals (Collis and Hussey, 2014). In terms of theory development, there is also a tendency by pragmatists to combine deductive, inductive and abductive approaches (Saunders et al., 2015). In this case, inductive or deductive research is used to determine the theory's position in the research; qualitative and quantitative research design is also used to determine insight into the theoretical framework (Saunders et al., 2015). Creswell (2013) contends that mixed methods enrich research, allowing one database to assist the other; each method could explain different types of questions.

The current study applied a mixed-method approach through sequential explanatory stages. The research is designed of quantitative methodology followed by qualitative data collection and analysis techniques. The mixed-method approach helps the researcher to understand the research phenomena and to achieve the research objectives. The questionnaire was distributed to the respondents from different regions and companies; then, the researcher conducted interviews to get more information about the material management process.

An explanatory sequential mixed method is one whereby a researcher first conducts quantitative research, analysing the results and then elaborating on them, explaining them in more details through the qualitative research methodology. It is considered explanatory because the initial quantitative data produces further qualitative data. However, it presents challenges represented by identifying the quantitative results and applying them to further explore additional data (Curry et al., 2013; Creswell, 2014; Saunders et al., 2015).

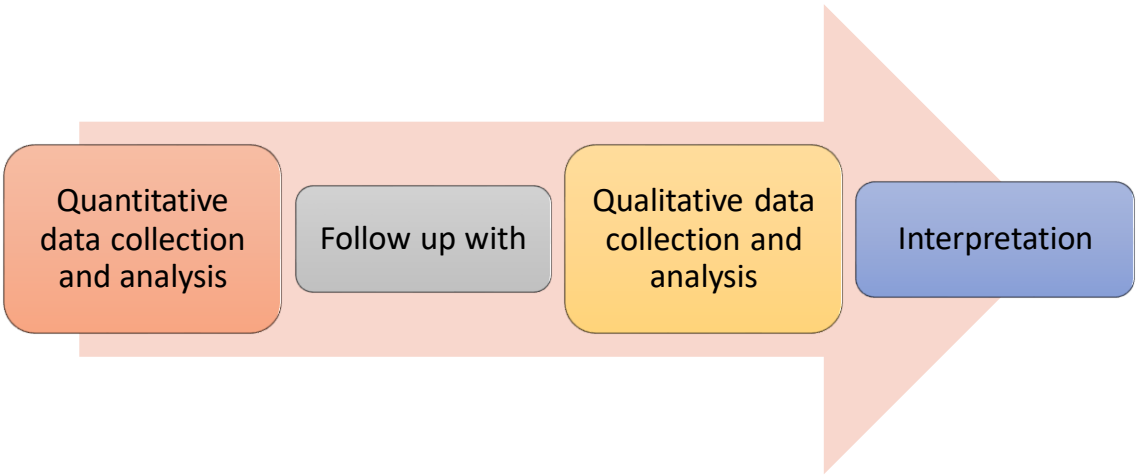

Figure (4.2): Explanatory sequential mixed method

Source: Creswell (2014:220) &Saunders et al (2015:170)

4.6 Research Strategy

Saunders et al., (2015) define the research strategy as "a general plan of how a researcher will go about answering the research question" (2009: 600). The research strategy is a methodological link between research philosophy and subsequent choice of methods to collect and analyse data (Denzin and Lincoln, 2011).

There are different strategies such as survey, case study, grounded theory, ethnography, and archival research (Cohen et al., 2013). The strategies are categorised into explanatory, descriptive and exploratory research, some of these strategies are deductive approaches while others are inductive approaches.

The current study aimed to develop a Libyan construction material model, focusing on the material function process, staff experiences, barriers, and methods using material activities. Therefore, the current study is explanatory because it aimed to explain the participants' attitudes and material management perspectives.

4.6.1 Case study

A case study is defined as an in-depth inquiry into a topic or phenomenon within its real-life setting (Yin, 2013). A case study is an in-depth exploration of multiple perceptions of the complexity of the specific project, policy, program or system in a real-life context. Case study research can refer to a person, group, organisation, association, change process or an event (Denscombe, 2014). Thus, a case study is essential to understand the context. Qualitative, quantitative, and mixed-methods are used in the case study to form an insight into the research context and the dynamics of the case (Saunders et al., 2015).

A case study can provide in-depth information that other research approaches cannot. Also, the case study allows the researchers to go deeper into a research project (Yin, 2013). Case studies are based upon two discrete dimensions; single or multiple case designs. Single cases are used to confirm or challenge a theory or to represent a unique or extreme case (Yin ,2013). It supports the researcher in conducting in-depth investigations of the phenomenon through rich description and understanding (Saunders et al., 2015). On the other hand, in multiple case studies, the focus is on whether the findings can be replicated by all the cases used, with the possibility of "literal replication" (Yin, 2013).

In the current study, a single case study has been selected to investigate the topic, applying the mixed-method approach to obtain in-depth information, to understand the research phenomenon and to identify the Libyan construction authorities' perceptions. It is the best choice because it helps the researcher to develop a theory (Yin, 2003).

4.7 Time Horizon

According to Beckman (2014) and Attia and Edge (2017), it is one of the most critical layers of the research onion. Herein, it can be said that all research work should be carried out within a given time frame so that the study can be completed on time; therefore, its overall effectiveness can be improved. There are two types of time horizons as per the research onion – cross-sectional and longitudinal. Cross-sectional studies are limited to exploring a particular phenomenon which is very particular to time. On the other hand, longitudinal studies focus on analysing the topic as thoroughly as possible. In such type of studies, the researcher can control the changes and development during the process of the study. Although this method is very time consuming, it is considered to be very useful, mainly due to the fact that it helps in conducting the research efficiently and effectively (Bauer, 2014). The purpose of the research, research questions, time available for the researcher and the sample size, are all determinants of the choice (Cusack et al., 2018). The present study is cross- sectional, as are most projects carried out for academic purposes because they are time-bound (Saunders et al., 2015).

Cross-sectional research investigates a particular phenomenon at a certain point in time (Cusack et al., 2018). Data is collected in a single stage over a short period of time, providing a snapshot of the phenomenon under study (Collis and Hussey, 2014); survey is thus an appropriate strategy (Edge, 2017). Qualitative strategies, such as case study, can also be used in cross-sectional studies (Bauer, 2014). Longitudinal research, as the name suggests, investigates a group of subjects over a long period of time, to form an in-depth understanding of the dynamics of a certain problem. It involves repeated observations of the research subject/s to identify the degree of stability or change (Collis and Hussey, 2014).

4.8 Sampling and population

Population refers to the full set of cases to take a sample. However, selecting a sample enough from a population is not easy for the researcher. So, the researcher needs to adopt a more manageable definition of the population, which "is called the target population" (Saunders et al., 2015: 275). To achieve the research aim, a target audience of Libyan construction stakeholders from different companies is selected; it includes contracters, project managers, consultants, planners and engineers.

4.8.1. Sampling techniques

Tashakori and Teddlie, (2010) defined sampling as a process of selecting a subset or sample unit from a larger group or population of interest. However, sampling is not only about selecting individuals for interviews, but it also includes making decisions about the settings and social processes.

According to Saunders et al., (2015), the two core types of sampling technique are:

1- Probability sampling: each member of the population has an equal and known chance to appear in the sample. This technique includes a simple random, systematic, stratified and cluster sampling.
2- Non-probability sampling: the probability of each member being included in the sample is unequal and unknown. This technique includes convenience, judgmental, quota and snowball sampling.

Before selecting the sampling design, probability or non-probability, researchers need to consider the sampling frame, a list of all the targeted population (Saunders et al., 2015). In case-based research, sampling is carried out in the process of analytical induction. Cases are sampled by similarity. After the researcher has designed the study's theoretical framework

and the research questions, cases are selected from the intended population and examined. The generalisation is made by analogy (Creswell, 2014).

The selection of probability and non- probability sampling is based on some considerations such as the nature of research, the relative magnitude of non- sampling, and degree of error tolerance. For the quantitative study, convenience sampling is a type of non-probability sampling which is chosen instead of random sampling because such a technique is a convenient source of data for researchers (Saunders et al. 2015). Also, because of time constraints and accessibility, the researcher is unable to survey a large number of respondents from different construction projects and regions in a short time. This included respondents who are available and willing to be part of this study. Online questionnaire was used to collect data; in fact, the researcher sent the questionnaire to colleagues in the Libyan Engineers Syndicate to obtain large amounts of data very quickly.

On other hand, the sampling selection process is applied as part of the qualitative method. It is essential to interview the Libyan construction stakeholders who are informed and who have more experience and knowledge about construction material management. Thus, purposive sampling is most appropriate (Creswell, 2014). Purposive samples are used when a particular group of people is chosen because the group members are known to provide important information that could not be elicited by other sampling design techniques (Garg, 2016). Purposive sampling aims to select a small number of participants, usually no more than 30, from whom in-depth information could be obtained (Guetterman, 2015).

This study interviewed 14 Libyan construction authorities (project managers, senior managers, purchase managers, contractors, consultants, warehouse managers and employees, material officers and planners) who are part of the process of developing material

management; their experience provides information that helps understand the phenomena thoroughly.

4.9 Data Collection Methods

In quantitative research, questionnaires are used as a method of data collection. However, in a qualitative research, semi-structured interviews are adopted as a data collection method.

4.9.1 Questionnaires

The questionnaire survey is described as quantitative; it is usually a self-administered document, as in this case; the questionnaires have different advantages, containing mainly accurate information (Collis and Hussey, 2014). They are "generally less expensive and time-consuming than observation and interviews (Soni and Kodali, 2012).

Electronic questionnaires have the advantage of being simple to administer over a wide geographic area; respondents may answer at their own convenience; however, there is a minimum of interviewer bias. The data can be collected within a short period of time, and the method is highly cost-effective (Sekaran& Bougie, 2016). However, online questionnaire respondents need a computer and internet to complete the survey (Creswell, 2014).

The researcher selected this method in order to present a more thorough and competent analysis of the research topic. It is considered a very quick method for collecting relevant information about the subject matter (Soni and Kodali, 2012).

This study adopted an online questionnaire as a tool to identify the Libyan construction stakeholders' perspectives; the participants are experienced; they are responsible for improving material management process; they belong to different age groups, have various positions, live in different cities and have diverse educational backgrounds.

In the current study, the questionnaires were based on the material management process components. They took approximately 10 minutes to complete. The questionnaire design was based on insights gained from the literature review, from surveys carried out on the same topic. The research questionnaire consisted of three parts; each elicits information related to the (participant`s experience, the operation of construction on-site, and the use of ICT in construction site); it incorporates 29 closed questions besides three questions with a multiple choice. The first three questions had multiple choices (participants can choose any or all) to identify the material management current situation; including the participant`s position and experience, and the factors that impact the material management process. From question four to the end of the questionnaire, Five-Likert scale questions were introduced (see Appendix 1).

The questionnaire and the interview questions were translated by a certified Arabic-English translator working for a well-known translation agency to guarantee the accuracy of the translation. The questionnaires were distributed online to the respondents. Table 4.2 displays the response rates. A total of 200 participants took the online questionnaire, of whom 120 completed all the questions; their responses constituted the survey sample. 80 uncompleted questionnaires were excluded from data analysis.

Table 4. 1. Response rate of the questionnaire. Source: Author

Questionnaire	Distributed	Returned	Response rate
Measure the material management activities.	200	120	60%

4.9.1.1 Survey questionnaire design

There were certain aspects that the researcher has to pay attention to while designing the questionnaire. It was important for the scholar to ensure that these criteria and aspects are properly considered and that the best version of the questionnaire was developed for the study

(Attia and Edge, 2017). For instance, the researcher has to ensure that the purpose of the survey design is clear and that it is clearly stated and explained to the participants. The objective here was to ensure that the participants knew about their role and involvement in the study. Table 4.3 provides a checklist of the aspects that were considered while developing the questionnaire survey.

Table 4. 2. Checklist for the survey method. Source: Author

(Creswell checklist questions)	Common
Is the purpose of the survey design clearly stated?	Yes. A self- completion questionnaire as a tool to examine materials management on Libyan construction sites.
Is the reason for choosing the design mentioned?	Yes, this research seeks to improve materials management on construction sites. The survey was the best way to identify the perceptions of professional people on construction in Libya. It helps the study to collect a large number of responses in a short time at a low cost.
Is the nature of the survey identified?	Yes, to identify the perceptions of professional people on construction in Libya. It helps the study to improve materials management on sites. The survey adopted a similar approach to that of the measurement system developed by reviewing past studies of (Shibob et al. 2012; Salah et al. 2014 and Kasim et all 2008). it examines the factors of materials management.
Is the population together with its size mentioned?	Yes, this study adopted an online questionnaire as a tool to identify the perceptions and attitudes of professional expert people in the Libyan construction industry. It needs a large number of respondents. Therefore, it is the best way to collect information. The questionnaire was sent to the head of the public construction company in Libya to distribute to the staff of the company such as; project managers, Engineers, contractors/subcontractors, surveyors, consultants and designers, etc.
Will the population be stratified? If so, how?	For the quantitative data, non-probability sampling techniques are used to achieve the research objectives. Convenience sampling techniques are chosen because of their accessibility.
How many people will be involved in the sample? On what basis was this size chosen?	The population of this study will be 200 respondents, minimum 30 respondent s for each factor. The minimum sample size required here will be calculated using the following formula (Saunders et al., 2015: 281:283): Actual Sample Size= (Minimum sample size)*100 Estimated response rate expressed in %.
What will be the procedure for sampling these individuals (e.g. random, Non-random)?	The researcher asked all respondents to complete the survey. The sample of the respondents based on convenience is chosen for this study because of the virtue of its accessibility.
What instrument will be used in the survey? Who developed the instrument?	Online questionnaire. Yes, to identify the perceptions of professional people on construction in Libya. It helps the study to improve materials management on sites. The survey adopted a similar approach to that of the measurement system developed by reviewing past studies of (Shebob et al. 2012; Salah et al. 2014 and Kasim et all 2008). It examines the factors of materials management. The researcher reviewed these studies on materials management measurement to examine in the Libyan construction site.
What are the content areas addressed in the survey? The scales?	This study will be adopting two types of validity, internal and external validity. Internal validity comprised content and criterion validity. For external validity, the Pearson test will be applied for discernment validity. The study also will be employed Cronbach's alpha for internal consistency reliability.
What procedure will be used to pilot, or field test the survey?	The survey tested by an Arabic translation officer to ensure that the participants can understand PhD students and construction professional expert. A pilot study helped the researcher to check the time required to complete the questionnaire, and to provide the researcher with feedback.
What is the timeline for administering the survey?	This survey needs 20 minutes to complete.
What are the variables of the study?	Survey questions will be analysed, and any questions that serve as key variables, these variables are cited in research questions (improve materials management; apply supply chain management and lean construction).

How do these variables cross-reference with the research questions and items on the survey?	In this study, the researcher will make sure that the survey questions met the research objective of examining demand-side perceptions. A survey is a useful tool for reviewing the professional expert attitudes, and any questionnaires have missing of data will be excluded from the analysis.

4.9.1.2 Pre-testing of questionnaire

Before conducting the survey, pre-testing the questionnaire is recommended to avoid misinterpretation, falsified answers, failure of response, and a potentially offended participant who encourages others to abstain (Bryman and Bell, 2015). Piloting a study allows the researcher to identify poorly worded questions, and to provide good feedback. Cohen et al. (2013) suggest that a research questionnaire should be pre-tested on sample a similar to the potential participants. Pre-testing was initially piloted in English on three engineer PhD students studying at the University of Salford who shared a cultural and educational background similar to that of the research sample. The questionnaire was finally administered in Arabic; this sample pilot test was conducted on 12 PhD students. 11 questionnaires were returned, with no negative comments; the participants agreed that it took no more than ten minutes to complete. The researcher was satisfied with this number because all the 11 respondents agreed that the questions were clear, and that the time was reasonable4.9.1Validity and reliability

4.9.2Validity and reliability

Validity and reliability are techniques used to evaluate the quality of the research (Creswell, 2013). Validity refers to the researcher's ability to draw inferences from the scores obtained (Sekaran and Bougie, 2016) The ability to measure the factors and concepts with the absence or lack of error is reliability (Creswell, 2013). By measuring both, the researcher can assess the quality of the data collected (Sekaran and Bougie, 2016).

Validity

Any instrument of measurement that explains a specific concept has to be valid; there are two types of validity: internal and external. External validity indicates the extent of the generalisation of the findings. It was achieved through examining discernment and convergent validity. In order to ensure a high level of research validity, various sources, both primary and secondary, were formulated as the basis for the current study.

Triangulation (Collis and Hussey, 2014) was implemented to explain the information collected from three key sources; it enhances the validity of the findings and assesses whether the data agree (converge), complement (are complementary) or contradict each other (are dissonant). Dissonance, in this respect, does not indicate a failure in the study; rather it can be considered constructive if it leads to new findings or rich understanding (O'Cathain, et al., 2010). According to Tonkin-Crine et al. (2016), the literature identifies four types of triangulation:

• Methodological: the use of more than one research method or a data collection technique; this study adopted a mixed method (quantitative and qualitative research method) to collect data.

• Data: the use of multiple data sources; this study reviewed the literature related to the material management concepts; a questionnaire was used to collect data from the target population to obtain more information, a semi-structured interview was conducted.

• Theoretical: the use of multiple theories; this study reviewed different theories related to the research topic.

• Investigator: the use of two or more researchers in the analysis.

The internal validity demonstrates how a study's design excludes errors (Zohrabi, 2013). According to Creswell (2014), there are three types of internal validity applied for surveys:

1- Content validity, which is concerned with the extent to which the measurement scale appears to measure the characteristics that it is supposed to measure.

2- Criterion validity, which is the ability of the questions to make accurate predictions.

3- Construct validity, which is a measure that refers to the extent to which the questions measure the constructs that the researcher intended to measure within the intended interpretation of the variables.

In this study, all three forms of validity were determined in order to confirm the validity of the research. The survey adopted an approach similar to that of the measurement system developed by Shebob et al. (2012); Salah et al. (2014) and Kasim et al., (2008); it examines the construction activities, and the factors impact on the material management process. These factors were selected after reviewing the past studies (Abdul-Rahman et al., 2006; Madhavi et al. 2008; Kassim, 2010; Ghulam and Kassim 2012; Ayegba, 2013; Hannure and Kulkarni 2014; Safa, 2014; Amar et al., 2015) (see Chapters (2 and 3). The supervisor assessed the relevance of the content in the questionnaire and the interview questions and gave his feedback to the researcher. Table (4.3) displays a checklist for the survey methods.

Reliability

Creswell, (2013) defined reliability as an instrument that measures a specific concept providing a description of that instruments. To achieve a high level of reliability, the researcher employed a mixed method (a qualitative and quantitative research method). In addition, the study used Cronbach's alpha to assess the reliability of the survey measurements.

There are several approaches for assessing the reliability of scale such as test-re-test, which is obtained by correlating data collected with those derived from the same questionnaire under near-equivalent conditions; internal consistency; and alternative form (Saunders et al., 2015),

Internal consistency reliability is a function of homogeneity among items formulating a construct in the instrument (Sekaran and Bougie, 2016). Creswell (2013) states that internal consistency reliability assesses the correlation level of items in the measurement. Also, the level of correlation between construct items is exhibited through the reliability measure of Cronbach's alpha (α), which is widely recognised as an indicator of a scale's level of reliability. Internal consistency reliability was used to assess the level of correlation between items of measurement (Saunders et al., 2015). According to Wong (2013), the lower limit for Cronbach's alpha is 0.70 but it can be lowered to 0.6 in exploratory research. Table (4.4) summarises the results of the internal reliability of the scales using Cronbach's alpha, where the values are 0.797. This is above 0.7, implying that the findings are reliable, and that it is 79.7 % probable that it could achieve the same result when applied at different times.

Table 4. 3 Reliability statistics. Source: Author

Cronbach's Alpha	N of Items
.797	28

4.9.3 Quantitative data analysis

The quantitative data from the questionnaires was first analysed and then used to plan the qualitative follow-up. Statistical Package for Social Science (SPSS) version 25 was used to analyse the quantitative data. This study used Anova and Cronbach's Alpha, and the descriptive statistical analysis of the data in terms of frequencies and percentages summarises

in a simple way, whilst means and standard deviation were combined and calculated to indicate the spread of data within continuous variables through alternative testing.

4.9.4 Interviews

To achieve the research, aim and objectives, it was essential to interview the Libyan construction stakeholders who have broad experience and extensive knowledge about the construction material management. Before conducting the interviews, the researcher discussed the research aim and objectives highlighting its importance to the Libyan construction authorities to encourage interviewees to give more details related to the research phenomena. A semi-structured interview is the most commonly used method for data collection due to two reasons: first, data can be analysed by applying different methods and second, the interviews are easier to arrange (Collis and Hussey, 2014).

The interview protocol prepared by the researcher beforehand helps to collect the data in an organised and systematic manner. The researcher can change the order of questions, omit some, and use different words depending on the context (Bryman, 2012). The researcher's task in this case is to encourage the participants to speak freely about all the issues covered (Sekaran and Bougie, 2016). Semi-structured interviews provide a structure focusing on the main points, with the possibility to add more questions depending on the flow of the interview (Creswell, 2014). The interview question guide is listed in Appendix 2. The questions were translating into Arabic to help the participants understand the questions before answering them. The questions prepared in advance covered the:

- Material management functions.
- Material management system including tools and technology.
- Factors impact Libyan construction project.

In addition, semi-structure interviews have proved to be the most valuable and widely used data collection tools in qualitative research (Collis and Hussey, 2014). Interviews are used in almost all types of qualitative research, positivist, interpretive or critical, and they can be conducted face to face, on the telephone or by utilizing a social media technique (Saunders et al., 2015). Semi-structured interviews support the researcher to:

• Gain better understanding of the research problem and identify the central themes that need to be focused on.

• Develop a theory, which is the main aim of this study, as mentioned above.

• Explore the material management activities involved in the construction project process and identify the tools the Libyan authorities chose to reduce the material cost and time.

With a diversity of research methods and the rise of technology, many more possibilities could be explored for qualitative research, such as using Skype for remote face-to-face interaction, face time and zoom (Renosa et al., 2021). Skype free communication service provides the opportunity to call, see messages, and share with people whoever they are (Janghorban et al., 2014). This study used Skype video call to conduct interviews with the Libyan construction stakeholders.

4.9.5 Pilot study

The purpose of using a pilot study is to identify problems in the design of the questions and to ensure that all questions were understandable by the participants (Loh, 2013). This step helps the researcher to practice the interviewing techniques. The researcher arranged pilot interviews with three Arab colleagues, PhD students at the University of Salford, who acted as Libyan construction stakeholders to check the questions. The researcher asked them to refine the questions and to manage the interviews correctly. Their feedback and comments

were considered, especially those related to removing repetition and managing the time. The researcher did two pilot interviews. This was useful, and the researcher was able to handle the time properly.

4.9.6 Validity and reliability of qualitative interviews

Reliability and validity are concepts used to evaluate the quality of the research. Reliability is about the method's consistency in a measure, and validity is about its accuracy of measurement (Creswell, 2014). The validity and reliability criteria depend on the design of the research questions' structure and the success of the pilot study (Saunders et al., 2015). In contrast to the quantitative method, the qualitative method has no statistical tests for reliability and validity. According to Linclon and Cuba (1986, as cited in Loh, 2013 and to Korstjens and Moser, 2018), the researcher considers four criteria for the qualitative method; these are credibility, transferability, Confirmability and dependability. These criteria have been applied to this study, as illustrated in Table (4.4).

Table 4.4 Qualitative data quality. Source: Author

Credibility (internal validity): refers to the trustworthiness of the finding	-This study applied mixed methods; interviews are used for the Libyan construction stakeholders after a questionnaire survey to understand the research phenomena as an appropriate solution for increased reliability and validity. - The researcher spent more one hour with each respondent to make sure all the questions are answered. - The interview questions are designed to achieve the research objectives; the researcher asked the same questions in a different way; each question is explained to each participant to make sure they understand it correctly. -Every interview was translated and transcribed word by word, checking the transcripts to make sure that they had no obvious mistakes.
Transferability	-This study conducted interviews with different Libyan construction authorities

(external validity): refers to the result being generalised.	(project managers, senior managers, contractors, consultants, planners, and warehouse managers) to extract different views and perceptions. -The participants helped to share information about their experience and knowledge in the interview context; the finding is described in detail in Chapter Six
Dependently(reliability)	- The process of study was reported. Two pilot studies were conducted to refine the interview questions as described above and to determine the interviews' timing. Also, the researcher made an appointment with participants and asked them to read the background information of the study carefully and to sign the consent form; interviewees were assured that all information would be in confidence and anonymous (see Appendix 3). - Each interview was translated and transcribed word by word, checking the transcripts to make sure they are correct. -The interview transcripts were analysed to accurately understand the embedded meanings on which the results are based.
Confirmability (objectively): refers to the quality of the result. To examine if the finding emerges from the data	- All the interview questions come from the literature review. The researcher prepared the main questions before the interviews and obtained ethical approval. -The transcript was checked word by word before starting the analysis. - Data analysis was manual to make sure it included all the items to be analyzed. The analysis chapter was written in detail to help the reader see the themes emerging from the collected data. - The findings were compared with those presented in the literature and with the quantitative findings.

Cited from Korstjens and Moser (2018:121)

4.9.7 Qualitative data analysis

Qualitative data analysis "generally consists of preparing and organising the data (i.e., text data in transcripts or image data as photography) for analysis, then reducing the data into themes through a process of coding and condensing the code and finally representing the data in figures, tables or discussions." (Creswell, 2013: 148).

The process of data collection started after collection and analysis of the quantitative data; it was undertaken using Skype as clarified above. Skype is a communication program used for qualitative research to conduct interviews with individuals as well as groups, to contact small focus groups, and much more (Lo Iacono et al., 2016). With the rise of technology, communication over distance has become much easier and more convenient (Sullivan, 2012). This software allows the interviewer to record the video conversation (Lo Iacono et al., 2016). It helps the researcher to interview geographically dispersed populations with a recorded interaction that at least mimics face-to-face interactions (Sullivan,2012). In this study, Skype was used because the researcher could not make an appointment for face to face interviews with the participants and he could not travel to Libya. Travelling to Libya is not direct, and most countries do not accept his passport because it is old. Therefore, the researcher contacted the participants and made appointments with them then he made interviews with them.

Semi-structured interviews were conducted with 14 members of the Libyan construction companies, five managers, two contractors, two consultants, one project administrator, one planner, one senior construction, one material officer, one warehouse employee (none of them were questionnaire respondents). The number of participants consulted for qualitative research normally depends on the number required to give a full account of the most important information related to the phenomenon under study (Sergeant, 2012). In this study,

the data collection process continued until enough information had been collected, with no further data required to fulfil the needs of the study, and no further insights forthcoming from the interviews (Myers, 2013: 123). The purpose was to identify the opinion of people belonging to the different position levels regarding material management as they have sufficient knowledge to give in-depth information.

These criteria were satisfied after 14 interviews, conducted between January and March 2019. In addition, four interviews were conducted but not included in the analysis. Before conducting interviews, each participant received the information sheet that provides them with more information about the study, such as the research aim. The participants were informed about the research before being interviewed; the information sheet was sent by email before the interviews, explaining the research aim and the rationale behind selection of the participants (see the Appendix). All the interviewees signed consent forms about their rights to privacy and data confidentially. The consent form states clearly that the participation is voluntary, anonymous and the participants have the right to withdraw from the research at any time. Not all the interviews conducted for this study were used in the analysis. As a part of the quality information considered for this study, four interviewees were discarded due to the fact that the participants did not share the useful information and that they did not provide complete information such as the answer yes or no; besides, they did not like to provide any details. The researcher did not find any useful information.

Based on the research aims, interviews were conducted with the Libyan construction stakeholders who have long experience in the construction's material management. Data collected from interviews were recorded to make it useful for the further analysis. The interviews were recorded in Arabic, and then loaded on the researcher laptop. The process of analysis started after the data collection was completed; the interviews were first translated by the researcher and transcribed verbatim to make sure no important information was

missing; the translation was checked by an independent translator. Then, all the transcripts were stored in a computer folder and thematic analysis was used to identify and present the themes found in the data (Alhojailan, 2012). This study used the manual method (hard copy and pen) for analysing the interviews, which increased familiarity with the data and helped the researcher to make comparisons between the interviewees; it is the best way to enable revision of the text many times and to identify the themes more easily (see the Methodology Chapter for more details). In order to organise the analysis, process the first research question is answered in three parts followed by the second research question.

4.10 Ethics Approval

Every researcher is required to obtain approval from the ethics committee of the University of Salford. This approval is essential before undertaking any field research study. The current study was granted approval and permission by the ethics committee. While conducting this study, the researcher paid close attention to the different ethical aspects.

One of the critical ethical concepts related to the study was to explain the aim and objectives of the study to the participants (Daudt et al., 2013). It was important to secure the participants` understanding of the aims, objectives and the question meanings and to help them comprehend the reasons for conducting the research. Furthermore, the questionnaire was distributed to the heads of the administration of the public construction companies across Libya. The participants were assured that their responses would be kept safe, secure and confidential. They were informed that their responses would be kept anonymous, and while filling out the questionnaire survey, they could leave at any time and withdraw their responses without giving any reason. Thus, it can be said that confidentiality was one of the main aspects of the study. In addition to this, the participants were also asked to sign the consent form indicating that they have participated in the study out of their own will and were

adequately informed about it in terms of its aim and objectives and the possibility of leaving the study at any time.

4.11. Summary

This chapter identified the research philosophy, research approach, research strategy, research method, and data collection tools. The justification for each strategy was given. Questionnaire was developed to elicit the participants' responses and to extract the required information. Sami-structure interviews were conducted to understand the research phenomena and to achieve the research aim.

Research philosophy is based on pragmatism**:** it allowed the researcher to adopt mixed method: qualitative and quantitative, positivism and interpretivism, deductive and inductive.

Research approach (abductive): it allows additional explanation of the phenomenon, identify and explore themes and patterns regarding their perceptions to develop a theory.

Research Strategy: a single case study strategy is used to obtain rich data, to understand the research phenomenon and to help the researcher to develop a theory.

Research method (mixed method) helps the researcher to understand the research phenomena and to achieve the research objectives.

Data collection methods.

1- A questionnaire is used to identify the Libyan construction stakeholders' perspectives. The stakeholders are selected because they have concrete experience and they are responsible for improving the material management process; they belong to different age groups, occupy

diverse positions, live in various cities and have different educational backgrounds. Convenience sampling is used to collect a large number of respondents.

2-Sami-structure interview are conducted to obtain better understanding of the research problem and to identify central themes that need to be focused on. Purposive sampling is used because this study needs to interview a particular group to obtain more information related to the research phenomenon**.**

CHAPTER FIVE: QUANTITATIVE DATA ANALYSIS

5.0 Introduction

The chapter starts by presenting the analysis and research findings of the questionnaire. It is divided into three parts: the role of experience on construction site, comparison between factors that affect materials management on site. A normality test was used to determine whether the data followed a normal distribution, followed by the descriptive statistics, such as frequencies concerning the demographic factors of respondents, to explore their features and characteristics. The first part presents the position and experience of material management on Libyan construction site. Part two identified the most factors affects material management. ANOVA test used to identify the differences between respondents' perceptions. Part three presents the whole sample, applying factor analysis to identify the important factors that should improve materials management. All these techniques were undertaken using the statistical package SPSS version 23.

5.1 Questionnaire Format

The questionnaires contained a set of eight questions with various sub-sections (refer to the Appendix1). There was multiple choice or structured in a matrix. In the latter, the respondent was given a scale of 1 to 10 on which to make his choice. In addition, "yes/no" answer options were used. In order to ensure a collective understanding of the questionnaire and the purpose behind it, an introduction and information session was given by the researcher. At this point, respondents were given the right to ask questions and to withdraw from the process. Respondents were also told that their participation was voluntary in nature and that their anonymity and data protection were assured. They were given the option to withdraw at any stage, without having to provide a reason. The questionnaire contained questions on the following topics:

The questionnaire contained questions on the following topics:

- Preparation of the Libyan construction sector about material management.

- Position and experience on the construction site.

- The operation on construction site.

- Important factors that affect material management on site.

- Knowledge and technology using on Libyan construction site.

- Suggested new factors related to material management not covered by the survey.

5.2. Criteria for normal distribution

A normal distribution describes data distributed symmetrically around the centre of all scorers with the greatest frequency of scores in the middle and with the smaller frequencies deviating from the centre and decreasing towards the extremes (Field, 2005; Hinton et al., 2014). A normal distribution is a bell-shaped curve; most of the data values tend to cluster around the mean (Dakhale et al., 2012). Data normality describes the distribution of the individual measurement items of the study variables and can be tested by evaluating skewness and kurtosis values. The normality test was applied to question whose (14) 37 attributes are measured on the Likert scale. (see table5.1).

Table5.1: Tests of Normality. Source: Author

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
The purchasing of the materials.	.373	120	.000	.602	120	.000
Minimise the wastage of materials on site.	.277	120	.000	.711	120	.000
The expertise of sub-contractors.	.198	120	.000	.794	120	.000
Improve the activity between the owner and the contractor team on the site.	.169	120	.000	.888	120	.000
Reduce the real cost of the project.	.162	120	.000	.891	120	.000
Minimise the wastage of materials on the site.	.257	120	.000	.715	120	.000
Improve procured management.	.329	120	.000	.549	120	.000
Ensuring labour availability	.198	120	.000	.892	120	.000
Improvement in the process of material handling	.168	120	.000	.900	120	.000
Ensuring materials are provided on the construction site.	.306	120	.000	.649	120	.000
Improved productivity on the part of the available labour forces.	.203	120	.000	.801	120	.000
Minimise the shortage of material on site.	.281	120	.000	.749	120	.000
The better capability of quality control	.326	120	.000	.651	120	.000
Materials delivery.	.248	120	.000	.737	120	.000
Poor stores	.266	120	.000	.744	120	.000
Improper project planning and scheduling.	.207	120	.000	.810	120	.000
Poor site management and supervision.	.291	120	.000	.602	120	.000
Inappropriate construction methods.	.180	120	.000	.871	120	.000
Poor contractor experience.	.157	120	.000	.874	120	.000
Changes in materials prices.	.232	120	.000	.803	120	.000
Do you use emerging technologies (such as wireless technologies bar-coding, radio frequency identification (RFID). Tagging technologies, etc.) in your materials management?	.100	120	.005	.948	120	.000
Does the current ICT tools support tracking of materials on site?	.152	120	.000	.924	120	.000
Effect of using old technology.	.153	120	.000	.920	120	.000
Role of Material Management	.123	120	.000	.837	120	.000

a. Lilliefors Significance Correction

As per Kolmogorov-Smirnov and Shapiro-Wilk, the p-value for all the variables is less than 0.05, showing that none of the variables is normally distributed.

5.3 Descriptive Statistics

This study used descriptive statistics to describe the research data. It provides simple summaries and simple graphics for the quantitative analysis data. The purpose of descriptive statistics shows the potential relationships between variables.

5.3.1 Position

The demographic characteristics of potential construction people in this study were measured by a set of questions at the of the questionnaire regarding the respondent's, experiences, employment status, and level of education. The summary of demographic characteristics is represented in table 5.2 which shows that the majority of the respondents in this research were engineers as they were more than 50% of the entire population. Second-most responses were obtained from contractors (18.3%), owners (11.7%), site supervisors (6.7%), surveyors and project managers (both 3.3%). (See table and figure below).

Table 5.2: The position of participates. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Contractor	22	18.3	18.3	18.3
	Site supervisor	8	6.7	6.7	25.0
	Engineer	64	53.3	53.3	81.7
	Owner	14	11.7	11.7	93.3
	Surveyor	4	3.3	3.3	96.7
	Project manager	4	3.3	3.3	100.0
	Total	120	100.0	100.0	

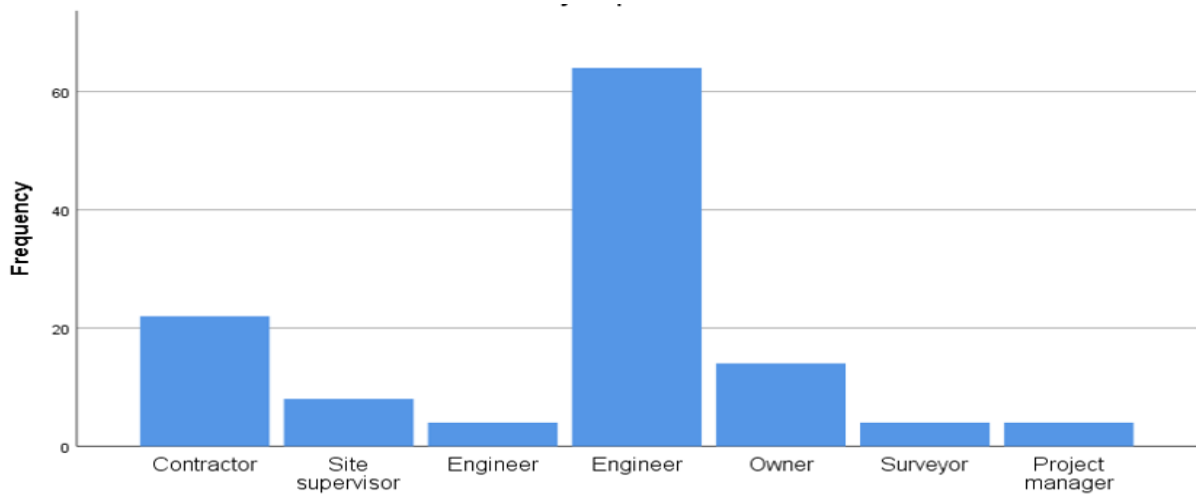

Figure5.1: The position of participates. Source: Author

5.3.2 Experience

45% of participants had experience of 6-10 years in the construction industry, while 21.7% had less experience of 1-5 years. On the other hand, only 15% had experience of more than 20 years. 11% of the population had worked in the industry for more than 11 years, while almost 7% had experience of 16-20 years in the sector. (see table 5.3 and figure 5.2)

Table 5.3: The experience of participates. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-5 Years	26	21.7	21.7	21.7
	6-10 Years	54	45.0	45.0	66.7
	11-15 Years	14	11.7	11.7	78.3
	16-20 Years	8	6.7	6.7	85.0
	Over 20 Years	18	15.0	15.0	100.0
	Total	120	100.0	100.0	

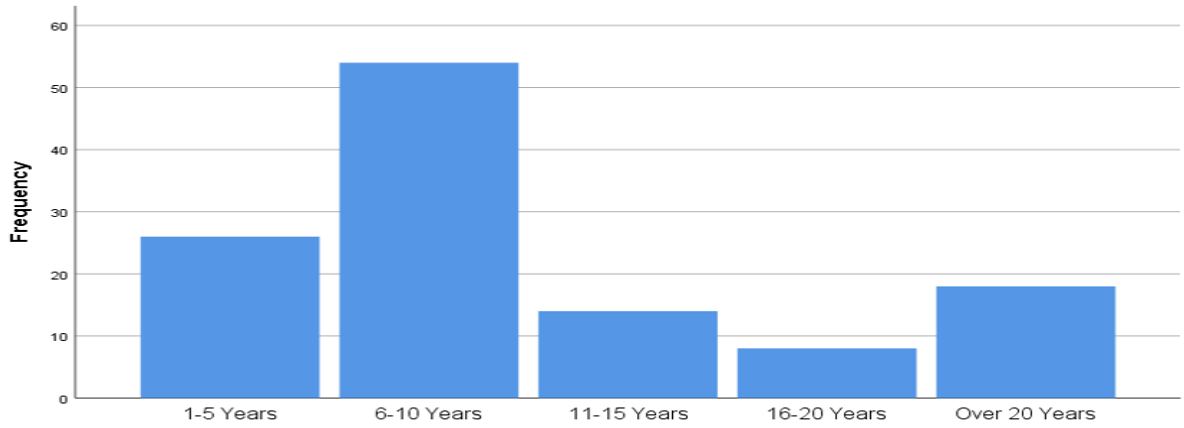

Figure 5.2: The experience of participates.3 Source: Author

5.3.3 Contractor effects

65% of the respondents replied that contractors have a significant association with the aspect of materials management, while the other 35% were not in favour of contractors being crucially important for materials management. (see table 5.4 and figure 5.3)

Table 5.4: Contractor effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	42	35.0	35.0	35.0
	Yes	78	65.0	65.0	100.0
	Total	120	100.0	100.0	

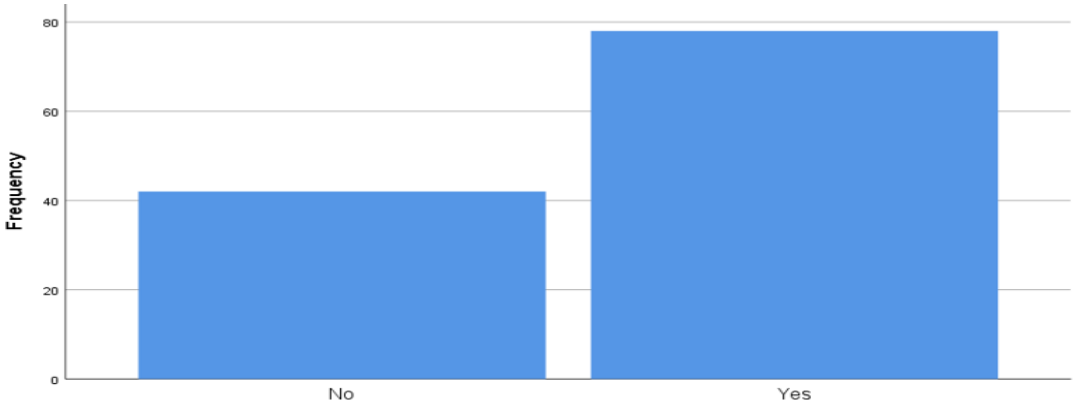

Figure 5.3: Contractor effects. Source: Author

5.3.4 Consultant effects

Almost 52% population does not think that consultants are important to materials management, while the rest 48% of participants have opposing views. (see table 5.5and figure5.4)

Table 5.5: Consultant effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	62	51.7	51.7	51.7
	Yes	58	48.3	48.3	100.0
	Total	120	100.0	100.0	

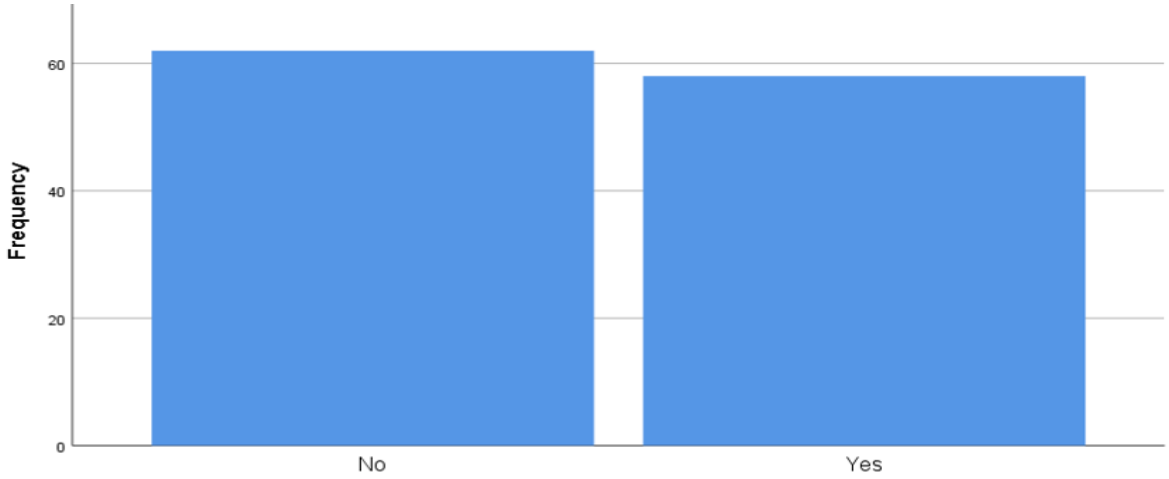

Figure 5.4: Consultant effects. Source: Author

5.3.5 Material effects

70% believe that materials are the most important aspect of effective materials management. (see table 5.6 and figure 5.5)

Table 5.6: Materials effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	36	30.0	30.0	30.0
	Yes	84	70.0	70.0	100.0
	Total	120	100.0	100.0	

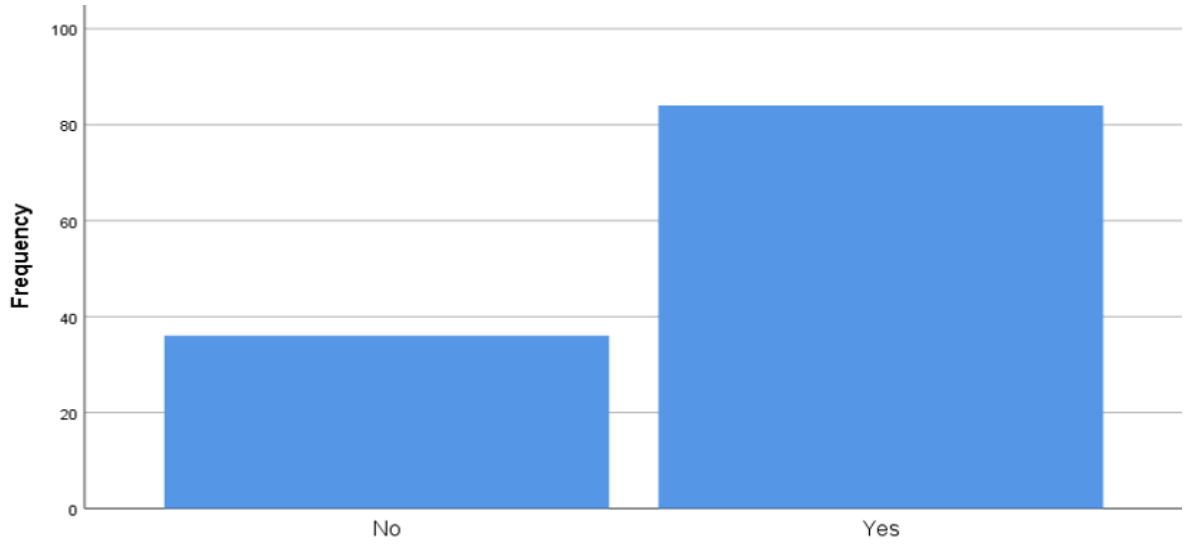

Figure 5.5:materials effects. Source: Author

5.3.6 Designer effects

Designers are not related to materials management, as replied by 80% of the total population. While on the other hand, 24 participants think that designers are crucial for effective materials management. (see table 5.7 and figure 5.6)

Table 5.7: Designer effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	96	80.0	80.0	80.0
	Yes	24	20.0	20.0	100.0
	Total	120	100.0	100.0	

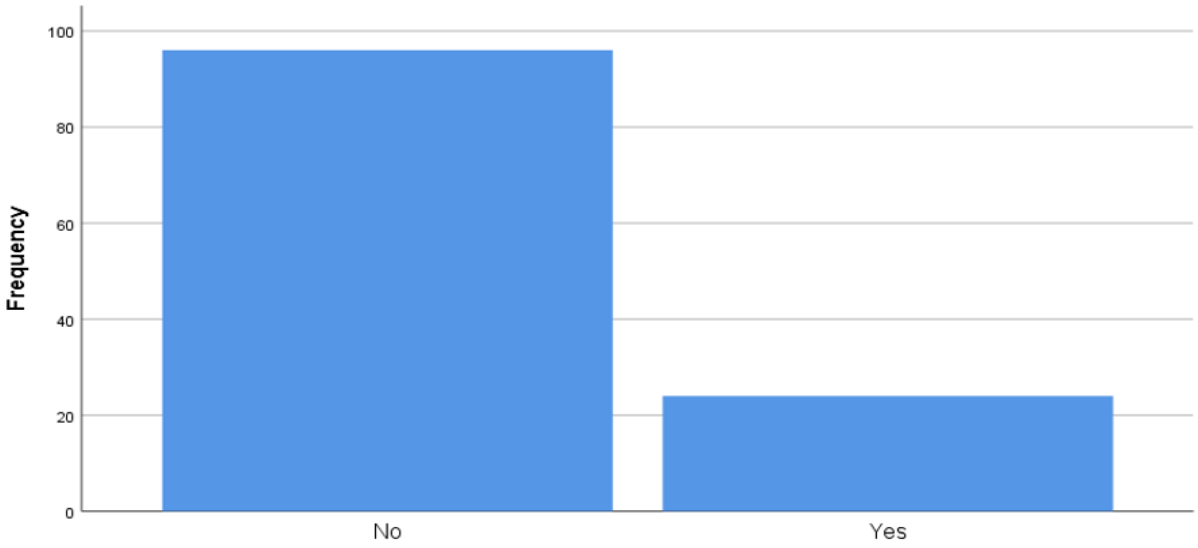

Figure 5.6: Designer effects. Source: Author

5.3.7 General labour effects

32% participants think that general labour has a direct and significant impact on the aspect of materials management while remaining 68% have the opinion that the general labour is not at all important to the cause. (see table 5.8 and figure7).

Table 5.8: General labour effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	82	68.3	68.3	68.3
	Yes	38	31.7	31.7	100.0
	Total	120	100.0	100.0	

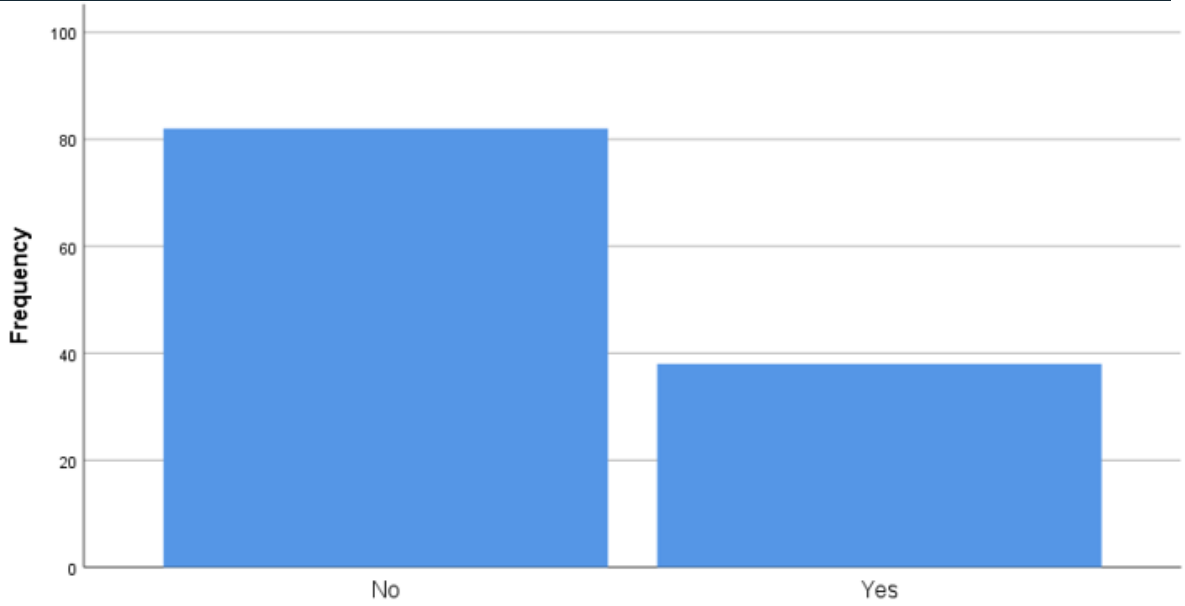

Figure 5.7: General labour effects. Source: Author

5.3.8 Surveyors effects

90% of the total population is of the opinion that surveyors do not have any association with materials management. (see table 9 and figure8)

Table5.9: Surveyors effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	108	90.0	90.0	90.0
	Yes	12	10.0	10.0	100.0
	Total	120	100.0	100.0	

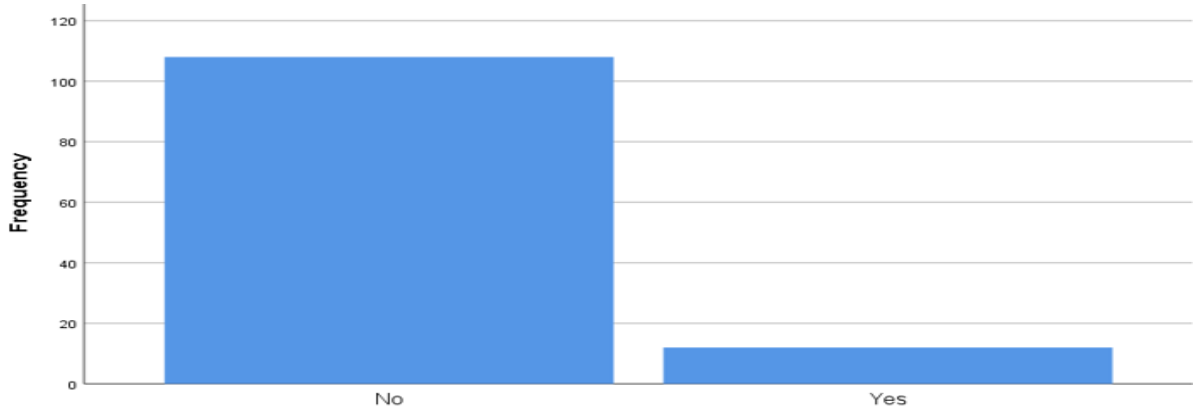

Figure5.8: Surveyors effects. Source: Author

5.3.9 Suppliers effects

According to 55% of the respondents, suppliers are not critical to materials management. (see table10 and figure 9)

Table5.10: Surveyors effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	66	55.0	55.0	55.0
	Yes	54	45.0	45.0	100.0
	Total	120	100.0	100.0	

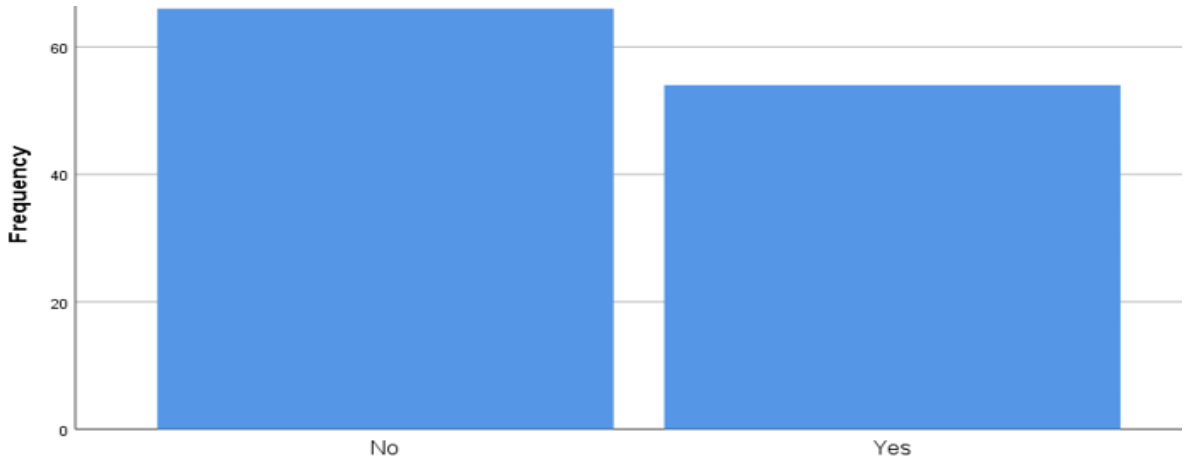

Figure5.9: Surveyors effects. Source: Author

56% of participants think that owners have a direct and significant impact on the aspect of materials management. 43% population does not share similar feelings. (see table 11 and figure 10)

Table 5.11: Owner effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	52	43.3	43.3	43.3
	Yes	68	56.7	56.7	100.0
	Total	120	100.0	100.0	

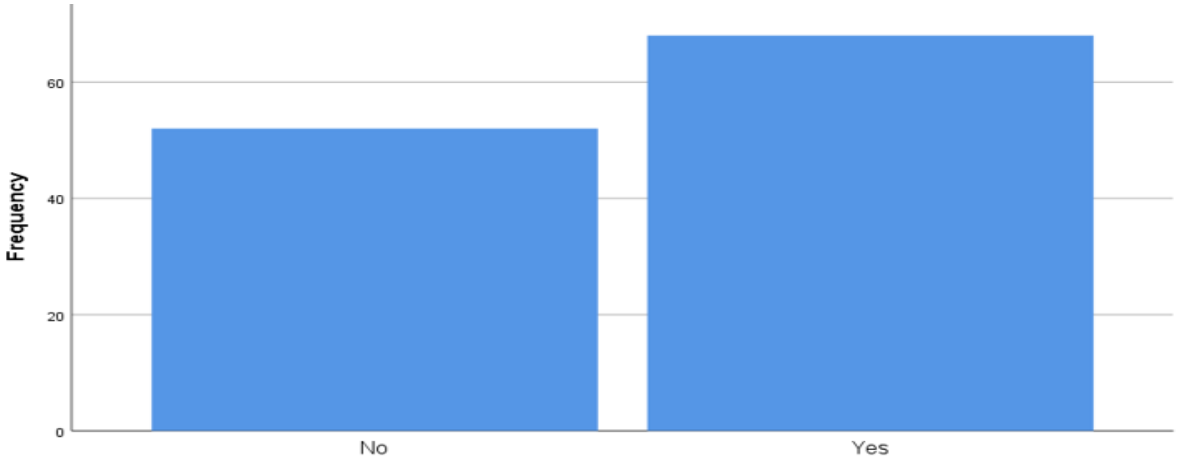

Figure5.10: Owner effects. Source: Author

5.3.11 Environment and political issues effects

Environment and political issues, according to 60% population, is not an important factor and is not directly associated with materials management. 40% of respondents think otherwise. (see table12 and figure11)

Table5.12: Environment and political issues effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	72	60.0	60.0	60.0
	Yes	48	40.0	40.0	100.0
	Total	120	100.0	100.0	

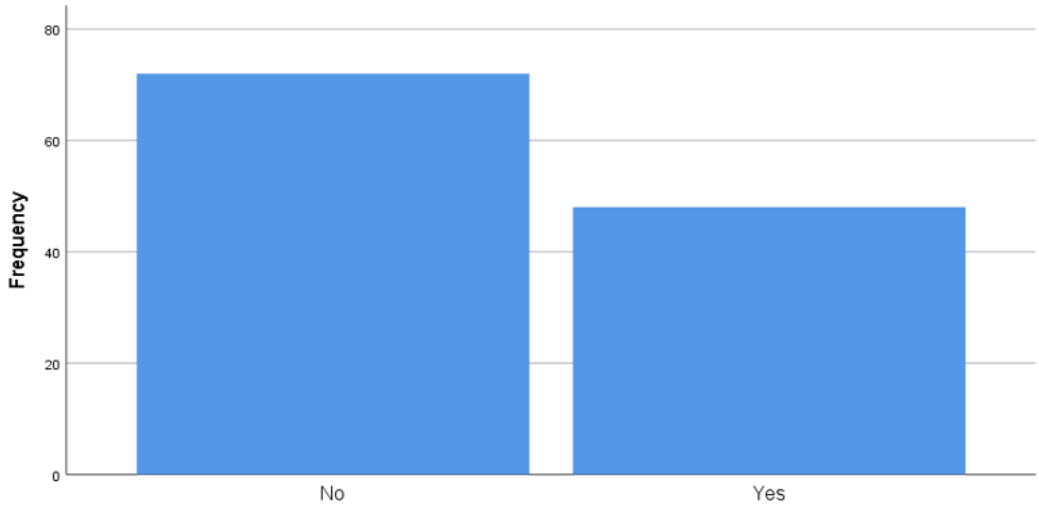

Figure 5.11: Environment and political issues effects. Source: Author

5.3.12 Technology effects

According to 41.7% of participants, using technology has an influence over the aspect of materials management. However, a vast majority (58.3%) participants believe that technology is not an important factor in relation to effective material management. (see table5.13 and figure5.12)

Table5.13: Technology effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	70	58.3	58.3	58.3
	Yes	50	41.7	41.7	100.0
	Total	120	100.0	100.0	

According to 41.7% of participants, using technology has an influence over the aspect of materials management. However, a vast majority (58.3%) participants believe that technology is not an important factor in relation to effective material management.

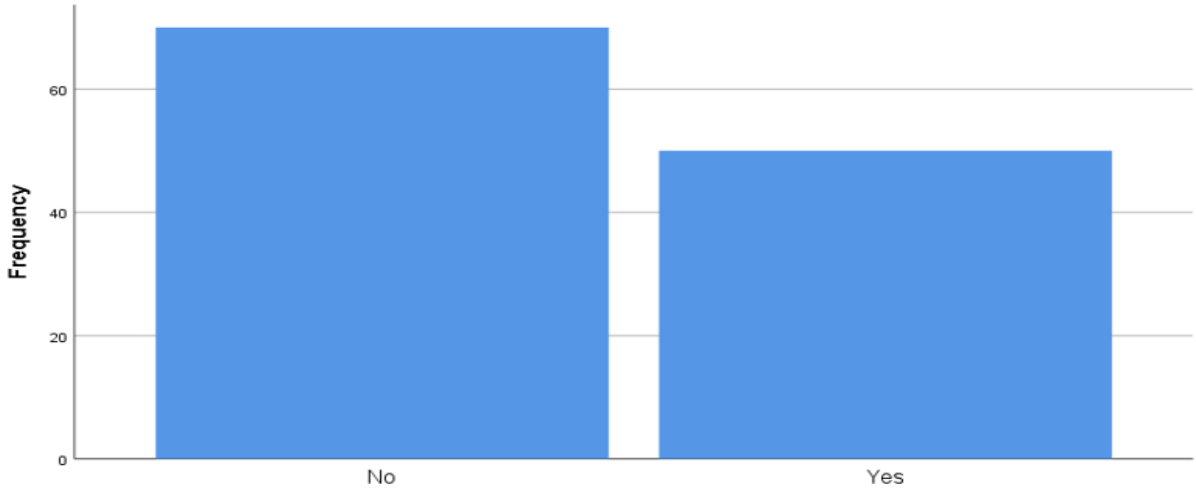

Figure5.12: Technology effects. Source: Author

5.3.13 knowledge and skills of the sites people effects

While 43.3% of participants think that knowledge and skills of the people at site matter and thus affect materials management, 56.7% population do not have similar thoughts, as they disagreed with it. (see table5.14 and figure5.13).

Table5.14: knowledge and skills of the sites people effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	68	56.7	56.7	56.7
	Yes	52	43.3	43.3	100.0
	Total	120	100.0	100.0	

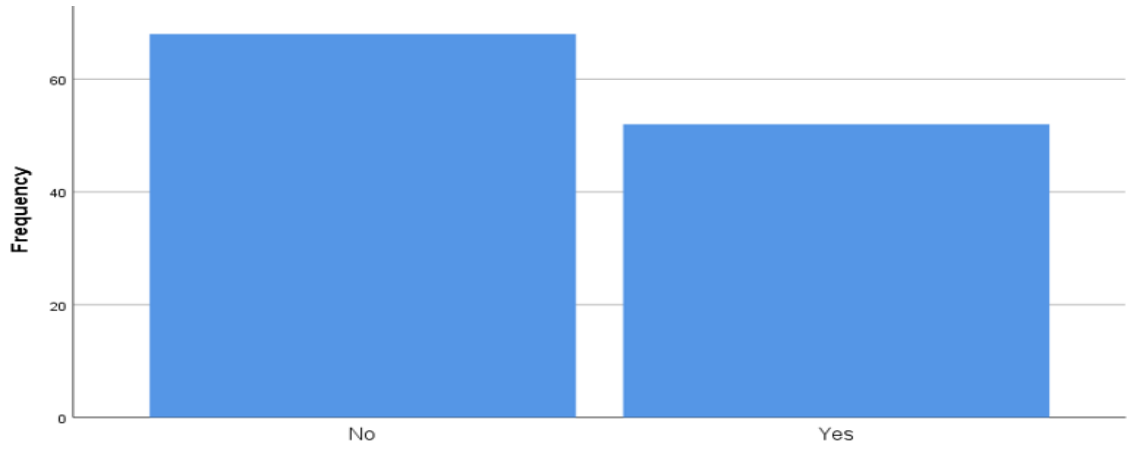

Figure5.13: knowledge and skills of the sites people effects. Source: Author

5.3.14 The effects of purchasing material

Here it can be seen that majority of the participants responded that purchasing the materials is the best way to improve the processes of materials management. 12 participants gave this aspect rank of 8, indicating that by purchasing the materials, materials management can be improved by a significant margin. Descriptive statistics show that mean for this aspect was 9.11, meaning that it is one of the most important and effective ways of improving the material management processes. (see table5.15 and figure5.14)

Table5.15: The effects of purchasing material. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important	2	1.7	1.7	1.7
	5	2	1.7	1.7	3.3
	6	2	1.7	1.7	5.0
	0	12	10.0	10.0	15.0
	8	12	10.0	10.0	25.0
	9	10	8.3	8.3	33.3
	Extremely important	80	66.7	66.7	100.0
	Total	120	100.0	100.0	

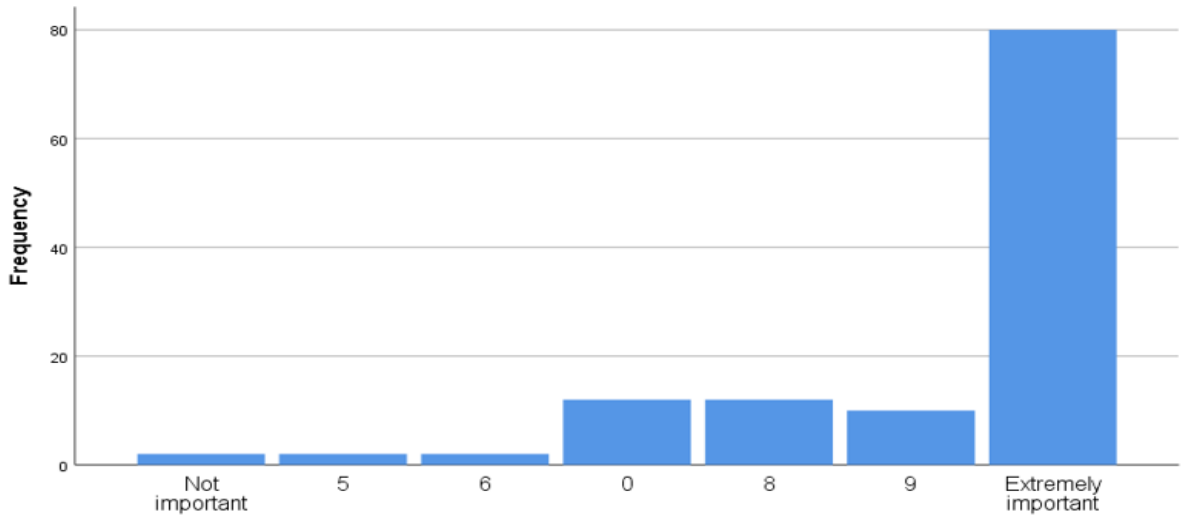

Figure5.14: The effects of purchasing material. Source: Author

5.3.15 Effects of materials wastage on the site

54 participants stated that by minimising the wastage of materials on the site, materials management could be improved. Usually, materials in large quantities are wasted during a construction project. This negatively affects the process of materials management. Only a handful of the participants responded that it is not important to improve materials management. Further, the mean was computed to be 8.61, showing that it is an effective way of enhancing the materials management systems. (see table5.16 and figure5.15).

Table5.16: Effects of materials wastage on the site. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important	2	1.7	1.7	1.7
	2	2	1.7	1.7	3.3
	5	10	8.3	8.3	11.7
	0	8	6.7	6.7	18.3
	8	14	11.7	11.7	30.0
	9	30	25.0	25.0	55.0
	Extremely important	54	45.0	45.0	100.0
	Total	120	100.0	100.0	

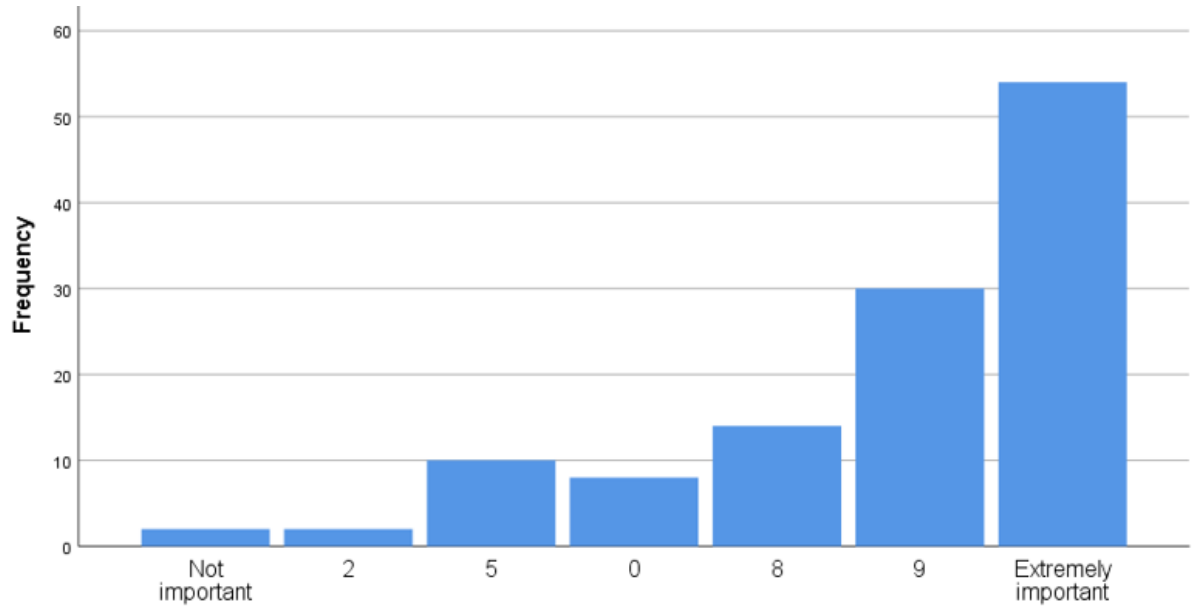

Figure5.15: Effects of materials wastage on the site. Source: Author

5.3.16 Subcontractor's effects

In order to improve materials management, the expertise and knowledge of the contractors are of great essence. This can be observed through the above table, as almost 50% of the participants ranked it as important and extremely important factor. From replies to some of the respondents, it can be noted that materials management is not based on the expertise of the contractors. Mean for this factor came out to be 8.26, meaning that it is significantly important for the current aspect. (see table5.17 and figure5.16).

Table5.17: Subcontractor's effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important	2	1.7	1.7	1.7
	2	2	1.7	1.7	3.3
	3	2	1.7	1.7	5.0
	4	2	1.7	1.7	6.7
	6	10	8.3	8.3	15.0
	0	12	10.0	10.0	25.0
	8	24	20.0	20.0	45.0
	9	24	20.0	20.0	65.0
	Extremely important	42	35.0	35.0	100.0
	Total	120	100.0	100.0	

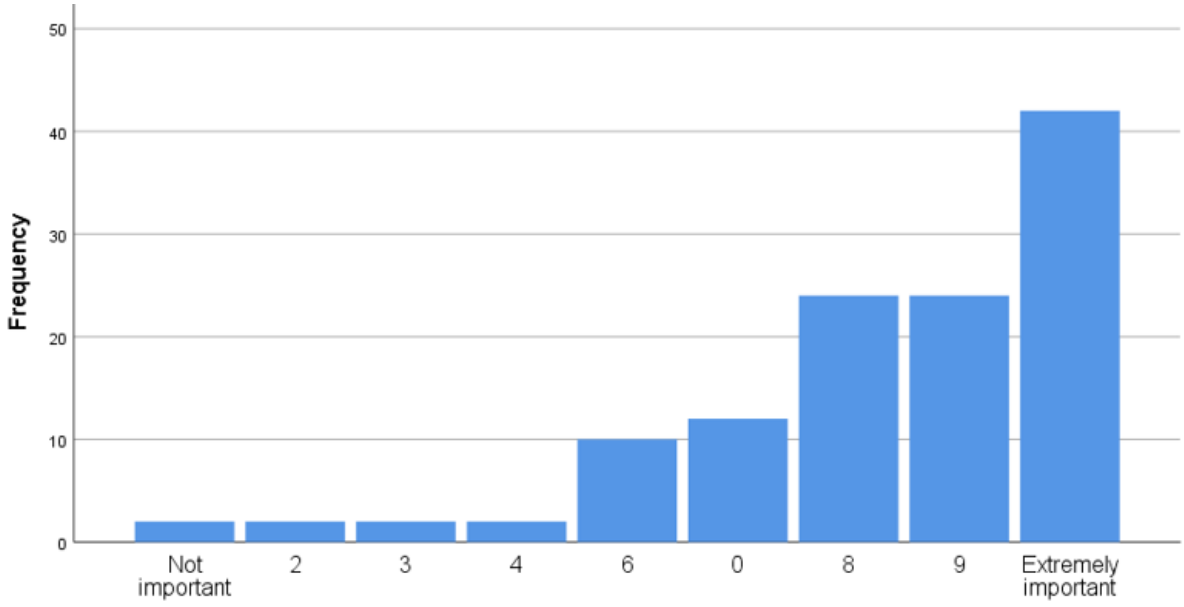

Figure5.16: Subcontractor's effects. Source: Author

5.3.17 Effects the relationship between the owner and the contractor

A large number of the respondents are of the opinion that materials management can be improved by way of improving activities or interactions between the owner and the contractor's team on the site. 12 participants ranked this aspect only five out of ten, indicating that they do not believe this aspect has any relevant impact on improving materials management. Mean was 7.21 further showing that although it is an important factor, it is not an extremely important one and has only a limited impact on the aspect. (see table 5.18 and figure5.17).

Table5.18: Effects the relationship between the owner and the contractor. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important	2	1.7	1.7	1.7
	2	6	5.0	5.0	6.7
	3	6	5.0	5.0	11.7
	4	8	6.7	6.7	18.3
	5	12	10.0	10.0	28.3
	6	4	3.3	3.3	31.7
	0	16	13.3	13.3	45.0
	8	18	15.0	15.0	60.0
	9	18	15.0	15.0	75.0
	Extremely important	30	25.0	25.0	100.0
	Total	120	100.0	100.0	

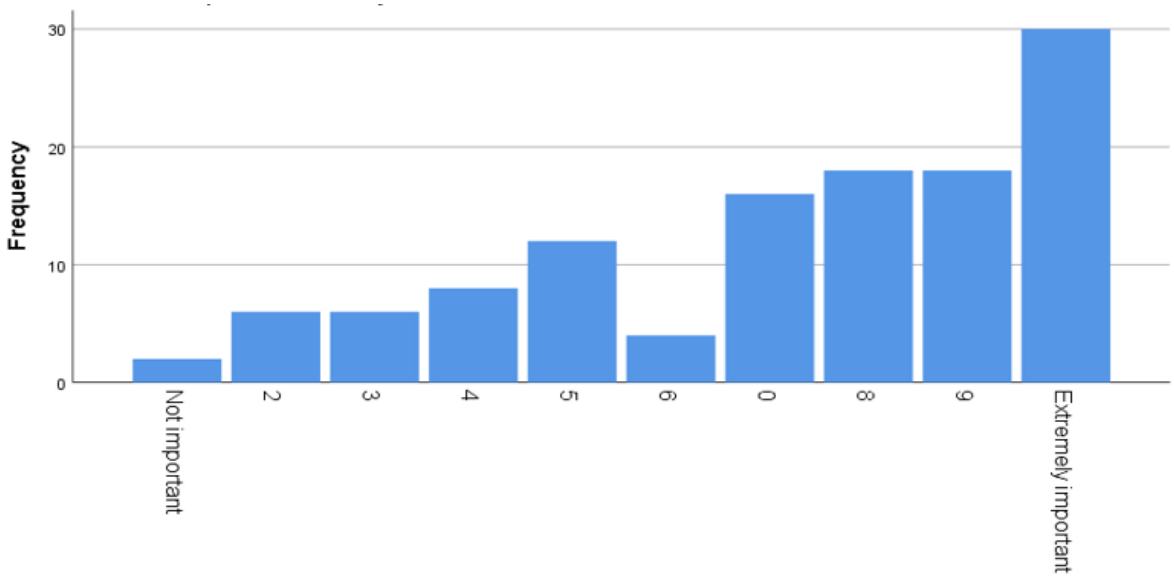

Figure5.17: Effects the relationship between the owner and the contractor. Source: Author

5.3.18 Effects of procuring management

63% of the participants replied that by improving the procuring management process, the material management system could be improved by a great margin. This means that majority of the respondents have a positive opinion towards this aspect. Only a handful of the participants did not have a positive outlook towards the aspect. Mean for this factor was 9.26, which shows that it is a very important factor and can be crucial in improving the material management systems. (see table5.19 and fugure5.18).

Table5.19: Effects of procuring management. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important	2	1.7	1.7	1.7
	6	2	1.7	1.7	3.3
	0	4	3.3	3.3	6.7
	8	14	11.7	11.7	18.3
	9	22	18.3	18.3	36.7
	Extremely important	76	63.3	63.3	100.0
	Total	120	100.0	100.0	

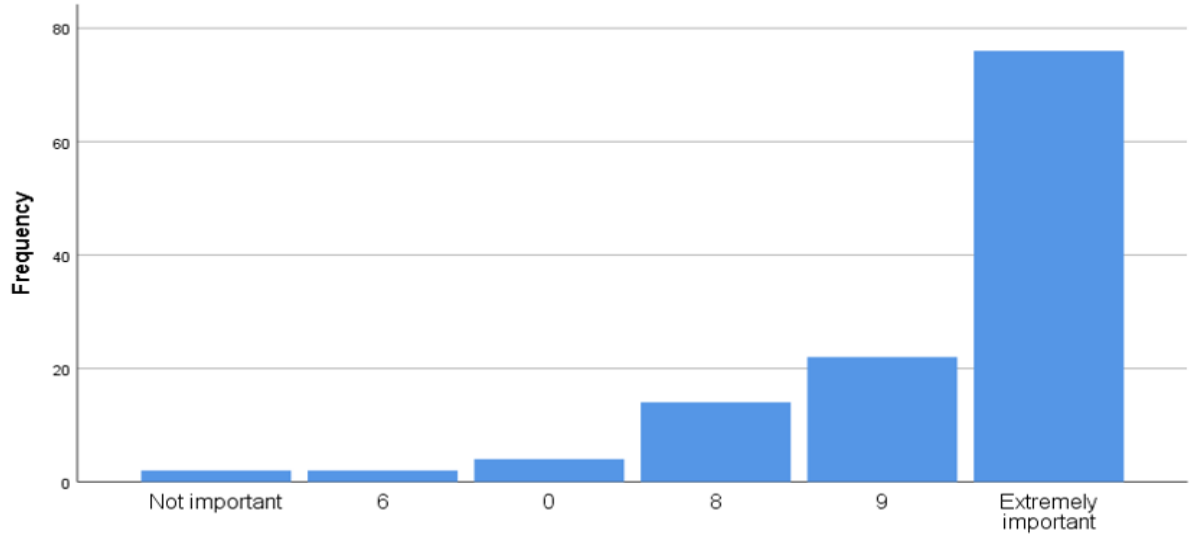

Figure5.18: Effects of procuring management. Source: Author

5.3.19 Material handling effects

25% of participants ranked this factor eight out of ten, while 23.3% of participants ranked it as zero. This means that 25% of the population considers that by improving the process of material handling can have a significant positive impact on the material management process. On the other hand, 23% of participants do not concur with this opinion. They are then supported by a handful of the participants who replied that although it does not have a direct or significant impact on the aspect of material management, it does have a slight impact on the said aspect. The mean for this factor was 7.41.(see table5.20 and figure5.19)

Table5.20: Material handling effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	6	5.0	5.0	5.0
	4	4	3.3	3.3	8.3
	5	6	5.0	5.0	13.3
	6	14	11.7	11.7	25.0
	0	28	23.3	23.3	48.3
	8	30	25.0	25.0	73.3
	9	8	6.7	6.7	80.0
	Extremely important	24	20.0	20.0	100.0

	Total	120	100.0	100.0	

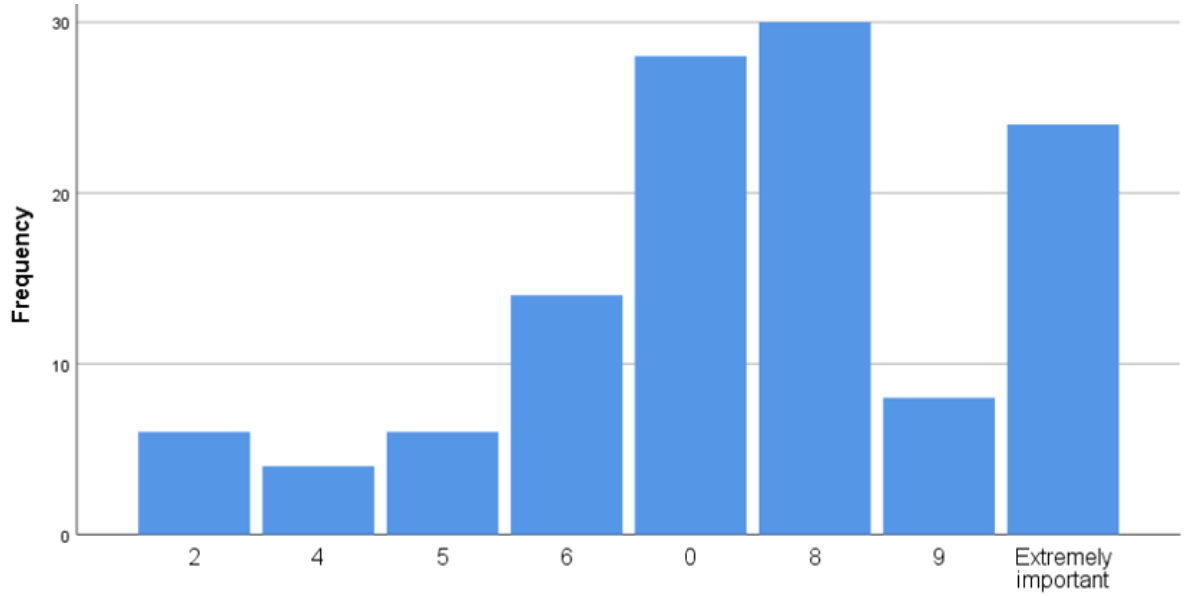

Figure5.19: Material handling effects. Source: Author

5.3.20 Shortage of material on site effects

51% of participants believe minimising the shortage of materials on site and controlling it can be very useful in improving the material management function. This opinion was contrasted only by a handful of the participants, who did not show similar feelings and opinions. Mean herein was 8.56, supporting the feelings of 51% of the respondents. (see table5.21 and figure5.20)

Table5.21: Shortage of material on site effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important	2	1.7	1.7	1.7
	4	2	1.7	1.7	3.3
	5	8	6.7	6.7	10.0
	6	8	6.7	6.7	16.7
	0	10	8.3	8.3	25.0
	8	12	10.0	10.0	35.0
	9	16	13.3	13.3	48.3
	Extremely important	62	51.7	51.7	100.0
	Total	120	100.0	100.0	

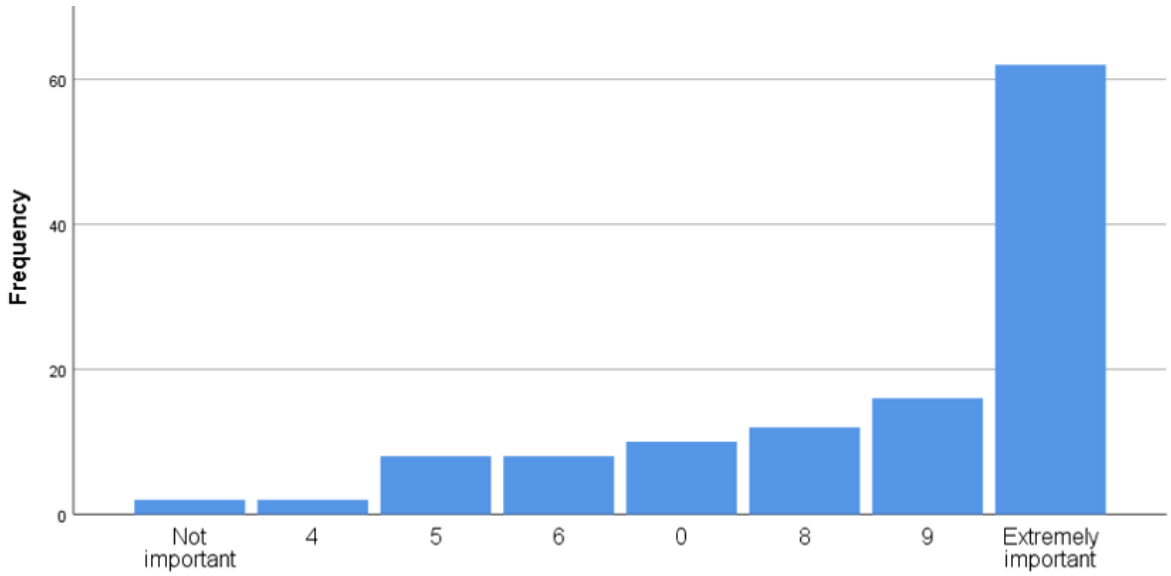

Figure5.20: Shortage of material on site effects. Source: Author

5.3.21 Better capability of quality control effects

60% of respondents agree that better capability in terms of quality control can be the most effective in improving material management. Similar responses were recorded from 16% and 13% of the total population as well, who ranked this factor eight and nine, respectively. 1.7% of respondents had a different view, as they ranked this factor very low; while 20% population gave it a rank of zero. Mean for this factor was 9.06, meaning that the majority of the participants stated this factor to be an extremely important one in improving the material management function. (see table5.22 and figure5.21).

Table5.22: Better capability of quality control effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	1.7	1.7	1.7
	5	4	3.3	3.3	5.0
	6	2	1.7	1.7	6.7
	0	4	3.3	3.3	10.0
	8	20	16.7	16.7	26.7
	9	16	13.3	13.3	40.0
	Extremely important	72	60.0	60.0	100.0
	Total	120	100.0	100.0	

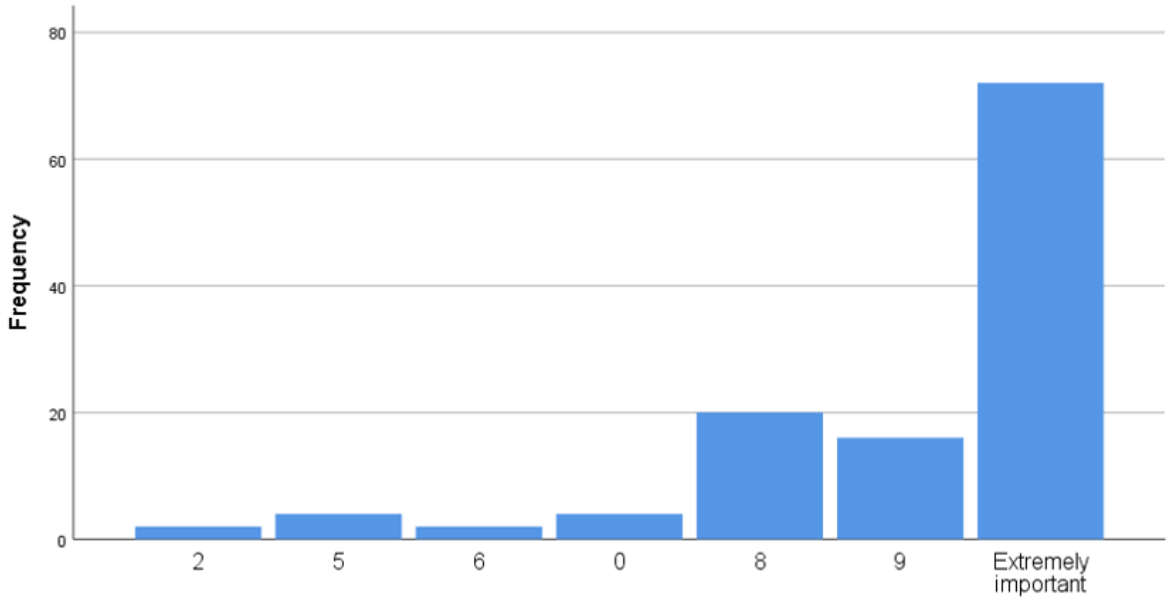

Figure5.21: Better capability of quality control effects. Source: Author

5.3.22 Materials delivery effects

A large section of the total population ranked the factor of materials delivery to be an extremely important one in improving material management. Only a handful of the respondents shared feelings other than this. Mean for the factor came out to be 8.53, which means that it is a fairly important factor and tends to have a deep impact on the processes and functions of material management. (see table5.23 and table5.22).

Table5.23: Materials delivery effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important	2	1.7	1.7	1.7
	2	2	1.7	1.7	3.3
	3	2	1.7	1.7	5.0
	5	2	1.7	1.7	6.7
	6	6	5.0	5.0	11.7
	0	14	11.7	11.7	23.3
	8	18	15.0	15.0	38.3
	9	16	13.3	13.3	51.7
	Extremely important	58	48.3	48.3	100.0
	Total	120	100.0	100.0	

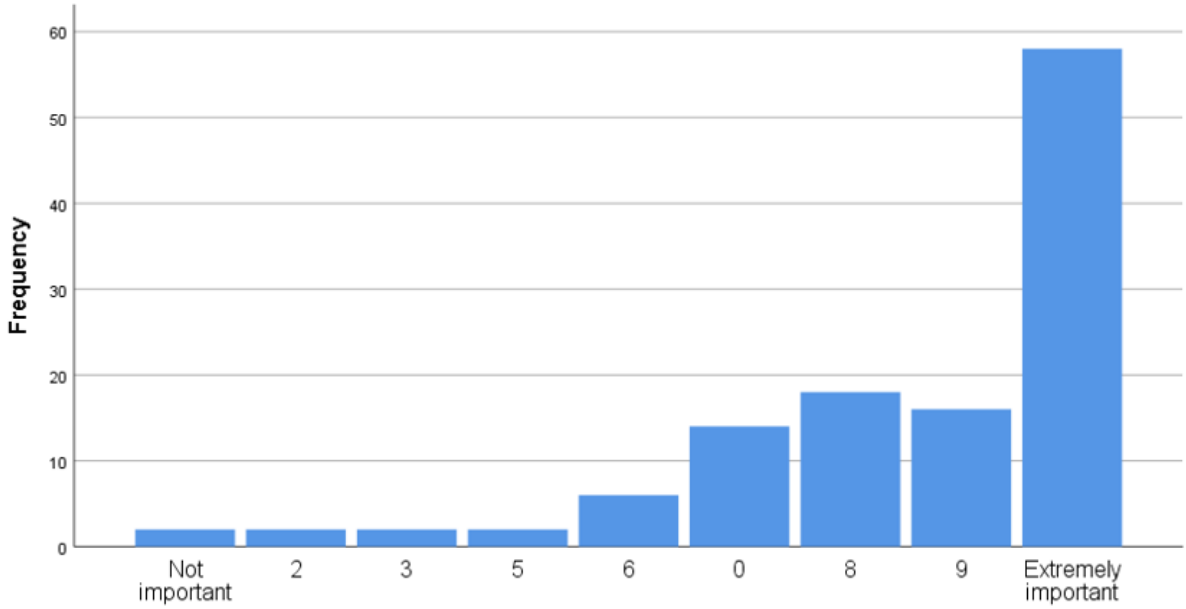

Figure5.22: Materials delivery effects. Source: Author

5.3.23 Poor stores effects

With a mean of 8.61, the factor of poor stores shows that it has a significant impact on material management process, but it is not the most important factor in this regard. Half of the total population responded in favour of this factor, but it fails to show that it is the most important factor that can help in improving the materials management. (see table5.24 and figure5.23).

Table5.24: Poor stores effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important	2	1.7	1.7	1.7
	4	2	1.7	1.7	3.3
	5	8	6.7	6.7	10.0
	6	4	3.3	3.3	13.3
	0	6	5.0	5.0	18.3
	8	24	20.0	20.0	38.3
	9	14	11.7	11.7	50.0
	Extremely important	60	50.0	50.0	100.0
	Total	120	100.0	100.0	

With a mean of 8.61, the factor of poor stores shows that it has a significant impact on material management process, but it is not the most important factor in this regard. Half of the total population responded in favour of this factor, but it fails to show that it is the most important factor that can help in improving the materials management.

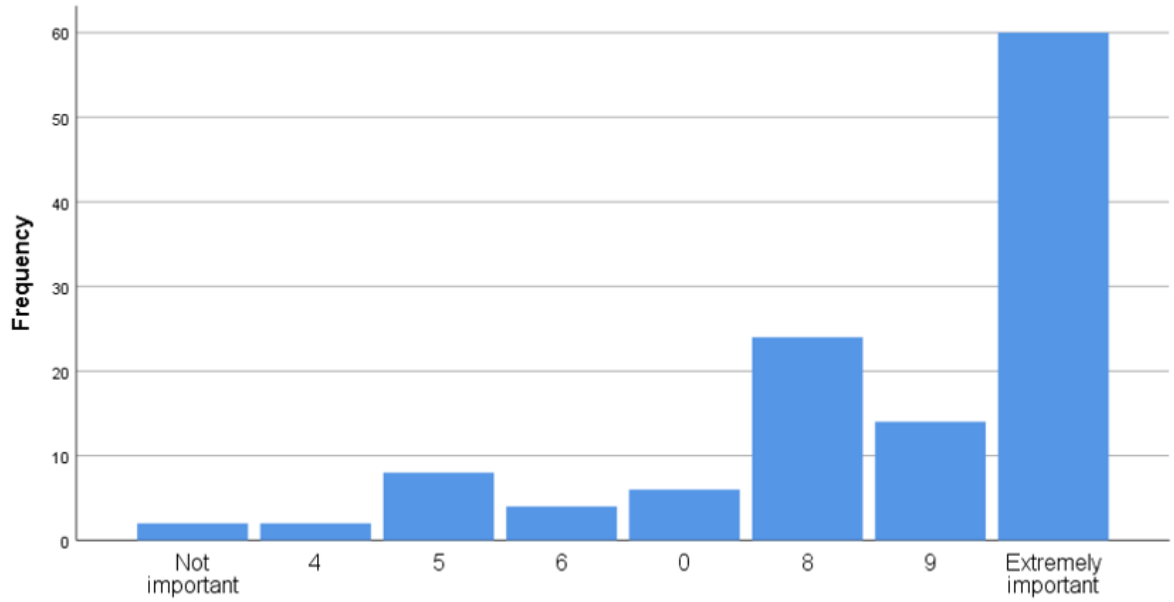

Figure5.23: Poor stores effects. Source: Author

5.3.24 Planning and scheduling effects

A significant portion of the population thinks that improper planning and scheduling of the project influences the process and function of materials management. A further 21% of the respondents ranked this factor at eight, showing that it is a factor that has a significant impact on materials management. Mean for this factor came out to be 8.43. (see table 5.25 and figure5.24).

Table5.25: Planning and scheduling effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	1.7	1.7	1.7
	3	2	1.7	1.7	3.3
	5	6	5.0	5.0	8.3
	6	4	3.3	3.3	11.7
	0	14	11.7	11.7	23.3
	8	22	18.3	18.3	41.7
	9	26	21.7	21.7	63.3
	Extremely important	44	36.7	36.7	100.0
	Total	120	100.0	100.0	

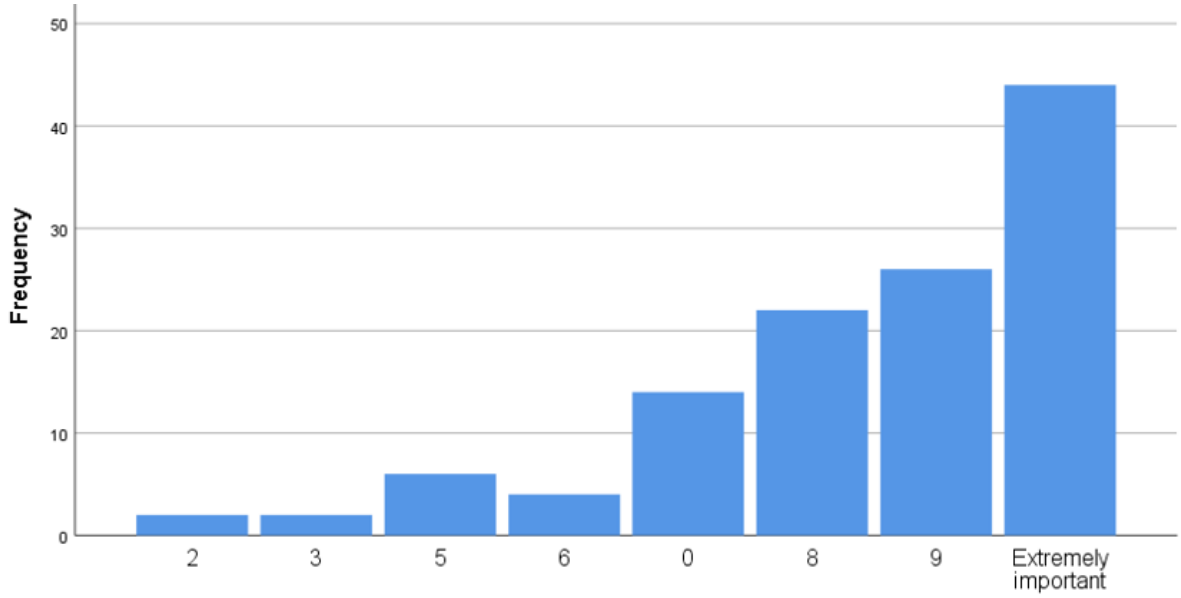

Figure5.24: Planning and scheduling effects. Source: Author

5.3.25 Site Management and supervision effects

Management and supervision of the site come out to be a very important factor that tends to have a significant impact on the processes of materials management, with a mean of 9.15. 56% of the total population agreed to this, while almost 7% disagreed with it and a further 1.7% ranked it as a factor that is not important at all. (see table5.26 and table5.25).

Table5.26: Management and supervision effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not important	2	1.7	1.7	1.7
	0	8	6.7	6.7	8.3
	8	18	15.0	15.0	23.3
	9	24	20.0	20.0	43.3
	Extremely important	68	56.7	56.7	100.0
	Total	120	100.0	100.0	

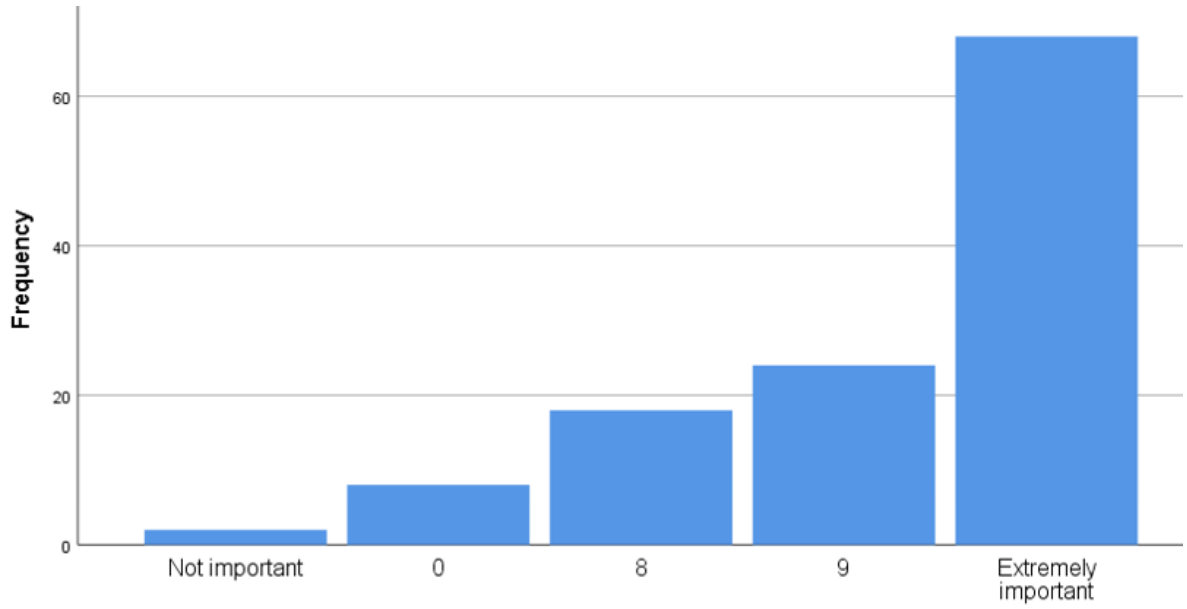

Figure5.25: Management and supervision effects. Source: Author

5.3.26 Inappropriate construction methods effects

With a mean of 8.16, inappropriate construction methods tend to have a significant impact on materials management processes, as per the responses obtained during the study. 31% of the respondents believe that it is an extremely important factor and has the most negative impact on material management. On the other hand, almost 9% of the population gave this factor a rank of 5. (see table5.27 and figure5.26).

Table5.27: Inappropriate construction methods effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	2	1.7	1.7	1.7
	4	2	1.7	1.7	3.3
	5	10	8.3	8.3	11.7
	6	8	6.7	6.7	18.3
	0	12	10.0	10.0	28.3
	8	28	23.3	23.3	51.7
	9	20	16.7	16.7	68.3
	Extremely important	38	31.7	31.7	100.0
	Total	120	100.0	100.0	

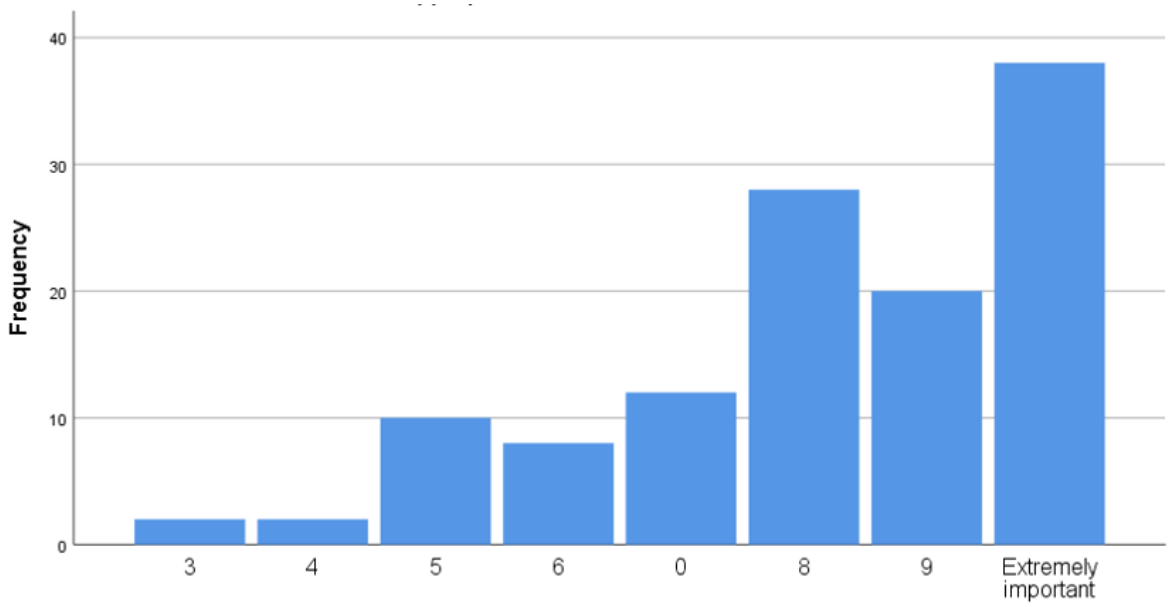

figure5.26: Inappropriate construction methods effects. Source: Author

5.3.27 Poor contractor experience effects

According to the responses obtained, it can be observed that majority of the participants agree that poor contractor experience influences the materials management, as the mean came out to be 7.88 showing that it is an important factor but has limited impact on materials management. 25% population consider this factor to be extremely important, while 3.3% believe it is very less important to the whole experience. (see table5.28 and figure5.27)

Table5.28: Poor contractor experience effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	4	3.3	3.3	3.3
	3	2	1.7	1.7	5.0
	5	4	3.3	3.3	8.3
	6	16	13.3	13.3	21.7
	0	18	15.0	15.0	36.7
	8	24	20.0	20.0	56.7
	9	22	18.3	18.3	75.0
	Extremely important	30	25.0	25.0	100.0
	Total	120	100.0	100.0	

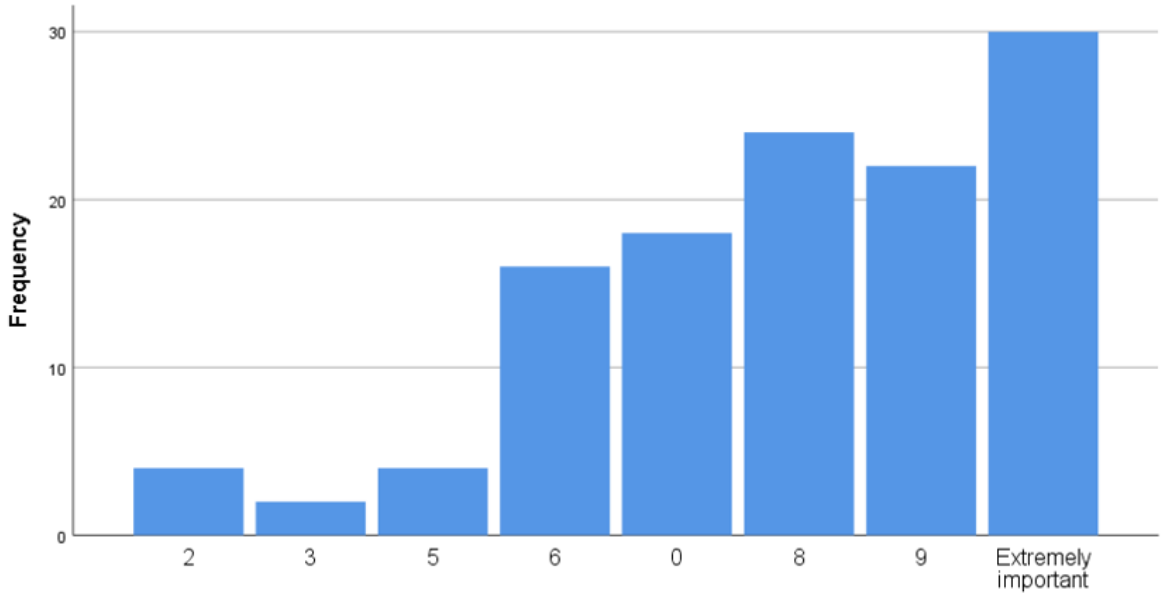

Figure5.27: Poor contractor experience effects. Source: Author

5.3.28 Changes in materials prices effects

43% of respondents replied that changes in prices of materials affect the materials management process. Similarly, 20% population ranked this factor at 9, showing that it is an important factor and has a major influence on the aspect of materials management. 5% of the population disagree with this, as they gave it a rank of five out to ten. Mean for the factor was 8.68. (see table5.29 and figure5.28).

Table5.29: Changes in materials prices effects. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	2	1.7	1.7	1.7
	5	6	5.0	5.0	6.7
	6	6	5.0	5.0	11.7
	0	8	6.7	6.7	18.3
	8	22	18.3	18.3	36.7
	9	24	20.0	20.0	56.7
	Extremely important	52	43.3	43.3	100.0
	Total	120	100.0	100.0	

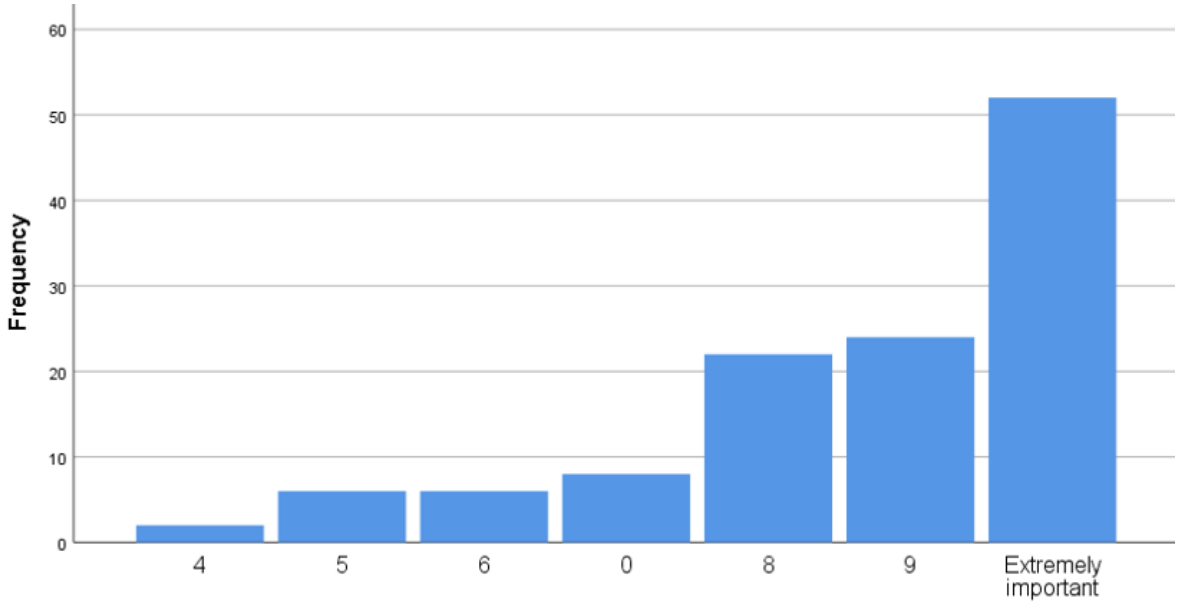

Figure5.28: Changes in materials prices effects. Source: Author

5.3.29 Other important factors

Table5.30: Other important factors. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	N/A	76	63.3	63.3	63.3
	By using the advanced technologies for example BIM can help to deliver materials on time with the right plan.	6	5.0	5.0	68.3
	Safety and weather conditions	10	8.3	8.3	76.7
	Managing supply chain processes	8	6.7	6.7	83.3
	Monitoring and Controlling materials	10	8.3	8.3	91.7
	Most of the effect's management of materials on Libyan construction sites are the engineer and owner	5	4.2	4.2	95.8
	The most important factor is to supervise the site.	5	4.2	4.2	100.0
	Total	120	100.0	100.0	

63% of responses collected were not valid. % respondents think that using advanced technologies such as BIM can help in improving materials management. 8.3% think that

safety and weather conditions, 6.7% believe supply chain can be crucial in improving the materials management, while 8.3% think that monitoring and controlling can be highly effective in improving this aspect. 4.2% believe that improved supervision can be the most effective way to manage and improve this aspect.

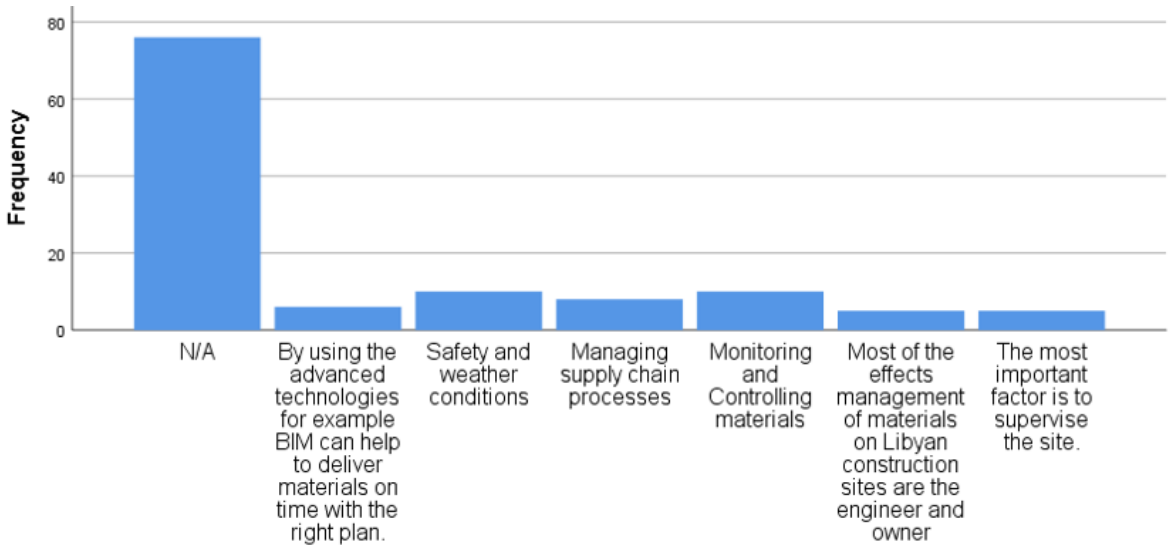

Figure5.29: Other important factors. Source: Author

5.3.30 Technologies and ICT tools

A mean of 5.46 shows that majority of the population uses various emerging technologies. 8.3% stated that they are extremely dependent on such technologies, as they use them on an everyday basis. 10% of respondents gave it a rank of six, while 15% ranked it at five. This shows that the use of technology is fast increasing, and it can be an effective way of improving material management. (see table 5.31and figure5.30).

Table5.31: Technologies and ICT tools. Source: Author

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low use	12	10.0	10.0	10.0
	2	8	6.7	6.7	16.7
	3	14	11.7	11.7	28.3
	4	10	8.3	8.3	36.7
	5	18	15.0	15.0	51.7
	6	12	10.0	10.0	61.7
	7	14	11.7	11.7	73.3
	8	12	10.0	10.0	83.3
	9	10	8.3	8.3	91.7
	High use	10	8.3	8.3	100.0
	Total	120	100.0	100.0	

A mean of 5.46 shows that majority of the population uses various emerging technologies. 8.3% stated that they are extremely dependent on such technologies, as they use them on an everyday basis. 10% of respondents gave it a rank of six, while 15% ranked it at five. This shows that the use of technology is fast increasing, and it can be an effective way of improving material management.

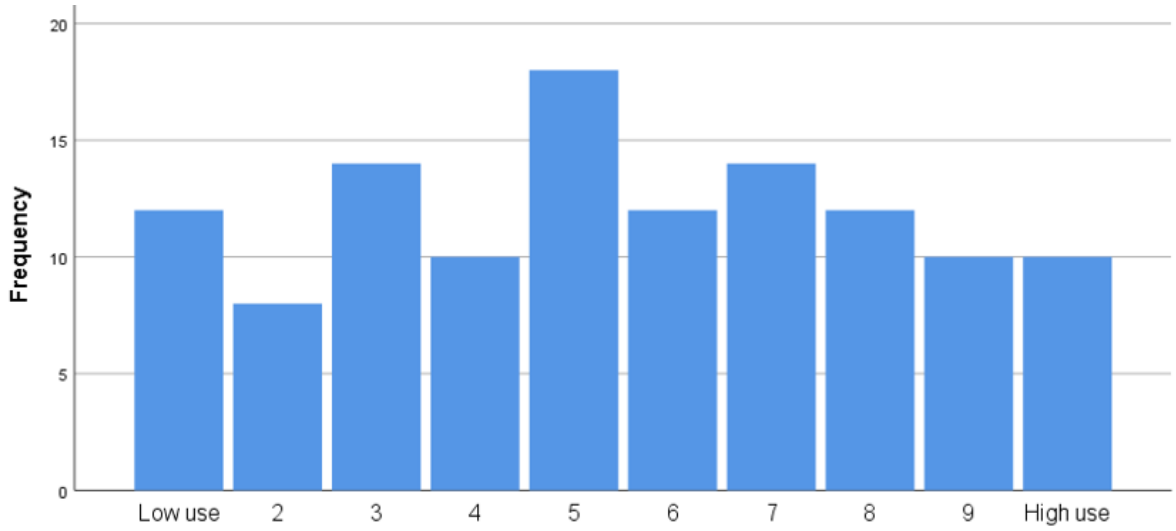

Figure5.30:Technologies and ICT tools. Source: Author

5.4 Factor analysis

The main aim of using factor analysis (Maximum likelihood) in this study is to identify the important factors related to the perceptions of the construction stakeholders. Factor analysis can be used to explore the data for patterns, to confirm the initial hypotheses and/or to reduce the numerous variables to a more manageable number (Pallant, 2011). Factor analysis is usually applied to a large set of variables; it involves identifying the common and unique sets of variances called factors or components. It allows the researcher to condense the information into a manageable number of related variables prior to using them for conducting other analyses such as multiple regression or multivariate analysis of variance. Additionally, it helps the researcher to determine the number of latent variables of a set of items, and to define the substantive meaning of variables that account for the variations among a large number of items in a questionnaire (Field, 2013).

Maximum Likelihood Factor Analysis is a common technique used to estimate the factor loading (Crisci, 2011). MacCallum etal., (1999) stated that the simple size impacts the factors analysis solutions and offers useful information**.** They believe that the simple size should be at least 100.

5.4.1 Sampling adequacy

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Barlett's Test of Sphericity (BTS) were both calculated (Pallant, 2011); Barlett's Test of Sphericity (BTS) is a test of significance of correlation matrix; the significant level is larger than 0.03.

As Table 5.32 demonstrates, the occurrence of many correlation coefficients is at or above 03. The KMO test shows 0.574 which is satisfactory; the BTS was also significant (P=0.000) and df= 561. Therefore, factor analysis was considered appropriate for this study (Pallant, 2007: 190).

Table 5.32: KMO and BTS tests. Source: Author

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.574
Bartlett's Test of Sphericity	Approx. Chi-Square	2292.930
	Df	561
	Sig.	.000

5.4.2 Rotated components matrix

Rotation is used after extraction to improve the interpretability and to clarify data structure (Costello & Osborne, 2005). In this study, the varimax rotation is used as it provides better interpretation, leading to more interpretable factors as it allows a smaller number of variables to load highly on each factor. The varimax method of rotation is the most appropriate technique to use because it produces results which are easy to interpret (Pallant, 2011). Following rotation, factor loadings should be more transparent to the researcher. According to Field (2009), factor loading of the variables >0.3 is considered significant, factor loading variables >0.4 are very important, and a factor loading variable >0.5 is considered very significant.

5.4.3 Maximum likelihood

As mentioned above, this study utilised maximum likelihood estimation as a method to determine how many variables the construction stakeholders consider and which items belong together because the collected usable sample data was (N=120) and this study used parametric tests.

This result presents the most components of the material management activities which the construction stakeholders consider. The purpose of the rating scales in the questionnaire was to focus on the common components of the material management process. According to the

study's findings, three latent variables were identified from the material management process: activities of material management, internal factors, and external factors. The respondents rated material management high in terms of 28 components, but very low (negative) in the six variables identified above, (which are dropped out): supplier effect, supervising site, financial, improvement of the storage site, and using advanced technologies BIM.

Factor one is labelled, "activity of material management" and it includes 10 variables. This factor is based on the managing material waste with the highest loading (.821). The other variables which are included in the material management process are related to the purchasing of the materials, logistic management, controlling the quality of material, transport services, tracking, handling, and project management experience. These attributes are essential for improving material management.

Factor two, the internal factor has 10 attributes. The data showed that most respondents are concerned with factors that impact their productivity, training, health and safety, knowledge and skills, contractor, and subcontractor experience. The respondents expressed a strong interest in joining a training course that improves their skills and knowledge.

Factor three, the external factor has 8 attributes**.** This factor has low loading compared to the other factors (activities of materials management and internal factor), Those with the highest loading are poor stores (.562), followed by those using technology (.529), This factor is of great significance to the construction industry because good project managers used technology to improve the material management process. The improper project planning and political situation can threaten material management improvement.

These factors are important for the Libyan construction stakeholders because they improve the material management process.

Table 5.33: Exploratory factor analysis results. Source: Author

	Extraction Method : Maximum Likelihood		**Rotation Method: Varimax**			
No		**Factors**			**Factors Identifications**	
	Variables	**1**	**2**	**3**	Activity of material	
1	Managing materials waste	.821			management	
2	The purchasing of the materials	.768				
3	Improving logistic management	.702				
4	Ensuring that the materials are provided on the construction site	.698				
5	Controlling the quality of material	.618				
6	Project manager experience	.588				
7	Transport services	.576				
8	Tracking	.522				
9	Handling material handling	.416				
10	Factors related to the owner	.361				
11	Availability of labour		.740		Internal factors	
12	Training		.725			
13	Healthy and safety		.705			
14	The expertise of the subcontractor		.698			
15	Experience of contractor		.642			
16	Knowledge and skills related to the people		.623			
17	Engineers experience		.617			
18	Material delivery		.547			
19	Material cost		.469			
20	Poor site management and supervision		.317			
21	Poor stores			.562	Externail factors	
22	Effect of using technology			.529		
23	Improper project planning and scheduling		.	. 501		
24	Inappropriate construction methods			.486		
25	Changes in materials prices			.458		
26	Weather factor			.422		
27	Political and environmental factors			.418		
28	Designer impact			.415		
		Total variance explained				
		Kaiser-Meyer-Olkin Measure of Sampling Adequacy				

5.4.4 Reliability Statistics

Reliability lies in testing and assessing the quantitative method. The idea can be used in a major research study. To determine the reliability of the research questions in this study, Cronbach's coefficient alpha test was adopted. Cronbach's coefficient alpha is used to test reliability in the questionnaire development across different sectors. the degree level of correlation among a set of items and the variance among the items should be reached at least 0.70 (Golafshani, 2003). The Cronbach's alpha for the given set of items is coming out to be 0.738, which is more than 0.70; thus it can be said that the given dataset is reliable. (see Table 5.32)

Table 5.34: Reliability test. Source: Author

Cronbach's Alpha	No of Items
0.738	28

5.4.5 Validity

Validity is an important characteristic of tests and social research. There is a consensus that the trustworthiness of any substantive research depends on the validity of the instruments employed to gather the data (Baghaei & Yazdi, 2016). It is defined by Heale and Twycross (2015) as the extent to which a concept is accurately measured in a quantitative study. According to De Vaus (2013), three ways are applied to assess validity: criterion, content, and construct validity; criterion and content validity were discussed in Chapter Four.

5.4.6. Discriminant validity

There are two types of validity: discriminant and convergent validity. Discriminant validity is the extent to which a measure does not correlate with other constructs from which it is supposed to be different (Lu, 2007; Hair, 2015). It involves demonstrating the lack of

correlation between the different variables (Hair, 2015). It was defined by Taherdoost (2016) as the ability to distinguish between the relevant subject groups. To test the discriminant validity of the study variables, Pearson correlation was used here. It measures the strength of association between the variables as a parametric test (Gust & D'journo, 2015). The correlation between each independent variable should not be too high (not more than 0.7) (Pallant, 2010).

Table 5.35 illustrates the correlation coefficient between the variables in the model. Discriminant validity was established by comparing the Pearson correlation among 10 attributes; these variables were the most important factors for the participants, respondents, and the literature review researchers. As can be seen, most of the correlation between variables is not more than 0.7.

Table 5.35: illustrates the correlation coefficient between the variables in the model. Source: Author

Factors		Experience	contractors	consultant	materials	designers	labour	surveyors	suppliers	owners	technology	skills
Experience	Sig.(2-tailed)	1										
N		120										
Factors related to contractors	Person correlation Sig.(2-trailed	.031	1									
	N	.739	120									
Factors related to consultant	Person correlation Sig.(2-trailed	.051	.290	1								
	N	.578	.001	120								
Factors related to materials	Person correlation Sig.(2-	.008	.435	.415	1							
trailed		.328	.000	.000	120							
	N											
Factors related to designers	Person correlation Sig.(2-trailed	.229*	.105	.183*	.236**	1						
	N	.012	.255	.045	.009	120						
Factors related to general labour	Person correlation Sig.(2-	.142	.274**	.417	.367**	.107	1					
trailed		.002	.002	.000	.000	.243	120					
	N											
Factors related to surveyors	Person correlation Sig.(2-	.081	.105	.100	.097	.389**	.131	1				
trailed		.382	.225	.225	.292	.000	153	120				
	N											
Factors related to suppliers	Person correlation Sig.(2-	.78	.102	.131	.227	.134	.176	.034	1			
trailed		.397	.268	.155	.013	.145	.054	.516	120			
	N											
Factors related to owners	Person correlation Sig.(2-trailed	.062	.204	.375	.308	.017	.306	.045	.047	1		
	N	.498	.025	.000	.001	.000	.001	.001	.001	120		
Factors related to technology	Person correlation Sig.(2-trailed	.131	.124	.400**	.258	.085	.224*	.056	.051	.262**	1	
	N	.153	.177	.000	.004	.359	.014	.541	.580	.004	120	
Factors related to skills	Person correlation Sig.(2-trailed	.011	.148	.366	.426	.151	.200**	.067	.223*	.154	.421**	1
	N	.604	.107	.000	.000	.099	.028	.465	.014	.093	.000	120

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

5.4.4 Convergent validity

Convergent validity is the extent to which scales correlate positively with other measurements of the same construct (Hair, 2015: 258). Construct validity is achieved when an item has a high correlation with another item that measures the same construct (Bolarinwa, 2015; Hair, 2015). The term convergent validity specifies the degree to which the items of a particular construct converge or has a high proportion of variance in common. Factor loading, variance extraction, and composite reliability can be used to assess convergent validity (Hair et al., 2011).

In this study, factor analysis was used to establish the convergent validity of the image attributes. The Average Variance Extracted (AVE) was calculated to assess the convergent validity of the constructs. This value is calculated manually, by using the formula:

$$AVE = \sum \lambda^2 / n$$

λ is the standardised factor loading. It is divided by the number of attributes (variables) (Hair et al., 2010). The value of AVE should be 0.5 or more for this validity to be achieved (Quinn, 2015). Based on the results given in Table 5.36, the AVE was above 0.5 for all items. The lowest AVE was seen for the external factor at.51, but since this value was higher than 0.50 and it is highly significant, convergent validity is supported.

Table 5. 36 Convergent validities. Source: Author

Construct	AVE
Activity of material management	.60
Internal factor	.61
External factor	.51

5.5 Summary

The chapter introduced the questionnaire analysis to identify the most important attributes the majority of the construction Libyan companies are concerned with. It started with the descriptive data of the variables examined in the questionnaire. This result presents the most important components of material management: managing material waste, waste materials, logistic management, controlling material quality, transport services, tracking, handling, project management experience, productivity training, health and safety, knowledge and skills and contractors and subcontractors' experiences. Finally, the chapter introduced reliability and validity: discriminant validity and Convergent validity.

CHAPTER SIX: QUALITATIVE DATA ANALYSIS

6.1: Introduction

This chapter presents the qualitative findings of the interview data, to establish a rich, in-depth picture of the issues explored in this study. It describes the data collected through semi-structured interviews. Semi-structured interviews are considered appropriate, as they offer an opportunity to ask more follow-up questions. The justification for conducting the interviews was to collate in-depth data to support the quantitative data since the literature on improved material management is still in its introductory stages. This would make it possible to explore the points of view among construction companies' professional staff when required.

To achieve the research aim, it was necessary to interview the different staff members of the Libyan construction companies. As stated in the previous chapter, semi-structured questions dealt with the factors that influence improved material management.

The respondents were interviewed individually to discuss their perceptions regarding the fact of adopting new material management strategies. All the respondents were assured the confidentiality of the information they provided in the interviews. They were given unique codes, as mentioned below. In addition, their identity, names and positions remained anonymous throughout this research.

6.2 Descriptive analysis

The process of data analysis began after the collection of quantitative data; the interviews were undertaken using Skype (as discussed in Chapter Three). As with other communication tools, Skype has been supported by researchers, Skype is a communication program used for qualitative research to conduct interviews with individuals as well as groups, to hold small focus groups, and much more (Lo Iacono et al., 2016). With the rise of technology over the

last few decades, communication over distance has become much easier and more convenient with almost no end in sight (Sullivan, 2012). This software allows the interviewer to record the video conversation with both parties captured in the recording (Lo Iacono et al., 2016). It helps the researcher to interview geographically dispersed populations with a recorded interaction that at least mimics face-to-face interactions (Sullivan,2012). However, despite its growing importance in everyday life, Skype offers very little discussion in terms of academic research, with very few articles covering qualitative interviews using video and audio VoIP tools as their main topic (Lo Iacono et al., 2016).

In this study, Skype was used because the researcher could not make appointments for face-to-face interviews with the participants. Travelling to Libya is not direct, and most countries do not accept my passport as it is old. Therefore, the researcher contacted the participants to schedule appointments with them and then conducted the interviews.

Semi-structured interviews were conducted with 14 members of the Libyan construction companies: five managers, two contractors, two consultants, one project administrator, one planner, one senior construction, one material officer and one warehouse employee (none of them were questionnaire respondents). The number of participants consulted for qualitative research normally depends on the number required to give a full account of the most important information in relation to the phenomenon under study (Sergeant, 2012). In this study, the data collection process continued until enough information had been collated, with no further data required to fulfil the needs of the study, and no further insights forthcoming from the interviews (Myers, 2013: 123). The purpose was to identify the opinions of the different ranks of positions regarding material management as they have sufficient knowledge to give in-depth information. These criteria were satisfied after 14 interviews, conducted between January and March 2019. Also, four interviews were conducted but not included in the analysis.

Before conducting interviews, each participant received the information sheet that gives him more detailed information about the study, such as the research aim. The participants were informed about the research before being interviewed; the information sheet (see the Appendix) was sent by email before the interviews were conducted, explaining the research aim and the rationale behind the selection of the participants. All interviewee signed the consent forms about their rights to privacy and data confidentially. The consent form states clearly that the participation is voluntary, anonymous and that the participants have the right to withdraw from the research at any time. All interviewees signed the consent form**.** Not all the interviews conducted for this study were used in the analysis. As a part of the information quality considered for this study, four interviews were discarded due to the fact that the participants did not share information deemed as useful or complete, such as yes or no answers that were not followed up with details.

Based on the research aims, interviews were conducted with the Libyan construction stakeholders who have experience in the construction material management. Data collected from interviews were recorded to make it useful for further analysis. The interviews were recorded in Arabic, then loaded into the researcher's laptop. The process of analysis started after completing the data collection; the interviews were first translated by the researcher and then transcribed verbatim to make sure that no important information was forgotten. They were then corrected by an independent translator. All the transcripts were stored in a computer folder and thematic analysis was used to identify and present the themes found in the data (Alhojailan, 2012). This study used the manual method (hard copy and pen) for analysing the interviews, which increased familiarity with the data and helped the researcher to make comparisons between the interviews; it is the best way to enable the revision of the text many times and to identify the themes more easily. This section was discussed in details

in the methodology chapter above. To organise the analysis process, the first research question is dealt with in three parts; it is then followed by the second research question.

6.3 Participants data

Table6.1: Participant's data. Source: Author

N0	Gender	Date	Job Title	Work Experience
1-	Male	12/1/2019	Project manager	15
2-	Male	13/1/2019	Construction site manager	7
3-	Male	22/1/2019	Planner	10
4-	Male	30/1/2019	Project administrator	8
5-	Male	5/2 /2019	Warehouse house employee	5
6-	Male	10/2/2019	Material officer	4
7-	Male	12/2/2019	Senior construction staff member	9
8-	Male	17/2/2019	Purchase manager	7
9-	Male	21/2/ 2019	Contractor	5
10	Male	23/2/2019	Consultant	6
11	Male	26/2/2019	Construction manager	9
12	Male	3/3/2019	Contractor	4
13	Male	5/3/2019	Warehouse manager	6
14	Male	7/3/2019	Consultant	7

Q1 What are the significant factors supporting active materials management (MM)?

To analyse the data related to this question, it is necessary to clarify the following points:

6.4 Material management process

According to Phu and Cho, (2014), material management is a process applied to planning, assessing the requirement, sourcing, purchasing, transporting, storing and controlling materials, minimizing wastage and optimizing profitability by reducing the cost of material.

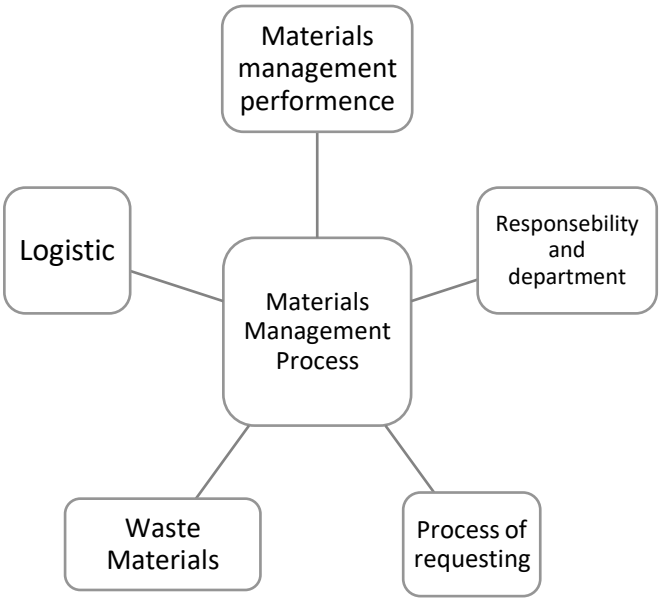

Figure (6.1). Material management process. **Source: Author**

6.4.1 Responsibility and departments (Material management system).

According to the interviewees, the Libyan company does not have a policy or a standard for handling material management; however, it has its own system and methodology to manage the procurement process and to order and move materials, which are not too far from its peer.

During the interviews, the rationale underlying this launch became apparent, with the participants offering different views on addressing material management, some of which are listed below.

*"There is not any policy for managing material management, all our work just our effort (*interviewee no.2,9,11.14)".

"In our company, we have system to managing the material management (interviewee no 7,5,12)"

"Organising and controlling materials management by use standard work (interviewees no 1, 4)".

Interviewee no. 10 confirmed that the Libyan construction companies do not have any policy in place to manage the material in building, some engineers develop systems to manage and organise their work in the firm for ordering and moving materials. This answer was found nine times during the coding process.

In addition to talking about the purchase of materials, the participants defined the procurement process. Although most of the procurement process is conducted in the purchasing department within the company, home office, the first actions that concern the building materials started from the general planning department throughout the planning stage. The planning is the first step taken to manage the building materials.

"The process of procurement is including ranges of demand steps, starts with purchase planning (interviewees no 3, 7, 13)".

"The purchase department is responsible for the procurement process, its common after the planning or preparing which researching, selection possible suppliers, and time schedule (interviewees no 1,2,5, 12)".

This finding agrees with that drawn by Arijeloye and Akinradewo, (2016) which indicates that the material management process starts with a plan for material management incorporated into the project plan. The planning material team along with the project management team prepare the material submittal log then send it to the consultant for approval; it is concerned with the project's milestone, target, time of deliveries, dates of manufacturing, transporting, customs, delivering to the site, handling, and other relevant information.

Yet another interviewee stressed the ***procurement process:***

"The purchase department send the plan list to the consultant this is concerned with the project milestone, time, delivers to the site, customs, handling, and all the relevant information (interviewee no 4)".

Other participants agreed that "*the procurement management plan like all management plans, the purchasing department needs to discuss with a consultant about the company needs, consulted who needs to determine the suppliers (interviewees no 6,10)".*

Participant no. 14 expressed a different view: the Libyan construction company focused on an easy means for ordering and moving material; there are differences between private and public organisations. Therefore, procurement is different between the two sectors. In the private sector, the procurement process is part of the company strategy. The focus is on the necessary materials that need to be purchased and the cost that makes a successful company; besides, the fact that it should be close to the company needs. In the public company, the big quantity means that the purchase of materials does not match the company needs.

"The purchases in public company are different to the private sector because in public we focus on the long process, sometimes our purchases more than we need (interviewee no 14)".

Other participants explained that the purchase department is an important function in the construction material management:

"*The purchases department is the important functions; it is responsible for implementing its activities including evaluating and selection supplier which is related to the construction material management interviewees no 8&9".*

This finding supports that drawn by Musau, (2014) when he states that the purchasing department is responsible for acquiring all the material that the company needs. The purchasing department sets the overall direction of procurement based on the companies' goals; it is also involved in the evaluation of suppliers and in developing long-term relationships with them.

Planning

The planning stage is the first step in the material management process life cycle. It focuses on financial and technical viability. This stage comprises the materials initial activity; it is concerned with the preparation and arrangement of actions necessary to guide material design and competition (Bell and Stukhart, 1986).

The planning process seemed to be extensively applied practically. More efforts are exerted by most of the participants involved in the material management process at this stage. However, there are different perceptions about this stage. Some participants agree with the people who are responsible for this stage; they typically prepare a time schedule for the entire project, and then start working in detail on the design phase that determines the necessary resources, activities, and durations.

"At the early step of purchase department (designer and planner) set up strategies, techniques, and any things related to this stage, such as choose people to work for receiving and handling the materials" interviewees 3,5,11.

However, other participants pointed to the barrier which is improper planning**.** Participants 6 &10 stated that they generally are not sure about what they are aiming to accomplish; unfortunately. They lack clear priorities and this made them much more susceptible to unpredicted interruptions and events. Consequently, they usually miss deadlines of procedure and fall behind the schedule. In addition, they do not have competent staff to apply project control to save time.

"We don't have any proper plan, we suffer from misunderstanding, what to do first and when we should be finish, it's difficult for the workers to put the right plan in right way, also, we do not have any control project due to the unavailability of good project staff to save the time, these the greatest challenges face the project management in the material process "interviewees no6&10.

This finding is opposite to that of Klein (1999) who pointed out that the objective of the project plan was to determine the period of the project activities when starting and finishing; the aim of resource allocation is to ensure the sufficient and timely supply of resources for project execution.

Design phase

The majority of participants agree that design activity comes after the planning stage. The design function is based on the planning, the project manager updating, identifying the requirements, developing the bill of quantities to achieve the project cost, and obtaining an initial technical approval for items.

"Design function is usually come after the planning functions, this is the project manager job, it is very important because help to control the project and achieving the project cost, it is based on the planning function, in this stage the project manager revise all the planning documents then updating the requirements, developing the quantities of bill and obtaining an initial technical approval for items interviewees no 2,7,8."

Participant no1 agrees with the above statement; he explained that contracting structure impacts the design function and he hinted to the example of the relationship with the supplier.

"This my job, this activity is one of the purchases processes which depending on the planning stage, it's come after planning function and before the purchases function…. we need to prepare update the schedule of requirements, determine the quantities of the materials. but sometimes happens change the request according to the contracting structure which the major impact this function such as the contract with the supplier, I should be say if the relation with supplier is crucial for success of a project interviewee no 1".

These findings are consistent with those reported by Handfield, (1993) who clarified that design emerges from the planning function; a function for identifying what materials are needed and how much work can be executed initially from plot plans or flow sheets; the data are then updated during the construction.

The lack of the design team experience is another issue which impacted the material management process in the Libyan construction companies as result of the lack of coordination between the people who work in this phase.

Design is one of the most important stages; unfortunately, we do not have any experience within the Libyan construction team. This could be attributed to the lack of coordination between the design team and the contractor resulting in delays and time overrun.

In construction building, it is important to manage all materials from the design phase to the completion of the construction stage of the project because the poor materials negatively impact the entire construction projects performance regarding quality and productivity, time and budget (cost) (Arijeloye and Akinradewo, 2016).

6.4.2 Process of requesting material

In terms of requesting material, participants mentioned that it is the construction site managers' job. The process started with the construction site managers preparation of the quantity bill to determine the types and quantities of materials that are required for times or the stage of the project. The documents are then submitted to the storekeeper on the site to be booked and preserved until needed on the field. If the materials are available, they can be requested by an internal request form, which is signed by the construction site manager.

If the materials are not available, the storekeeper prepares and signs the external request form and sends it to the project manager. The project manager sends it to the purchasing manager after reviewing it. The purchasing manager, in turn, signs the form and sends it to the warehouse within the main construction company to prepare and arrange delivery to the project site store. If the materials are not available in the main warehouse, the purchase department has to contact the supplier who is agreed on in the earlier stage, asking him to send the request form which includes information such as the types of materials, quantity, agent, after approvals from the consultant. Sometimes, the purchase department looks for other suppliers or offers due to the material cost.

The materials officer is responsible for transporting the materials, tracking the delivery to the site. Here, the materials officer contacts the storekeeper to prepare and receive the materials. Once the materials have been received and updated on the inventory system, the receiving

team prepares the related receiving report, which includes data such as the quantity, the quality control report, the damaged items, etc. In some cases, the materials received from the main warehouse are then sent to the project site. However, no technologies are used such as wireless technologies for managing the material in these constructions.

"The project manager, planner, material administrator and quantity surveyor updating the bill of quantity (interviewees 2,5,7)".

Interviewees no. 6 and 8 agreed that the "*project manager is responsible for purchases in the company after he prepares the purchases list and contacts the planner, material administrator and quantity surveyor to update the bill of quantity after the purchases department receives the material from supplier. The project manager and the material officer are responsible for receiving and moving materials within the site"*.

Moreover, other interviewees believed that the project manager and his team are responsible for ordering the material.

"The project manager and his team, especially the quantity surveyor review the list of material request and send the report to the material administrator within the purchasing department (interviewees no3 ,9, 13)".

While other participants explained the role of the purchasing department in the requesting material process.

The *purchasing department are responsible to sign the material form and send it to the warehouse in main company to prepare to the site store, if the material is not available in the main warehouse, the purchase team send the request to the supplier who already assigned in earlier stages (interviews no 4,10).*

This finding supports that inferred by Arnold et al., (2011) who observed that the purchasing department managers and the company's procurement process are responsible for working with the supplier on any changes in the delivery requirements.

Another idea is very clear during the interviews and participant no 6 appreciated that this mode

"The material officer is responsible for transporting material, shipment, tracking the deliveries to the site., Also, his team prepares the related receiving report, receiving quality control report, request quantity report, and damaging report (interviewees no 12)".

However, interviewee no 6 explains that requesting the materials include the storekeeper besides other departments mentioned by other participants above.

"My job in the managing of material is the daily used materials, a building foreman can fill the form of internal material request then send it to the storekeeper, the storekeeper in turn issues the required material, and send the copy of the form, which was signed by the recipient, to the construction manager. In addition, I prepare a store shortfalls list and send it to the main warehouse (interviewees no 6)".

6.4.3 Managing wasting material

A waste management plan should be adopted at the early stage of the project by the designer (Jimenez-Rivero et al, 2017). However, the management of waste material in the Libyan companies is absent. The Libyan companies lack a waste management policy. The interviewees highlighted the most important issues related to material management, with the majority agreeing that Libya does not have any recycling method for waste material and that there is not any direction from the management site. The Libyan companies still throw away materials such as crushed concrete blocks, plastics, and cardboard which can have an adverse

effect on human health, animals, and the environment. Also, there was no waste scrap bin which might be recycled by the waste management contractor. This finding is in line with those deduced by Manowong, (2012) and Ferronato & Torretta, (2019) who reported that in developing countries, there is still poor understanding of waste management and most companies did not have a policy on material waste management.

"We do not have any policy for managing the waste of materials and we lack recycle market" 10 interviewees

This view was similar to that expressed by another staff member who indicated that the Libyan companies lack construction waste management.

"Lack of construction waste management has caused the Libyan constructions to have little profit" Interviewee no 9.

In addition to the waste materials, 5 of the interviewees noted that:

"There was no waste scrap bin for materials such as crushed concrete blocks or blocks, plastics and cardboard".

This statement agrees with that made by other interviewees about waste material:

"The waste of material in Libya is a big problem, because there is no policy for managing waste materials, another issue is inadequate facilities for the disposal of construction waste" interviewees no 12

Another participant highlighted the impact of waste materials on human health and the environment. It is not only a pollution problem, but it is also an economic loss; he explains:

"Unfortunately, the cardboard and plastics are burned, these materials are harmful on the air and breath, because the companies do not have any method to recycle them..... These are not just health and environment problem, but also an economic loss". (interviewee no 8).

However, these findings contradicted those arrived at by the (Nagapan et al., (2012) who concluded that there are regulatory policies in developing countries for handling waste.

On the other hand, waste material such as metal and wood could be sold to another small business (Forge) for use for different purposes. The leftover metal and wood derived from the reinforcement off cuts or drop ceilings, due to the requirements, have to be cut in some metal lengths to fit the required modifications; they are sold out to other businesses (domestic markets) to be recycled to make other products.

"The leftover metal is sold to people who work in small businesses "this statemented is repeated more than several times.

This is further supported by another participant who explains:

"After the wood and metal are cut off to the length to fit the required modification, all the leftovers are collected and sold to other small business who recycle them into doors, tables, windows... I mean used in many things' interviewee no 7.

Moreover, awareness was one of the factors that was emphasized by five interviewees. The Libyan construction management authority is not aware of the problem of waste material and it does not know why companies need to manage these wastes. The authority supported the view concerning the importance of awareness in managing the waste of construction materials; those in charge planned training programs to provide knowledge about the importance of managing the material waste. These findings align with those recommended by Abarca-Guerrero et al., (2017) who observed that awareness and education are two major

factors constituting barriers for improved construction practices such as managing waste materials because most people do not know how to act sustainably.

"Most of the workers in our companies' site have no awareness about the management of material waste, what needs to be considered to improve the management of construction waste by training programs to explain about the benefits and negative of the construction waste interviewees no 4,5,11,13.

The lack of prior knowledge of the term 'waste material' was initially regarded as a challenge; however, the researcher thinks it could be turned out to benefit the research. Since, most of the construction company stakeholders were not aware of the term.

According to the interviews, the government impacts construction waste management; the Libyan government has no technique to manage material waste and storage.

"Here the government do not have any strategy to manage the waste of a construction company …. especially as many engineers offer possible suggestions and suitable methods to manage of these waste - interviewee no6".

6.4.4 Logistics

The main reasons for working in logistical planning are to save money and to gain an increased efficiency in the production, according to the interviews with the managers, project members and contractors. The managers of the construction companies illustrated the importance of considering logistics early in the projects; this allows the company to avoid more losses. They also expressed the view that the managers do not intrude in the logistical implementation of each project, but the company has chosen people to solve the equation related to the logistics. The interviews highlighted the most important factors related to the storage and handling of materials, the majority agreed that in Libya before this time, most

companies had a waste problem, but now the materials are handled and stored correctly on site, and the waste rate is reduced by controlling over ordering and using a better procurement system.

In our company, logistical techniques are adopted.

"Compare by the past, the logistic techniques are employed in most Libyan companies due to most of the project managers educated interviewee no 3".

Another participant agrees with above:

"Most waste in material is reduced after adopted logistics techniques such as storage material and ordering system interviewees no 9".

However other participant has different idea which mention that "The managers do not intrude in the logistic implementation for each project, but the company chosen logistic team to solve the equation interviewee no 6".

Interviewee no 11 suggested that construction staff should consider logistics to save costs.

> *"To be able to work efficiently and save money should be the focus on the logistics and the production related to the logistics" interviewee no 11.*

6.4.5 Material management performance

A performance measure is used to calculate the effective working of a function. The measures divide the materials management system into parts and make the system's working more efficient (Narmadha & Thenmozhi, 2015). Materials management is a good candidate for efficiency measures since it is a results-orientated process. Plemmons & Bell, (1995) observed that effectiveness, the extent of performing the right things right, assesses process performance by comparing the actual results with the target or planned results.

The participants highlighted different views related to the measurements of materials management performance and to the people who are involved in the material management process, such as the material officer, project manager and warehouse officials using some techniques for examining performance in the field. However, they do not have a mechanism that could be used for appraising the performance of the material management process.

We do not have any mechanism for assessing the material management performance, we only used some techniques to examine the material process (interviewees no1,5 &13).

Participant no 6 agreed that Libyan companies lack the mechanism for evaluating the material management performance.

The participants interviewed discussed the evaluation and the effectiveness of the material delivery process. The Libyan construction stakeholders use some techniques such as those of making comparison between the planned and the actual delivery time for evaluating the delivery material process, comparing the planned material delivery schedule with the updated actual one. While, for examining the request of materials process, a comparison was drawn between the internal and external material request for determining the material withdrawal request lead time, which can give an indication to the ability of the company team to early identify and request the requirements, thereby giving a minimum time of waiting for the material. In addition, the warehouse used the report as a part of the control by proceeding with quality insurance through recognising the rejection of nonconforming items prior and after shipment. This finding is consistent with that drawn by Patel and Vyas, (2011) who suggested that the performance of materials management should be measured because a performance measure calculates the effective working of a function.

"Here in our company, we use different techniques for control and examining the material request …. Such as for delivery material process, we made the comparison between the

planned and the actual delivery time ……construction company used performance measure to improve their work "interviewee no 13.

"However, interviewee no 6 believe each company or site has different techniques or system used to evaluate the material performance,,,,,, we do not examine all the material process…. Here on the warehouse department responsible on most of the evaluation of the material performance

For the warehouse or a site-store, the warehouse manager along with the control team, monitor processing the material requests, correctly issuing the required material for the construction operation, prior. If the field is required by a set date, it could be performed by examining the dates of the requests and the releases.

"The warehouse manager who checks out the material request……and he is examining the of the requests and releases Interviewee no 4".

However, opposing ideas were very clear during the interviews and three participants appreciate this mode:

"In fact, the staff site sends the requirement form to the control team not directly to the warehouse manager ... they made comparison between internal and external material request for determine the material withdraw request lead time interviewee no 5,7, 9".

The Libyan construction company authorities check the reports, inputs, outputs, and the feedbacks from and to any function within the material management process to examine the performance of the information management system and the documentary cycle.

Construction managers stated that *"for evaluating the documentary process and the information system we check all the reports inputs fill, outputs from any task related to the material management interviewees no 1& 13".*

6.5 Material inventory and tracking

6.5.1 A function of inventory in the site space

Materials inventory management is important as materials demand a large amount in construction cost. This is because poor inventory management can affect not only the increase in costs, but it can also contribute to schedule and projects delays (Subramani et al., 2017).

Most of the participants agree that all the inventory and storage activities are part of the warehouse activities. This function is managed by the storekeeper and the warehouse manager. Each construction site has many areas available for storage, and the process of materials storage is recorded and verified via inventory utilisation during the process of taking in and out of materials from the storage area. This requires the integration with work programmes in order to identify specific materials for related work tasks.

"All the inventory task is under warehouse and storekeeper responsibilities, also they recorded all the materials activities such as taking into or out from the storage area to avoid several problems such as materials have been not delivered or material out of stock interviewees no 6,7,9.12".

Another participant stated that no technology is used to manage the inventory activities on the construction site.

> *"The manual practice used for checking delivery and stock inventory..... we do not use any techniques to the handling of material in the storage interviewee no 13.*

6.5.2 Material tracking

The other factor related to the managing inventory and touched upon by the interviewees was tracking. The literature review shows that material tracking is important because of two reasons: firstly, it provides timely information on materials availability to enhance crew-level work planning and improve labour productivity. Secondly, it enables real-time on-site measurements of project performance indicators that provide project management with feedback information for controlling the project (Liwan et al., 2013).

According to the interviewees, current manual practices are used in the Libyan construction companies for tracking and checking materials delivery, but no specific tool or technique was used to aid the handling of materials on site. This finding aligns with that inferred by Mani, et al., (2017) indicating that material tracking practices rely on the manual method of collecting and recording data related to the tracking activities, a process which is labour intensive.

> *"In our company, manual methods are still used to facilitate tracking materials for delivery confirmation and inventory checking management interviewee no 5".*

Other participants agree with above statement; manual practices are currently used in this project for tracking and checking materials delivery and stock inventory, but no specific tool or technique was used to aid the handling of materials on site (interviewee no 12 pointed out) while other participant stated that material was manually used along with bar-coding to facilitate materials tracking activities.

> "*In here, we use manual techniques but there are many human errors and too much paperwork therefore we started using bar-coding to assist tracking and checking construction daily activities interviewee no 6".*

However, the same participant added that his manager is aware of the importance of technology for tracking material in the site to avoid numerous problems.

"Our manager is aware of the importance of used technology on the site to facilitate tracking materials…… many problems happen due to use manual methods in the construction sites such as some staff forget to record the movement of the materials interviewee no 8".

6.6 Material management problem

There are many problems which cause poor material management activities in construction projects. Zakeri et al. (1996 as cited in Pho & Cho 2014), observed that waste, transport difficulties, improper handling of sites, misuse of the specifications, lack of proper work plan, inappropriate materials delivery, and excessive paperwork all adversely affect the materials management process. Lack of time delivery, inadequate equipment to transport materials or lack of a logistic site affect craftsman's productively (Jusoh & Kasim, 2017).

Throughout the interviews, those consulted along with the construction managers discussed the barriers facing material management in the Libyan construction companies. This section presents the overall problem facing the construction sector in Libya. For long periods, there was incredible progress in the construction sectors during the seventies and eighties which helped the country to improve the economy. At the beginning of the nineties, the construction sectors started facing problems which caused delays and failed projects, due to the missing experience of the national and international companies that entered the Libyan market at that time; in addition, the lack of skilled labour impacted the build quality during that time.

Up to the 2002, there was stunting growth in the Libyan construction sector because many of the Libyan engineer students worked in the European countries. At the beginning, in 2010,

there was rapid growth in the construction sector because massive financing was made available to the infrastructure and housing projects, but there are more defects in the new buildings. The main reason for the defects in the new buildings was the poor design; they are more advanced in construction.

According to the interviewees, there are common problems that impact material management such as not being able to receive material when they are required. This led to reduction in productivity. Sometimes, the wrong quantity of material is received. Mostly at the construction site, large quantity of materials that are not needed are received, causing a high risk of damage in quality or sometimes, damaged materials are received such as broken bulk.

"There are many problems impact the material management process sometimes we don't receive the material on times or receiving large quantity of material which need storage after period we found damaging, like this mistake led the company to lose" (no, 5,7.9.12.14).

Participant's nos. 10 and 11 agreed:

"Storage the material problem because sometimes we receive large quantity of materials and we have not space to storage, most of these material waste it such as broken bulk".

This is further supported by most participants who pointed out that inadequate planning has negatively impacted the process of material management.

"To complete a project without any issue, planning should be done in advanced for each stage before started any project, however here we lack the plans, and this led the Libyan construction companies to the inefficiency and low productivity interviewee no 3&4".

The same idea was reinforced by other participants, who claimed that not all staff considered the planning stage:

"Proper planning should take place before beginning work,,,,,, if the implementation period for the project was relatively short and the project was longer this will impact the cost of the materials ,,,,,, and some materials bought without any plan interviewees no 6,8,12).

This finding supports the (Gulghane & Khandve, 2015) idea who suggested that Lack of planning is one of the major problems for construction on site.

However, participant no. 4 remarked that among the problems facing management material in the construction company is coordination among construction site stakeholders**.** Lack of coordination and unclear internal communication between stakeholders such as management staff and project coordinators influence material planning, design phases and development. Development and improvement of the management waste material need more sharing of information among stakeholders to achieve their aim.

> *The biggest problem facing the material management the lack of coordination or co-operation between the construction site officials that impact our work such as planning, design phase, he added work such as manage waste material need communication between management and projects to develop and improve the work* (no. 4).

In addition, participant no. 12 stressed the need for collaboration among all the construction stakeholders to choose the supplier when buying material to help supply the chain team to reduce cost and improve quality.

> *"Libyan construction companies should be contact to each other and choose the supplier to help them to reduce the cost and improve quality" (no 12).*

This finding is consistent with that reported by Alaloul et al., (2016) who noted that coordination is important between individuals in the construction projects since it is a core issue that helps improve performance in the construction companies.

There was high consensus among participants regarding experience which is stressed by four interviewees. They said that experience adversely affects materials management. Unfortunately, in Libya, an unqualified contractor is sometimes given the contract; he was unable to do the job. A university degree is not an adequate qualification; more important is the considerable period of field work, A graduate engineer should not be held responsible for a project immediately after graduation; rather, he should gain more experience to be responsible for a project. One of the staff members stated that sometimes the manager is highly qualified, but he lacks practical experience.

"Most of the contractors in Libyan companies are recently graduated from university, it is not qualification without experience "interviewee no 4, 7,8,10.

Interviewee no 9 agree with statement above when said some managers have high qualification but they do not have experience.

One of the managers explained how the contractor`s lack of experience negatively affects the project under construction; it might cause various problems such as delays in receiving the material on site, poor planning, lack of building knowledge, etc.

"New contractor who has inadequate experience… he seems to be the main problem of material management because he causes delay to receive the material in site, poor planning, lack of knowledge building and time schedule" (no 13).

Another factor pointed by one of the participants was that financial issues which can also negatively affect management material process in constructions companies. Financial and political stability are among the major causes of delay in ordering material and delay in payment. This finding is supported by Hamzah et al., (2011) who indicated that finance is an essential factor affecting the performance of the construction projects, it affects project completion, and it is a key to the success of a construction project.

Financial resources are one of the problems impact the procurement procedures and material management process in our company, current Libya situation (government stability) affect the work on the construction companies such the funding which causes delay of payment and delay of finish the project (interviewee no 5).

On the other hand, most of the participants agree that Libya's political situation impacts the construction company job. The majority of Libyan construction companies are no longer operating; funding has stopped since February 2011 due to the lockdown, which caused many companies to lose hundreds of thousands of dollars in damage and stolen property.

"The instability government affect the construction company; from 2011-2014, all the construction companies were closed, we lose and lost property".

6.7 Technology in material management

Throughout the analysis process of the staff interviews, two hot issues emerged:

- Technology tools.
- Factors that impact the introduction of technology in the material management process in construction companies

6.7.1Technology tools

The use of technology plays a significant role in the success of the modern construction sites. Technology is one of the factors that affect the successful material management process. However, the technology services are not extensively used by the Libyan construction companies; all participants agreed that most Libyan companies still use the traditional techniques such as concrete manually mixed on site or concrete manually moved to the upper floors rather than using cranes. This impacts the time required to complete the projects and affects the building quality.

"In our company, we do not used any technology only used for simple things".

In addition, one of the interviewed staff said that he urged the manager more than once to use technology since it reduces material waste and increases productivity, technology can be used to purchase orders, ship documents, make material lists or invoices and issuing payment transfers between designers; however, the Libyan companies used the PC computer to record basic data; unfortunately, the material management documents are still dealt with manually.

"Many companies used technology for purchase orders, shipping documents, material lists, invoices and payment transfers between designers but in Libya we only used the PC computer" Interviewee no 9.

6.7.2 Materials management processes and technology

Factors and problems facing the introduction of technology in materials management processes in the Libyan companies.

Throughout the interviews, the construction company stakeholders discussed the barriers facing the Libyan construction companies while applying technology to material management process. Technology has unique features that influence the material management process as a tool. Therefore, it is important to identify the factors that hinder the constructions company providers from adopting it in their work.

The findings demonstrated that most participants agree that there are issues affecting the adoption of technology in the material management processes of the construction companies. They highlighted that the problem lies in the lack of efforts to apply technology in the material management process. Five participants gave their opinions in this regard, acknowledging the fact that it is difficult to adopt technology in the Libyan construction companies. Experience was the first factor mentioned by the participants; they referred to it

as an obstacle facing people from different backgrounds. The participants believe that experience is an important factor helping engineers on the construction site or in an office to reduce the time and the cost; however, most of the staff have limited experience.

In addition, participant no 8 agreed with the above statement claiming that experience helps the engineer to use specific software in the construction projects instead using traditional method to manage the materials.

"Using technology needs engineer has experience to help them choose the specific software to manage the material in the construction project instead using traditional method interviewee no 8".

Meanwhile, according to two managers, facilitating condition is another factor influencing adopting technology. The electric power line is not always available in the construction companies; it sometimes runs out of the companies. Therefore, we cannot depend on the technology to perform all tasks.

"We used technology for limited work because in Libya the electric line sometimes runout interviewees no 8&6".

6.8 Summary

This chapter has presented the findings of the thematic analysis of a series of interviews in terms of the proposed aims to improve material management in the Libyan construction companies. This study used Skype as a method to interview participants. The Libyan construction Authority stated that the Libyan constructions do not have any policy for managing the material building but they have a system for managing the procurement process and for ordering material. Waste material management is still absent from the construction sector in Libya. There are factors that affect the management of waste material such as awareness and government rules.

Data analysis confirmed that there are several factors affecting the material management process in the Libyan construction companies; these are the lack of proper planning, lack of coordination and internal communication among the construction stakeholders, lack of experience, and financial limitations. Also, the findings show that the Libyan companies do not utilize extensively the technology services in material management processes; however, the construction company in Libya used manual practices for tracking, checking materials delivery and for stock inventory.

In the final analysis, the results revealed many issues affecting the Libyan construction sector to applied technology, such as the lack of experience; all these parameters could have a negative impact on improving the material management processes.

The findings' key points:

1- This study used Skype as a tool to collect data from to the participants, because it was difficult to make face to face interviews with the participants.

2- The constructions companies in Libya have a system for managing the procurement process and for ordering material.

3- Most Libyan construction stakeholders lack knowledge of the term 'waste material'.

4- Libyan constructions companies lack coordination and internal communication between construction stakeholders.

5- Technology is not used in the material management process in Libyan construction companies; rather manual practices are used for tracking, checking materials de-livery and stock inventory.

CHAPTER SEVEN; DISCUSSION

7.1 Introduction

This chapter's aim is to triangulate and discuss the results of chapters five and six and to link them to the literature review in chapter two. A model is then proposed for improving material constructions management, which is the main research aim.

In the previous two chapters, data collection methods and analysis tools together with the research findings were discussed. Mixed methods for data collection and analysis were applied quantitatively; data were obtained via a questionnaire survey and qualitatively by interviews. The questionnaire collected attitudinal data reflecting the participants' beliefs and perspectives on people who work in the Libyan construction building companies providing a more objective fact-based understanding of the topic. However, the need for a more comprehensive and in-depth insight into the individuals' beliefs and attitudes necessitated the use of semi-structured interviews for collecting qualitative data. Semi-structured interviews provided the interviewer with the opportunity to ask follow-up questions and to make comment on the interviewees' responses in an attempt to obtain the most comprehensive and thorough view of the Libyan construction company professional staff. Both approaches included items and questions about the material management process.

7.2. Material Management Process

The aim of material management is to improve productivity in building construction projects and to ensure that the material is available at their point of use when needed (Phu & Cho 2014). Ayegba, (2013:18) defined material management as a process that coordinates planning and assesses the required sourcing, transporting, storing, purchasing, and controlling of materials, reducing wastage and increasing profitability by minimizing the cost of materials. In addition, materials management is the system of planning and controlling to

ensure that the right quality and quantity of materials and equipment are specified in a timely manner (Okorocha, 2013).

7.2.1. Planning

As a discussed above in qualitative analysis chapter, more than half of the interviewees highlighted that the planning is the first phase in managing the construction material. It involves the scheduled time; the purchase department is responsible for this stage. This remark was made many times during the coding process; it was positive. This finding aligns with those reported in the literature on materials management; the system began with planning to ensure that the right quality and quantity of materials and equipment are specified promptly (Okorocha, 2013). The implementation team of material management is responsible for creating the initial phase: a project plan for the entire project, determining responsibilities for the different activities and specifying due dates (Al-Mashari et al., 2003: Umble et al., 2003).

However, other participants highlight the greatest issues that impact this phase: the unavailability of good project staff, which causes waste in time and losses in the schedule of procedure or missing deadlines. This is consistent with the observations made in the literature. Successful plan project implementation requires strong leadership and professional personnel from the top management to support the costs, demand and champion the project (Umble et al., 2003). During the interviews, some of the participants indicated other challenges facing the Libyan construction projects, among which is that continuous monitoring does not always happen due to the top management's lack of experience.

On the other hand, the quantitative finding indicates that about 26 (22%) of the respondents highlighted that improper planning impacts the material management process; this point was maintained by the qualitative participants in chapter six. This finding agrees with that

adduced by Sambasivan & Soon, (2007) who stressed proper planning at the project's initial phases. This causes delays at various levels raising the cost of the materials. This happens because of the lack of management practices and inadequate contractor's experience.

This is consistent with the finding arrived at by Sambasivan & Soon, (2007) who concluded that construction project process suffers from improper planning at the initial phases of the project because of a lack of management and inadequate contractor's experience.

7.2.2 The procurement processes

Procurement refers to organising the purchasing and scheduling delivery of materials to the suppliers; this is the first phase of the automated materials implementation system. The procurement process begins with determining the purchasing responsibilities. It defines who is responsible for purchasing the automated materials tracking system (Sindhu et al., 2014). Management procurement approach focuses on the management and integration of the design and construction of projects (Rashid et al.,2006).

The interviews indicated that the procurement process usually started by planning the material management in the building construction projects. The contractor and the purchase department are responsible for the procurement process. This finding is consistent with that concluded by Salah & Bloomer, (2014) who contended that the process of the procurement of material management requires successful policies, planning, and human and natural resources.

While the quantitative method shows that 80 (67%) respondents believe that the procurement process is essential for the material management process, the procurement process occurs once the speciality contractor is assigned (Sindhu et al., 2014).

7.2.3 Design

The participants highlighted the importance of this stage; throughout the interviews, most of the participants pointed out that design usually come after planning the material management process. However, most of the participants observed that the Libyan Construction Company lacks the design team experience; this leads the people who work at this stage to disregard coordination between the design team and the contractor. It is important in construction building to manage all materials from the design phase to the final construction stage of the project because the poor materials affect the overall performance of the construction projects in terms of time, budget (cost), quality and productivity (Arijeloye & Akinradewo, 2016). However, on the quantitative side, 96 (80%) of the respondents believe that the material management designer does not impact the material management process; these means do not concern the material management design in the planning stage

7.2.4 Process of Requesting Material

The interviewees explained the process; the manager of the construction is responsible for this process; the construction site manager prepares the quantity bill and determines the types and quantities of materials that are required at a certain stage of the project. The documents are then submitted to the storekeeper on the site for the purpose of booking and preserving these materials until they are needed on the field. If the materials are available, they can be requested by an internal request form, which the construction site manager signs as discussed in detail in chapter six.

7.2.5 Managing Wasting Material

The majority of interviews highlighted that the management of waste material was absent from a Libyan construction company. Libya has no recycling method for waste materials, and

there is no direction from the management site. This finding aligns with that inferred by Manowong (2012) and Ferronato & Torretta, (2019) who reported that developing countries still have poor understanding of waste management and that most companies did not have a policy on material waste management. The participants also clarified the impact of waste materials on human health and the environment. It is not only a pollution problem, but it also involves economic loss. This finding agrees with that deduced by Udeaja et al., (2013), who stated that material waste has become a serious environmental issue in many large cities worldwide. On the other hand, the quantitative method finding shows that most respondents agree that the management of waste material is very important.

7.2.6 Logistics

Logistics is a concept that emphasizes the movement of materials; it includes virtually all aspects of all movements of raw materials, work in process, or finished goods within a construction site (Gulghane & Khandve, 2015). The interviewees highlighted the most important issues related to the storage and handling of material and the ordering process. The majority of participants agree that most companies in Libya encounter waste problem, but nowadays, materials are handled and stored properly on site, and the waste rate is reduced by reducing over-ordering and using a better ordering system. This finding agrees with that concluded by Duiyong et al., (2014) who confirmed that the main factor in construction project management is logistic, which reduces costs and increases the overall productively.

Other participants concede that the Libyan company does not consider logistic management techniques. The finding indicated that the process concerning logistics management was inefficient. This caused many problems such as materials unavailability and equipment schedule disturbance, which may contribute to productivity loss. Efficient logistics practice can significantly enhance efficient construction process. This finding is consistent with that

inferred by Duiyong et al., (2014) who stressed that the efficient logistics practice can significantly enhance the competent construction process; it will improve delivery, storage and protection from theft and damage and reduce the waste of time by removing non-value-adding activities.

While the quantitative method shows that the respondents agree that the logistic management impact the material management process, most of the respondents consider that material handling, material shortage, quality control, and material delivery affect the material management process. They agree that improving logistic can reduce the project cost. This finding is consistent with that drawn by Duiyong et al., (2014) who considered logistics management is an important management tool that ensures the flow of production materials, the overall strategy.

7.2.7 Staff experience and skills

The contractor and project manager should have good skills to achieve the project objectives. As stated by the interviewees, the Libyan construction companies' staff has long years of work, but they have no experience. As a result, the project cannot finish on time; this incurs high cost. Some of the interviewees agree that the cooperation among the project staff members is absent. This is one of the major challenges facing the companies because the contractor and project manager lack skills. This finding aligns with that arrived at by Fisher (2011) who states that the manager should improve his performance and solve conflicts.

All participants also agreed on the need for training courses to produce skilled workers that could realize the project goals. This agrees with the conclusion drawn by Patanakul and Milosevic, (2009) who asserted that the employee objectives may not be achieved if the employees lack training.

According to the quantitative data, 45% of the respondents have experience in the construction industry between (6-10) years. Simultaneously, 21.7% have less experience, 1-5 years. Only 15% has experience of more than 20 years. On the other hand, 65% of the respondents replied that the contractors have a significant impact on materials management. They agree that it is essential to select the successful contractor to complete the project work. Most of the contractors in the Libya construction companies have a long time of work, but they do not have any skills to finish the project on the scheduled time.

7.2.8 Material inventory and tracking

Building materials inventory management is vitally important in construction as it incurs a huge amount of construction costs. Inefficient inventory management impacts the project schedule and wastes time and money (Lu et al., 2011), in a large construction project. One needs to consider the inventory because it is affected by other factors such as inadequate storage space (Sardroud, 2012).

According to the interviewees, most participants believe that the inventory and storage activities are part of the warehouse activities. The contractor is responsible for all the project activities; he chooses people to manage the activity. The storekeeper and the warehouse manager manage this function. Each construction site has many availability areas for storage; the material in the storage is recorded and the inventory is verified while taking materials in and out of the storage area. All the processes are conducted manually by labourers who work in this department.

Material tracking is one of the challenges in the construction building sites; the challenge is associated with tracking materials which involves a large number of materials and components required for the improvement process; also, the on-site material tracking function is bound to the traditional manual method (Kasim, 2010).

According to the interviews, the current manual practices are used in the Libyan construction companies for tracking and checking materials delivery, but no specific tool or technique was used to aid the handling of materials on-site; the environment in the company is uncontrolled whereby inventory and tracking material management are required. There are many human errors and too much paperwork; therefore, bar-coding is used to assist tracking and checking the construction daily activities. This finding agrees with that drawn by Kasim (2010) who noted that the manual method is often used, a process which provides inaccurate information regarding the materials.

On the other hand, the quantitative method reported that more than 62 (51%) of the respondents agree that controlling the inventory is very important for material management process. They also recommend improving delivery; the material handling process can significantly impact the material management process.

7.2.9 Technology in material management

Technology applications in construction building can successfully improve material management process activities (Lu et al., 2011). They have made comprehensive improvement in the construction project process's performance in terms of time, cost, quality, and client satisfaction (Sanvido et al., 1992: Ofori-Kuragu et al., 2016). However, according to the interviewees, the technology services are not used extensively in the Libyan construction companies; the staff all agreed that most Libyan companies still use the traditional techniques such as performing the concrete mixing manually on the site and moving the concrete manually to the upper floors rather than using cranes.

However, the participants noted that the problem lies in the lack of effort required to apply technology in the material management process. The lack of experience was the first factor mentioned by participants, referring to it as an obstacle hindering people from different

backgrounds. The participants believe that experience is important since it helps engineers in the construction site or in an office to reduce the time and cost; however, most of the staff have limited experience. This finding agrees with that inferred by Muller & Turner, (2007) who maintained that a contractor with inadequate experience cannot plan and manage the projects properly, leading to disastrous consequences.

This finding is consistent with that deduced by Peansupap and Walker, (2005) who confirmed that the construction companies should use a computer system because it is capable of capturing, organising, storing, analysing, exchanging and transmitting, improved access to richer information that aids decision making, and sharing information (Peansupap and Walker, 2005). The quantitative data show that the respondents agree that the technology helps them improve the material management process. They believe they started to use technology but that they still need more time to use modern technology on the project site.

7.2.10 Awareness

Awareness is a theme emerging from the analysis of the interviews. The findings showed that the Libyan construction stakeholders lack awareness about some techniques related to material management. This can be noticed from the participant's comment. There is still a lack of knowledge, understanding, and awareness among contractors towards adopting ICT for the management of materials. This finding contrast with that drawn by Kasim (2010) who observed that research construction material procurement should use Internet-based agent system recommended to assist human purchasers in carrying out solicitation for identifying suppliers, searching for materials, and preparing purchase orders.

The lack of environmental awareness should be tackled because people do not know how to act sustainably. In other words, if people are unaware, they cannot increase productivity and

reduce waste and project cost. Decision-makers must be made familiar with awareness benefits to establish environmental policies and training advice.

The interviews showed that the Libyan authorities had little awareness about improving the material management process. Therefore, they need to encourage all construction stakeholders to share their experience and to understand the material management process. Technology and communication are part of the material management process and they should be highlighted.

7.3 A proposed model for developing material management in construction companies in Libya

The process of material management in construction companies is very complicated, particularly in a developing country such as Libya. Therefore, there is a need for efficient materials management to control productivity and cost in construction projects. Materials management is an important function that improves the construction projects' productivity (Bell and Stukhart, 1986). Therefore, if the material management in construction projects is not handled properly, a crucial cost variance issue will be created (Gulghane & Khandve, 2015). Despite the importance of material management to project performance, few studies focussed on this topic (Salah & Bloomer, 2014: 3; Jusoh & Kasim, 2017). Therefore, this study aims to develop a model for improving the material management process.

The best practice model (the proposed model) below was developed after the data were analyzed and the literature was reviewed, summarising the themes and patterns that emerged from both (Figure7.1). The proposed model aims to provide a useful, practical tool that helps managers identify the best elements involved in the material management process. Its design requires all stakeholders' involvement in the material management processes, especially the perceptions of the contractors, subcontractor owners, project managers, designers, planners

and staff members in middle management. The model below has several components involved in developing material management process. The following section explains these elements in detail.

Input

The first function in the model, the model in this phase considers the financial, human resources, experience, skills, training, and technology.

Skills

The successful key of the construction building project has a reliable project manager. According to Pant & Baroudi (2008), a project manager is a person who has the overall responsibility for the successful planning and execution of a project. In construction, excellent project management should have a good project manager, an expert site manager, and a perfect contractor who has extensive experience in construction, professional subcontractors, and good engineer sites (Muller & Turner, 2007). The project manager is responsible for motivating, managing, coordinating, and maintaining the morale of the whole project team (Pant & Baroudi, 2008). However, in the Libyan construction companies, the project manager and contractor lack inadequate experience and skills. Generally, project managers in Libya have low language skills. Simultaneously, some of them cannot speak any other language, which causes problems in communication between the project manager and the team members. Therefore, the project managers and contractors should consider the English language skills to achieve the project goals.

According to the finding, the Libyan construction project lacks effective coordination; the contractor and project management lack the management skills; there is no communication

among the decision-makers or among the staff members. This causes different design errors, challenges, waste material, cost overrun, delay, and time overrun. Therefore, the construction companies should consider training and skill development programs compulsory for the decision-makers to enhance the management abilities and knowledge. Such courses should be held yearly, to keep the professional and the individual abreast of global developments and to improve their methods.

Staffing

Staffing is an important aspect of construction material management process. Staffing includes supervisors, inspectors' technicians, and civil mechanical and electrical engineers; one needs a selection process for work. Staffing ensures that the right people with skills are available at the right time in the right place. It is a process that involves everything from identifying the nature of the job and implementing a recruitment and selection process to ensuring a correct match within the company. Human resource departments should consider the required criteria identified for interviews; both selection and interviewing are performed to recruit the required personnel. The human resource department should identify the training needs for improving working practices in this stage. One of the staffing objectives has always been ensuring that people are recruited; they should be retained (Ghauri & Prasad, 1995).

In Libya, the Construction Company and contractors are local, but most other staff members are from foreign countries with a construction background. However, this created many problems for the contractor because they need a complex selection process. These processes are often lengthy, and they fall beyond the contractor's control; therefore, nowadays, the majority of the workforce is Libyan.

According to the finding, the level of education impacts the material management process. Construction Libyan Authorities should consider the requirements of people work.

Contractor and project manager experience

Based on the literature review and data analysis, the contractor's experience is considered the most important factor utilised in the contractor selection procedure. Contractors' experience is usually evaluated depending on the project size, current and completed contracts, type of the projects, and experience in the region. Moreover, experience in the tender sum determining the contractor’s profit margin is also essential, thus, one needs to avoid a comparatively outrageously high or ridiculously low delicate sum.

The results also indicated that the contractor experience is a critical issue nationally for the contractor selection procedure due to a lack of experience among Libyan contractors and decision-makers. Local contractors often fail to develop a practical and workable knowledge, a ‘‘work program’’ at the initial planning stage. This failure is related to a lack of systematic site management and an inadequate contractor’s experience. The consultant only checks and reviews the contractors' work program based on experience and intuitive judgment. Improper planning at the initial stages of a project manifests itself throughout the project and causes delays at various locations. Only a project that is well planned can be well executed.

The relationship between the contractor and te project manager is the key factor for any project's success. They are the ones who are directly responsible for any outcome of the project. Good communication within a project team will help each one understands the other; this will definitely lead to the success of the project. Therefore, project management requires that the construction professional meets the project requirements.

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and the demands that need to be handled and a project to success. Therefore, project management requires the construction professional to meet project requirements.

Training

In the construction project, training is important for the decision-makers (such as project managers) to achieve an acceptable quality decision-making. The Libyan construction company needs adequate training for project managers. Therefore, the government should build training centres to teach the employees the skills which are needed. The management skill will help the project manager and contractor to complete the project successfully. The Libyan government should also share information from other developed countries as training programs, such as new technology, to help them create a professional team. Also, the National associations and the Regulatory bodies involved in construction practise should have regular workshops to educate members and to monthly inspect on-going projects to ensure that the practitioners meet the high standards (Ogunde et al., 2017).

The implementation of technology in the material management process could help the effective performance and control of materials on site. However, the adoption of technology in construction companies should be speeded up; employees need to adopt and use technology to enhance productivity (Kasim, 2010). Libyan construction companies still lack the technology tools in material management; therefore, they should add technology to the project activities to meet the project requirements. According to the finding, most of the Libyan construction staff lacks awareness of the importance of technology to material management. They need to be aware of technology to complete the project on time with the best cost.

Although a proper selection of personnel will minimize the necessary training, some training for each project is required. Still, formal training in management, business and computers is increasing.

Financial

Construction contractors' success mainly depends on the specific terms and sufficient funds for achieving planned projects (Gundes et al., 2019). Therefore, the owner should ensure on-time availability of funds because the lack of finance causes many problems such as delays or material mismanagement. This model considers the financial factor as one of the main elements in material management process.

Process

Project manager transfers the inputs in a useful way into output. Communication is essential to all stages because it integrates the managerial functions, making managing material possible. Managing construction projects requires an integrated process to ensure that they are completed on time, on budget, and within the contract specifications—communication system helps link the project with its external environment.

Planning

Planning is the main element in the material management process. According to the literature, planning is a critical ingredient for a successful material management process (Kasim, 2010; Jusoh & Kasim, 2017). Planning should include consideration of all these activities, procurement (identification and determination of required materials list), material records system, delivery schedule, inventory and tracking control, number of workers, time, and cost. Project planning consists of project structuring with project scheduling and resource allocation tasks. While project scheduling aims to determine the start and finishing dates of project activities, resource allocation aims to ensure the sufficient and timely supply of

resources for project execution. Project planning comprises project structuring with project scheduling and resources allocation tasks. While the objective of project planning is to determine the start and finishing dates of project activities, resources allocation aims to ensure the sufficient and timely supply of resource for project execution (Klein 1999). In building construction companies, these resources include money, labour, equipment and construction materials and availability of labour; equipment has to be made available on time since this is the main aim of the construction project planning (Gulghane & Khandve, 2015). according to the literature and the data collection.

The construction procurement process is used to identify and select all materials for the construction project process (Curtis et al., 2009). The first step in the procurement process is the planning for purchases and acquisitions, specifically the development of procurement plans that state what to procure, when, and how (Kerzner, 2017: 842). Planning and procurement are an equally important processes that control the total project cost (Jusoh & Kasim, 2017). Procurement is the purchase of materials and services from an outside company (Kasim, 2010). People involved in procurement decision-making should formulate a systematic selection approach, which will help remove unnecessary project demands (Mathonsi & Thwala, 2012). Good public service outcomes depend on good procurement.

Designing: According to the literature and the data collection, designing usually follows the planning activity; it is important to manage all the materials from the design stage to the completion stage of the project (Jusoh & Kasim, 2017). The design falls under this category of the project procurement process (Kasim, 2010). Designing material management aims to reduce the waste of materials in the future. The planner, designer and contractor should consider designing early-stage to avoid loss of profit for construction companies (Jusoh & Kasim, 2017). In development, the country considers this activity, but the Libyan projects

still do not consider it well. Therefore, designing phase should be considered to manage the material properly.

Logistics

logistics includes all materials, tools, equipment, purchase, transportation, warehousing, loading, and unloading, transporting, packing, allocation, information processing and so on the entire process. Staff productivity enhancement, which reduces project costs and increases productivity, is one of the major factors in construction project management. If performed efficiently, logistics management is one of the major factors in increasing labour productivity (Almohsen & Ruwanpura, 2011). The construction sector should consider logistic as one of the important factors that impact the construction management process.

Material Inventory and tracking

Tracking for inventory management of material plays a definite role throughout the construction process. Poor inventory management impacts the cost of materials and project schedule; it even causes the project delays. Therefore, it is important to improve the project site the tracking for inventory materials management to reduce waste, losses and to increase business growth.

While many developing countries such as Libya still used the traditional material tracing process, a construction project needs to consider tracking inventory management concepts when improving the material management process to increase productivity and avoid project delays.

The weather should be considered in the material management process because most of the year, the weather is terribly hot in Libya and the staffs do not want to go to Libyan to work in hot weather with the traditional method. Therefore, this model will consider it when improving the material management process.

Stock and Material Waste

According to the literature review and the research finding, construction waste is a serious problem in the construction building industry. However, Libya has no system for separation, storage, collection, transportation, waste removal, or effective implementation of hazardous waste management regulations. The construction sector is one of the major contributors to environmental problems such as air pollution. Waste construction can damage humans and living animals and kill fish and plants.

The increase in construction wastes is caused by the inefficient waste management practices in construction projects. All the construction wastes produced from construction activities hurt the surrounding environment, cost, productivity, time, social and economy. From the construction industry perspective, this issue will contribute to the value reduction of construction productivity and reduce the overall projects' performance. Therefore, the construction sector should manage construction waste when improving the material management process. Education and awareness regarding waste management at the site will lead construction stakeholders to implement effective practices in reducing generated wastes. The use of improper equipment in handling material causes damage and loss to the construction materials, subsequently contributing to waste generation at the site. This issue normally occurs during the delivery process, where the wrong equipment is used to bring down construction material (Phani & Methew, 2019).

On the other hand, stock control is a technique applied to cover all available items when required. Stock control can include raw materials, processed materials, assembly components, consumable stores, general stores, maintenance materials and spares, work in progress and finished products. The bulk of construction materials delivery must require proper stock control management (Kasim, 2011).

Labour effectiveness

Labour efficiency is the basis of most tender estimates and the means by which performance is measured and monitored. Various factors can be addressed to improve labour effectiveness, such as motivation, health and safety, and physical limitations. Construction is one of the major dangerous sectors (Dozzi & Abou Rizk, 1993). Physical injuries and illnesses always cause a reduction in craft productivity. Therefore, they should be considered when improving the material management process. Productivity improvement in construction is best understood when constructing the process is visualized as a complete system. Productivity improvement in construction is best understood when construction the process is visualised as a complete system (Van Tam et al., 2018).

According to the literature, the health and safety aspect is an important factor necessary to be assessed in the contractor's selection process to enhance knowledge and awareness of the labour particular casual staff. This challenge needs to pay more attention to sustained improvement in health and safety by staff induction, training, or workshop. Health and safety depend on the country's labour policy; there may be some rules regarding the safety and health of the employees. These rules and controls over organizations against employees may include compulsory workman compensation schemes where all organizations must ensure employees at work.

Cooperation between project members

There is no model in the construction material management literature that highlights the importance of cooperation between internal stakeholders. Establishing collaboration and coordination between construction stakeholders is essential for creating a successful material management process. It should be considered the first step for improving the material management process. All construction project stakeholders should be involved in it because

they are part of this process; project manager and contractors cannot achieve their aim without cooperation between all members. Effective internal communication between all members will help them avoid many challenges and understand the development process. It is essential to identify goals, resources, and opportunities to encourage employees, managers and planners across the Libyan construction sectors to share ideas before making decisions or designing a strategy and learn from each other the process of implementing the development strategy. This also helps them to identify major issues that influence the development process. Feedback is the final communication process component, meaning that the material management process has been completed and understood. Developing a material management process requires marketing research to enhance customer services and improve material project attributes. Feedback helps the Libyan construction authorities to explore misunderstanding between all stakeholders.

Outputs

Outputs are the decisions and actions of the construction stakeholders. They produce effects and consequences directly related to the systems attitude and behaviour. The output is a production made by the construction authorities. Outputs include products, profits and behaviour. In this model, the output is material management information and recommendation. Feedback must be considered by the construction Libyan authority to improve the material management process. (see figure 7.1)

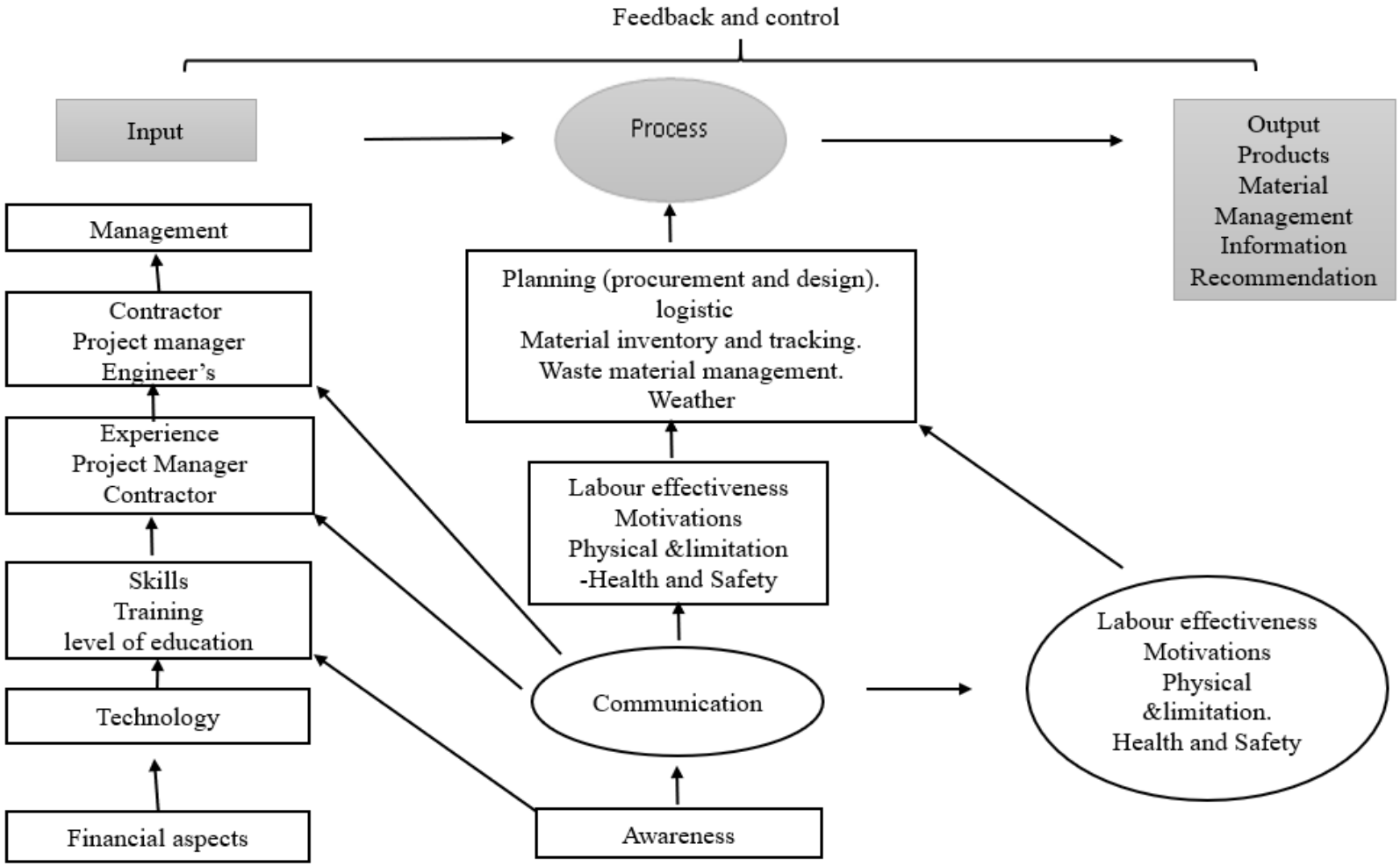

Figure: (7.1): A proposed model for developing material management on Libyan construction sites. Source: Author

7.3.1 Control and monitor framework

General contractor:

Toole, (2002) remarked that the general contractor is in charge of controlling the framework and the extent of the subcontractors' control over job site conditions like temporary utilities, layout and housekeeping; however, the general contractor role is vital because s/he works mostly while the other subcontractors are also on the job site. The leverage of site control for general contractors is very powerful due to the fact that they are openly responsible for coordinating and monitoring the subcontractor's work.

Architects and engineers:

Architects and engineers can exercise control over the job site; however, they do not have the required authority based on the expertise, the distinctive general conditions, and the constant site attendance to control the site. They hardly ever become part of the decision making that includes scheduling the trades, site layout, or housekeeping. Nonetheless, Gambatese (2000) pointed out that architects and engineers can play key role in decision making considerably impacting what must be realized on-site.

Own level of site control:

The owners' level of site control relies on the owner type. Unfortunately, most owners do not possess the knowledge and the qualified staff to exercise any control over the job site. Some expert owners have their own operational or sanitary procedures, resulting in the fact that trained in-house construction representatives often get involved in matters related to site control.

As Construction Excellent (2004) puts it, the general contractor/subcontractors, engineers, designers, and owners are components of the supply chain management that intends to improve materials management on construction site.

7.4. Summary

This chapter discussed and analysed the findings and results of Chapters Five and Six, linking them to the literature review. It presented the activities related to the material management process such as planning, procurement, logistics, waste material management, material inventory and tracking, health and safety, contractor experience, staff, skills. Also, factors such as technology and training were highlighted. Finally, the proposed model for improving Libya material management process was considered.

CHAPTER EIGHT: CONCLUSIONS AND RECOMMENDATIONS

8.1. Introduction

This chapter discusses the research conclusions and presents the research contribution with recommendations to Libyan construction authorities and other countries. It acknowledges the limitations and makes suggestions for further study.

8.2 Research findings with relation to the research objectives

The research aimed to achieve three objectives and to answer three questions. This section summaries how these questions have been answered and the research objectives achieved. The research questions objectives are as follows:

Q1- What are the professional's stakeholders' perceptions (contractors, consultants and project managers) regarding the material management process activities?

Objective 1- To identify the perception of professional's stakeholders (contractors, consultants and project managers) currently involved in the material management process.

This objective was addressed through the interviews with the Libyan construction authorities to identify their perceptions, as they are responsible for developing material management process. The objective was achieved, as described in Chapter Six.

The study revealed that the procurement process is conducted in the company's purchasing department; the purchasing department and the contractor are responsible for the procurement process. The procurement often starts with the first actions planning. The planning is the first step in managing the building materials. The planning material team with the project

management team are responsible for this stage. However, Libyan public companies buy a large quantity of material that does not meet much of their needs.

Design is one of the most important stages; unfortunately, the Libyan construction company lacks the design team experience because of poor communication between the design team and the contractor. Libyan construction companies have no policy for managing the building material; some engineers develop a system to manage and organise their work in the firm for ordering and moving materials.

The management of waste material in the Libyan company is absent; the Libyan company lacks a waste management policy. Libya construction has no recycling method for waste recycling, and there is no direction from the management site. Libyan construction stakeholders lack knowledge about recycling material which may impact the environment.

The project managers do not consider the logistic function. Logistics management was inefficient in the Libyan construction project. Failure to do so creates many problems such as materials unavailability, equipment schedule disturbance, and disorganized sites that may contribute to productivity loss.

The storekeeper and the warehouse manager manage the inventory and storage activities. Manual practices are currently used in Libya building construction for the recorded process, tracking and checking materials delivery and stock inventory. Technology is not used to aid the handling of materials. This causes many problems, such as inaccurate information or inability to record information. However, Libyan construction stakeholders lack awareness and knowledge about the role of technology to tackle many problems.

Q2- What are the techniques used by practitioners to determine the significant construction functions that can be used to improve the material management process?

Objective 2- To evaluate the current situation to determine the functions that can be used to improve the material management process

This objective was achieved as described in Chapters Five and Six through the survey and interviews with the Libyan construction stakeholders from different levels, positions and experience backgrounds to identify their perceptions.

Empirical findings showed that the contractor experience is considered based on the data analysis because it impacts the process, procedure and the project achievement time and recognises its strengths and weaknesses from the technical and management capability's viewpoint. The contractor is responsible for executing the construction work activities and completing the project. The contractors and project managers are responsible for all the activities such as planning, design, waste management, inventory, logistic, etc. The contractor was also the most responsible party for the delays, time, and cost in the Libyan construction projects.

The questionnaire survey data analysis exhibits that the consultants, suppliers, general labourers, owners, and designers have impacted construction material management; Construction project management includes complicated functions. Therefore, it requires strong communication skills, solving problem techniques, deep awareness and knowledge of the building process. According to the Libyan construction regulations, subcontractors and all workers work under a contractor, and the contractor is responsible for their health and safety.

The results show that the project manager is the most important figure in the construction project success because he can lead the project in the right direction, and he is involved in all the material management functions. Therefore, the participants agree that he should be experienced when project managers are selected.

For material management as a performance measure, Libyan construction stakeholders use some techniques to compare the planned and the actual delivery time for evaluating the delivery material process, comparing the planned material delivery schedule with the updated actual one. Also, they made a comparison between an internal and external material requests to determine the material withdraw request lead time. The warehouse used the report as a part of the control quality insurance through recognising the rejection of nonconforming items prior and after shipment.

The findings show that planning and scheduling, procuring management, stores, material delivery, quality control, handling, managing, wastage, and logistic are the most important activities in the material management process; however, design activity is not paid due attention according to the Libyan construction stakeholders' perspectives.

Q (3): What factors currently influence the Libyan construction projects' material management process?

Objective (3): To determine the factors currently influence the Libyan construction projects' material management process

The results show that one of the major impacts is the poor experience of the contractors and project managers which impacts the completion of work on time.

However, due to a lack of proper planning and experience, there are common problems that impact the material management, such as not receiving material at the time required or receiving the wrong quantity of the material ordered mostly on the construction site; a large quantity of material that is not needed is received causing inventory and damage; damaged materials such as broken bulk might be received. Such problems cause huge losses to the construction public sector.

Lack of coordination and unclear internal communication among stakeholders such as management and projects influence the material planning, design phases and development. Development and improvement of managing waste material need more sharing of information among stakeholders to achieve the desired aims. Therefore, improving the material management process in Libya needs more efforts from the contractors and the project managers.

The literature review states that climate can impact the outdoor activities of the construction material management process (Rashid, 2015). The weather is another factor that impacts the material management process because it influences the workers' productivity; the hot dry weather for most times of the year in Libya is due to the fact that the majority of the areas is a desert.

Lack of technology and training in the Libyan construction projects; the manual method is used throughout all material management process, which causes many problems such as losses and delays in completing the project as specified. Most of the employees need training to use ICT in their job; the Libyan construction authority conceded that it needs ICT to achieve the project aim on time, but they have no plan to apply it soon.

Political situation: the findings affirm that the Libya's political situation impacts the construction company performance. The majority of the Libyan Construction Company is pending; funding has stopped since February 2011 due to the lockdown, which causes many companies to lose hundreds of thousands of dollars in damaged and stolen property. The instability of the political situation is a major factor that affected the organisation's regulatory guidelines; any change in the government impacts the strategy work. Therefore, the policy should take care of the contractors and clients because the government is the key to the success of the construction sector.

8.3. Contribution to Knowledge

This study contributes to knowledge by understanding the process of material management of construction projects. It relates to Libya as a developing country, adding to the existing literature on material management process research in a construction project. Moreover, little work has been carried out in the Middle East on material management; hence this study may be regarded as a pioneer in the Libya construction context. The findings of this study have good theoretical implications for future studies because they provide a base for further research to build new frameworks, helping researchers to understand the process of improving the material management process. The study reviews and critically discusses the concept of material management, activities of material management in detail, and challenges; besides, the influence of material management and the responsibilities of the staff members in the construction process. It reviews the different components of the proposed model to clarify the material management process.

This present study further adds to the existing theory by developing a suitable model for improving the material management process based on the perceptions of construction stakeholders, adding all the important elements in addition to the skills and experience of contractor and project managers. The findings suggest that it is beneficial to the project managers and contractors with respect to improving their work since it explains the material management process.

The literature reviews different studies on material management conducted by Abdul-Rahman et al., (2006); Madhavi et al. (2008); Kassim, (2010); Ghulam and Kassim (2012); Ayegba, (2013); Hannure and Kulkarni (2014); Safa, 2014; Amar et al., (2015); each study considered the topic from a different angle, and none explained the process of material management comprehensively. This study contributes to knowledge by illustrating the process of material management of construction project. It considers practitioners involved in

the current situation related to material management in the Libya Construction Company to perceive their perceptions. It also defines the input attributes offered by providers and highlights the importance of understanding other aspects of material management, such as skills, experience, staff training. The findings also demonstrate the Libya's failure to choose a project manager or contractor who has experience and skills.

Another significant contribution of this study is that it highlights the importance of communication among the team members, one of the leading components in developing material management. This study suggests that the contractor and project manager should focus on cooperation and collaboration among the project team members to create mutual awareness and to help the staff understand the construction project process.

Additionally, it provides information that can inform the type of adjustments that need to be incorporated into the Libyan construction to mitigate mistakes impacts before they become consequences. Although this research is undertaken in Libya, the results can be generalised to other countries with slight modifications and with similar construction characteristics.

This study presents a proposed model to ensure that the entire material management activities are included. The model is straightforward and practical; therefore, it is appropriate for developing Libya ‘construction material management. This model can be used for any project, by any company, or country that needs to improve its material management processes. The proposed model will help the Libyan construction practitioners develop their project material process, and it may help them change their strategy and improve their work.

This study is a useful resource for academic researchers and students interested in understanding the process of improving construction material management. It contributes to knowledge by providing a significant database for other researchers in this area, helping them to understand the factors that would impact the material management process.

It makes another practical contribution by using a mixed-method approach to help Libyan construction authorities address the issues facing their construction sector, particularly the negative factors.

8.4. Recommendations

This study endeavours to improve the material management process by minimising cost and time overruns in construction projects. The proposed model has proved to be a successful aid for researchers. There are several recommendations for further research derived from this study, which can include the following:

- In future studies, the different knowledge and experience of construction people should be considered in the data analysis so that to be clear and more beneficially.
- Further studies could focus on areas related to the success or failure of the contractor selection.
- The Libyan construction authority should make efforts to promote technology use in their work, to reduce time and cost. Training and educational courses can be implemented to include all the construction staff. Increasing awareness can help the sector to avoid any delay and to achieve the project aim.
- Developing the construction material management process is not an easy task. Therefore, active collaboration and cooperation among all construction project stakeholders need to be undertaken to define issues and to implement strategies and plans. The cooperation will help them to succeed in the process of improving their work, overcoming many challenges.
- The study recommends that the Libyan authority discusses and deals construction material issues. Libya should focus on improving the infrastructure in the regions where this is necessary so that materials transportation be easy and low cost.

- This study focused on improving materials management on Libyan construction sites. Therefore, the researcher recommended that comparison with develop countries such as the UK in future studies.

8.5. Research limitations and further study

The current study has some limitations, which present an opportunity for further research.

- Researching a construction company is not an easy task, especially in Libya; the complex political situation in Libya makes the process of collecting data difficult. This limitation may provide the opportunity for a further study, using the qualitative method. Focus groups would help the researcher explore more information about participants 'perceptions, allowing them to talk rather than to merely complete a survey questionnaire.
- The lack of previous studies and data relevant to the material management process was one of the most limitations of this research; however, the available information is minimal; this limitation is addressed by the researcher collecting almost all data personally.
- Another limitation is related to the time constraints; this study does not make any comparison between Libya and other developing countries such as Egypt or Tunisia. This limitation may be addressed by further studies in the future.
- This study used a mixed method (survey and interviews). Still, it did not cover all

regions in Libya. This study survey covers the east and west parts of Libya, which are active areas of the country in terms of the construction projects, but they do not cover Libya's south due to Libya's political situation during data collection. This limitation can be addressed by a similar study and questionnaire covering all Libya's regions to improve the information collected and to make the model more efficient.

8.6. Summary

This chapter concludes the thesis; the main findings of the study were presented. The thesis covered the literature review, research methodology and the analysis of the questionnaire and interviews data. The findings were discussed in detail and were linked to the literature review, forming the basis for the framework development; the summary of the conclusions realizes the research objectives, and sheds light on the research contribution to the theory and practice of material management. Recommendations for further research are given.

CHAPTER NINE: REFERENCES

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Appendix

Appendix 1): Questionnaire

Improve Materials Management on the constructions Site

*Required

A. E XPERIENCE & ROLE

1. **What is your position?** *
   Mark only one oval.
   - ◯ Contractor
   - ◯ Site supervisor
   - ◯ Supplier
   - ◯ Engineer
   - ◯ Owner
   - ◯ Surveyor
   - ◯ project manager
   - ◯ Other: _____

2. **How many years' experience do you have in the construction industry?** *
   Mark only one oval.
   - ◯ 1-5 Years
   - ◯ 6-10 Years
   - ◯ 11-15 Years
   - ◯ 16-20 Years
   - ◯ Over 20 Years

Construction Materials Management (MM)

Factors that Affects the Operation of Construction on Site.

3. **Which of the following factors do you think are associated with materials management? (Please, tick as many as apply)** *

Tick all that apply.

- [ ] Which is related to the contractors
- [ ] Which is related to consultants
- [ ] Which is related to materials
- [ ] Which is related to the designers
- [ ] Which is related to general labour
- [ ] Which is related to surveyors
- [ ] Which is related to Suppliers
- [ ] Which is related to the owner
- [ ] Which is related to environment and political issues
- [ ] Which is related to using Technology
- [ ] Which is related to the knowledge and skills of the sites people
- [ ] Other: _____

The operation of construction on site

In this section, we would like to explore with you the images you have about the role of materials management

(A)- Please scale from 1-10 for each element which you feel are most important to obtaining to improve materials management?

4. **The purchasing of the materials.** *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

5. **Minimise the wastage of materials on site.** *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

6. **The expertise of sub-contractors.** *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

7. **Improve the activity between the owner and the contractor team on the site.**
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

8. **Reduce the real cost of the project.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

9. **Minimise the wastage of materials on the site.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

10. **Improve procured management.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not Important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

11. **Ensuring labour availability** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

12. **Improvement in the process of material handling** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

13. **Ensuring materials are provided on the construction site.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not important	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

(B)- Please scale from 1-10 for each element which you feel are most affects materials management?

14. **Improved productivity on the part of the available labour forces.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not affect	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely affect

15. **Minimise the shortage of material on site.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not affect	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely affect

16. **The better capability of quality control** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not affect	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely affect

17. **Materials delivery.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not affect	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely affect

18. **Poor stores** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not affect	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely affect

19. **Improper project planning and scheduling.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not affect	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely affect

20. **Poor site management and supervision.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not affect	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely affect

21. **Inappropriate construction methods.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not affect	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely affect

22. **Poor contractor experience.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not affect	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely affect

23. **Changes in materials prices.** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Not affect	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	Extremely important

24. **Are there other important factors?**

USE OF ICT IN MATERIALS MANAGEMENT

25. **Do you use emerging technologies (such as wireless technologies bar-coding, radio frequency identification (RFID). Tagging technologies, etc.) in your materials management?** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Low use	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	High Use

26. **Does the current ICT tools support the tracking of materials on site?** *
Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Low	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	High

27. **Effect of using old technology.** *

Mark only one oval.

	1	2	3	4	5	6	7	8	9	10	
Low	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	High

28. **Do you have other information that benefits the site staff?**

Thank you for your participation. If you want a copy of the results, please leave your personal data. If you have any questions, you can contact the researcher at the attached email.

29. **Name and email**

Appendix 2: Interview questions

Improve Materials Management on Libyan Construction Sites.
تحسين إدارة المواد في مواقع البناء الليبية
''Interview''

PART 1

RESPONDING DETAILS

Name	
Position	
Year experience	
Company name	
Contact number	
Email address	
Date of Interview	

PART 2

A. E XPERIENCE & ROLE الخبرة والدور في العمل

1. What are your functions and responsibilities on this project?
ما هي مهامك ومسؤولياتك في هذا المشروع؟

2. How long have you been involved in managing materials on construction sites?
منذ متي وانت تشارك في إدارة المواد في مواقع البناء؟

B. MATERIALS MANAGEMENT PROCESSES عمليات إدارة المواد

I. Do you have a specific department (procurement division or others) for managing materials on your projects? هل لديكم قسم متخصص لادارة المواد بمشروعك؟

2. Do you have a specific materials procurement system (e.g. such as purchasing procedures, delivery procedures, follow-up procedures, etc.)?
هل لديكم نظام شراء محدد يتضمن كيفية الشراء والمتابعة والتسليم؟

3. Do you have a specific approach to materials management (e.g. such as recording System, target inventory level, materials tracking, delivery frequency, access& routing, etc.)?
هل لديك نهج معين لادارة المواد (علي سبيل المثال التسجيل وتتبع المواد ... الخ)

4. How do you manage material handling in terms of transportation and materials tracking on site?
كيف تستخدم المواد في الموقع من حيث النقل والتتبع؟

5. How do you undertake inventory management (in terms of storage and site space)?كيف تدير المخازن في الموقع؟

6. How do you manage logistics (movement or routing) of materials during site Activities?كيف تقوم بالخدمات اللوجستية كالحركة والتوجيه في الموقع اثناء ساعات العمل؟

7- How do you manage waste materials on site? كيف تقوم بإدارة النفايات في الموقع؟

C. Materials management problems مشاكل إدارة المواد

I. What problems do you have in materials management?ما هي المشاكل لديكم في إدارة المواد؟

2. How do you address these problems? (E.g. using previous experience, consulting, colleagues or seniors, refer to an expert, specific tools and techniques, etc.) كيف تعالج هذه المشاكل على سبيل المثال هل تستخدم الخبرة السابقة، المستشارين، الزملاء، كبار السن، أدوات وتقنيات محددة؟

3. How can improve your materials management processes in the future? كيف يمكن تحسين عملية إدارة المواد الخاصة بكم في المستقبل؟

D. USE OF ICT IN MATERIALS MANAGEMENT. استخدام تكنولوجيا المعلومات والاتصالات في إدارة المواد

1. What technologies do you use to facilitate materials management in your sites? ما التقنيات التي تستخدمها لتسهيل إدارة المواد في مواقعك؟

2. Do you use emerging technologies (such as wireless technologies bar-coding, radio frequency identification (RFID). Tagging technologies, etc.) in your materials management? (I f NO, answer Q 3 and If YES, answer Q 4, Q5, Q6, Q7.

هل تستخدم تقنيات ناشئة مثل اللاسلكي او الراديو او وضع علامات في إدارة المواد الخاصة بك, اذا كان الجواب لا اجب عن السؤال رقم 3, واذا كان الجواب نعم اجب الأسئلة 4,5,6,7.

IF NO:

3. What factors hinder the introduction of such ICT in materials management processes in your organisation? ما العوامل التي تعيق إدخال مثل هذه تكنولوجيا المعلومات والاتصالات في عمليات إدارة المواد في مؤسستك؟

IF YES:

4. What benefit has your organisation experienced from the implementation of such ICT tools? ما هي المنافع التي اكتسبتها مؤسستك من استخدام أدوات تكنولوجيا المعلومات والاتصالات؟

5. How can such ICT tools be used to support current materials management practices on large and complex construction projects?
كيف يمكن استخدام أدوات تكنولوجيا المعلومات والاتصالات هذه لدعم ممارسات إدارة المواد الحالية في مشاريع البناء الكبيرة والمعقدة؟

6. How could the use of emerging technologies improve on-site logistics and tracking of materials? كيف يمكن استخدام التقنيات اللوجستية لتتبع المواد داخل الموقع؟

7. What are the implications for construction workers in the adoption of these emerging technologies? (E.g. such as upskilling. training, organisational/ human factors, etc.)
ما هي الاثار المترتبة على عمال البناء في تبني هذه التقنيات مثل التدريب المتقدم والعوامل التنظيمية والبشرية؟

E. THE FUTURE OF MATERIALS MANAGEMENT

1. What are the key ingredients in a successful materials management system?
ما هي أسس إدارة المواد الناجحة؟

2. What tools/techniques do you wish you had to improve your materials management practices? ماهي الأدوات والتقنيات التي ترغب في تطبيقها لتحسين إدارة المواد؟

3. Who is in the best position to manage the use of emerging ICT in Materials Management? ما هو افضل وضع لاستخدام تكنولوجيا المعلومات والاتصالات في إدارة المواد؟

4. Which of the emerging ICT tools (such as wireless technologies, bar-coding, RFID, etc.) has the most potential to improve your materials management practices?

أي من أدوات تكنولوجيا المعلومات والاتصالات الناشئة (مثل التقنيات اللاسلكية ، والترميز ، والتعرف على الترددات اللاسلكية ، وما إلى ذلك) لديها القدرة على تحسين ممارسات إدارة المواد الخاصة بك؟

PART 3

A. MATE'RIALS TRACKING PRACTICES **ممارسات تتبع المواد**

1. What is your specific approach to tracking materials on site?
ما هو أسلوبك المحدد لتتبع المواد في الموقع؟

2. How do You address particular problems in managing tracking of materials on site?كيف تتعامل مع المشاكل الاستثنائية في إدارة تتبع المواد في الموقع؟

3. What methods of reporting are used for tracking of materials in inventory Management on site?ما أساليب ادراة المخزون في الموقع

4. How do you undertake problems on safety of materials at storage area?
كيف تتعامل مع المشاكل المتعلقة بسلامة المواد في منطقة التخزين؟

B. ICT IMPLEMENMATION IN TRACKING SYSTEM تنفيذ تكنولوجيا المعلومات والاتصالات في نظام التتبع

I. What technologies do you use to facilitate tracking of materials on site?
ما هي التقنيات التي تستخدمها لتسهيل تتبع المواد في الموقع؟

2. How does the current ICT tools support tracking of materials on site?
كيف تستفيد من تكنولوجيا المعلومات والاتصالات في الموقع؟

3. What are the potential impact of the emerging ICT tools (such as wireless Technologies bar coding, ...) on logistics and tracking of materials on site?
ما هو التأثير المحتمل لأدوات تكنولوجيا المعلومات والاتصالات الناشئة (مثل اللاسلكية تكنولوجيا ، ...) على الخدمات اللوجستية وتتبع المواد في الموقع؟

4. What is your comments regarding the implementation of the emerging ICT tools (such as wireless technologies, bar coding, ...) to improve materials tracking practices?
ما هي تعليقاتكم فيما يتعلق بتنفيذ أدوات تكنولوجيا المعلومات والاتصالات الناشئة (مثل التقنيات اللاسلكية ، ...) لتحسين ممارسات تتبع المواد؟

Appendix 3: Ethical Approval

PARTICIPATE CONSENT FORM

Title of Project: **The Development of a Framework to Improve Materials Management on Libyan Construction Sites**

Ref No: ……..

Name of Researcher: School of the Built Environment, University of Salford, UK

➢ I confirm that I have read and understood the information sheet for the above study and what my contribution will be.	**Yes**	**No**	
➢ I have been given the opportunity to ask questions (face to face, via telephone and e-mail)	**Yes**	**No**	
➢ I agree to employees of my company being invited to participate in an online survey.	**Yes**	**No**	**NA**
➢ I agree to forward information to my employees by email regarding completing the online survey	**Yes**	**No**	**NA**
➢ I understand that my organisation's participation is voluntary and that I can withdraw from the research at any time **without giving any reason**	**Yes**	**No**	
➢ **I agree to take part in the above study**	**Yes**	**No**	

Name of participant:

Signature:

……

Date: ……

Name of researcher taking consent: ……..

Researcher's e-mail address: ……..

If you have any concerns about this research that have not been addressed by the researcher, please contact the researcher's supervisor via the contact details below:

Supervisor's name

Supervisor's email address:

Appendix 4: Ethical Approval

University of Salford MANCHESTER

Research, Innovation and Academic Engagement Ethical Approval Panel

Research Centres Support Team
Room 827 Maxwell Building
University of Salford
M5 4WT

T +44(0)161 295 5278

www.salford.ac.uk/

6 August 2018

Naser Maauf

Dear Naser,

RE: ETHICS APPLICATION STR1718-60: The Development of a Framework to Improve Materials Management on Libyan Construction Sites.

Based on the information you provided, I am pleased to inform you that your application STR1718-60 has been approved.

Important Condition: Please be advised that the approval is conditional and is limited to the first phase of data collection and thus only covers the questionnaire survey.

If there are any changes to the project and/ or its methodology, please inform the Panel as soon as possible by contacting S&T-ResearchEthics@salford.ac.uk

Yours sincerely,

APHigham.

Dr Anthony Higham
Chair of the Science & Technology Research Ethics Panel

Appendix 5: Publications

International Postgraduate Research Conference (IPGRC 2017)

ID 064

DEVELOPMENT OF A FRAMEWORK TO IMPROVE MATERIALS MANAGEMENT ON LIBYAN CONSTRUCTION PROJECTS

N. Maauf and R. Gameson

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Abstract: Poor materials management on construction sites is one of the key factors of delay in construction projects in Libya, involving poor handling of materials and Waste Materials (WM). Further challenges to managing materials on construction sites include materials, labour, machinery and the project's environment. The aim of this research is therefore to develop a framework for materials management on Libyan construction sites. The objective of this paper is to investigate and analyse problems pertaining to inappropriate application of materials management. This paper reports on the early stages of the research, and presents a critical review of the literature on materials management in order to identify the key factors in construction projects and thereby develop a theoretical framework. The study also explores the potential role of supply chain management and lean construction methodologies in relation to materials management in recovering from delay and reducing WM. The research to date concludes that human error and unskilled labourers have an impact on the use and application of materials in construction activities and management. It also highlights the need to further investigate the most advanced solutions to the management of materials in order to solve the delay problem. The theoretical framework presented will be tested empirically, and then validated at a subsequent stage of the research.

Keywords: Construction Projects, Lean Construction, Libya, Materials Management, Supply Chain Management.

1. INTRODUCTION

Construction projects play a significant role in the Libyan economy, retaining and creating jobs and wealth for the country. They represent an important business that contributes 5.2% of the national Gross Domestic Product (GDP) ((Fathi et al. 2016; Omran, 2015). However, construction projects in Libya face several problems that prevent achievement of their goals, including materials, labour, machinery and the market. Although over the last two decades Libyan researchers have focused on the causes of delay in construction projects, they have ignored the role of materials management to overcome these problems, through coordination, planning and monitoring to control quality and optimise the use of materials. The three determinants are time, cost and quality. To ensure that materials management results in improvement of the construction project and control of the site, it should be linmked to specific roles in order to provide materials at the right time and reduce the waste of materials, for example, by the use of supply chain management and lean construction. Koskela (2000) identified that supply chain management (SCM) has four roles in construction sites in Finland: 1. feasible action to improve construction supply chains; 2. improve supply chains; 3. transfer activities from the site to the supply chain; and 4. integrate the site and the supply chain. On the other hand, James et al. (1990) identified that lean construction is a useful technology to manage and improve the construction process, and therefore deliver the needs of the customer. This study critically reviews the role of materials management on site to reduce the delay in building projects in the Libyan construction sector.

Risk Assessment of Construction Projects in Libya

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Abstract
In today's world, project risk management has always been a complicated topic, especially in the construction industry; thus managing project risks is required as compulsory for any construction project to be successful.
This study presents an analysis of Risk Assessments of Construction Projects in Libya and the significant impacts of its application on the success of a specific project's delivery. It identifies different types of project risk management processes and frameworks used by construction projects. To examine how risk and risk management process is perceived in construction projects, a case study of Libyan construction projects is chosen, and data collection methods of questionnaire survey are applied. The primary purpose of this study is to explore, describe and analyse the perceived risk management practice in Libyan construction project. Managing risks in the Libyan construction industry has been recognised as an essential project management process to achieve the project objectives regarding time, cost, and quality. The study will examine and evaluate the risk management process in Libya and fundamentally analyse the empirical findings. Finally, the study generalises, develops the project risk assessment and management from Libyan construction projects, and suggests project managers make better decisions under unsafe conditions.

Keywords
Risk management, Libya, construction industry

FACTORS AFFECTING MATERIALS MANAGEMENT ON LIBYAN CONSTRUCTION SITES

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Abstract: Materials management is crucial in construction projects. It contributes to the achievement of the project on time and, as such, affects the overall economy of any country. Inappropriate materials management results in cost and time overruns that delay the overall project. The purpose of this paper is to identify and analyse the factors affecting materials management on Libyan construction sites. A survey questionnaire was distributed to professionals on construction projects: owners, contractors, site supervisors, consultants, engineers, and suppliers. The questionnaire comprised four sections of pre-defined factors: human, management, technology, and political and civil war issues. The Statistical Package for the Social Sciences (SPSS) was employed, and the factors were analysed. The most significant factors identified affecting materials management were: the contractors' experience and skills, factors related in materials on the site (receiving, storing, handling and tracking), and site supervision. The results of this paper will provide awareness and a better understanding of factors affecting materials management on Libyan construction sites.

Keywords: materials management, construction site, contractors and technology