JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF GRADUATE STUDIES

FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING

CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

IMPACT OF POOR CONSTRUCTION MATERIAL MANAGEMENT ON BUILDING CONSTRUCTION PROJECT COST AND TIME IN JIMMA TOWN

A Thesis Submitted to the School of Graduate Studies, Jimma University, Jimma Institute of Technology (JiT), Faculty of Civil and Environmental Engineering in Partial Fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering (Construction Engineering and Management)

By

Yinchachu Mersha Tilahun

June, 2021

Jimma, Ethiopia

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Main Advisor: - Dr. Lucy Feleke

Co-Advisor: - Engr. Mamaru Dessalegn (MSc.)

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YINCHACHU MERSHA TILAHUN

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DECLARATION

I declare that this research entitled "IMPACT OF POOR CONSTRUCTION MATERIAL MANAGEMENT ON BUILDING CONSTRUCTION PROJECT COST AND TIME IN JIMMA TOWN" is my original work and has not been submitted as a requirement for the award of any degree in Jimma University or elsewhere.

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Name	Signature	Date

As research Adviser, I hereby certify that I have read and evaluated this thesis paper prepared under my guidance, by Yinchachu Mersha Tilahun entitled "IMPACT OF POOR CONSTRUCTION MATERIAL MANAGEMENT ON BUILDING CONSTRUCTION PROJECT COST AND TIME IN JIMMA TOWN" and recommend and would be accepted as a fulfilling requirement for the Degree Master of Science in Construction Engineering and Management.

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ABSTRACT

Proper construction material management is important to deliver a construction project pre-estimated project cost and time. However, construction material management is a major problem in the Ethiopian construction industry that has important implications for the efficiency of the industry due to the lack of effective management. This contributes to several negative consequences such as high project costs and delays in the progress of work at hand. Likewise, the building construction project in Jimma town reflects various problems ranging from delays in project completion time and cost overrun. Therefore, this research aimed to assess the impact of poor construction material management on building construction project cost and time in Jimma town

The population for this research was all ongoing building construction project sites in Jimma town and purposive sampling techniques were used. To achieve these research objectives questionnaire survey and interviews were used to collect relevant data from contractors, consultants and client representatives on-site. A total of 45 valid questionnaire survey was returned 31(83.78%) from contractors, 9(81.82%) from consultants and 5(62.50%) from clients. So that, based on the respondent's agreement the relative importance index (RII) value and percentage were used to rank and explain their agreement by using Microsoft excel.

Finally, the findings from the study identified that report the problems of construction material on-site(40%) and following up the prices in the market & recording the variation of prices (40%) are construction material management techniques not performed usually and recording by using informal forms on site and contractors are faced high challenges to implementing construction material management techniques in building construction projects due to fluctuation in the price of construction materials (RII 0.83), material demand fluctuation (RII 0.80), material monopoly by supply (RII 0.74), overall suspensions that can incidentally due to peace of a country or town (RII 0.72) and lack of a systematic method to record and control materials during the construction phase with the manual method being preferred in projects (RII 0.71). Also, construction material management has a high impact on building construction project cost due to materials price fluctuation(RII 0.80), delay in progress payment by owner(RII 0.78), design changes (RII 0.76), improper storing methods (RII 0.72), inadequate qualified & experienced staff (RII 0.71), Shortage of materials in the market (RII 0.71), an improper study on material availability study and its source (RII 0.71), excessive paperwork (RII 0.70), lack of communication between main office & site office(RII 0.70) and misuse of the specification (RII 0.70). Correspondingly, construction material management has a high impact on building project time due to design changes (RII 0.76), materials price fluctuation (RII 0.75), availability of specified construction materials in the market (RII 0.73), improper study on material availability study and its source (RII 0.70) and Changes of materials specification during construction (RII 0.70). On the other hand, most building construction projects exceeded up to 11% - 20% of total project cost and time due to poor Construction material management.

***Keywords**: Building construction, Impact, Material management, Project cost and Project time.*

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ACRONYMS

FIFO	First in first out
GNP	Gross national product
GRV	Goods Receiving Voucher
JIT	Jimma Institute of Technology
MDV	Material Dispatch Voucher
MOE	Minister of education
MR	Material Request
PR	Purchase Request
RFID	Radiofrequency identification
RII	Relative Importance Index
SIV	Store Issue Voucher

CHAPTER ONE

INTRODUCTION

1.1. Background

The construction industry plays an important role in the social, economic & political development of a country. However, according to a study done by Semere (2006), the Construction industry is not only one of the major sectors of an economy but it is also the largest and accounts from 12% to 25% of the GNP of both developed & developing countries. Also, this study concludes that the construction industry consumes a higher percentage of the annual budget of a country. Specifically, in our country Ethiopia, it covers 58% of the annual budget. However, the construction industry in developing countries failed to meet the expectations of governments, clients, and society as a whole (Jekale, 2004). Although in Ethiopia construction industry shares many of the problems and challenges the industry is facing other developing countries, perhaps with greater severity. Among those challenges and problems, poor resource management takes a major part. According to Balaji & Venugopal (2017) investigation, in recent days: -

- 20% of construction industries were practicing effective resource management systems along with proper planning and scheduling.
- 5%-10% of construction industries were aware of it but they are not adopting it during practice on consideration of the uncertainties.
- The remaining construction companies execute unplanned systems only with their experience or simply by directions for top-level management.

However, as many researchers study the problem and challenges in the construction industry, the Lack of proper resource management was one of the main reasons that facing Ethiopian construction projects (Yadeta, 2019). So that this improper implementation without planning and scheduling contains high-risk factors, uncertainties and construction contractors were in lack knowledge about its impact on time and cost. As a result, in this day's Construction project facing many challenges especially time overrun and uneconomic projects because of resource improper management or resource-related factors. One of the major resources used in the construction project was construction materials which are explained by Patil & Pataskar (2013). Therefore, proper construction material management is important to deliver a construction project pre-estimated time and cost of a project. Poor construction material management is one of the major problems in the Ethiopian construction industry. This problem has important implications for the efficiency of the industry due to a lack of proper management and planning

(Asmara, 2015). So that for the successful execution of construction projects within given cost, time, and quality, good handling of construction materials on construction site requires systematic planning and controlling of the construction works.

Construction material constitutes a major cost component in any construction project. The total cost of installed material maybe 50% or more of the total cost (Patil & Pataskar, 2013). Improvement in construction material management process and control on-site is resulted in saving of cost and time. As explain in Chitkara (1998), a small saving in construction materials cost, say even 5%, through efficient management of construction materials, can result in a large contribution especially, when competitive bidding is for small profit margins, varying from 3.5% to 10% of the project cost.

Therefore, construction material management is just the method by which an organization is supplied with the goods and services that it desires to achieve its objectives of buying, storage, and movement of materials. Mainly, construction material management is concerned with the planning, identification, procuring, storage, receiving, and distribution of materials. The purpose of construction material management is to assure that the right construction materials are in the right place, in the right quantities when needed. But one of the major problems in delaying construction projects is poor construction materials management. Ensuring a timely flow of construction materials is an important concern of construction material management. Management of procuring construction materials is serious as any construction materials surpluses or shortages will delay the project and put it at risk. This affects a consistent flow of construction materials for production and overall project performance. However, most construction company's focus on getting work done while ignoring the management of construction materials by construction companies. The neglecting of proper construction material management contributes to several negative consequences such as the breaking of materials satisfaction by the client and reduction in the productivity of workers, construction material wastage, high project cost and delay in the progress of work at hand, which affects the maximization of limited recourses.

The construction sector in Jimma town is also an important sector for the economy and has been a key driver of the economic growth of a town. As the industry has to deal with imported construction materials the delivery time of material, quality and cost of the construction material have high uncertainty, which directly has an impact on the project delivery.

1.2. Statement of the Problem

In our country Ethiopia project management systems are unsatisfactory (Ayalew, et al., 2016). As a result of poor management of construction material brings the occurrence of stock out, interruption of construction and wastage of material, result to delay the construction of house, unsatisfactory or annoyance of customer, in return lost some profit and goodwill in the long run. The unavailability of construction materials is not the only aspect that can cause problems. Excessive quantities of construction materials could also create serious problems for managers. The storage of construction materials can increase the costs of production and the total cost of any project. So that, the project was delayed and planed costs increased from predetermined requirements at the beginning of the project (Ayalew, et al., 2016). Also, a construction project in Jimma town reflects various problems ranging from delays in project completion time on most of the building projects execution, substandard work, disputes, cost overrun and decrease in expected project profitability as a result of construction materials shortage and wastages on sites, displacement of construction materials on sites, as well as poor accounting and security system of the concerned sites. According to Asmare (2016) investigation, the problem of construction material management in Jimma town building construction projects appears quite high.

So, construction materials were being wasted or unavailable on-site due to improper management was becoming intolerable to the contractor building projects due to its effect on profit margin and project time. Therefore, the overall intention of this study is to assess the impact of poor construction material management on building construction project cost and time in Jimma town.

1.3. Research Questions

The research is done to answer the following core research questions: -

1. What are existing construction material management techniques in the Jimma town building construction sector?
2. What are the challenges facing contractors in using construction material management systems in the Jimma town building construction sector?
3. What is the impact of factors affecting construction material management on building construction project cost and time in Jimma town?
4. To what extent poor construction material management impact building construction project cost and time in Jimma town?

1.4. Objective

1.4.1. General objective

The general objective of this study is: -

To assess the impact of poor construction material management on building construction project cost and time in Jimma town.

1.4.2. Specific objectives

The specific objectives of this study are: -

1. To assess the existing construction material management technique on building construction projects in Jimma town.
2. To assess the challenges facing contractors in the implementation of construction material management on building construction projects in Jimma town.
3. To identify the impact of factors affecting construction material management on building construction project cost and time in Jimma town.
4. To measure the impact of poor construction material management on building cost and time in Jimma town.

1.5. Significance of the study

This research focuses on the assessment of the impact of poor construction material management on building construction project cost and time. Hence, understanding these factors which affect construction material management and existing construction material management techniques is helpful for the construction professionals who work on the initial phases of construction planning to efficiently deliver the project plan.

The findings from this research will serve as a guideline to the Jimma town construction contractors to improve construction material management. The main goal of the study is to provide essential information about the impact of construction material management on the cost and time of building construction for the project contractors who enable to project's success. Also, that will minimize certain loss of profits, build a good relationship of stakeholders and project will not affect and construct building will rich for its purpose.

This research also useful to the field professionals as well as valuable for the academicians too and serve as a support of what the past researchers have written about the impact of construction material management in construction building projects.

Furthermore, it will also provide information for further researchers who are willing to investigate this particular or similar case of construction material management on building construction in other areas of Ethiopia.

1.6. Scope of the study

There is an unlimited amount of resources that are utilized within a construction project. However, this study will be limited to construction material management because construction materials constitute the largest contribution to project resources.

Because of a shortage of time and budget, this study focuses on the impact on building construction project time and cost without considering other building project constraints.

The research is concerned with building construction only and did not take into account the other categories of the construction industry like road construction and utility construction (sewage and water supply).

The research did not cover all building construction projects in Jimma town. So, only focus on the projects recently active to assess updated information on particular objectives.

The research attempts to cover all building construction projects which perform store managements on construction site. Because store management had great significance in monitoring construction material cost and time.

1.7. Limitation of the study

One of the limitations of the study was an absence of reference materials especially on topics related to the case of our country Ethiopia. Also, most of the respondents seem bored of completing the researcher's questionnaires due to a lot of researcher conducts in Jimma town. In this regard, the researcher faced a big challenge to collect adequate information for the study. Despite the above problems, the researcher has exerted extreme effort and was able to overcome this problem by holding prolonged dialogue and discussion with the respondents and giving more time to respondents to fill the questionnaires.

CHAPTER TWO

LITERATURE REVIEW

2.1. Construction Project

A guide to the PMI (2008, p-5) has defined a project as "a temporary endeavor undertaken to create a unique product, service or result. The temporary nature of projects indicates a definite beginning and end. The end is reached when the project's objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists. Temporary does not necessarily mean short. Temporarily does not generally apply to the product, service or result created by the project; most projects are undertaken to create a lasting outcome". Also Keith & James (1996) define a project as "a unique process, consisting of a set of co-ordinate and controlled activities with an assumed start and known finish dates, undertaken to achieve an objective conforming to specific requirements including constraints of time, cost and resources".

Therefore based on the above statement, a construction project is a high value, time-bound, special construction mission of creating a construction facility or service, with predetermined performance objectives defined in terms of quality specification, completion time, budgeted cost, and other specified constraints as explain in (Chitkara, 2011). The success of the construction projects is depending on the triangular relationship of project constraints. These are the cost, time, quality, and scope of the projects.

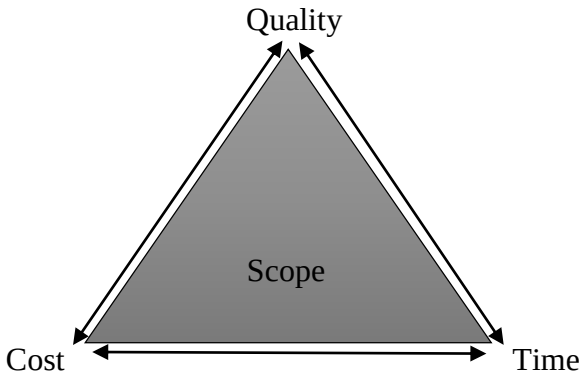

Figure 2.1: The project triangle constraints (Stojcetovic, et al., 2014).

The project constraints are interactive, that is each parameter is a function of the other. Subramani, et al. (2014) argue that the evaluation and balancing of the interrelationship among the five project constraints (cost, time, quality, scope, and resources) is a complicated process. However, in a given project, the scope and quality of work in terms of quantity and specifications are stated and these parameters are not exposed to change (unless scope changes considerably). Also, they explained these constraints are interlinked and must be kept in balance to achieve project objectives efficiently and

effectively within changing environments. For that reason, completion of a construction project with an intended budget is frequently seen as a major criterion of project success by clients, contractors, consultants, and related stakeholders according to Zewdu & Aregawu (2015).

Most construction building projects were failing to achieve their mission of creating facilities within the specified cost and time (not all) (Subramani, et al., 2014). Hardly few projects get completed on time and within budget, since construction projects are exposed to uncertain environments because of such factors as construction complexity, the presence of various interest groups such as the project owners, end-users, consultants, contractors, financiers, materials, equipment, project funding; climatic environment, the economic and political environment, and statutory regulations. As a result, there is a probability that the cost of manpower, equipment, and material increases hereafter increases the cost of a project. The source of impact on building construction project constrain comes from the project resource factors. However, in building construction projects major resources were:- Construction material, machinery or equipment and Human resource and Money (Balaji & Venugopal, 2017). But from those, a major building construction resources construction material are major constitutes in particular projects. Therefore, this research focus on this major constituent resource which is construction materials in building construction.

2.2. Construction Materials

Construction material can be defined as the physical materials that are purchased and used to produce the final product and do not suggest that materials are the final product (Hasnain, et al., 2019). Other may be defined as, materials the items that are used to produce a product and which include raw materials, parts, supplies, and equipment items (Stukhart, 1995).

Construction materials in building account for a high percentage of a project's total cost and so that requires an important and attractive resource to control mechanism (Navon & Berkovich, 2005). According to Arijeloye & Akinradewo's (2016) explanation, construction material constitutes a major cost component in any construction project. The cost of materials may be 50% to 70% of the total construction cost depending on the type of project. Another scholar Feng & Chen (2011) states that the total material cost is the cost of construction materials that accounts for 65% to 75% of the total project cost. Also, this scholar suggests for construction enterprises control construction material costs, and there are great potential savings. The construction material cost control of the Construction Company should start with the choice of construction material suppliers and the surplus of construction material consumption. Initially, construction Company’s should select suppliers which have a less freight, good

quality and low price of supply unit and establish long term relationship with such suppliers. After all, to effectively control the cost of materials, construction enterprises make checks at all levels planning, procurement, inspection, storage, recipients.

Based on the above scholars, Construction material constitutes a major cost component in any construction project. The total cost of installed material more than 60% or more of the total cost. Construction material management is a critical component of the construction industry. As such, organizations need to understand the effects of proper construction material management techniques on the effectiveness of project execution. A lot of literature and reports criticize the lack of efficiency and productivity in construction projects. Most building construction projects are entitled to time overruns, cost overruns, and claims. A properly implemented construction material management can achieve the timely flow of construction materials and equipment to the job site and thus facilitate improved work face planning, increased labor productivity, better schedules, and lower project costs (Aditya & Sabihuddin, 2015).

According to (Rani & Syammaun, 2019), based on the process the construction project construction materials can be divided into 4 categories as follows:

A. **Raw materials**: -are the materials delivered to the project location. They are still in the raw type for processing. The raw materials include stone, sand, cement, steel, and wood.
B. **Finished materials**: - are the material delivered to the project location and can be directly installed. The finished materials include tile, roof tile, glass, ceramic, and light.
C. **Fixed materials**: - are the material delivered to the project location as the fixed materials. They include ready mix concrete and hot mix asphalt.
D. **Prefabricated materials**: - These are the materials cast or installed outside the project location by the other parties. When delivering to the project location, it is only installed. The prefabricated materials include precast concrete, steel frame, door, and window sills.

So, construction Material management is activated containing planning and control related to the construction material regarded from several sectors including procurement, supply, purchase, delivery, acceptance, warehousing, and distribution. Construction material was a major project manager activity in building construction.

2.3. Construction Material Management

Many scholars give many definitions of construction material management in the construction sector. But most of them were give almost the rear to some meanings. According to Patil & Pataskar (2013) define construction material management is "the process to provide the right material at the right place at right time in the right quantity to minimize the cost of a project." Also, different researchers obtain different meanings but generally, construction material management is concerned with the planning, identification, procuring, storage, receiving, and distribution of materials. Therefore, the purpose of material management is to assure that the right materials are in the right place, in the right quantities when needed (Daniel, 2019). It is the responsibility of the department (construction material management department) for the flow of construction materials from the time construction materials are ordered, received, and stored until they are used in construction projects. Generally, the purpose of construction material management is to control the flow of materials effectively.

The availability of construction materials may greatly influence the schedule in projects with a fast track or very tight schedule. Sufficient time for obtaining the necessary construction materials must be allowed. In some cases, more expensive suppliers or shippers may be employed to save time. Construction material management is also a problem at the organization level if central purchasing and inventory control is used for standard items. In this case, the various projects undertaken by the organization would present requests to the central purchasing group. In turn, this group would maintain inventories of standard items to reduce the delay in providing material or to obtain lower costs due to bulk purchasing (Cavinato, 1994).

The role that a construction material manager plays in an organization is strictly economical since the construction material manager should keep the total cost of construction material as low as possible. The person in charge of handling construction materials should keep in mind the goals of the company and ensure that the company is not paying extra money for construction materials. The goal of every company is to make a profit. This is the basis for company survival, costs should not exceed income, but keeping in mind customer's expectations. The typical tasks associated with a construction material management system are: - procurement and purchasing, expediting, materials planning, materials handling, distribution, cost control, inventory management/receiving/warehousing and transportation as stated by koriom, et al. (2019).

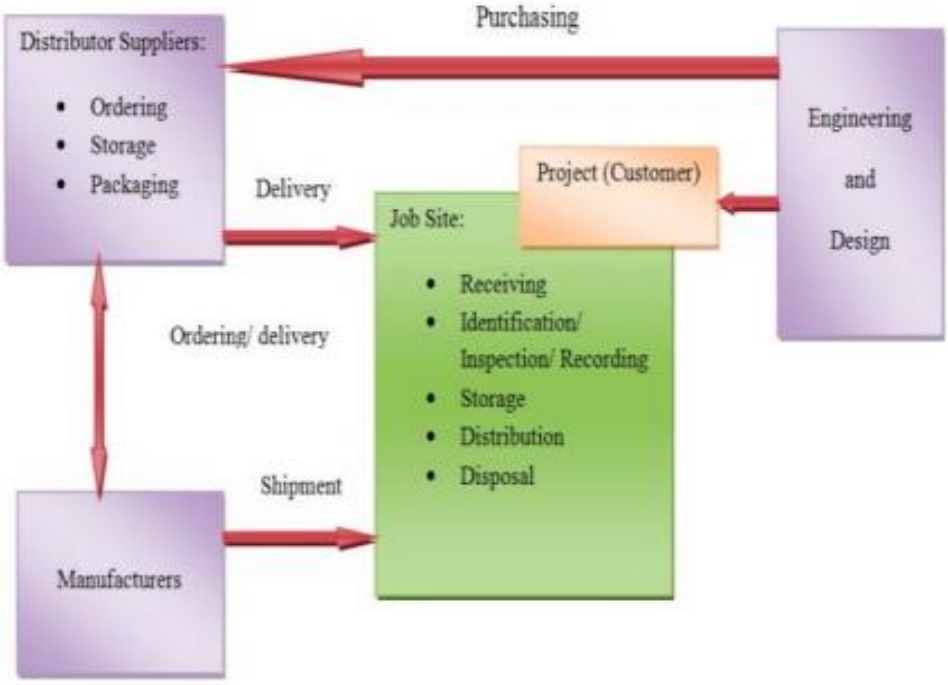

Figure 2.2: Typical construction material management in construction (Koriom, et al., 2019).

2.3.1. Construction material management processes

Construction Materials are a major expense in building construction projects. So that minimizing procurement cost improves opportunities for reducing the overall project cost such as efficient material planning, buying or purchasing, procuring and receiving, storing and inventory control, stock and waste control, supply and distribution of material, quality assurance, good supplier and customer relationship, improved departmental efficiency, reduce the cost of the project, time-saving, achieve economy in the project to fulfill all these purposes. It is necessary to establish harmony and good coordination between all the employees of the construction material management department and this department should have good coordination with the other departments of the organization to serve all production centers. However, other researchers explain construction material management process initiates from the need generated from the site then this information is conveyed to the store department and construction material is ordered in the store, the indent is generated. Vendor selection is to be carried out for the least value and best items. Construction materials are received at the store department and inspection is carried out by Kumar & Nayak (2018).

Generally, construction material management is categorized into 5 processes. These processes are majorly followed on construction sites they are namely: - Planning, Procurement, Logistics, Handling, and Waste control processes.

1. Materials planning includes quantifying, ordering, and scheduling. Companies may have two major levels in planning- micro and macro level (Patel & Vyas, 2011).
2. Procurement is described as the purchase of materials and services from outside organizations (Narimah Kasim, 2013).
3. Purchasing procedure can be described as: -

   Step 1-material indent,

   Step 2- inquiry to vendors,

   Step 3 - vendor comparison,

   Step 4 -vendor selection and negotiations,

   Step 5 - purchase order,

   Step 6 -vendor evaluation.

According to Patel & Vyas (2011) Receipt system can be divided into. Receipt from outside suppliers and Receipts from internal divisions. Also, Patel & Vyas (2011) stated that Inspection can happen in two ways. Pre-dispatch inspection and Inspection on site. Also, this study states the responsibility of the inspector to inspect all materials delivered to the site before them being used in the work. It is desirable to perform an inspection of materials or fabricated products before their delivery at the site. There are three methods of inspection: Visual, Tactile, and Statistical.

4. Logistics is a concept that emphasizes the movement of materials.
5. Materials handling encompasses virtually all aspects of all movements of raw materials, work in process, or finished goods within a construction site.

However, building a construction site required systematic construction management techniques to record and control materials during the construction stage to minimize time and cost impact on project performance.

2.4. Construction Material Management Techniques on Construction Sites

The majority of contractors monitor the construction material usage, plan and construction material purchases and forecast the materials needed on-site. Besides that, conduct onsite construction material checks and have an appropriate quality guarantee system. The common procedure used in the ordering and storage of materials is scheduling materials.

According to Kuebutornye, et al. (2018) in construction material managers on the level of practice construction material management techniques were used the following construction material techniques can reduce costs and contribute significantly to project success.

1. Planning & monitoring material schedule

In construction material management:- Providing a list of materials in the project and recording/ inventory of materials during construction, Adequate pre-construction survey on the material, Providing material cards at the site store that contain for example (input-output balance), Providing materials purchase order including for example (order number-material description- required quantity-price)and Planning the access route and site layout before delivering materials to the site activities are performed to monitoring cost and time.

2. Good contractor/supplier relations

Such as good business relationships (open and mutual trust), prompt payment to suppliers, offering a closer and long-term working relationship with suppliers and providing clear specifications to suppliers were accompanied for effective construction material management.

3. Provision of adequate security

To make safe the construction material on site: Employment of security personnel on-site, Employment of storekeeper and providing lighting systems at vintage points were employed.

4. Use of competent manpower /training

Like Skilled and experienced workers and Training of workers.

5. Use of ICT

Using basic technology like mobile telephony or laptop or internet for knowing the new materials and their prices and for tracking materials.

Also according to Al-Ostaz (2004) and Haddad (2015)conclusions, most contractors were interested in using some techniques in construction material management on site such as:- providing a list of materials, includes for example (material name- material number- unit- price), daily recording of used materials, the record illustrates for example (material name- material number- unit- used quantity- the item in which the material is used), providing a store card for each material, it contains for example (input-output- balance), providing materials purchase order form, it includes for example (order number- material description- required quantity- price), recording the received materials on site, the record shows for example (delivery number- material name- material description- quantity), reporting the situation of materials in the store, the report illustrates for example (supplier name- order number- quantity input- quantity output- balance), reporting the problems, for example (wastage and breakage, theft and loss, shortage in deliveries, etc.) and following up the prices in the market and recording the variation of prices are performed to monitoring project cost and time on site.

As well as, the contractor needs to anticipate possible problems and provide possible solutions so that the project would not be affected in the case that problems arise. But they are many challenges facing building construction contractor's encounter to construction material management.

2.5. Challenges in Implementation of Construction Material Management

According to (Mehr & Omran, 2013) explanation, an effective construction material management process is a key to the accomplishment of a construction project in the best way. Currently, successful management of construction materials has to be based on thorough and updated information and procedure of using well-designed construction material management software. There are many challenges during material management. These challenges are divided into three categories: -

Challenges related to information technology: The success of material management highly depends on accurate and correct generation and convey of information. In this case, computerize and network information offer fast, accurate, and maintenance of information. In a large company, a person who is in charge of material purchasing needs to ensure an accurate quantity of construction material is ordered while make ensure which construction materials are needed, where and when the supplier must deliver them. During the construction and post-construction, one of the most challenges is tracking of materials. Automated systems like bar codes, radio frequency identification (RFID) technology, information, and Communication Technology (ICT), improve tracking and inventory control and loss and misplacement of materials.

Challenges related to decision modeling: It is the role of the contractor to decide on qualified suppliers who can meet the construction materials requirements effectively. During the procurement phase, it is necessary to decide how much construction materials are required, and when construction materials should be delivered to the site. It is important to make sure the number of construction materials which is required is available and there is no shortage.

Challenges related to implementation management: Change in setting up, process, and methods, using new information technology where decision models are in use have been identified as stressful for organizations that follow improvements. In this situation, better material management practice and decision-making models increase the efficiency and effectiveness of the process and reduce the overall cost. Also, this study (Mehr & Omran, 2013) analysis detaining the following Challenges in construction material during construction are:

Lack of user-friendly construction materials software packages and lack of capable personnel in using computer-based materials management systems are considered the main difficulty in using a computer in construction materials management.

Manual materials management and supervise processes are inadequate as they are labor concentrated, imprecise, and fault-prone.

Insufficient and poor production of raw material by the country: the reason for the shortage of material during construction included the incomplete supply of material coupled with a general shortage in the industry, poor communication between the site and head office, poor purchasing planning, and material management.

Cost of materials: the price of material highly depends on supply and demand and is affected by many other things such as quality, quantity, time, and place. It also depends on currency exchange, low or high demand, material specification, inflation, and availability of new materials and

Fluctuation in the price of materials.

However poor construction material management of interrupts the whole construction project in terms of time, cost, value and output. These are due to different factors affecting construction material management in construction projects.

2.6. Factors Affecting Construction Material Management in Construction Industry

According to (Vipin & Shabeen, 2019) study, the factors affecting material management under the category of material planning, vendor analysis, material purchasing, storage and inventory and supply distribution and on-site were identified and categorized into a group in the following table.

Table 2.1:The factors affecting construction material management (Vipin & Shabeen, 2019).

Stages	**Construction material management factors**
Material Planning	Poorly defined roles and responsibilities
	Storing materials in faraway stores
	Poor store layout
	Forecasting materials price in the market
	Unclear and inadequate details in material specification

	Waste from the uneconomical shape of a material
	Insufficient instructions about handling materials at the site
	Locating the source of procurement
	Misunderstanding of owner's requirements by a design engineer
	Impossibility to order small quantities
	Severe weather conditions
	Poor use of advanced software
Vendor Analysis	Poor coordination and communication among the contractor and material supplier
	Rework due to poor material quality used before
	Timeliness of delivery
	The financial condition of the company
	Time-lapse in testing and inspection
	Manufacturing defects on materials
	Competitiveness of price
Storage and Inventory	Local issues causing material delays and unavailability
	Lack of materials (due to closure)
	Too early receiving of material
	Usage of materials without systematic control
	Ineffective control of storage
	Too early receiving of materials
	Communication to previous stages
Material Purchasing	Availability of modern equipment & methods for handling
	Poor storage of materials
	Shortage of skilled labor for handling
	Burglary, theft, and vandalism
Supply, Distribution, and On-site	Damage of material on site
	Lack of onsite materials control.
	Existence of unnecessary materials on site
	Using excessive quantities of materials
	Use of incorrect material

Also another researcher Hasnain, et al. (2019) and Ahmad, et al. (2018) there were identified twenty factors affecting construction material management in the construction industry as follows:- The poor financial status of a company has an impact on procurement procedures and loss, How would you rank the effect of "Right construction methods & proper handling" on project cost?, Changes in Material Specifications during Construction result in project cost overrun, Improper planning, Poorly defined responsibilities and coordination of the team results in expensive procurement, Materials planning and procurement process are critical in the context of the project cost, How critically you see the company's procurement policies impact the project cost?, The prices of cement and steel increase with the increase in fuel prices in the market, Late delivery of materials affects the project budget, Improper market survey (To what level you agree that the profit is lost if the market is not surveyed properly?), Poor design/revision of design has an impact on material management, Poor estimation of materials is the main reason for the cost overrun of the projects, Poor price check from authorities, Inefficient warehouse management, Supply monopoly in the market, Procurement directly from the company, A rise in the cost of electricity has an impact on the cost of cement and steel increase, Cost overrun due to delay in time, How severely have you faced the shortage or increased cost of cement and steel due to supply and demand problems? and An increase in the cost of cement and steel is the main reason for the cost overrun of the projects are construction material management factors that have an impact on construction project delivery.

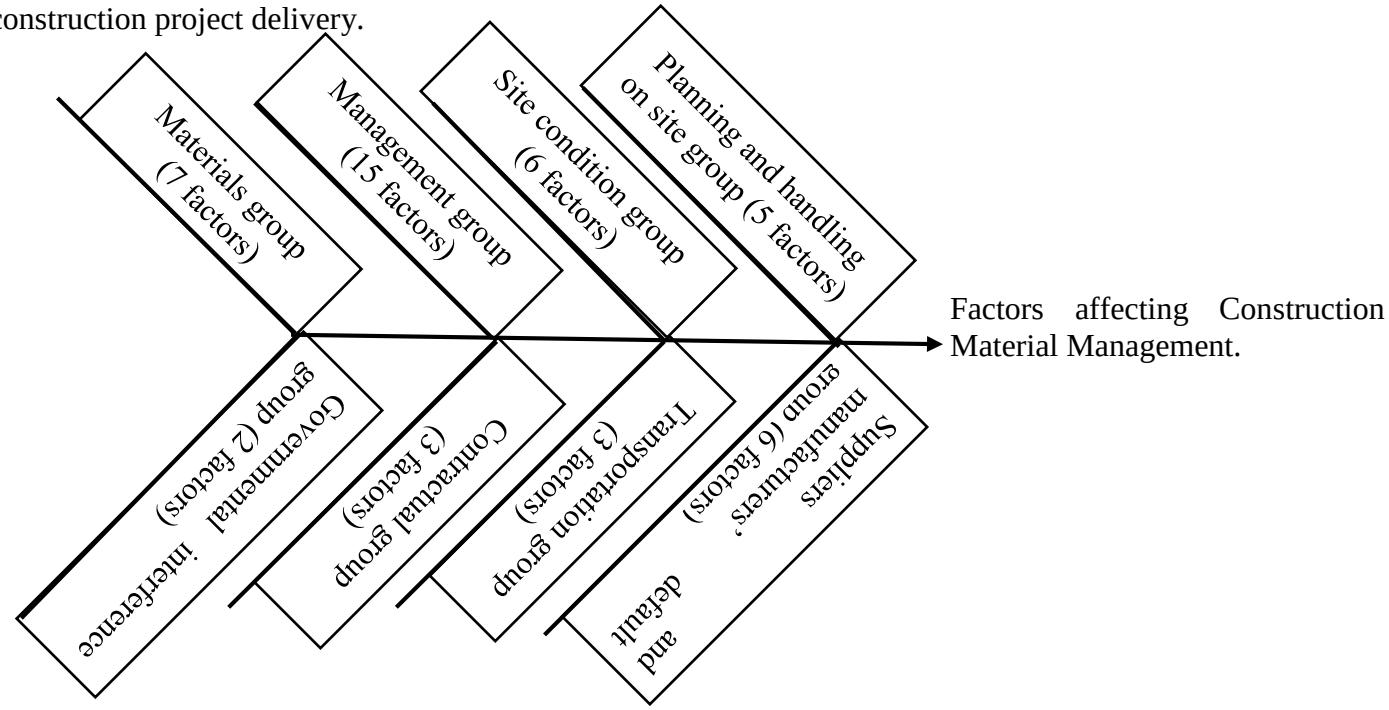

Figure 2.3: Fishbone diagram of group factors of construction material management efficiency (Jusoh & Kasim, 2017).

Generally, the factors influencing construction material management have been the subject of inquiry especially in aspects such as time overrun, cost overrun, construction wastes, and low productivity. These factors are then categorized into 8 specific groups according to their respective themes according (Jusoh & Kasim, 2017).

These are states in the following table is overall, this study has extensively identified the various factors that might affect materials management efficiency in construction projects time overrun, cost overrun, construction wastes, and low productivity in building construction projects.

Table 2.2: Factors of construction material management efficiency (Jusoh & Kasim, 2017).

Factors of Construction Material Management Efficiency			
A	**Materials group (7 factors)**	**D**	**Site condition group (6 factors)**
	Poor quality of materials		Lack of materials storage
	Materials price fluctuation		Restricted equipment movement at the site
	Damages of materials		Unsuitable site storage
	Shortage of materials in the market		Improper storing methods
	Materials supplied without pallet		Congestion of site
	Fluctuating demand for materials		Materials stored far from the working area
	Improperly marked of materials	**E**	**Suppliers and manufacturers' default group**
B	**Transportation group (3 factors)**		Delay in materials delivery by suppliers
	Poor delivery of materials to the site		Suppliers errors
	On-site transportation difficulties		Delay in manufacturing
	Damage during transportation		Lack of competent suppliers
C	**Management group (15 factors)**		Work stoppages at factories
	Unsystematic documentation		Monopoly control by a particular supplier
	Ordering errors	**F**	**Planning and handling on-site group**
	Shortage of fund		Inadequate planning
	Excessive paperwork		Poor material handling
	Delay in materials procurement		Inefficient equipment for unloading
	Communication breakdown		Lack of protection during unloading
	Poor coordination		The unsystematic flow of materials
	Taking off error	**G**	**Contractual group (3 factors)**
	Lacking in qualified staffs		Wrong materials from specification

	Inefficient communication in construction sites		Changes of materials specification during construction
	Improper material usage		Ambiguous materials specification
	Waste due to negligence	**H**	**Governmental interference group**
	Delay in forwarding information on sizes of materials to be used		Delay in custom clearance for imported materials
	Lack of supervision		Lack of policy in procuring materials
	Lack of materials control		

Also, other scholars (Jusoh, et al., 2018) examine the influential factors for effective construction material management identified influential factors and classified them into eight (8) groups. Those are: - Contractual (5 items), Governmental interference (4 items), Expediting (5 items), Transportation (5 items), Management (12 items), Purchasing (8 items), Site storage & condition (6 items) and Supplier (5 items). Although, all factors of construction material management mentioned in the above statement have an excessive impact on the building construction project constraints namely on project time and cost of building construction project depending on different researchers.

2.7. Impact of Poor Construction Material Management on Construction Project.

According to (Murali & KumarInternational, 2019) investigate the main causes of time and cost overruns in construction projects are poor construction material management and construction material management always related to time and cost. But most construction projects are affected by several factors that have a high impact on the quality, time and cost of the project due to poor construction material management. Many construction projects nowadays manage these critical resources by paper forms and human memory. Due to these construction projects are incurring unnecessary costs and time taking a risk. That is an obstacle to their ability to grow and compete in an industry (Mane, et al., 2017). However, there were a lot of factors affecting construction material management that leads to improper construction material management, which had negative effects on project time, cost, quality, productivity and waste (Jusoh & Kasim, 2017). But, in the context of this research, limited to the impact of construction material management-related factors on project time and cost.

According to Jusoh & Kasim (2017) which had investigated construction-related factors and their effects on construction projects, they identified the effect of construction material management to 5 criteria of project performance. Those are:- the availability and sufficient materials and equipment affect time, quality, productivity and performance, appropriate quality material affects time, cost and quality

performance, on-time and reasonable time of material procurement affect time and cost performance, efficient inventory systems and documentation affect time and waste performance, reasonable changes affect time performance, on-time delivery affects time performance, minimizing procurement cost affects cost performance, appropriate site storage affects productivity and waste performance, the efficient site layout affects product performance, easy site access affects product performance, unconfined working space affects productivity performance, efficient material controlling affects waste performance and appropriate handling affects waste performance are factors of construction material management effects on project performance.

Genarly Ayegba (2013) conclude that factors of effective construction material management on construction sites are: design changes, lack of proper work planning and scheduling, inefficient workforce, fraudulent practices /negligence and corrupt practices, lack of security personnel, waste on construction site and lack of or inadequate storage facility.

Another researcher Zakeri, et al. (1996) suggested that transport difficulties, waste, improper handling on-site, misuse of specification, lack of proper work plan, inappropriate materials delivery, and excessive paperwork all have an immense effect on materials management. Also, Kasim (2008) highlighted that problems could emerge due to human error, especially because some construction firms still rely on manual methods for material management which involves paper-based techniques. Besides study states that problematic use of paper-based reports for exchanging information relating to construction materials components with the supply chain can result from misunderstanding and poor coordination.

Also another research done by Gulghane & Khandve (2015) state that, problematic management of construction materials are due to overstock materials because of: Improper planning, Damaged materials due to logistics, Handling or in application, Loss of materials because of improper supervision, Waiting of the materials to arrive in location due to improper tracking system, Frequent movement of materials due to improper site layout, Inflation, Material changes in buying or purchasing situation starting from the prepared cost estimation, Bulk construction material, the shortage and changes of construction materials quantity required, Material inefficient on-site, Stealing and loss of construction material, Material shipment, work repairing, Delay in updating or posting storage system on-site, Inaccurate estimation of shipment quantity of materials, Uneconomical order quantity of materials poor shipping time, Increasing transport cost of materials, Material over usage in location of

project, Choosing the wrong materials for construction, The increasing storage cost of materials, The poor buying ability of managers and Delay of payment for materials.

On the other hand's study done by Sarowar, et al. (2018) stated that the main factors of construction material management were: -

For Large firms: Delay due to rejection of materials from quality control team, Transportation problems, Seasonal problems.

For Medium firms: Delay due to rejection of materials from quality control team, Transportation problems, Seasonal problems, Labor strikes, and Improper handling of materials are major factors.

For Small firms: Delay due to rejection of materials from quality control team, Transportation problems, Seasonal problems, Labor strikes, Communication problems, a Hike in material prices, Lack of material management, and Improper material handling.

Generally in the Ethiopian construction project, inflation or price increases in materials, lack of quality materials, late design and design documents, slow delivery of materials, and late release budget/ funds were material related factors that had a very high impact on construction project time overrun and cost overrun (Gebrehiwet & Luo, 2017).

2.7.1. Impact of poor construction material management on construction project cost.

A study was done on construction material wastage in the Netherlands that construction materials account for between 20-30% of project cost overruns (Adewuyi & Otali, 2013). Therefore, during the past years, various academics researchers were conducted studies investigating to find out the issues of construction material management-related factors and their impact on building construction cost in construction projects. Among these studies were: -

Rahman, et al. (2013) stated that construction materials are the essence in the construction industry which represents a substantial proportion of the total value of the project. Construction material related issue contributes to cost overrun. Hence, efficient construction material management is an important criterion for the success of any project. A construction material management system includes the fundamental functions required in any construction project such as identifying, acquiring, storing, distributing, and disposing of materials. A regular and adequate supply of the materials is a very critical task as late or irregular delivery or wrong types of material delivered during construction affect the utilization of other resources like manpower and machinery. This leads to poor productivity, time delay, and cost overrun.

Patil & Pataskar (2013) argue that effective construction material management in construction projects can reduce the overall cost of the material. For example, in the purchasing process, discounts and bulk orders may be economical as they reduced transportation and ordering costs (Aziz, 2013). It has been estimated that a saving of 2% material cost possibly will increase profits by 14.6% (Jusoh & Kasim, 2017). Thus, by minimizing the procurement cost of construction materials, the higher chances for reducing the overall project cost and concurrently increasing company profit. Also Rajaprabha, et al. (2016) state that, the factors that cause the cost overruns in building projects related to construction material management are classified into 8 categories based on the following issues: those are: - design-related issues, client-related issues, contractor related issues, site-related issues, labour and equipment related issues and external factors and market condition factors.

Planning and procurement are claimed as an equally important process that controls total project cost (Gulghane & Khandve, 2015). However, construction material control and expediting also important as the former process is to avoid shortage and surplus of construction materials occurred on site. While the later process ensures the material is delivered on time by suppliers (Aziz, 2013). In sum, all mentioned processes are important to reduce the escalation of construction costs.

Table 2.3: Construction material management-related factors impact on construction project cost.

No.	Construction Material management-related factors impact to project Cost	Source
1	Increase or Fluctuation of prices of materials	Husin, et al. (2017), Venkatalakshmi (2019), Rahman, et al. (2013)
2	Delay in material delivery	Husin, et al. (2017), M.S.B.A. Abd El-Karim, et al. (2015), Rahman, et al. (2013)
3	Theft of material	Husin, et al. (2017), M.S.B.A. Abd El-Karim, et al. (2015)
4	Material quality is below standard (specification)	Husin, et al. (2017), Rahman, et al. (2013)
5	The volume and type of material is not correct	Husin, et al. (2017), Rahman, et al. (2013)
6	Damage to material delivery and storage	Husin, et al. (2017), M.S.B.A. Abd El-Karim, et al. (2015), Venkatalakshmi (2019)
7	Limited material shelter or Problem in quality and storage facilities in the project site	Husin, et al. (2017), Venkatalakshmi (2019)
8	The supplier cannot fulfill material order, Planning & management of good materials, Material Handling	Husin, et al. (2017)
9	Material storage, Material procurement, Non-conforming material	M.S.B.A. Abd El-Karim, et al. (2015)

10	Material monopoly and Nominated vendor, where make an incremental of material cost in building construction projects.	M.S.B.A. Abd El-Karim, et al. (2015)
11	Shortages of materials	Rahman, et al. (2013), Venkatalakshmi (2019)
12	Changes in material Specification and type	Rahman, et al. (2013)
13	Escalation of materials like steel cement and metals	Venkatalakshmi (2019)
14	Material wastage exceeding the tolerance limit	Venkatalakshmi (2019)
15	The inadequate staff of contractor, Lack of experience of the material management team, Material Planning, Due to irregular geographical conditions, Inaccessibility to the site area during harsh weather conditions, Storage limitations	Rajole & Darade (2018)

2.7.2. Impact of poor construction material management on construction project time.

Because of the ineffective construction material management that in some cases of office building construction, causes the increasing amount of time or work delay up to 18% of the expected time (Veronika, et al., 2006).

Jusoh & Kasim (2017) as reviewing a different study on construction material management effects on project performance. Construction Project time affected due to construction material management the following: -

The insufficient stock of construction materials led to idling time as workers try not to exhaust the stockpile or it is worsened by a work stoppage. Due to this shortage, construction materials need to be reordered and causes longer idling time. Consequently, the work progress will be delayed. As a result, the availability and sufficient quantity of construction materials affect the time performance.

Construction Material inventory affects the construction time. The systematic inventory control and documentation reduce time consumption for labor to retrieve construction materials. Other effects are on-time delivery of construction material increases work progress, used appropriate quality construction material speed up finishing time, on-time material procurement reduces idling time and reasonable changes reduce an extra time for adjustment of resources. Other scholars Venkatalakshmi (2019) which investigated on construction material related factor impact on building construction time were suggested, the primary impact for the time delay is lack of material resources and on-time delivery systems in the project site. Also, other researchers put their investigation on construction material management-related factors and impact on construction time are as the following table.

Table 2.4: Construction material management-related factors impact construction project time.

No.	Construction Material management-related factors impact on project time	Source
1	Shortage of construction materials in the market	Marzouk & El-Rasas (2014), Aziz (2013), Agu & Ibe (2016), Al Maktoumi, et al. (2020)
2	Delay or slow in material delivery	Marzouk & El-Rasas (2014), Gebrehiwet & Luo(2017), Aigbavboa, et al.(2014), Agu & Ibe (2016), Aziz (2013), Al Maktoumi, et al. (2020)
3	Changes in material types and specifications during construction	Marzouk & El-Rasas (2014), Gebrehiwet & Luo(2017), Aziz (2013), Aigbavboa, et al.(2014), Agu & Ibe (2016), Al Maktoumi, et al. (2020)
4	Lack of quality materials	Gebrehiwet & Luo(2017), Aziz (2013)
5	Damage of sorted material while they are needed urgently.	Gebrehiwet & Luo(2017), Aziz (2013), Aigbavboa, et al. (2014), Agu & Ibe (2016)
6	Inflation/price increases in materials	Gebrehiwet & Luo(2017), Aziz (2013)
7	Delay in manufacturing materials	Aziz (2013), Agu & Ibe (2016)
8	Poor procurement of construction materials, Unreliable suppliers	Aziz (2013)
9	Late in ordering and procurement of materials	Aigbavboa, et al. (2014), Agu & Ibe (2016)
10.	Availability of specified construction materials in the market, Delivery of wrong materials, Fluctuation in material prices, Inappropriate storage of materials leading to damages.	Aigbavboa, et al. (2014)
11	Non-availability of materials in the market, The startup got delayed due to non-availability of specific accessories, Materials received found to be damaged, Delay in work-in-process due to non-availability of materials, Work in process materials stay for a longer time, Delay in arranging raw materials according to specification, Delay due to finishing materials scarcity	Al Maktoumi, et al. (2020)

2.8. Problems Arising Lack of Construction Material Management.

There are many factors described as the above statement in the area of building construction material management and each of those influences can make to covert problems in building construction projects. Those problems on-site arise due to factors affecting construction management are:- Receiving incorrect material type, Increase materials quantity in storage, Burglary, theft, and vandalism, Destroy material in shipping, High cost in material transportation, Unavailable required quantity, Too early receiving of materials earlier usage, Incorrect material take-off from drawing and design, Material Shortage during construction, Piling of inventory materials, Poor material selection, Project delay

because of slow delivery of materials, Suddenly alternation price of materials, Ineffective control of storage, Failure to order on time delays the projects, Delivery at the wrong time which interrupts the work schedule, Over ordering, Wrong materials or error in direction of materials requiring re-work, Double handling of materials because of the inadequate material as investigated by (Tedla & Patel, 2018) and (Donyavi & Flanagan, 2009).

So, most of the construction projects are affected by several factors that have a high impact on the efficiency of the workforce by reducing their overall productivity (Mane, et al., 2017). This affects the quality, time, and costs of the project. Therefore, construction material management problems or Poor management on building construction projects can lead to significant negative effects with cost and time overrun.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Study Area

This research was conduct on the impact of poor construction material management on building construction project cost and time. The study was conducted in Jimma town, which is found southwestern in Ethiopia located 354 km southwestern from the capital city of Ethiopia Addis Ababa. Jimma is the largest town in southwestern Oromia. It is a special zone of the Oromia region and surrounded by the Jimma zone. The geographical location of the town is approximately 7.41^{o} N latitude and 36.50^{o} E longitude. Also, the town has a temperature of 20 °C - 30 °C with an average annual rainfall of 800 mm- 2500 mm and an area has an altitude of 1718 m - 2000 m above mean sea level (Mesfun, et al., 2019).

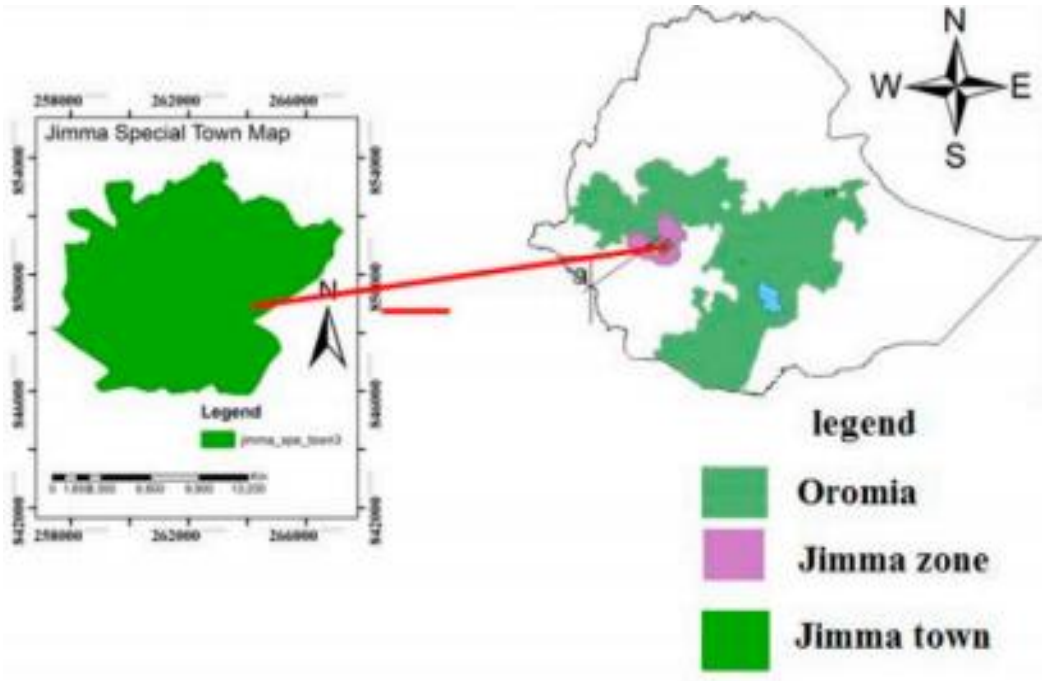

Figure 3.1: Map shows the location of the study area (Sorsa, et al., 2020).

3.2. Study Period

The study period of this research finished within 8 months, from August 1/2012 E.C. to March 30/2013 E.C.

3.3. Study Design

The research process was designed by defining the research problems, objectives, and questions. To accomplish these objectives and questions of research are made using the following methodologies.

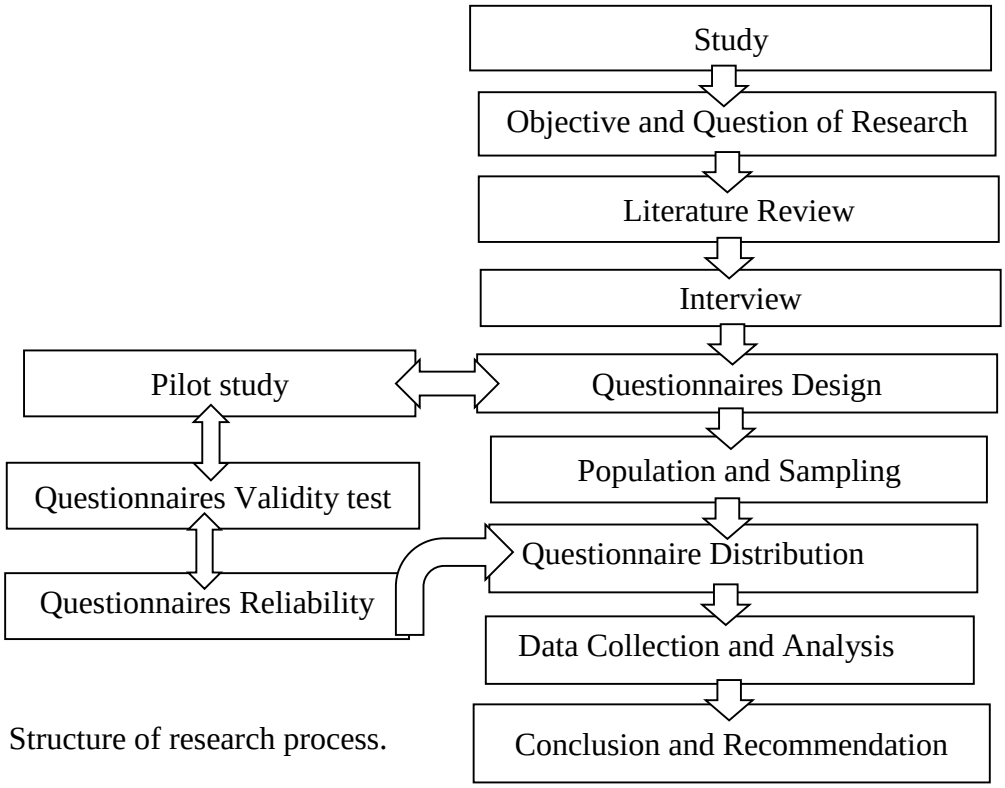

Figure 3.2: Structure of research process.

The key task in research was to design a research process that the information obtained permits the impact of poor construction material management on building construction project cost and time. This research design enabled to access the construction material management techniques, the challenges facing contractors to implement material management and the impact of poor construction material management-related factors on construction project time and cost to facilitate the suggestion of solutions. Site interviews and structured questionnaires were used in this research.

3.4. Study Variables

3.4.1. Independent variables

- Construction material management techniques.
- Challenges on construction material management techniques.
- Factors affecting construction material management.

3.4.2. Dependent variable

- Poor construction material management impact on building construction project cost and time.

3.5. Population and Sampling Method

3.5.1. Population

The populations for this research were all ongoing building construction project sites in Jimma town and the main sources of the information are contractors, consultants, and owners which were depending on their direct exposure to construction activities. Therefore, the respondents of this research were the

building construction contractors, consultants, and owners who performed in all ongoing building construction project sites in Jimma town. The data for the population was obtained from Jimma town construction office.

3.5.2. Sampling Method

This study adopted purposive sampling techniques which were used to select the respondents. Because the selected sample was aimed at the respondents who have an information-rich on the subject & to meet the objective of the study. Special in some building construction projects construction material management techniques is not implemented. The selection of respondents were all ongoing building construction project sites which were constructed by a different grade of contractors, consultants, and owners recently in Jimma town. A total of 37 questionnaires was distributed to the contractor's representative and 8 questionnaires were distributed to clients of selected projects. Also, 11 questionnaires were distributed to consultants to assess the insights of consultants. Generally, a total of 56 questionnaires were distributed for the three parties who were and are still engaged in building construction projects in Jimma town.

3.6. Source of Data

To achieve the intended objective and to answer the research questions of the study, this research used both primary and secondary data sources. The primary data for this research was provided by questionnaires and interviews and the secondary data was collected from reviewing related kinds of literature includes books, dissertations and journals of various authors.

3.7. Data Collection Procedure

After a review of relevant literature, an interview was conducted to find out other construction material management factors on-site, and finally, the questionnaire was developed. The questionnaire contains several questions to describe the characteristics of respondents and to assess existing construction material management techniques implemented in the building construction industry, challenges of construction material management systems and the impact on construction costs and time that occurred from construction material management relates.

Interviews were conducted to add more information to the data gathered by questionnaires. Five (5) building construction projects were selected randomly for the interview. The interview meeting conducted with each interviewee started by introducing of research title and explain the purpose of the research. The researcher scheduled appointments for each interview to have efficient time management for the interviewer.

3.7.1. Pilot study of questionnaire

A pilot study was conducted to evaluate the questionnaire; the researcher distributes the questionnaire to a sample arbitrarily to five contracting companies to fill them. The purpose of this step was to discover if the questions were well understood or not, also to find out any problem that may arise in filling the questionnaire. Generally, it appeared that respondents were not faced difficulty in understanding the items or the instructions to complete the questionnaire. However, they provide the researcher with some comments and suggestions which were taken into consideration while modifying the questionnaire structure.

In this research, the following problems were identified in the questionnaires: -

- There are redundant or the same concept of request to fill. Example- Shortage of qualified persons
- Other repetition of the sentence in the questionnaire.
- And there are few technical defects, such as punctuations, missing letters, etc. like- Taking off error

3.7.2. Validity of questionnaire

After preparing the questionnaire in its initial form, the Validity test in this research was conducted by taking 10 respondents and the Validity test was done by using product-moment correlation.

$$\boldsymbol{r} = \frac{\boldsymbol{n}(\sum \boldsymbol{xy}) - (\sum \boldsymbol{x} \sum \boldsymbol{Y})}{\sqrt{\{\boldsymbol{n}\sum \boldsymbol{x^2} - (\sum \boldsymbol{x})^2\}\{\boldsymbol{n}\sum \boldsymbol{y^2} - (\sum \boldsymbol{y})^2\}}} \quad \text{……Equation 1}$$

$$t_{count} = \frac{\boldsymbol{r}\sqrt{\boldsymbol{n-2}}}{\sqrt{\boldsymbol{1-r^2}}} \quad \text{…….Equation 2}$$

Where r= correlation coefficient, ∑x= number of item scores, ∑y= total score and n= number of respondents.

Validity criteria assessment criterion was: - If $t_{count} > t_{table}$, then the question item was significantly correlated to the total score (declared valid), and If $t_{count} < t_{table}$, then the question item not correlated significantly to the total score (declared invalid) (Husin, et al., 2017).

Therefore, in this research validity test was conducted distributing 12 (7 to contractors, 3 to consultants and 2 to clients) respondents. But out of 12 respondents, 10 (6 from contractors, 3 from consultants and 1 from clients) questionnaires were returned. So, the value of the t_{table} by taking 10 respondents is 0.632 by using a confident level of 95% (5% significant level). Test results for all question items indicated that $t_{count} \geq t_{table}$, so that the research instrument can be declared valid as summarized in table 3.1.

Table 3.1: Result of validity test.

Questionnaire Codes	Minimum t_{count}	t_{table}	Remarks
6 (1-12)	0.677	0.632	valid
7 A (1-8)	1.393	0.632	valid
7 B (1-6)	1.097	0.632	valid
7 C (1-12)	1.093	0.632	valid
7 D (1-7)	0.813	0.632	valid
7 E (1-6)	2.262	0.632	valid
7 F (1-4)	1.874	0.632	valid
7 G (1-5)	2.448	0.632	valid
7 H (1-3)	3.637	0.632	valid
8 A (1-9)	1.489	0.632	valid
8 B (1-5)	3.508	0.632	valid
8 C (1-14)	0.743	0.632	valid
8 D (1-8)	2.957	0.632	valid
8 E (1-6)	2.903	0.632	valid
8 F (1-4)	3.445	0.632	valid
8 G (1-5)	2.771	0.632	valid
8 H (1-3)	4.255	0.632	valid

3.7.3. Reliability of questionnaire

In this research, Chronbach's alpha was used to measure the reliability of the questionnaire between each field. The normal range of Chronbach's coefficient alpha value between 0.0 and + 1.0. The accepted reliability was when Cronbach α is greater than 0.3. If α is greater than 0.7 the collected data was considered highly reliable (Rahman, et al., 2013). The closer the Alpha is to 1, the greater the internal consistency of items in the instrument is assumed. The formula that determines alpha is fairly simple and makes use of the items (variables), k, in the scale, and the variance.

$$\boldsymbol{\alpha = \frac{k}{(k-1)}\left[1 - \frac{\delta^2 b}{\delta^2 1}\right]} \quad \text{.....Equation 3}$$

Where: - α = instrument reliability, **k**= number of questions, $\boldsymbol{\delta^2_b}$ = items variance and $\boldsymbol{\delta^2_1}$ = total variance (Husin, et al., 2017) and (Chronbach, 1951).

Chronbach's coefficient alpha was calculated for each field of the questionnaire. Also, Microsoft Excel was used to calculate (α). According to table 3.2, data from each category of the questionnaire were analyzed for its Cronbach value α value. This was used to ensure data to be collected are reliable to further analysis. As a result, the Cronbach value of the pre-survey questionnaire for each category factor was a range between 0.704- 0.953. This indicates the questionnaires are acceptable for this research.

Table 3.2: Result of reliability test.

Questionnaire Codes	C-Alpha	Remarks
6 (1-12)	0.824	Highly Reliable
7 A (1-8)	0.885	Highly Reliable
7 B (1-6)	0.804	Highly Reliable
7 C (1-12)	0.884	Highly Reliable
7 D (1-7)	0.837	Highly Reliable
7 E (1-6)	0.847	Highly Reliable
7 F (1-4)	0.704	Highly Reliable
7 G (1-5)	0.780	Highly Reliable
7 H (1-3)	0.760	Highly Reliable
8 A (1-9)	0.921	Highly Reliable
8 B (1-5)	0.914	Highly Reliable
8 C (1-14)	0.935	Highly Reliable
8 D (1-8)	0.953	Highly Reliable
8 E (1-6)	0.899	Highly Reliable
8 F (1-4)	0.846	Highly Reliable
8 G (1-5)	0.887	Highly Reliable
8 H (1-3)	0.888	Highly Reliable

3.7.4. Questionnaire distribution

After testing the validity and reliability questionnaire was distributed to building construction contractors, consultants, and owner's representative in Jimma town. This questionnaire was distributed to respective respondents with the help of assistants. The purpose of personally administering questionnaires to respondents was to establish rapport with the respondents while introducing the research, providing any clarifications required by respondents, and collecting the questionnaires soon after they were completed.

3.8. Data Measurement

This research follows a mixed-method, rating scales and ordinal scales were used. An ordinal scale is ranking or rating data that normally use integers in ascending or descending order. The numbers assigned to the important (1, 2, 3, 4, 5) do not indicate that the interval between scales was equal, nor do they indicate absolute quantities. Therefore, the respondent's answers for the structured part of the questionnaire were based on Likert's scale of five ordinal measures of agreement towards each statement (from 1 to 5). In this analysis relative importance index (RII) was used for this study and computed by using the following formula (Vipin & Shabeen, 2019).

$$\textbf{Relative Importance Index (RII)} = \frac{\sum \mathbf{W}}{\mathbf{AN}} \quad \text{..... Equation 4}$$

Where, W = is the weighting given to each factor by the respondents ranging from 1 to 5,

$\sum W = \sum [(f_1 \times n_1) + (f_2 \times n_2) + (f_3 \times n_3) + \ldots\ldots\ldots\ldots + (f_n \times n_n)]$

A =is the highest weight = 5,

N= is the total number of respondents,

f_n = score ranking and n_n = corresponding number of responses

Finally, calculated RII value categorizes into three: high, medium and low.

Table 3.3: Relative importance index (RII) value scale used to identify factor's impact.

RII value	Ranking
≥ 0.70	High
0.50 - 0.70	Average
≤ 0.50	Low

(Kassem, et al., 2020)

3.9. Data Presentation and Analysis

In this research methods of analysis used are selected due to the type of data available for the analysis and the objectives of the research. The questions in the questionnaire were both qualitative and quantitative; hence the descriptive method of analysis was best suited for the analysis. Such a method is applied for the presentation, interpretation and discussion parts on various dimensions of the appropriate to analyze, interpret, tabulate, and present the result of the study. The data gathered through questionnaires were coded, entered into a computer, analyzed and was presented in the form of figures, and tables by using Microsoft excel software. Finally, a conclusion was made based on the findings of the study and recommendations are forward based on the data analyzed.

3.10. Ethical considerations

The data collection process was conducted after getting the approval and permission letter from Jimma University, Jimma Institution of Technology postgraduate's department office for continuing the study. The research work was started after getting the willingness of the construction company.

3.11. Data Quality Assurance

With the aim of increase, the quality of the data, a researcher did the pilot study, validity, and reliability test before distributed the questionnaire to all respondents. And also, assistants were selected and trained to handle the data carefully. Finally, the collected data were also checked for reliability and accuracy.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1. General Information about Respondents

A total of 56 questionnaire surveys were distributed to 19 projects to assess the impact of poor construction material management on building construction project cost and time in Jimma town construction projects site. However, 45 questionnaires were collected and usable responses (80.36% response rate). Although 11 respondents were conducted an interview. Those were from three (3) construction professionals who were interviewed on building construction sites (7 Contractors, 2 Consultants and 2 Owners).

The questionnaire survey covers variables that contain topics such as existing construction material management techniques, the challenge facing contractors when implementing construction material management, the impact of factors affecting construction material management on building project cost and time and the impact of poor construction material management on building project cost and time. Generally, a questionnaire is arranged in a form of Likert scale items to get the feelings of respondents on a scale ranging from 1 to 5 and in the form of matching the feeling of respondents based on particular questions. Finally, the data has been analyzed by using Microsoft Excel 2016.

In this research, a total of 56 questionnaires were distributed for 8 clients, 37 contractors, and 11 consultants. These questionnaires were filled by those organization representatives in a different building construction project in Jimma town. Out of 56 questionnaires distributed on the designated samples, 45 responses were received with a return rate of 80.36% in this research. The other 8 (14.28%) questionnaires have not been received and the rest 3(5.36%) have received an incomplete questionnaire. Total questionnaire received were 31 (83.78%) from contractors, 9 (81.82%) from consultants and 5(62.5%) from client of respondents. Table 4.1 and figure 4.1 shows the general details of the respondent of a questionnaire.

Table 4.1: A response rate of a study.

Type of Organization	Number of distributed questionnaires	Number of returned questionnaires	Not been received	Received Incomplete questionnaires
Contractor	37	31	4	2
Consultant	11	9	1	1
Client	8	5	3	0
Total	56	45	8	3

Percentage	100.00%	80.36%	14.28%	5.36%

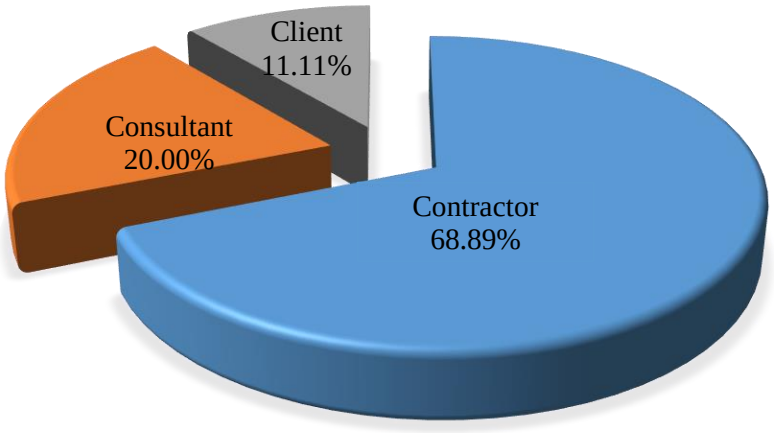

Figure 4.1: Distribution of type organization who filled the questionnaire.

The general information of respondents is based on the type of organization, sex, education qualification, and work experience. The type of sample size for the respondent organization that shows in table 4.1. The respondent of this research was composed of contractors, consultants, and clients of building construction. About 68.89% were contractors at a different level, 20% were consultants and 11.11% were clients of building construction projects. The respondents were contacted when there are participating in the building construction project site and have adequate knowledge of the issues being ascertained. This shows that the questionnaires were filled by all the above respondents in the building construction project thereby ensuring the credibility and reliability of the findings. In this study, the contractor's representatives are more than the client's and consultant's representatives. Because they are very key professionals engaged in construction material management of building construction projects in Jimma town. Also, from the total of respondents, 66.67% are male and 33.33% are female as shown in figure 4.2.

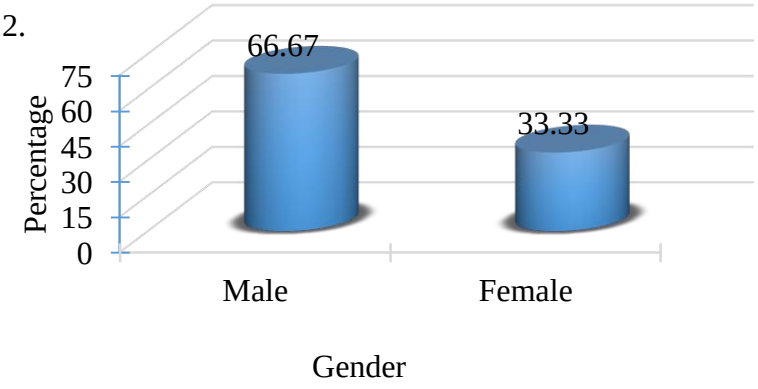

Figure 4.2: Gender of respondents.

More (64.44%) of respondents have an educational qualification of bachelor of science (BSC) and followed by master of science (MSC) holders which accounts for 31.11% and finally only 4.44% advance diploma holders as shown in figure 4.3. This indicates that the respondent has enough educational qualification to assure the questionnaire and to provide their views on the impact of construction material management on building construction project time and cost.

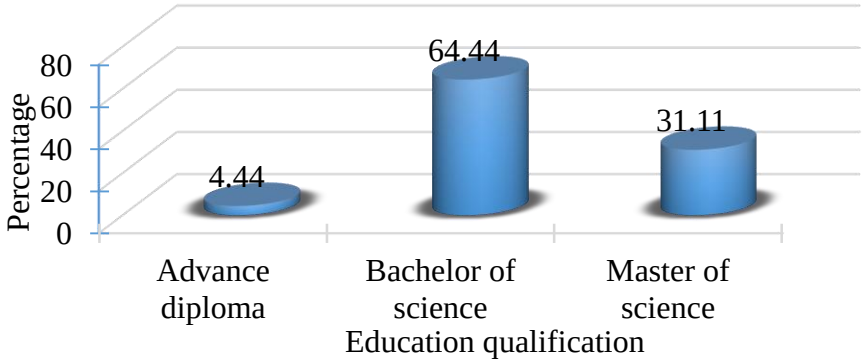

Figure 4.3: Education qualification of respondents.

On the other hand, 31.11% of respondents have working experience between seven to ten years, about 29.89% of respondents have both ones to three and four to six years working experience and the rest (11.11%) have a working experience of more than eleven years as shown on figure 4.4.

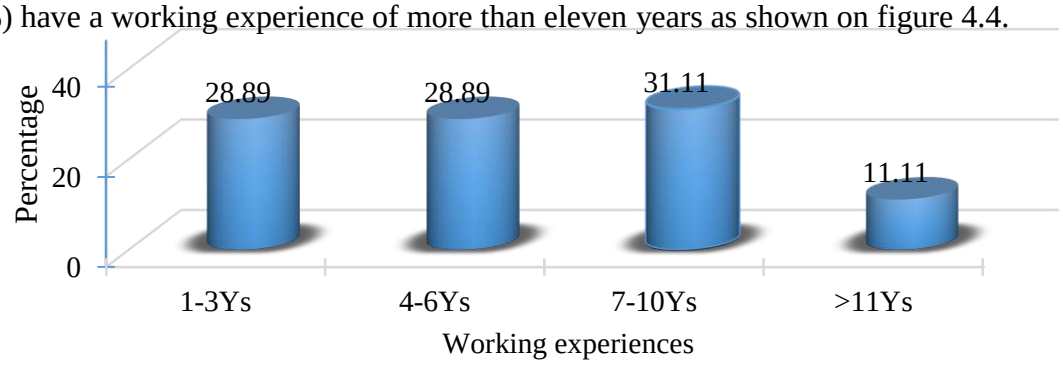

Figure 4.4: Working experience of respondents.

4.2. Data Quality

To increase the quality of data finally collected data was also checked for a validity and reliability test. As shown in Annex A.5 and Annex A.6, all collected data was reliable and valid respectively.

4.3. Existing Construction Material Management Techniques in Building Construction Projects.

In the building construction project site, there are a lot of activities performed by using different techniques in receiving, identification, inspection, recording, storage, distribution, and disposal of construction material to manage construction material recourses on site. According to interviews and

site observation conducted in some building construction projects, believe that implementation of construction material techniques is very important to complete building projects as per schedule and budget. However, as results, as part of this study, eight construction material management techniques applied in building construction projects site were identified from the literature reviews and the application of construction material management techniques building construction projects are discussed below based on respondents applied on the site to manage building construction project cost and time. However, some building projects are used more than eight techniques but those are not common to other projects who have only one project on their hands.

Table 4.2: Existing construction material management techniques.

No	Construction material management techniques	Frequency			Method of used			
		Never used	Sometimes used	Usually used	Without recording (in memory)	Recording without Formal form	Recording by using A form	Recording by using Computerized form
1	Daily recording of materials used in the project, the record illustrates for example (material name, material number, unit, used quantity, and the item in which the material is used).	4.4%	40.0%	55.6%	11.1%	8.9%	60.0%	20.0%
2	Following up the prices in the market and recording the variation of prices.	6.7%	53.3%	40.0%	13.3%	37.8%	22.2%	26.7%
3	Providing a list of materials in the project and recording of materials during construction includes for example (material name, material number, unit, and price) **(MR)**.	2.2%	37.8%	60.0%	6.7%	22.2%	51.1%	20.0%
4	Providing material cards at the site store that contain for example (input-output balance). (**Bin card**) or **store card**.	2.2%	15.6%	82.2%	6.7%	13.3%	60.0%	20.0%
5	Providing materials purchase order including for example (order number material description, required quantity, and price) (**PR**).	0.0%	31.1%	68.9%	0.0%	24.4%	53.3%	22.2%
6	Recording the received materials on site, the record shows for example (delivery number, material name, material description, and quantity) (**GRV**).	6.7%	22.2%	71.1%	8.9%	13.3%	57.8%	20.0%
7	Reporting the problems, for example (wastage and breakage, theft and loss, shortage in deliveries, etc.).	8.9%	51.1%	40.0%	13.3%	24.4%	40.0%	22.2%

8	Reporting the situation of materials in the store, the report illustrates for example (supplier name, order number, quantity input, quantity output balance).	4.4%	42.2%	53.3%	11.1%	17.8%	51.1%	20.0%

Based on survey data as table 4.4, shows most of the respondents (55.6%) used daily recording for used materials in the project usually and 60.0% of respondents use recording by using the prepared form. In other ways, most of the respondents (40%) used following up the prices in the market sometimes and more than half of respondents are not used any forms (without recording and recording without formal form).

Also, most of the respondents (82.2%) use usually having a list of materials in the project and record of materials during construction, and most of them (51.1%) record the data of material by using a recording by using the form. most of the respondents (82.2%) use material cards at the site store in the project usually and most of the respondents (60.0%) are use recording by using the prepared form. Likewise, most of the respondents (68.9%) used providing materials purchase orders on-site in the project usually and more than half (53.3%) of respondents are use recording by using the prepared form.

Most of the respondents (71.1%) used recording received materials on-site in the project usually and more than half (57.8%) of respondents are using recording by using the prepared form. Likewise, more than half of respondents (51.1%) report the problems of construction material on-site sometimes and more than half of respondents have not used any forms (without recording and recording without formal form). More than half (53.3%) of respondents are reporting the situation of materials in the store usually and (51.1%) of the recording by using a form.

As the result of interviews and site observation, all construction material management techniques which are stated in the questionnaire are important to reduce the impact of construction material management on project time and cost. These construction material management techniques are a daily recording of used materials, providing a list of materials in the project, providing a store card for each material, providing materials purchase order form, recording the received materials on-site, reporting the situation of materials in the store, reporting the problems and following up the prices in the market and recording the variation of prices.

However, were report the problems of construction material on-site and following up the prices in the market & recording the variation of prices construction material management techniques are not performed usually or performed sometimes or could be not used techniques on sites. Also, some

respondents used sometimes recording without formal forms. This agrees with the interview conduct on-site.

4.4. Challenges Facing Contractors in Implementation of Construction Material Management.

One of the objectives of this research is to access the challenge facing contractors when implementation construction material management on building construction projects in Jimma town. Therefore, in this section, the challenge facing contractors when implementation construction material management on building construction projects was rate by respondents to the level of their agreement on the five-point Likert scale item questionnaires range from strongly agree (5) to strongly disagree (1). Accordingly, the questionnaire items were analyzed based on the responses of respondents within RII value of ≥ 0.50 were Low, from 0.50 to 0.70 were average and from 0.70 to 1.00 RII value were high.

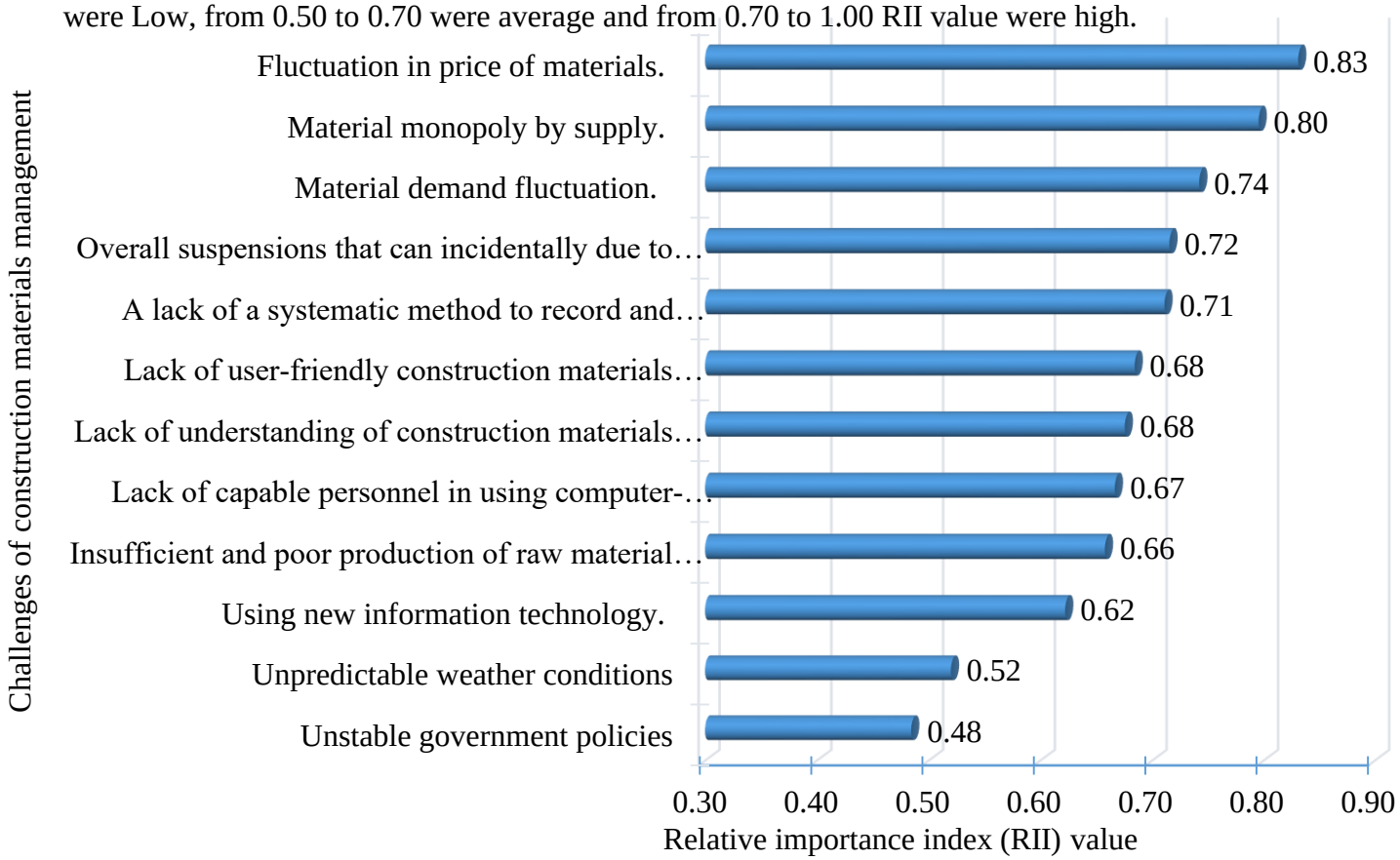

Figure 4.5: Challenges facing contractors in the implementation of construction material management.

Based on the survey data, overall challenges facing contractors in implementing construction material management in building construction projects have average challenges with RII value of 0.68. As it is illustrated in figure 4.5, the challenges facing contractors in implicating construction material

management are fluctuation in the price of materials 1st with RII value of 0.83, Material demand fluctuation 2nd with RII value of 0.80, Material monopoly by supply 3rd with RII value of 0.74, Overall suspensions that can incidentally due to peace of a country or town 4th with RII value of 0.72, A lack of a systematic method to record and control materials during the construction phase with the manual method being preferred in projects with RII value of 0.71, Lack of user-friendly construction materials software packages with RII values of 0.68, Lack of understanding of construction materials management system with RII values of 0.68, Lack of capable personnel in using computer-based materials management systems with RII values of 0.67, Insufficient and poor production of raw material by the country with RII value of 0.66, Using new information technology with RII value of 0.62, Unpredictable weather conditions with RII value of 0.52 and Unstable government policies with RII value of 0.48 are challenges facing contractors to implement construction material management.

From the above, it can be deduced that the challenges facing contractors in implementing construction material management techniques in building construction projects have average challenges. However, building contractors in Jimma town facing high challenges to implementing construction material management systems due to fluctuation in the price of materials, material demand fluctuation, material monopoly by supply, Overall suspensions that can incidentally due to peace of a country or town and A lack of a systematic method to record and control materials during the construction phase as obtained from survey data and also agree with interviews. Especially materials price fluctuation is highly challenged on-site because construction material price usually fluctuates every day. This has a high impact on project completion time and total project cost.

4.5. Impact of Factors Affecting Construction Material Management on Building Construction Project Cost and Time.

4.5.1. Impact of Factors Affecting Construction Material Management on Building Construction Project Cost and Time.

Another objective of this research is to access the impact of factors affecting construction material management on building construction project cost. Therefore, in this section impact of factors affecting construction material management on building construction project cost was the rate requires by respondents to the level their agreement on the five-point Likert scale item questionnaires range from high impact (5) to low impact (1). Accordingly, the questionnaire items were analyzed based on the responses of respondents within RII value of ≥ 0.50 was low impact, from 0.50 to 0.70 was an average

impact and from 0.70 to 1.00 RII value were high impact. Respondents have surveyed factors affecting construction material management by classifying in into eight groups that impacted the building construction project cost. Such groups as identified were; Site condition, Planning and handling on-site, Management, Materials, Suppliers and manufacturers' default, Contractual, Transportation, and Governmental interference. Total 51 factors were collected and Responses obtained in these criteria have been analyzed.

Based on respondents survey data Materials price fluctuation 1st with RII value 0.80, Delay in progress payment by owner 2nd with RII value 0.78, Design changes 3rd with RII value 0.76, Improper storing methods 4th with RII value 0.72, Inadequate qualified & experienced staff, shortage of materials in the market and Improper study on material availability study and its source 5th with RII value 0.71, Excessive paperwork, Lack of communication between main office and site office and Misuse of the specification 8th with RII value 0.70 is high impacts in building construction project cost. In otherwise Poor estimation of materials 11th with RII value 0.69, Storing materials in faraway stores, Monopoly control by a particular supplier, Lack of a proper work plan, Shortage of supply of construction material required, Lack of materials storage, Delay in materials delivery by suppliers 12th with RII value with 0.68, Rework due to mistakes, Lack of quality construction materials and Material wastage exceeding the tolerance limit 18th with RII value 0.67 and the all remaining construction material management factors are an average impact on building construction project costs as listed on Annex A.1.

The results show that majority of the construction professionals believe that construction material management factors are a relatively high impact on building construction project costs. Those are based on respondent's survey data materials price fluctuation, delay in progress payment by owner, design changes, improper storing methods, inadequate qualified & experienced staff, improper study on material availability study and its source, excessive paperwork, lack of communication between main office and site office and misuse of the specification are high impact in building construction project cost as shown in figure 4.6.

Also, according to interview results improper storing, material price fluctuation, design change, owner payment delay, shortage of construction material, poor estimation of materials, material wastage exceeding the tolerance limit, damage to material delivery and storage and misuse of the specification the major impact on building project costs. Therefore, the results of the survey data agree with the interviews. So that, due to these factors affecting construction material management the building project in Jimma leads to an increase in the project completion cost usually.

Generally, the impact of construction material management on building construction project cost is average (RII 0.643) due to factors affecting construction material management. But according to interviews, the impact of construction material management on building project cost appears high.

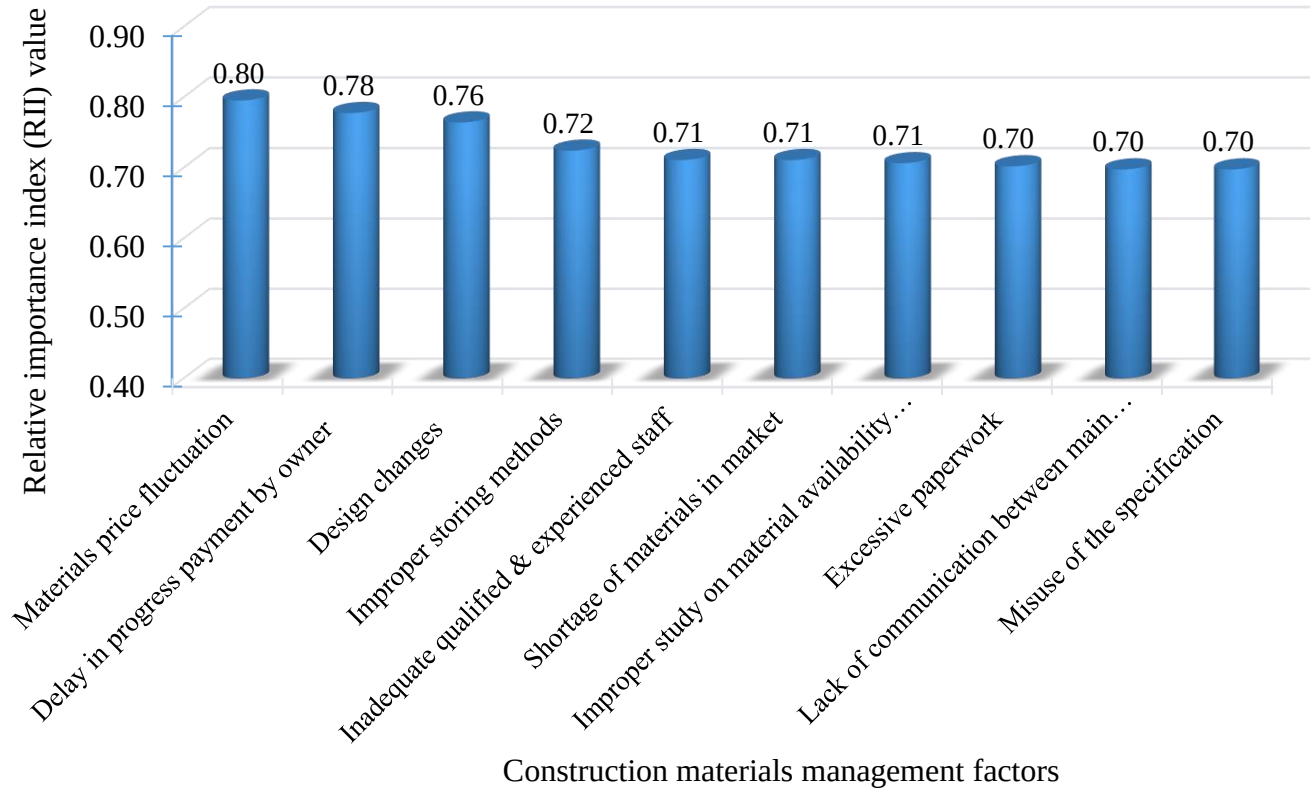

Figure 4.6: Construction material management factors have a high impact on building project costs.

4.5.1.1. Overall group factors impact building construction project cost.

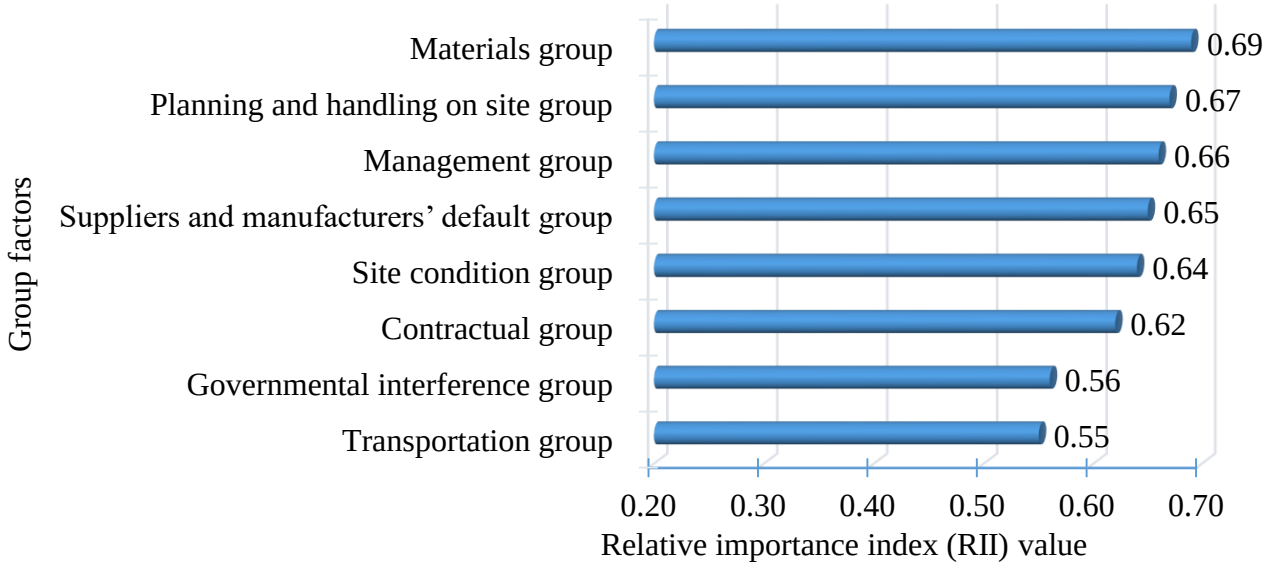

Figure 4.7: Rank of group factors impact on building construction project cost.

Based on the above figure 4.7, the Material group has ranked 1st from 8 groups with RII value of 0.69, which shows that the material group is the most dominant factor that affecting construction material management has an impact on building construction project costs. In otherwise Planning and handling on-site group 2nd with RII value 0.67, Management group 3rd with RII value 0.66, Suppliers and manufacturers' default group 4th with RII value of 0.65, Site condition group 5th with RII value of 0.64, Contractual group 6th with RII value of 0.62, Governmental interference group 7th with RII value of 0.56 and Transportation group 8th with RII value of 0.55 from 8 groups of a factor affecting construction material management impact on building construction project costs. However, all group factors affecting construction material management are an average impact on building construction project costs. So that, in this research, construction material management factors which is an impact on building project cost categorized into eight groups namely: -

4.5.1.2. Materials group

Under Materials, the group was identified 7 sub-factors of construction material management that have an impact on building construction project cost and ranked according to their relative importance index (RII) Value in their group and as a whole based on respondent's responses as shown in Annex A.4. In Materials, the group has been ranked 1st from 8 groups of construction material management factors that have an impact on project cost with a relative importance index (RII) Value of 0.69. This indicates that the factors listed under this group are a high impact on project costs in building construction projects. All Materials group factors of construction material management are ranked as in group and overall factors as shown in Annex A.2.

Based on Annex A.2, Materials price fluctuation are ranked 1st from its group with RII value of 0.80, Shortage of materials in the market are ranked 2nd in their group with RII value of 0.71, Poor estimation of materials are ranked in the 3rd place with RII value 0.69, Material wastage exceeding the tolerance limit and Lack of quality construction materials are ranked 4th in their group with RII value 0.67, Inappropriate materials delivery is ranked 6th place in its group with RII value 0.64 and Damage to material delivery and storage is ranked 7th in their group with RII value of 0.61 are material group factors of construction material management have to impact on building construction project costs.

In otherwise, Materials price fluctuation and Shortage of materials in the market are factors of construction material management that have a high impact on building construction project costs in Jimma town. The other remains factors categorized into material groups have an average impact on building construction project costs as shown in Annex A.2 and figure 4.8.

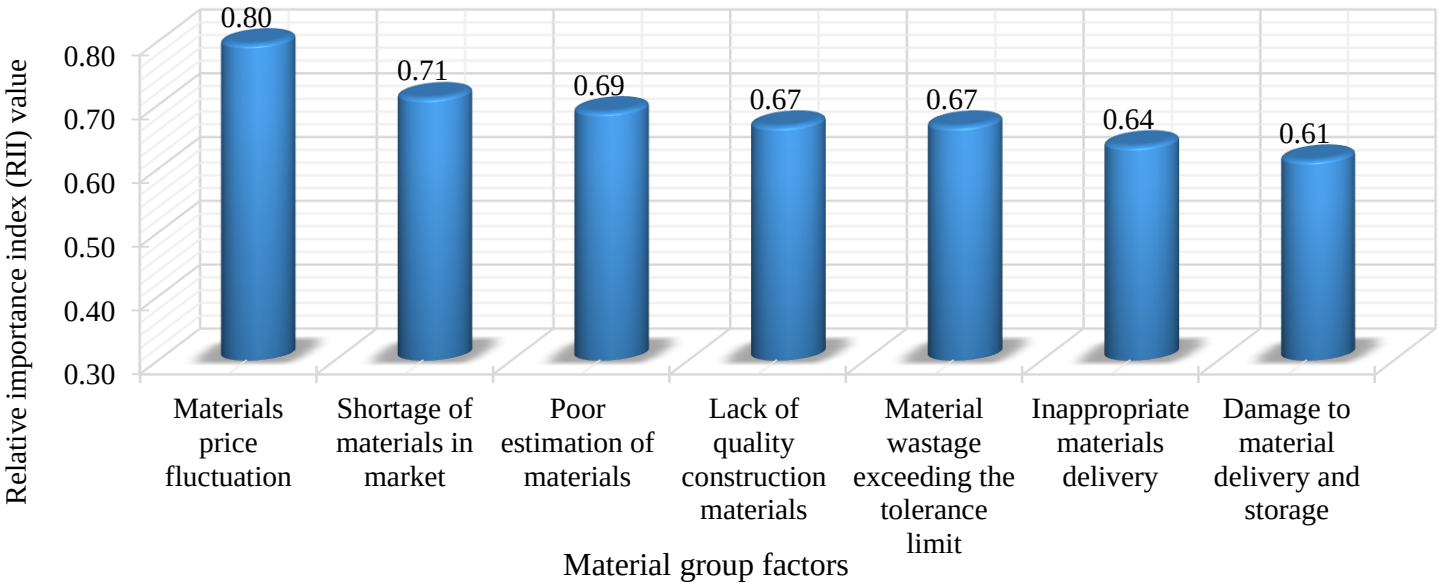

Figure 4.8: Material group construction material management factors impact on building construction project cost.

4.5.1.3. Planning and handling on-site group

Under planning and handling, the on-site group was identified 6 sub-factors of construction material management factors that have an impact on building construction project cost and ranked according to their relative importance index (RII) value in their group and as a whole based on respondent's responses. In planning and handling on-site group has been ranked 2nd from 8 groups of factors of construction material management impact on project cost with RII value 0.67. It indicates that the factors listed under this group are an average impact on project costs in building construction projects. Planning and handling on-site group of construction material management are ranked as in group and overall factors as shown in Annex A.2.

Based on Annex A.2 Storing materials in faraway stores are ranked 1st in a group with RII value of 0.68, Lack of a proper work plan is ranked 2nd in this group with RII value of 0.68, Rework due to mistakes are ranked 3rd in this group with RII value of 0.67, Wrong construction methods & improper handling on a project are ranked 4th in this group with RII value of 0.66, Insufficient instructions about handling materials onsite are ranked 5th in this group with RII value of 0.64 and Lack of protection during unloading material is ranked 6th in this group with RII value of 0.63 are construction material management factors have an impact on building project costs as shown in figure 4.9. In otherwise, all factors grouped under planning and handling on site of construction material management factors have an average impact on building construction project costs.

Also as shown in Annex A.2 indicates generally planning and handling on-site groups (RII 0.67) have an average impact on building construction project costs.

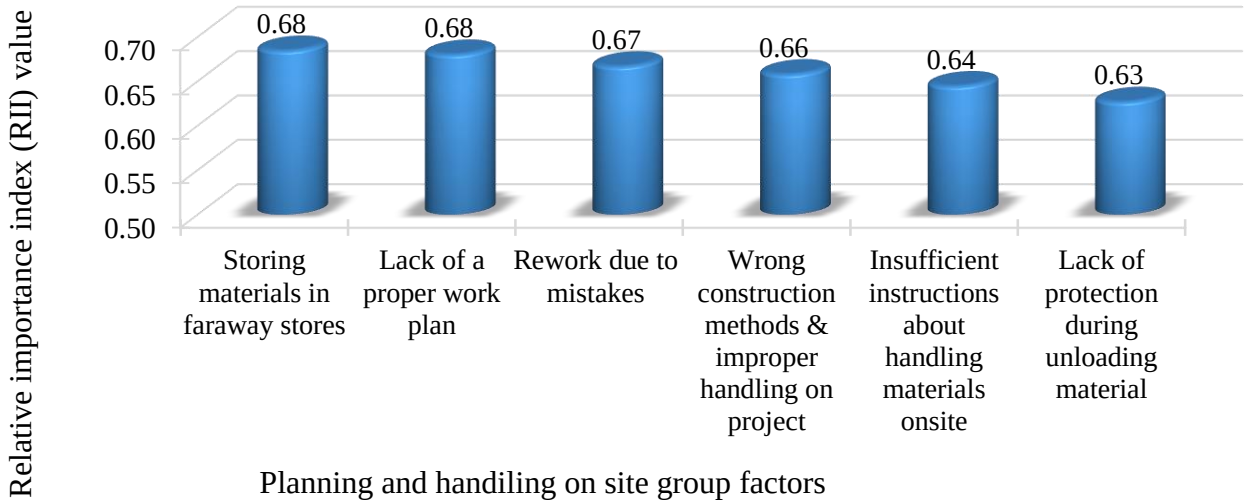

Figure 4.9: Planning and handling on-site group construction material management factors impact on building construction project cost.

4.5.1.4. Management group

The management group has 12 sub-factors which are ranked according to their relative importance index (RII) value. This study identified the core factor affecting construction material management which has an impact on building construction project costs. Management group ranked 3rd with a relative importance index (RII) value of 0.66 from 8 major groups of factors. Any management problems construction material management have a great impact on building construction project costs. The relative importance index (RII) value and rank in group and overall rank management group are summarized in the below Annex A.2.

Based on Annex A.2, Delay in progress payment by owner are ranked 1st from its group with RII value 0.78, Inadequate qualified & experienced staff and Improper study on material availability study and its source is ranked on the 2nd place with RII value of 0.71, Excessive paperwork and Misuse of the specification are ranked 4th place in its group with RII 0.70, Lack of supervision are ranked 6th in their group with RII of 0.66, Inefficient communication in construction sites are ranked 7th in their group with RII 0.65, Poor use of advanced engineering design software is ranked 8th place in their group with RII 0.64, Ordering errors are ranked 9th in their group with RII 0.62, Poor financial status of a company is ranked 10th within-group with RII 0.61, Accidents due to negligence are ranked 11th in their group with RII 0.57 and Takeoff error are ranked 12th in their group with RII 0.56 are management group factors impact on project costs.

However, Delay in progress payment by the owner, Inadequate qualified & experienced staff, improper study on material availability study and its source, Excessive paperwork, and Misuse of the specification are management group factors of construction material management that have a high impact on building construction project costs. The other remains factors categorized into the management group have an average impact on building construction project costs as shown in Annex A.2 and figure 4.10.

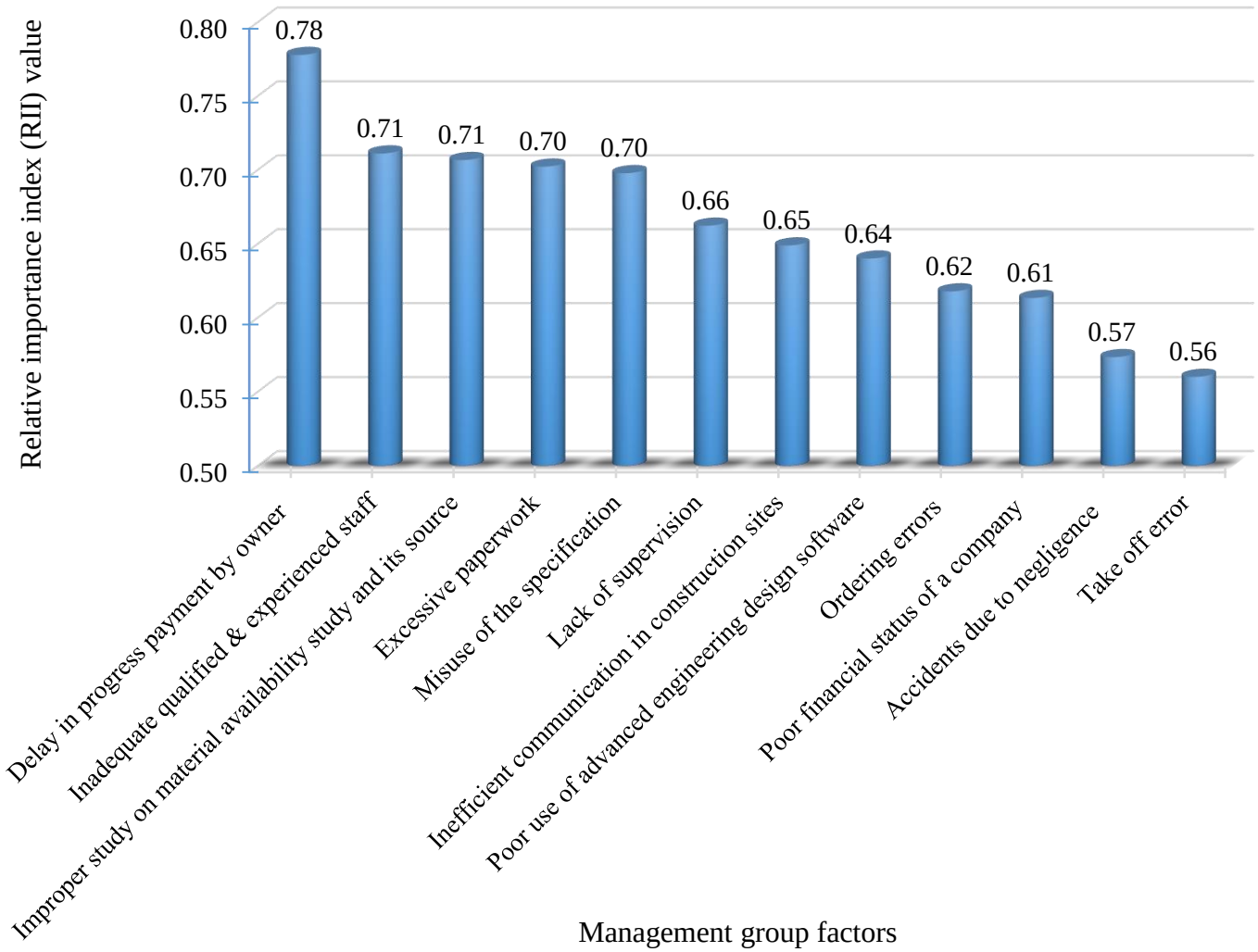

Figure 4.10: Management group construction material management factors impact on building project cost.

4.5.1.5. Suppliers and manufacturers' default group

In the Suppliers and manufacturers' default group were identified 6 sub-factors of construction material management have an impact on building construction projects cost and ranked according to their relative importance index (RII) value in their group and as a whole based on respondent's responses as shown in Annex A.2. Suppliers and manufacturers' default group has been ranked 4th from 8 groups of

factors of construction material management has to impact on project cost with relative importance index (RII) value 0.65. It indicates that the factors listed under this group are an average impact on project costs in building construction projects. Factors categorized under Suppliers and manufacturers' default group of construction material management which have an impact on building project cost are ranked as in group and overall factors as shows on Annex A.2.

Based on Annex A.2, which categorized under Suppliers and manufacturers' default group, Monopoly control by a particular supplier, Shortage of supply of construction material required and Delay in materials delivery by suppliers are ranked 1st from its group with RII 0.68, Work stoppages at factories and Lack of competent suppliers are ranked 4th in their group with RII 0.64 and Poor communication between contractor and the material supplier is ranked 6th place in its group with RII 0.63 are suppliers and manufacturers' default group factors of construction material management has an impact on building construction project costs.

In otherwise, all factors grouped under Suppliers and manufacturers' default groups have an average impact on building construction project costs as shown in Annex A.2 and figure 4.11.

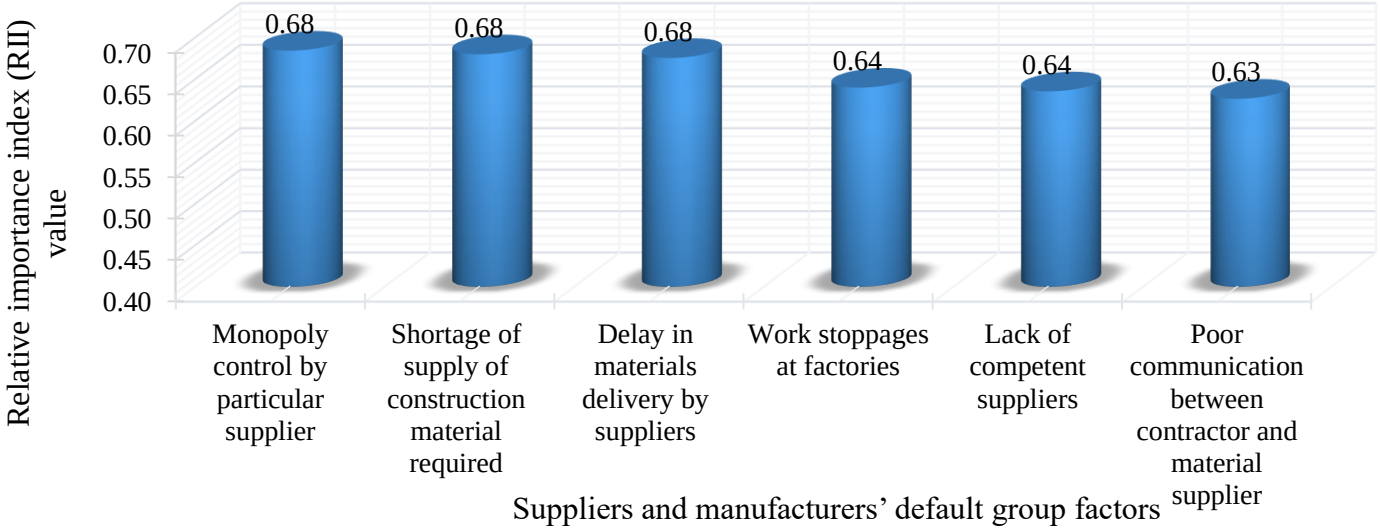

Figure 4.11: Suppliers and manufacturers' default group construction material management factors impact on building project cost.

4.5.1.6. Site condition group

Under-site condition groups contain 8 construction material management factors related to construction site conditions that have an impact on building project costs. Under site conditions there are 8 sub-factors are listed and each of them is ranked according to their relative importance index (RII) value in their group and as a whole. The site condition group has been ranked 5th among 8 groups of construction

material management-related factors impact on project cost with RII value of 0.64. This indicates that the factors listed under this group are an average impact on project costs in building construction projects. All site condition group construction material management factors are ranked as in group and overall factors as shown in Annex A.2

As a result, the Improper storing method is ranked 1st in a group with RII value of 0.72, Lack of communication between the main office and site office ranked 2nd in this group with RII value of 0.70, Lack of materials storage ranked 3rd in this group with RII value of 0.68, Lack of security personnel on-site ranked 4th with RII value of 0.65 and Existence of unnecessary materials onsite ranked 5th in this group with RII value of 0.64 is top five factors which have an impact on project cost. In other ways, Poor quality site documentation ranked 6th in this group with RII value of 0.63, severe weather conditions are ranked 7th in this group with RII value of 0.59 and Poor site layout are ranked 8th in this group with RII value of 0.56 is a factor affecting construction material management least impact on building project costs as shown in figure 4.12.

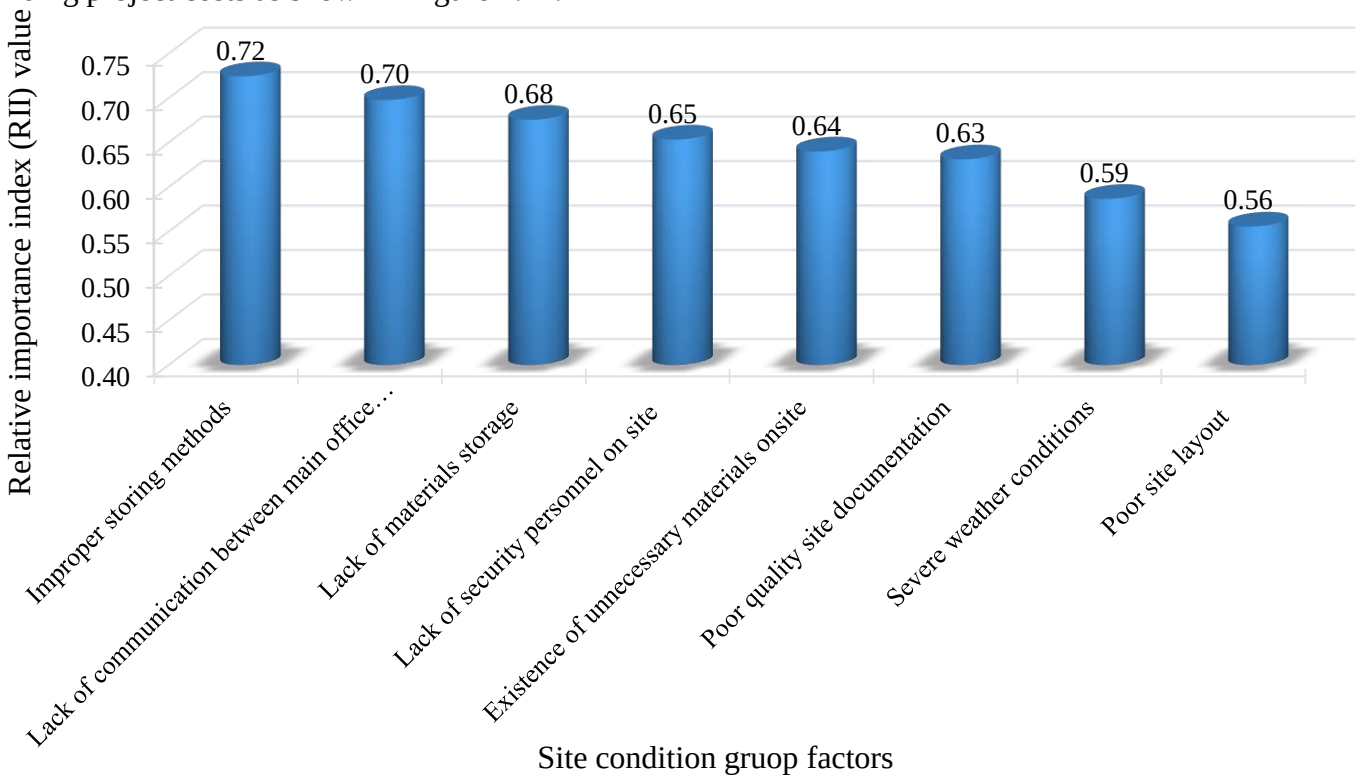

Figure 4.12: Site condition group construction material management factors impact on building construction project cost.

In otherwise, improper storing methods, Lack of communication between the main office and site office have a high impact on building construction project costs. The remaining 6 factors have an average

impact on building construction project costs. As shown in table Annex A.2 indicates generally site condition group (RII 0.64) has an average impact on building construction project costs.

4.5.1.7. Contractual group

In the contractual group's factor, there are 5 sub-factors are listed and each of them is ranked according to their relative importance index (RII) in their group and as a whole. Contractual group factor has been ranked 6th from 8 groups of factors of construction material management has an impact on building project costs with a relative importance index (RII) value of 0.62 which indicates that the factors listed under this group are average impact in building construction project cost. The relative importance index (RII) value and the rank of the Contractual group's factors are summarized in Annex A. 2.

On Annex. A.2 shows the relative importance index (RII) value and rank of the contractual group factor. Therefore, from the Contractual group, Design changes are ranked in 1st place with RII of 0.76, Unclear and inadequate details in the material specification are ranked in the 2nd place with RII of 0.61, Changes of materials specification during construction are ranked 3rd from the group with RII of 0.60, Ambiguous materials specification site are ranked 4th from its group with RII of 0.57 and Suspension of work ranked 5th from their group with an RII of 0.56. In otherwise all factors listed in the Contractual group which is a factor of construction material management have an average impact on building construction project cos1ts. However, Design changes from contractual group factors have a high impact on building project costs as shown in figure 4.13.

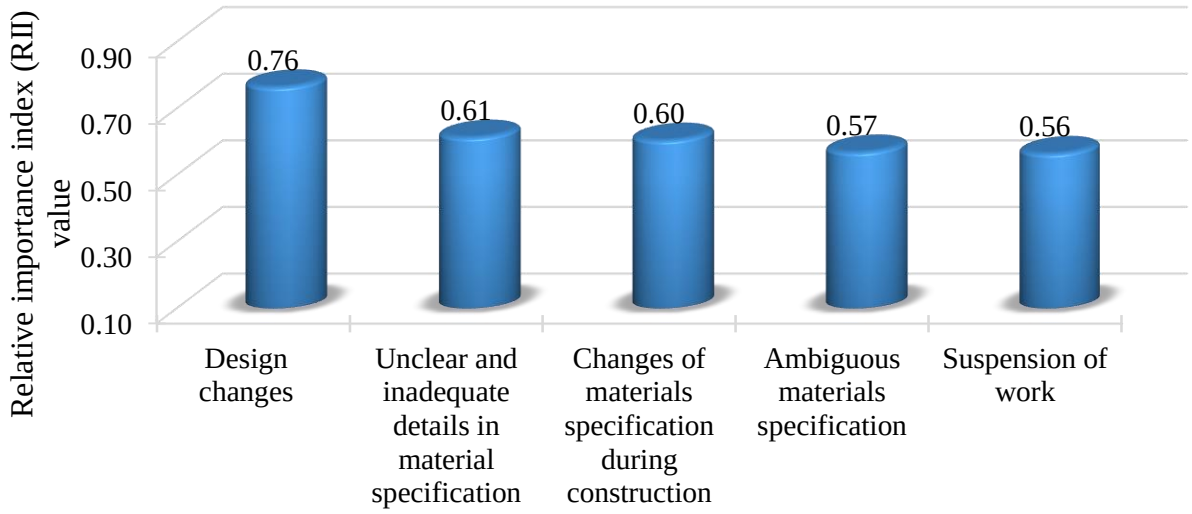

Figure 4.13: Contractual group construction material management factors impact on building project cost.

4.5.1.8. Governmental interference group

In most construction projects several government interferences group factors of construction material management have an impact on building project costs. In this study, the governmental interference group factor has 3 sub-factors and each of them is ranked according to their relative importance index (RII) value in their group and as a whole. Governmental interference group factor has been ranked 7th from 8 groups factors of construction material management has an impact on building project costs with a relative importance index (RII) value of 0.56, which indicates that the factors listed under this group are average impact in building construction project cost. The relative importance index (RII) value and the rank of Governmental interference group factors are summarized in Annex. A.2.

Based on Annex. A.2, Delay in custom clearance for imported materials are ranked 1st in their group with RII 0.60, Bureaucratic procedure is ranked 2nd in their group with RII 0.58, and Changes of government regulation are ranked 3rd place in their group with RII 0.52 has an impact on building construction project costs. However, governmental interference groups are major factors of construction material management. But in this research, all construction material management factors categorized under the governmental interference group have an average impact on building construction project costs.

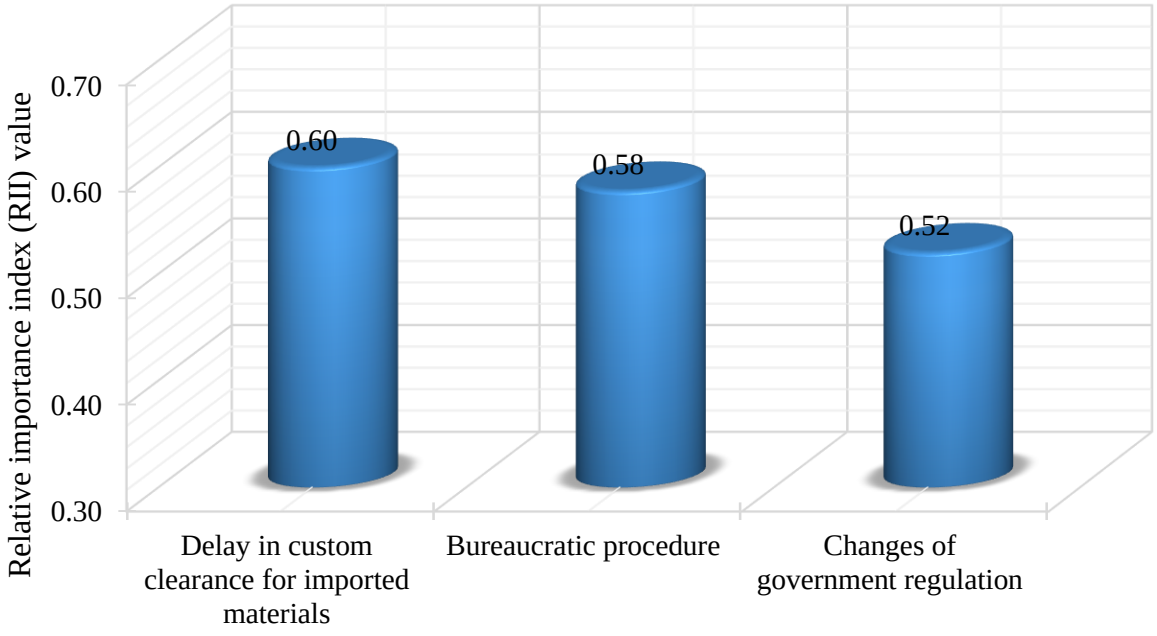

Figure 4.14: Governmental interference group construction material management factors impact building project costs.

4.5.1.9. Transportation groups

Under the transportation groups factor, there are 4 sub-factors are listed and each of them is ranked according to their relative importance index (RII) value in their group and as a whole. Transportation group factor has been ranked 8th from 8 groups of factors of construction material management has impact on building project costs with a relative importance index (RII) value of 0.55 which indicates that the factors listed under this group are average impact in building construction project cost. The relative importance index (RII) value and the rank of transportation are summarized in Annex A.2. Annex A.2 shows the relative importance index (RII) and rank of the transportation group factor. Hence, from the transportation group, On-site transportation difficulties are ranked in 1st place with RII of 0.58, Damage material during transportation and Unavailability transportation to the site is ranked 3rd from its group with RII of 0.56. Equipment failure on site 4th from their group with RII of 0.54. Otherwise, all factors listed in the transportation group which is a factor of construction material management have an average impact on building construction project costs as shown in figure 4.15.

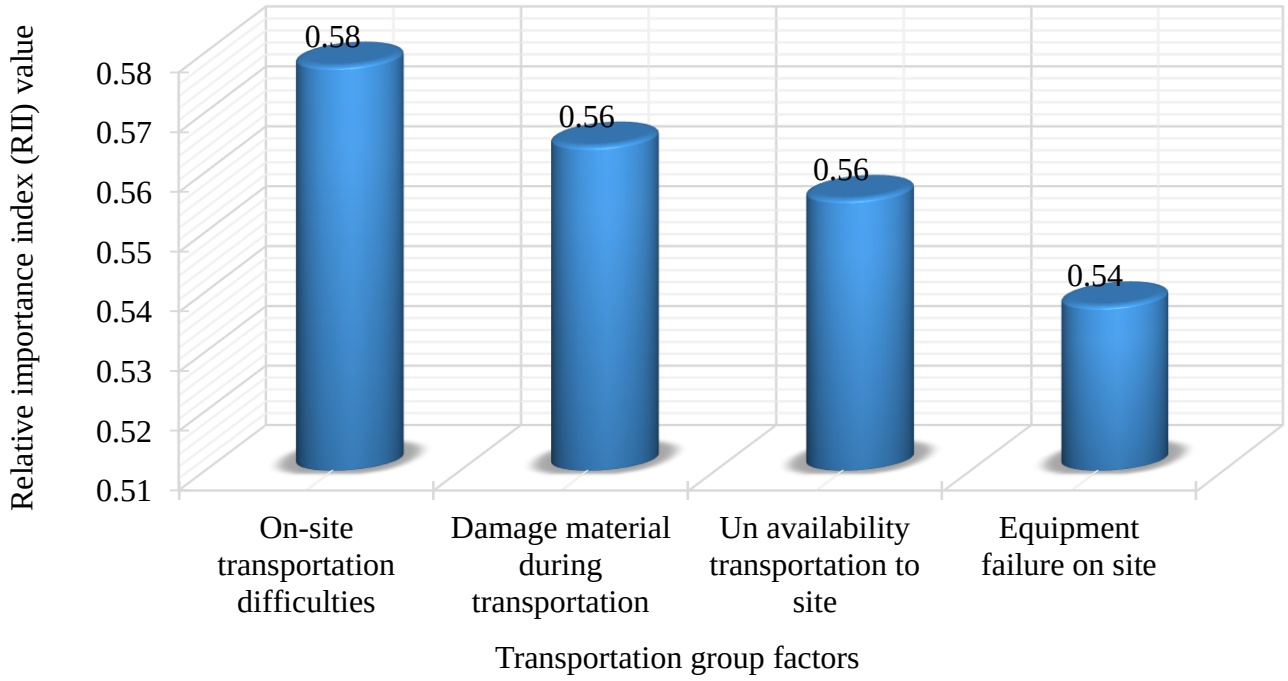

Figure 4.15: Transportation group construction material management factors impact on building project cost.

4.5.2. Impact of Factors Affecting Construction Material Management on Building Construction Project Time.

Another objective of this research is to access the impact of construction material management-related factors on building construction project time. Totally 54 factors were identified from the literature

reviews and interviews of respondents that construction material management factors have an impact on building construction projects time and each is sub-grouped into the main eight groups' factors.

Therefore, in this section impact of construction material, management-related factors on building construction project time rate were required by respondents to the level their agreement on the five-point Likert scale item questionnaires range from high impact (5) to low impact (1). Accordingly, the questionnaire items were analyzed based on the responses of respondents within a relative importance index (RII) value of ≤ 0.50 was low impact, from 0.50 to 0.70 was an average impact and from 0.70 to 1.00 of relative importance index (RII) value were high impact. As mentioned in the above statements, respondents surveyed factors affecting construction material management by classifying them into eight groups that have an impact on the building construction project time. Such groups as identified were; Site condition, Planning and handling on-site, Management, Materials, Suppliers and manufacturers' default, Contractual, Transportation, and Governmental interference. Total 54 factors were collected and responses obtained in these criteria have been analyzed.

Based on respondents survey data design changes are ranked 1st with RII value 0.76, Materials price fluctuation are ranked 2nd with RII value 0.75, Availability of specified construction materials in the market are ranked 3rd with RII value 0.73, and Improper study on material availability study and its source and Changes of materials specification during construction are ranked 4th with RII value 0.70, Lack of supervision and Poor estimation of materials are ranked 6th with RII value 0.68, Existence of unnecessary materials onsite are ranked 8th with RII value 0.67, Lack of quality construction materials, Scarcity because of the specificity and Inappropriate materials delivery are ranked 9th with RII value 0.66, Lack of competent suppliers and Monopoly control by particular supplier and Shortage of supply of construction material required are ranked 12th with RII value 0.65, Inadequate qualified & experienced staff are ranked 15th with RII value 0.64, Improper material usage, Ordering errors and Mistakes & delays in project design documents are ranked 16th with RII value 0.63, Delay in materials delivery by suppliers, Suspension of work and rework due to mistakes are ranked 19th with RII value 0.62 are construction material management factors have significant impact on building construction project time and the all remaining construction material management factors are average impact on building construction project time. But Changes in government regulation are ranked 54th with RII value of 0.49 value which is categorized under low impact on building construction project time.

Also, figure 4.16 illustrated factors of construction material management that have high impact on building construction project time.

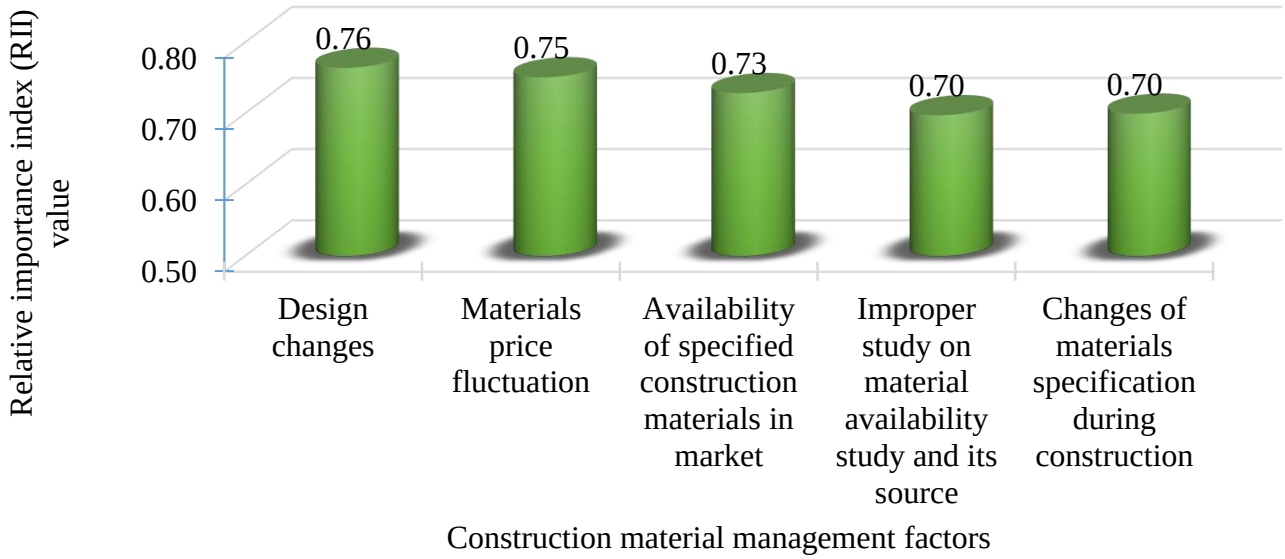

Figure 4. 16: Construction material management factors have a high impact on building project time.

Based on the above analysis design changes, materials price fluctuation, availability of specified construction materials in the market, improper study on material availability study & its source and changes of materials specification during construction are construction material factors that have a highly significant impact on building construction projects. But according to interview results, design changes, materials price fluctuation, availability of specified construction materials in the market, changes of materials specification during construction, poor estimation of materials, lack of quality construction materials and delay progress payment by a client are the major impact on building project time. These are strongly agreed with survey data. Generally, the impact of construction material management on building construction project time is average (RII 0.613) due to factors affecting construction material management. But according to interviews, the impact of construction material management on building project time appears high.

4.5.2.1. Overall group construction material management factors on building project time.

Based on surveyed data, Material group factors have ranked 1st from 8 groups with RII 0.67 which shows that the material group is the most dominant factor of construction material management that has an impact on building construction project time. In otherwise, Contractual group factors 2nd with RII 0.64, suppliers and manufacturers' default group factors 3rd with RII 0.63, Management group factors 4th with RII 0.61, Site condition group and Planning & handling on-site group factors are ranked 5th with RII 0.59, Transportation group factors are ranked 6th with RII 0.56 and Governmental interference group factors are ranked 8th with RII 0.55 from 8 groups of construction material management factors

have impact on building construction project time. However, all group factors of construction material management have an average impact on building construction project time.

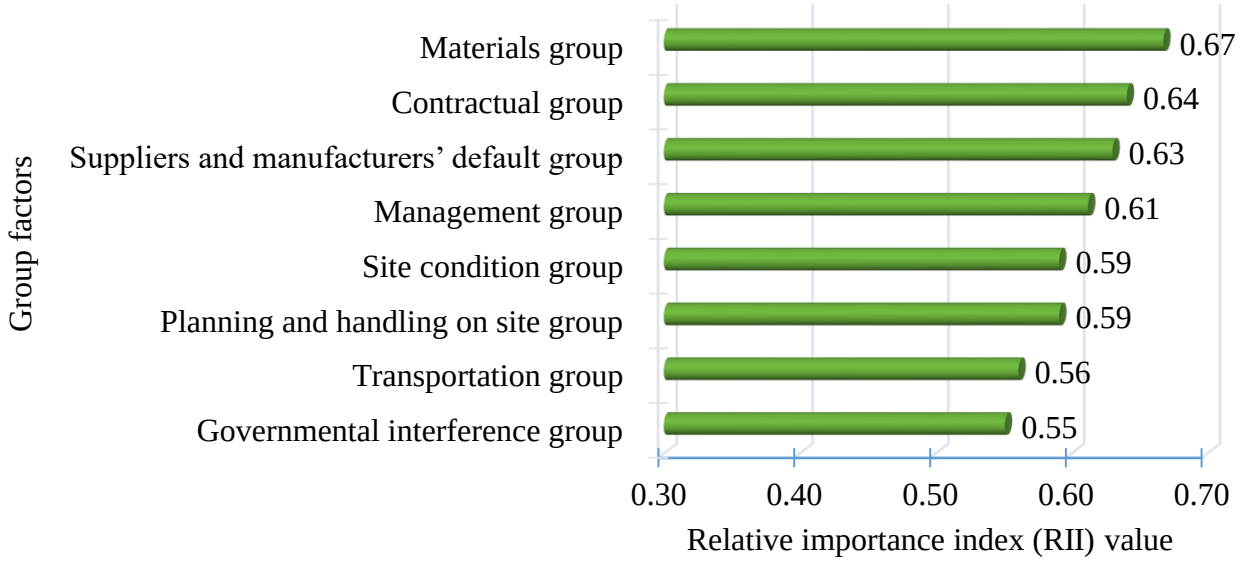

Figure 4.17: Rank of construction material management group factors impact on building construction project time.

Generally, in this research, construction material management factors that have an impact on building project time categorized into eight groups namely: -

4.5.2.2. Materials group

Eight (8) factors categorized under materials group construction material management factors impact on building construction project time that was identified from literature reviews. Construction material factors were categorized under material group were more related to material characteristics obtain during transportation, during construction, and properties materials. This study identified the core factor of construction materials management which has an impact on building construction project time. The material group ranked 1st with RII of 0.67 from 8 major groups of factors. Therefore, in this study respondents were surveyed on 8 factors that construction material management has an impact on project time. Responses obtained in these criteria have been analyzed in Annex A.4.

Based on Annex A.4 and figure 4.18, Materials price fluctuation are ranked 1st from its group with RII 0.75, Availability of specified construction materials in the market are ranked 2nd in their group with RII of 0.73, Poor estimation of materials are ranked on the 3rd place with RII 0.68, Lack of quality construction materials, Lack of quality construction materials are ranked and Inappropriate materials delivery is ranked 4th place in its group with RII 0.66, Damage of material on delivery and storage and

Time-lapse in testing and inspection are ranked 7th in their group with RII of 0.60 are material group factors of construction material management which have an impact on building construction project time. In otherwise, Materials price fluctuation and Availability of specified construction materials in the market are factors of construction material management that have a high impact on building construction project time. The other remains factors categorized into material groups have an average impact on building construction project time as shown in Annex A.4 and figure 4.18.

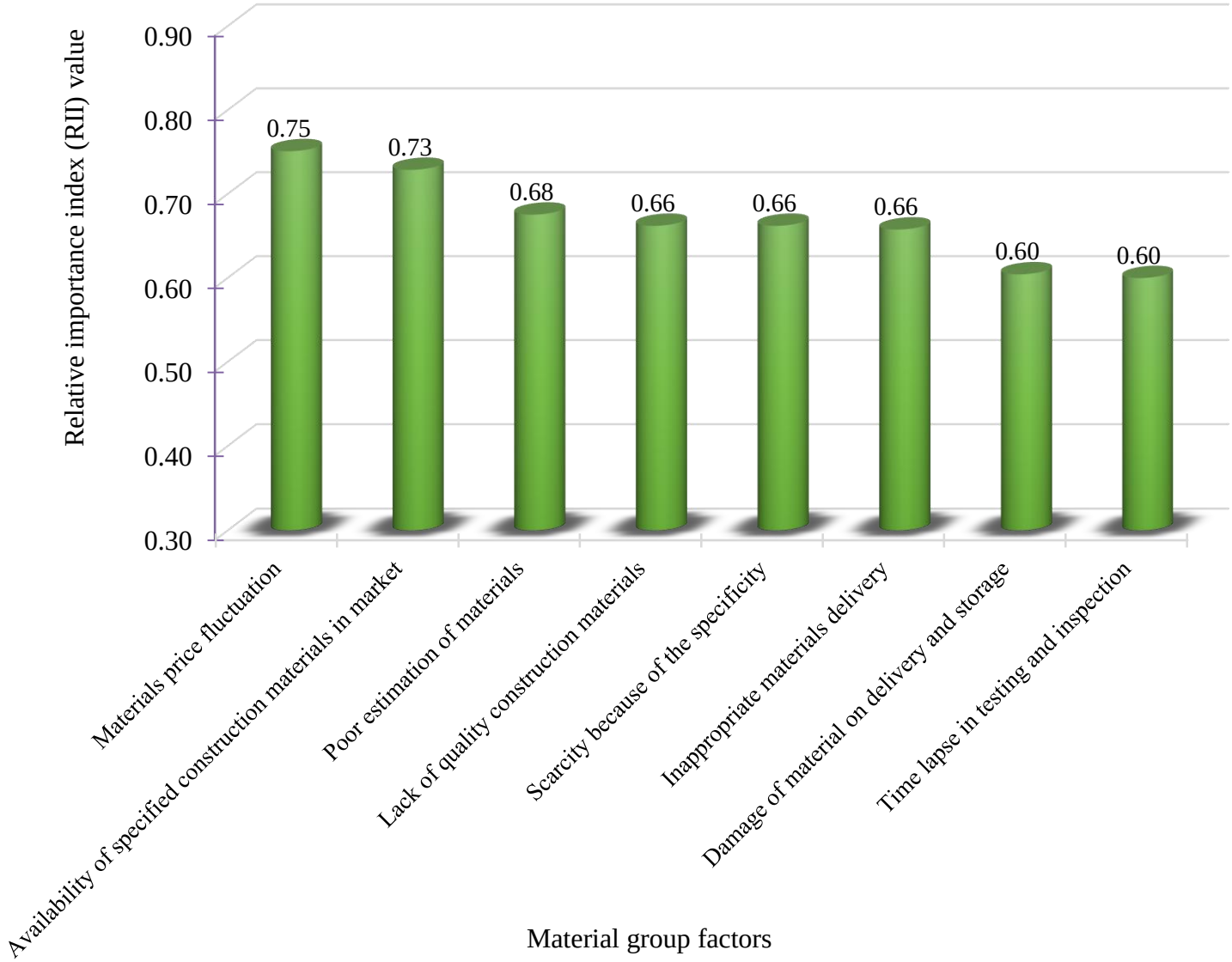

Figure 4.18: Material group construction material management factors impact on building construction project time.

4.5.2.3. Contractual group

In the contractual groups' factor, there are 5 sub-factors are listed and each of them is ranked according to their relative importance index (RII) value in their group and as a whole. The contractual group factor

has been ranked 2nd from 8 groups of construction material management has impact on building project time with RII of 0.64 which indicates that the factors listed under this group are average impact in building construction project time. The relative importance index (RII) value and the rank of contractual group's factors are summarized in Annex A.4.

Annex A.4 shows the relative importance index (RII) value and rank of the contractual group factor. Therefore, from the contractual group design changes are ranked in 1st with RII 0.76, changes of materials specification during construction are ranked in 2nd place with RII of 0.70, Suspension of work are ranked 3rd from this group with RII of 0.62, Unclear and inadequate details in the material specification is ranked 4th from its group with RII of 0.59 and Ambiguous materials specification are ranked 5th from their group with RII of 0.54. However, design changes are high impact factors on building construction project time which is categorized under contractual group. In otherwise, remaining all factors listed in the contractual group factor of construction material management have an average impact on building construction project time as shown in figure 4.19.

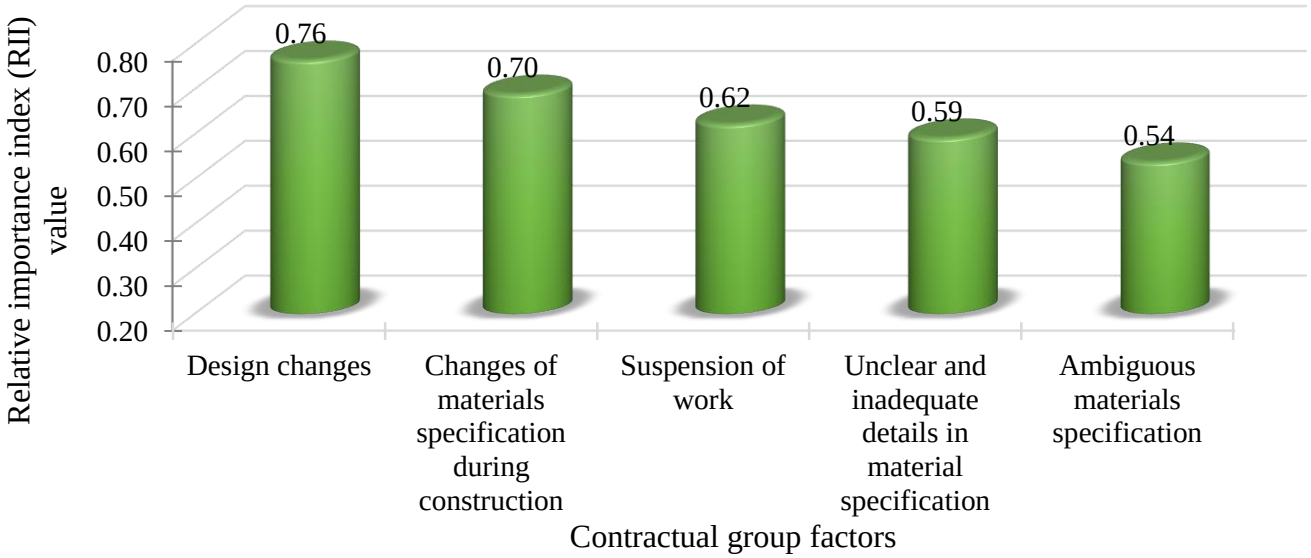

Figure 4.19: Contractual group construction material management factors impact on building project time.

4.5.2.4. Suppliers and manufacturers' default group

Under Suppliers and manufacturers' default group were identified 6 sub-factors of construction material management has an impact on building construction projects time and ranked according to their relative importance index (RII) value in their group and as a whole based on respondent's responses as shown in Annex A.4. Suppliers and manufacturers' default group has been ranked 3rd from 8 groups of factors of construction material management impact on project time with RII value of 0.63. It indicates that

the factors listed under this group are an average impact on building project time. Factors categorized under Suppliers and manufacturers' default group which have an impact on building project time are ranked as in group and overall factors as shows on Annex A.4.

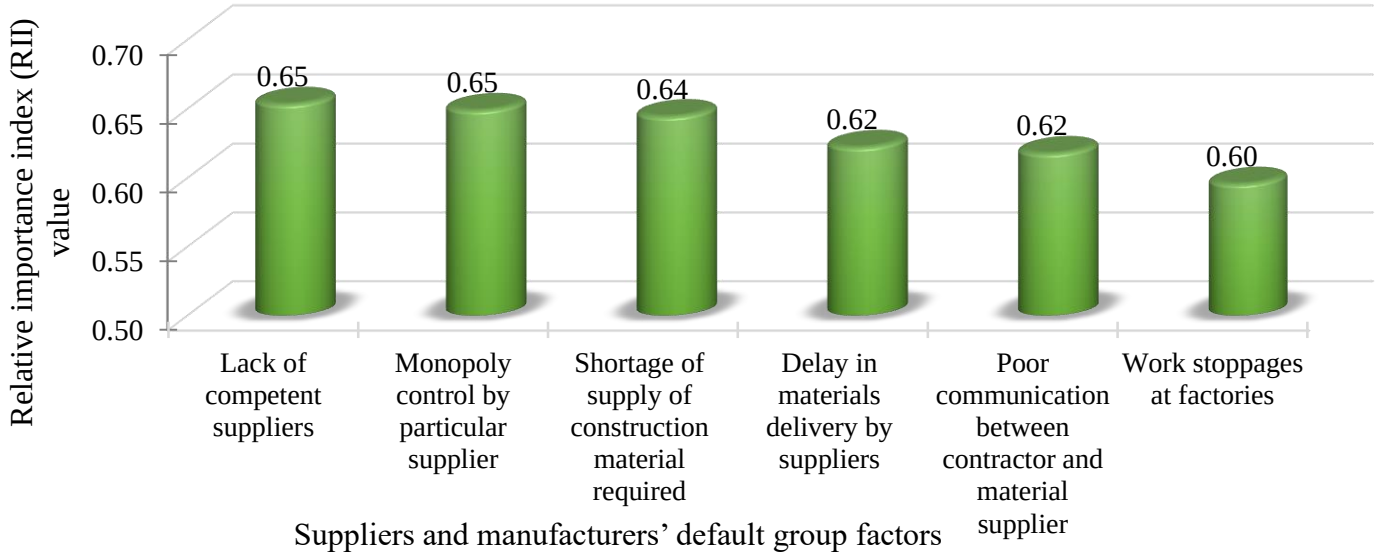

Figure 4.20: Suppliers and manufacturers' default group construction material management factors impact on building project time.

Based on Annex A.4, which categorized under Suppliers and manufacturers' default group, Lack of competent suppliers and Monopoly control by a particular supplier are ranked 1st in their group with RII of 0.65, Shortage of supply of construction material required is ranked on the 2nd place with RII 0.64, Delay in materials delivery by suppliers and Poor communication between contractor and the material supplier is ranked 3rd in their group with RII 0.62 and Work stoppages at factories are ranked 6th place in its group with RII 0.60 are suppliers and manufacturers' default group factors of construction material management which have an impact on building construction project time. In otherwise, all factors grouped under suppliers and manufacturers' default group have an average impact on building construction project time as shown in annex A.4 and figure 4.20.

4.5.2.5. Management group

The management group has 14 sub-factors identified from literature reviews which are ranked according to their relative importance index (RII) value. This study identified the core factor of construction material management which has an impact on building construction project time. The management group ranked 4th with a relative importance index (RII) value of 0.61 from 8 major groups of factors. Any management problems construction material management have a great impact on

building construction project time. The relative importance index (RII) value and rank in group and overall rank management group are summarized in Annex A.4.

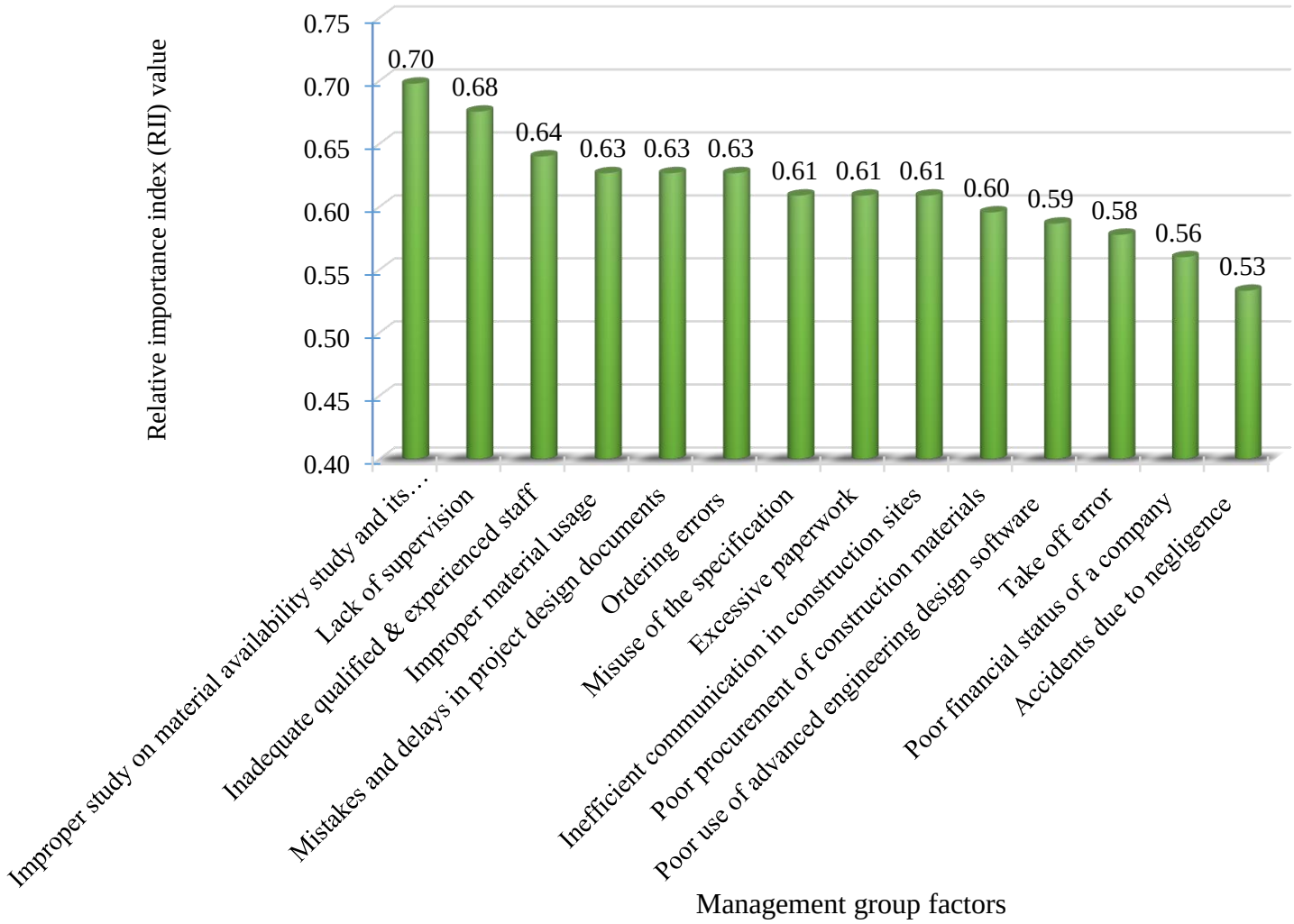

Figure 4.21: Management group construction material management factors impact on building project time.

Based on Annex A.4, Improper study on material availability study and its source are ranked 1st in their group with RII of 0.70, Lack of supervision are ranked on the 2nd place with RII 0.68, Inadequate qualified & experienced staff are ranked 3rd in their group with RII 0.64, Ordering errors, Improper material usage and Mistakes and delays in project design documents are ranked 4th place in it group with RII 0.63, Misuse of the specification, Excessive paperwork and Inefficient communication in construction sites are ranked 7th place in its group with RII 0.61, Poor procurement of construction materials are ranked 10th in their group with RII of 0.60, Poor use of advanced engineering design software are ranked 11th in their group with RII 0.59, Take off error are ranked 12th place in their group with RII 0.58, Poor financial status of a company are ranked 13th in their group with RII 0.56 and

Accidents due to negligence are ranked 14th within-group with RII 0.53 are grouped under management group factors which have impact on building construction project time. In otherwise, an improper study on material availability study and its source is management group factors affecting construction material management have a high impact on building construction project time. The other remaining 13 factors grouped under the management group have an average impact on building construction project time as shown in Annex A.4 and figure 4.21.

4.5.2.6. Planning and handling on-site group

There are five factors related to planning and handling on-site construction material management-related factors which have an impact on building construction project time that was identified from literature reviews. Annex A.4 shows the results of relative importance index (RII) value and rank of overall rank and in group rank factors that construction material management has an impact on building on project time. Based on Annex A.4, Rework due to mistakes are ranked 1st with RII value of 0.62, Wrong construction methods & improper handling on a project are ranked 2nd with RII value of 0.60, Insufficient instructions about handling materials onsite and Materials are damaged while handling on-site is ranked 3rd with RII value of 0.59 and Storing materials in faraway stores are ranked 5th with RII value of 0.56. In otherwise planning and handling on-site group factors of construction material management have an average impact on building project time with RII value of 0.59 and ranked in 5th place among 8 group factors. Generally, all factors of construction material management grouped under planning and handling on-site have an average impact on building construction project time as shown in figure 4.22.

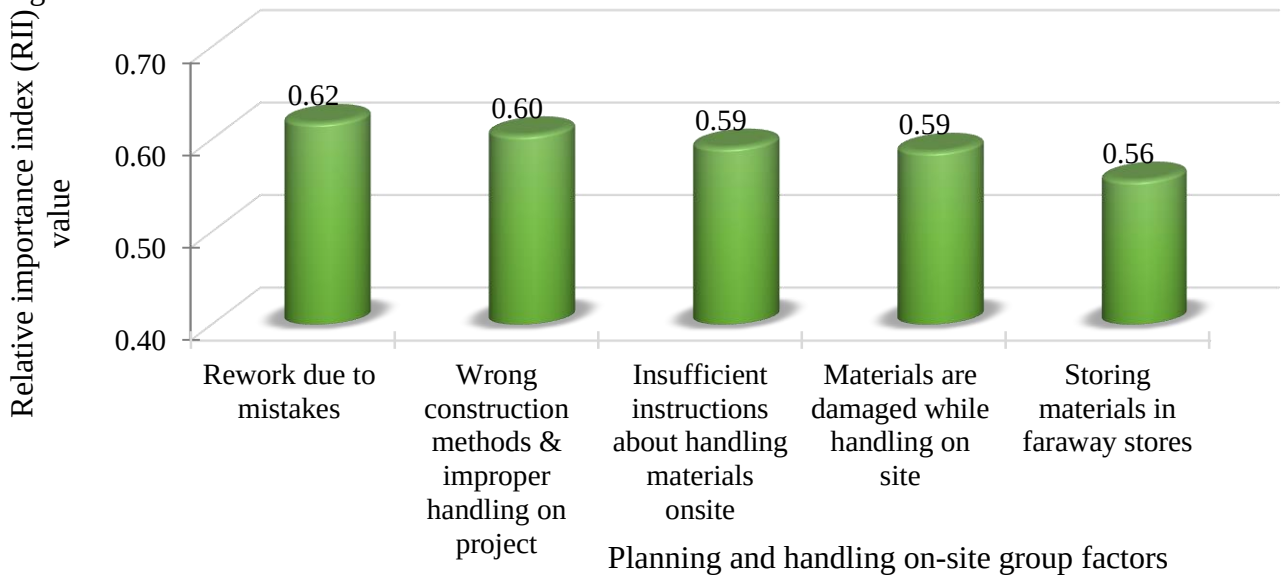

Figure 4.22: Planning and handling on-site group material management factors impact building project time.

4.5.2.7. Site condition group

There are 9 factors related to site conditions factors of construction material management that have an impact on building construction project time that was identified from literature reviews. Annex A. 4 shows the results of a relative importance index (RII) value, a rank of overall rank and in group rank factors of construction material management impact on building on project time.

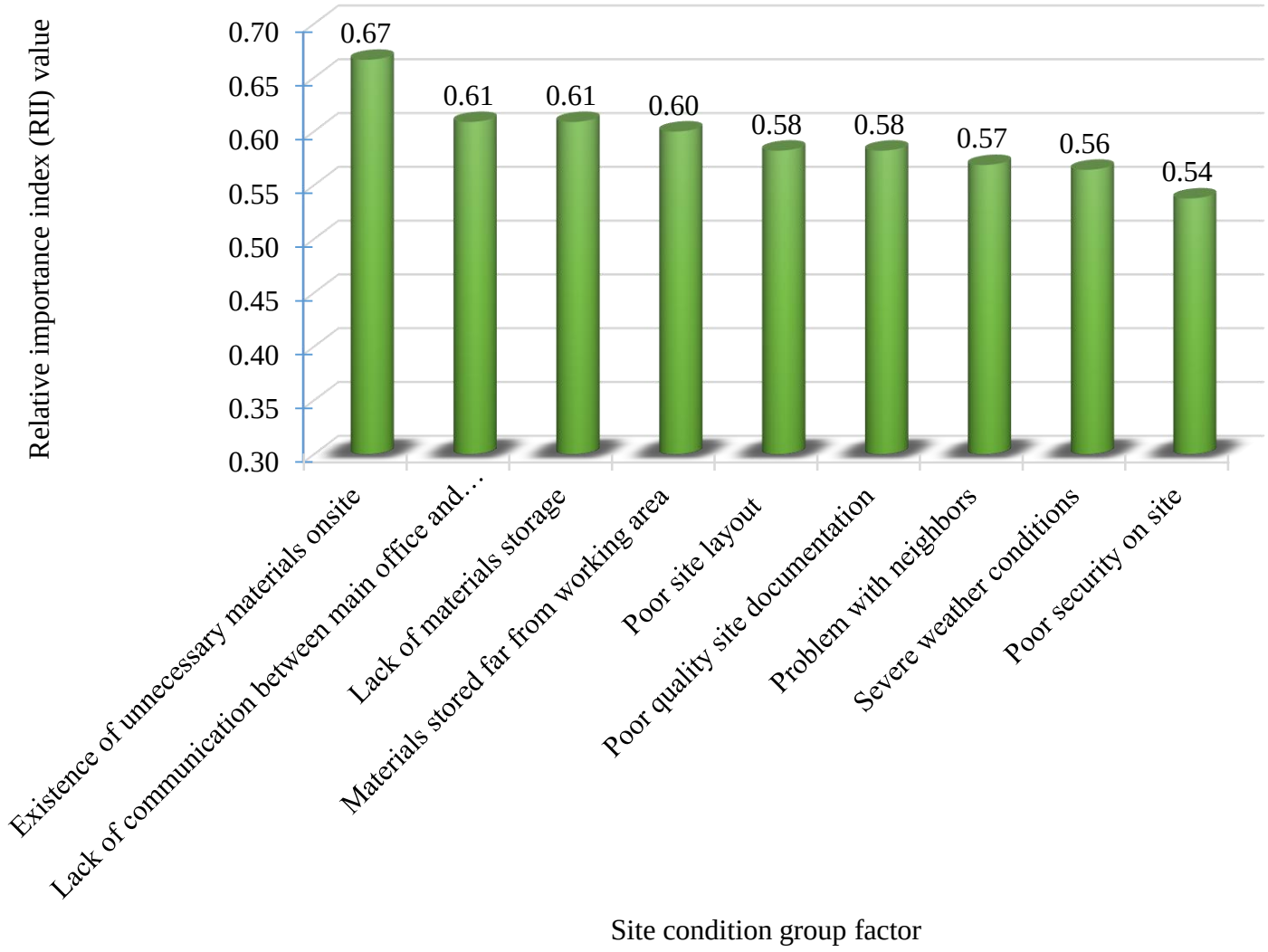

Figure 4.23: Site condition group construction material management factors impact on building project time.

As shown on Annex A. 4, the existence of unnecessary materials on site has been the 1st rank with RII value of 0.67, Lack of materials storage and Lack of communication between main office & site office are ranked 2nd with RII value of 0.61, Materials stored far from the working area are ranked 4th with RII value of 0.60, Poor quality site documentation and Poor site layout are ranked 5th with RII value of 0.58, Problem with neighbors is ranked 7th with the value of RII value of 0.57, Severe weather

conditions are ranked 8th with RII value of 0.56 and Poor security on-site is ranked 9th with RII value of 0.54 in a group of sit condition related factors construction material management has an impact on building project time. Generally, all construction material management factors categorized under site conditions have an average impact on building construction project time. In otherwise as a combination of site condition groups (RII 0.59) have an average impact on building project time and are ranked in 5th among 8 group factors.

4.5.2.8. Transportation group

Under the transportation groups factor there were 4 sub-factors are listed and each of them is ranked according to their relative importance index (RII) value in their group and as a whole. Transportation group factor has been ranked 7th from 8 groups of factors of construction material management have an impact on building project time with a relative importance index (RII) value of 0.56 which indicates that the factors listed under this group are average impact in building construction project time. The relative importance index (RII) value and the rank of transportation are summarized in Annex A.4.

Annex A.4 shows the RII value and rank of the transportation group factor. Therefore, from the transportation group equipment failure on-site is ranked in the 1st place with RII of 0.58, On-site transportation problems are ranked 2nd from this group with RII of 0.57, Damage material during the transportation is ranked 3rd from its group with RII of 0.56 and Transportation problems to the site are ranked 4th from their group with RII of 0.53.

In otherwise, all factors listed in the transportation group which is a factor of construction material management have an average impact on building construction project time as shown in figure 4.24.

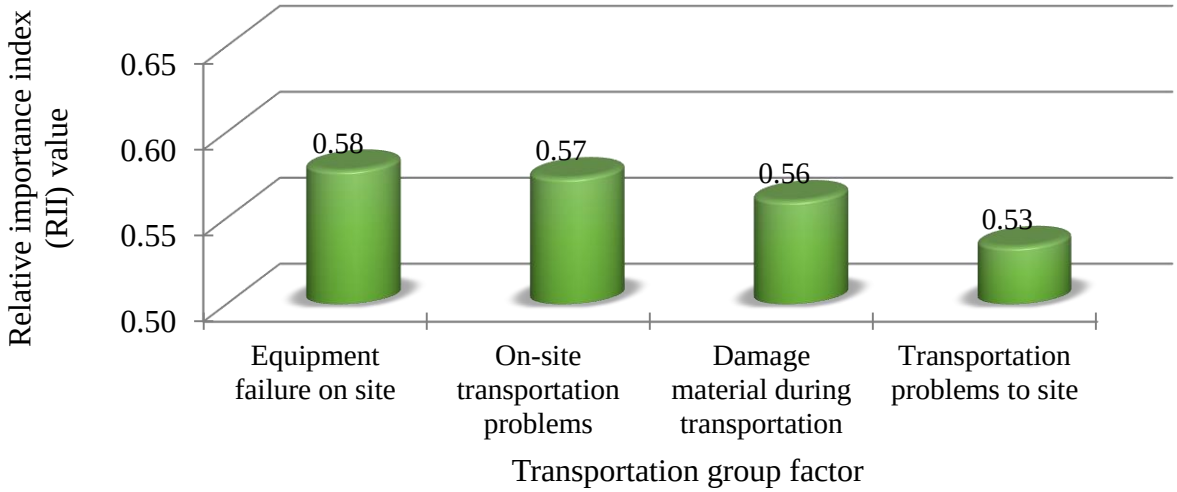

Figure 4.24: Transportation group construction material management factors impact on building project time.

4.5.2.9. Governmental interference group

There are 3 sub-factors identified under the Governmental interference group that has an impact on building construction projects time and ranked according to their relative importance index (RII) value in their group and as a whole based on respondent's responses as shown in Annex A.4. Also, the Governmental interference group has been ranked 8th from 8 groups of factors of construction material management impact on project time with a relative importance index (RII) value of 0.55. It indicates that the factors listed under this group are an average impact on building project time. Factors categorized under the governmental interference group of construction material management that have an impact on building project time are ranked as in group and overall factors as shown in Annex A.4.

Based on Annex A.4, which categorized under the governmental interference group, Delay in custom clearance for imported materials are ranked 1st from its group with RII value of 0.60, Bureaucratic procedure is ranked 2nd in their group with RII value of 0.56, and Changes of government regulation are ranked on the 3rd place with RII value of 0.49 are factors of construction material management have an impact on building construction project time. In otherwise, delays in customs clearance for imported materials and Bureaucratic procedures have an average impact on building construction project time. But, changes in government regulation have low impact on building construction project time as shown in Annex A.4 and figure 4.25.

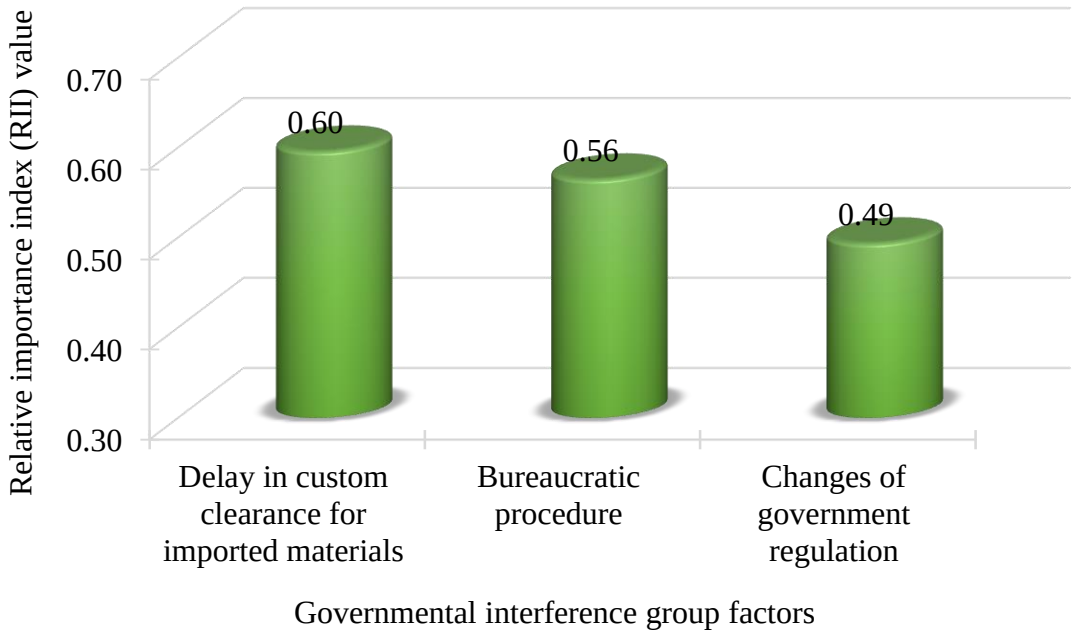

Figure 4.25: Governmental interference group construction material management factors impact on building project time.

4.6. Impact of Construction Material Management on Building Project Cost and Time.

4.6.1. Impact of poor construction material management on building project cost.

Generally, most of the respondents (80%) were facing building project cost overrun due to poor construction material management. Only a few respondents (20%) did not face cost overrun due to poor construction material management.

To analyses the impact of poor construction material management on project delivery in terms of cost overrun, the percentage of cost overrun was categorized into 6 groups and they were less than 10%, 11% -20%, 21%- 30%, 31% -40%, 41% -50% and more than 50%. Therefore, most of the respondents (30.56%) agree poor construction material management impact building construction project cost to 11%-20% of total project costs as shown in figure 4.26.

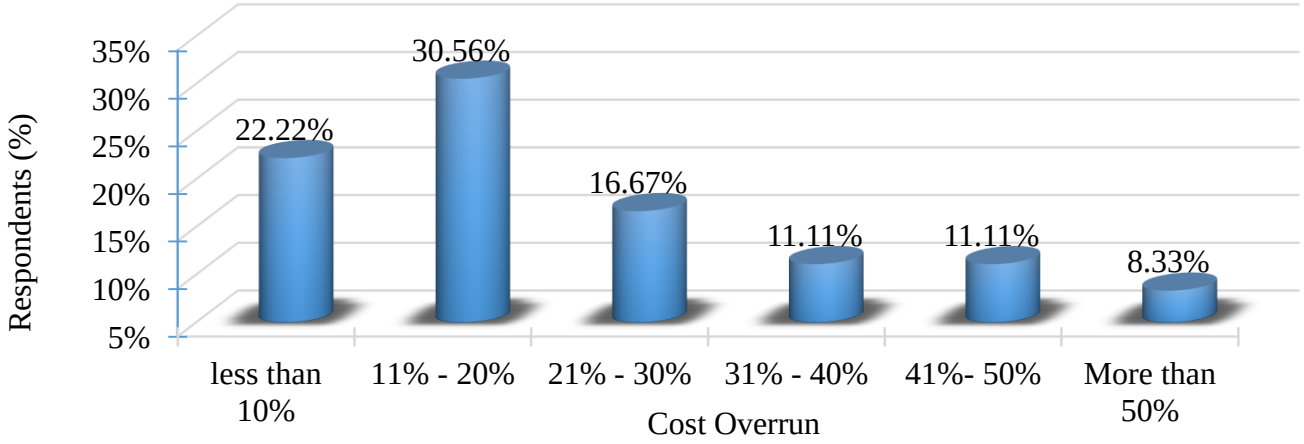

Figure 4.26: Impact of poor construction material management on building project cost.

But according to interview results, few of the interviewer the projects are in progress on the estimated project cost but most of the building projects have cost overrun due to poor construction material management. The magnitude of impact is varied in percentage. Most of them agree the impact of poor construction material management is up to 20% - 30% of total project costs. Only two interwar agree more than 30% cost overrun due to poor construction material management. Poor construction material management high impact construction project costs.

4.6.2. Impact of poor construction material management on building project time.

Generally, (82.2%) most building construction projects have facing building project time overrun due to poor construction material management. Only (17.78%) few projects are performed on the estimated project time. To analyses the impact of poor construction material management on project delivery in

terms of time overrun, the percentage of time overrun was categorized into 6 groups and were less than 10%, 11% -20%, 21%- 30%, 31% - 40%, 41% -50% and more than 50%. Generally, most of the respondents (27.03%) agree poor construction material management has an impact on building construction project time to 11%-20% of total project time as shown in figure 4.27.

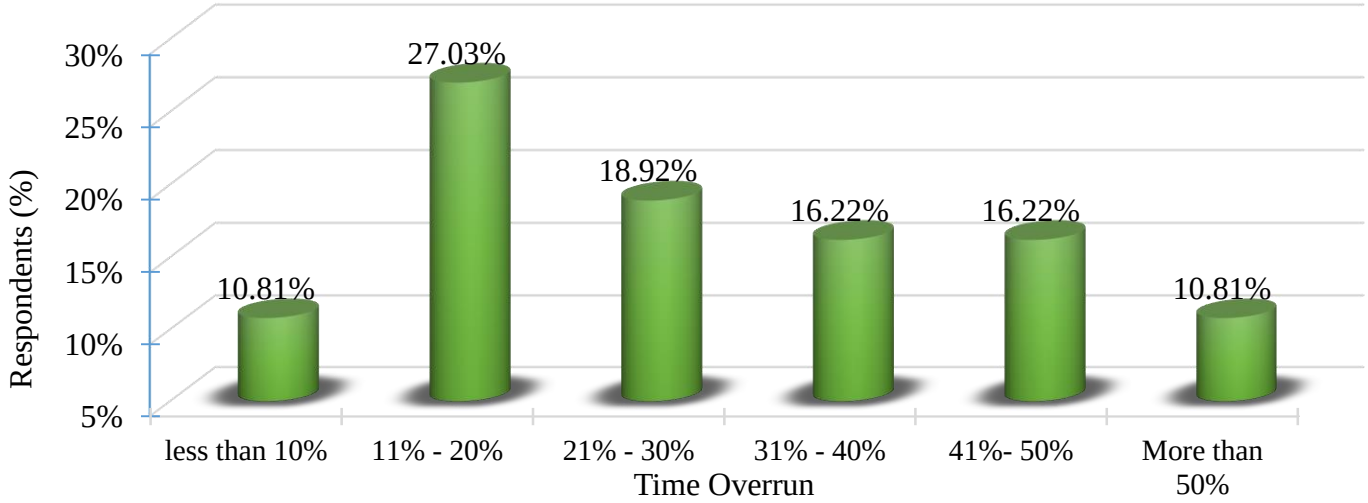

Figure 4.27: Impact of poor construction material management on building project time.

According to interview results, few of the interviewer the projects are in progress on the estimated project time. But most of the building projects have time overrun due to poor construction material management. The magnitude of impact is varied in percentage. Most of them agree the impact of poor construction material management is up to 20% - 30% of total project time. Only two interviewers agree more than 30% time overrun due to poor construction material management. Most of the interviewers thought that the impact of poor construction material management is similar in both building project cost and time in magnitude.

Therefore, effective construction material management is very important to overcome the above construction material management factors and using proper techniques to minimize building cost expenditure and time overrun. In Jimma town implementing an effective construction material management system very necessary to building construction projects.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Construction material management is a serious competency for the success of building construction projects. Even though there are best construction material management methods available theoretically those aids in the construction material management process. Most construction material managers still use individual and potentially inadequate execution in most of the construction material management decisions due to different factors, which is originated from internal and external factors. Generally, as the result obtained from the study and based on its specific objectives the following conclusions drawn:

Most building construction project contractors apply construction material techniques to monitoring construction material usually by using formal forms to record. Such as: providing material cards at the site store (Bin card) or store card (82.2%), recording the received materials on site (GRV) (71.1%) and providing materials purchase order (PR) (68.9%). However, most building construction projects not applied certain construction material management techniques usually in building construction projects. But, they used sometimes by using recording without formal form. Those are: -following up the prices in the market and recording the variation of prices (40%), reporting the construction material problems (40%). Most of the construction material management techniques are implemented in building construction project recording by using a form. But following up the prices in the market and recording the variation of prices are recording without formal forms. Also, all construction material management techniques used for monitoring construction materials, are not implemented by a computerized form in building projects. Building projects contractors faced high challenges during implementing construction material management techniques due to fluctuation in the price of construction materials (RII 0.83), material demand fluctuation (RII 0.80), material monopoly by supply (RII 0.74), overall suspensions that can incidentally due to peace of a country or town (RII 0.72) and lack of a systematic method to record and control materials during the construction phase with the manual method being preferred in projects (RII 0.71).

Construction material management has a high impact on building construction project cost due to materials price fluctuation(RII 0.80), delay in progress payment by owner(RII 0.78), design changes (RII 0.76), improper storing methods (RII 0.72), inadequate qualified & experienced staff (RII 0.71), Shortage of materials in the market (RII 0.71), an improper study on material availability study and its source (RII 0.71), excessive paperwork (RII 0.70), lack of communication between main office & site

office (RII 0.70) and misuse of the specification (RII 0.70). Also, design changes (RII 0.76), materials price fluctuation (RII 0.75), availability of specified construction materials in the market (RII 0.73), improper study on material availability study and its source (RII 0.70) and changes of materials specification during construction (RII 0.70) are high impact on building construction project time.

The progress of most of the building projects in Jimma town delays 11% - 20% of total project time and total project cost increases 11% - 20% of total project costs due to poor construction material management.

5.2. Recommendation

Based on the result of the study, to assess the impact of poor construction material management on building construction project cost and time and hereafter to minimize the impact of construction material management to project time and cost, the following important statements are recommended.

A. Recommendation for contractors

One of the most affected stakeholders by construction material management is contractors. Therefore, contractors should have used proper construction management techniques or tools to minimize building cost overrun and time overrun. However, a few contractors are not fully implemented. In generally recommended for contractors as follow: -

It is recommended that the existing material management techniques in use should be improved to minimize material cost fluctuations and construction materials shortage on-site when required on-site and this can be accomplished if: Contractors should be following up on the prices of construction materials in the market and recording the variation of prices usually are required, As much as possible construction material techniques method used by recording using computerized forms to minimize excessive paperwork and The site manager makes it compulsory to report the problems of construction materials usually on the site, like wastage and breakage of construction material, theft, and loss of construction material, shortage in deliveries of construction material, etc. to top project managers.

The following recommendations to the challenges facing contractors during implementing construction material management can be tackled and improved by: - Improving the relationship between construction enterprise and construction material supply, Proper planning and forecasting usually construction materials required for building construction projects by construction material management, Building construction contractors should minimize the interruption of brokers between the construction company and construction materials suppliers.

It recommends minimizing the impact of construction material management on building projects: - The enterprise should be forecasting construction materials prices usually, An enterprise should have proper storing methods at building construction sites, The enterprise should avoid misuse of the specification, The enterprise should have trained, adequately qualified and experienced staff in building construction project sites through proper and continuous training programs about building construction project performance, These can assist them to be more familiar with construction material management techniques and reducing mistakes during the construction stage, The enterprise should have to

investigate the availability and source of construction materials used for building construction, The enterprise should be minimized excessive paperwork at building construction sites by using computerized mechanize, The enterprise should have proper communication between the main office and the site office, The enterprise should investigate the availability of specified construction materials in the market during the feasibility study of projects and The enterprise should have adequate contingency allowances to cover increases in construction material costs.

B. Recommendation for owners

Other stakeholders affected by construction material management are the owners of the building constructed. Therefore, it is recommended to owners: - Pay progress payment to the contractors on time as it is a high impact on construction material management and providing of clear and brief explanation by the client before the designing stage to minimize design change.

C. Recommendation for consultants

It recommended for consultants: - Reducing design changes by proper feasibility study before the design stage, Make the effective involvement of all parties during the design stage and should be supervised the construction material storing method in a construction site.

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LIST OF APPENDIXES

Appendix -1: Field Survey Questionnaire

Questionnaire for data collection

Dear respondents

The purpose of this questionnaire and formats is to obtain information and data for the specified research conducted as partial fulfillment of the requirements for a master's degree in civil engineering (Construction Engineering and Management) at Jimma University.

Research Topic

Impact of poor construction material management on building construction project cost and time in Jimma town.

Objective

The purpose of this research is to assess the impact of poor construction material management on building construction project cost and time in Jimma town which leading a project to cost overrun and time overrun.

Confidentiality

The data collected and the information to be answered in this questionnaire will be used for academic research purpose only. All specific company and interviewee information will be kept confidential at all times. Only a generalized analysis of the information contained within this completed questionnaire will be utilized in the research process.

Instruction

Please answer, rate, and thick (✓) the questionnaire by choosing the appropriate choices. The questionnaire and data collection contain two sections. Section one contains the company and respondent's general information, section two deals with construction material management techniques, challenges facing contractors in the implementation of construction material management building construction projects and impact of poor construction material management on building construction project cost and time.

I realize that there are numerous demands on your time. However, your involvement is a vital requisite for this study. I appreciate your anticipated cooperation in answering this questionnaire, which may take less than 30 minutes of your valuable time.

Thank you for your earnest cooperation in advance.

Best Regards,

Sincerely yours

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SECTION A: - Background information about the respondents please use (√) in the relevant box for your response.

1. Gender. ☐ Female ☐ Male

2. Educational qualification.

☐ Diploma ☐ Adv. Diploma ☐ BSC ☐ MSC Other (Please specify) _____

3. Working experience (Years).

☐ 1-3 Yrs ☐ 4-6Yrs ☐ 7-10 Yrs ☐ >11Yrs

4. Type of your organization.

☐ Contractor ☐ Consultant ☐ Client

SECTION B: - please use (√) in the relevant space.

5. To what extent you evaluate the following application of construction material management techniques on the **frequency** and **method used** in your building construction projects?

No.	Construction material management techniques	Frequency			Method of used			
		Never used	Sometimes used	Usually used	Without recording (in memory)	Recording without Formal form	Recording by using A form	Recording by using Computerized form
1.	Daily recording of materials used in the project, the record illustrates for example (material name, material number, unit, used quantity, and the item in which the material is used).							
2.	Following up the prices in the market and recording the variation of prices.							
3.	Providing a list of materials in the project and recording of materials during construction, it includes for example (material name, material number, unit, and price).							
4.	Providing material cards at the site store that contain for example (input-output balance).							
5.	Providing materials purchase order including for example (order number material description, required quantity, and price).							
6.	Recording the received materials on site, the record shows for example (delivery number, material name, material description, and quantity).							
7.	Reporting the problems, for example (wastage and breakage, theft and loss, shortage in deliveries, etc.).							

8.	Reporting the situation of materials in the store, the report illustrates for example (supplier name, order number, quantity input, quantity output balance).							

6. To which extent you agree on the challenge facing contractors in the implementation of construction material management in building construction projects?

(1) Strongly disagree **(2)** Disagree **(3)** Neutral **(4)** Agree **(5)** Strongly agree

No.	Challenges facing contractors in implementation material management	1	2	3	4	5
1.	Lack of user-friendly construction materials software packages.					
2.	Lack of capable personnel in using computer-based materials management systems.					
3.	A lack of a systematic method to record and control materials during the construction phase with the manual method being preferred in projects.					
4.	Lack of understanding of construction materials management system.					
5.	Insufficient and poor production of raw material by the country.					
6.	Fluctuation in the price of materials.					
7.	Material monopoly by supply.					
8.	Material demand fluctuation.					
9.	Overall suspensions can incidentally due to the peace of a country or town.					
10.	Unpredictable weather conditions					
11.	Unstable government policies					
12.	Using new information technology.					

7. To which extent you evaluate the impact of factors affecting construction material management on building construction project cost?

(1) Very low **(2)** Low **(3)** Medium **(4)** High **(5)** Very high

No.	Factors	Impact on project cost				
		1	2	3	4	5
A.	**Site condition group**					
1.	Lack of communication between the main office and site office					
2.	Existence of unnecessary materials onsite					
3.	Improper storing methods					
4.	Lack of materials storage					
5.	Lack of security personnel on-site					
6.	Poor quality site documentation					
7.	Poor site layout					
8.	Severe weather conditions					
B.	**Planning and handling on-site group**					
1.	Insufficient instructions about handling materials onsite					
2.	Lack of a proper work plan					
3.	Lack of protection during unloading material					
4.	Rework due to mistakes					
5.	Storing materials in faraway stores					
6.	Wrong construction methods & improper handling of the project					

C.	**Management group**					
1.	Delay in progress payment by the owner					
2.	Misuse of the specification					
3.	Excessive paperwork					
4.	Improper study on material availability study and its source					
5.	Inadequate qualified & experienced staff					
6.	Inefficient communication in construction sites					
7.	Lack of supervision					
8.	Ordering errors					
9.	Poor use of advanced engineering design software					
10.	The poor financial status of a company					
11.	Taking off error					
12.	Accidents due to negligence					
D.	**Materials group**					
1.	Damage to material delivery and storage					
2.	Inappropriate materials delivery					
3.	Lack of quality construction materials					
4.	Material wastage exceeding the tolerance limit					
5.	Materials price fluctuation					
6.	Poor estimation of materials					
7.	Shortage of materials in the market					
E.	**Suppliers and manufacturers' default group**					
1.	Delay in materials delivery by suppliers					
2.	Lack of competent suppliers					
3.	Monopoly control by a particular supplier					
4.	Poor communication between contractor and material supplier					
5.	Shortage of supply of construction material required					
6.	Work stoppages at factories					
F.	**Transportation group**					
1.	Damage material during transportation					
2.	Un availability transportation to the site					
3.	On-site transportation difficulties					
4.	Equipment failure on site					
G.	**Contractual group**					
1.	Design changes					
2.	Ambiguous materials specification					
3.	Suspension of work					
4.	Changes of materials specification during construction					
5.	Unclear and inadequate details in material specification					
H.	**Governmental interference group**					
1.	Bureaucratic procedure					
2.	Changes in government regulation					

3.	Delay in custom clearance for imported materials					

8. To which extent you evaluate the impact of factors affecting construction material management on building construction project time?

(1) Very low **(2)** Low **(3)** Medium **(4)** High **(5)** Very high

No.	Factors	Impact on Project Time				
		1	**2**	**3**	**4**	**5**
A.	**Site condition group**					
1.	Lack of communication between the main office and site office					
2.	Poor site layout					
3.	Existence of unnecessary materials onsite					
4.	Poor security on site					
5.	Lack of materials storage					
6.	Materials stored far from the working area					
7.	Poor quality site documentation					
8.	Problem with neighbors					
9.	Severe weather conditions					
B.	**Planning and handling on-site group**					
1.	Insufficient instructions about handling materials onsite					
2.	Materials are damaged while handling on site					
3.	Rework due to mistakes					
4.	Storing materials in faraway stores					
5.	Wrong construction methods & improper handling of the project					
C.	**Management group**					
1.	Misuse of the specification					
2.	Excessive paperwork					
3.	Accidents due to negligence					
4.	Improper material usage					
5.	Improper study on material availability study and its source					
6.	Inadequate qualified & experienced staff					
7.	Inefficient communication in construction sites					
8.	Lack of supervision					
9.	Mistakes and delays in project design documents					
10.	Poor use of advanced engineering design software					
11.	Ordering errors					
12.	Poor procurement of construction materials					
13.	The poor financial status of a company					
14.	Takeoff error					
D.	**Materials group**					
1.	Availability of specified construction materials in the market					
2.	Inappropriate materials delivery					
3.	Damage of material on delivery and storage					
4.	Lack of quality construction materials					

5.	Poor estimation of materials					
6.	Materials price fluctuation					
7.	Scarcity because of the specificity					
8.	Time-lapse in testing and inspection					
E.	**Suppliers and manufacturers' default group**					
1.	Delay in materials delivery by suppliers					
2.	Lack of competent suppliers					
3.	Monopoly control by a particular supplier					
4.	Poor communication between contractor and material supplier					
5.	Shortage of supply of construction material required					
6.	Work stoppages at factories					
F.	**Transportation group**					
1.	Damage material during transportation					
2.	Transportation problems to the site					
3.	On-site transportation problems					
4.	Equipment failure on site					
G.	**Contractual group**					
1.	Design changes					
2.	Suspension of work					
3.	Ambiguous materials specification					
4.	Changes of materials specification during construction					
5.	Unclear and inadequate details in material specification					
H.	**Governmental interference group**					
1.	Bureaucratic procedure					
2.	Changes in government regulation					
3.	Delay in custom clearance for imported materials					

9. Did you participate in building construction projects that have experienced cost overrun due to construction material management recently? (If **YES** go to 10 and if **NO** go to 11).

☐ Yes ☐ No

10. If **yes**, what is the usual percentage of cost overrun to total project cost?

☐ Less than 10% ☐ 11% -20% ☐ 21% - 30%

☐ 31% -40% ☐ 41% -50% ☐ More than 50%

11. Did you participate in building construction projects that have experienced time overrun due to construction material management recently? (If **YES** go to 12).

☐ Yes ☐ No

12. If **yes**, what is the usual degree of time overrun to total project time?

☐ Less than 10% ☐ 11% -20% ☐ 21% -30%

☐ 31% - 40% ☐ 41% -50% ☐ More than 50%

Appendix -2: Interview

1. In your experience, what are the exciting construction material management techniques on your building construction projects?
2. In your opinion, what are the purpose of construction material management techniques in building construction projects?
3. In your opinion, what are the challenges facing contractors in using construction material management systems on your building construction projects?
4. In your experience, what do you think which construction material management factors have an impact on building construction project cost in your company?
5. In your experience, what do you think which construction material management factors have an impact on building construction project time in your company?
6. In your experience, what are the extents poor construction material management impact on building construction project cost in your company?
7. In your experience, what are the extents poor construction material management impact on building construction project time in your company?

Appendix -3: Survey Result

Annex A.1. Overall rank of factors affecting construction material management impact on building construction project cost.

Code	Factors	Impact on project cost					RII	Overall rank	Remark
		1	2	3	4	5			
D5	Materials price fluctuation	0	4	10	14	17	0.80	1	High
C1	Delay in progress payment by owner	2	2	13	10	18	0.78	2	High
G1	Design changes	1	2	14	15	13	0.76	3	High
A3	Improper storing methods	1	8	7	20	9	0.72	4	High
C5	Inadequate qualified & experienced staff	2	9	7	16	11	0.71	5	High
D7	Shortage of materials in market	2	6	12	15	10	0.71	5	High
C4	Improper study on material availability study and its source	2	3	17	15	8	0.71	5	High
C3	Excessive paperwork	1	5	15	18	6	0.70	8	High
A1	Lack of communication between main office and site office	3	2	17	16	7	0.70	8	High
C2	Misuse of the specification	2	7	11	17	8	0.70	8	High
D6	Poor estimation of materials	2	9	11	13	10	0.69	11	Average
B5	Storing materials in faraway stores	2	7	14	14	8	0.68	12	Average
E3	Monopoly control by particular supplier	2	4	18	15	6	0.68	12	Average
B2	Lack of a proper work plan	5	6	11	12	11	0.68	12	Average
E5	Shortage of supply of construction material required	1	6	15	20	3	0.68	12	Average
A4	Lack of materials storage	4	8	11	11	11	0.68	12	Average
E1	Delay in materials delivery by suppliers	2	7	13	18	5	0.68	12	Average
B4	Rework due to mistakes	3	8	13	13	8	0.67	18	Average
D3	Lack of quality construction materials	5	5	13	14	8	0.67	18	Average
D4	Material wastage exceeding the tolerance limit	2	5	19	14	5	0.67	18	Average
C7	Lack of supervision	6	5	11	15	8	0.66	21	Average
B6	Wrong construction methods & improper handling on project	5	8	7	19	6	0.66	21	Average
A5	Lack of security personnel on site	6	9	8	11	11	0.65	23	Average
C6	Inefficient communication in construction sites	3	10	12	13	7	0.65	23	Average
B1	Insufficient instructions about handling materials onsite	2	11	15	9	8	0.64	25	Average
A2	Existence of unnecessary materials onsite	2	9	15	16	3	0.64	25	Average
C9	Poor use of advanced engineering design software	5	10	11	9	10	0.64	25	Average
E6	Work stoppages at factories	2	11	12	16	4	0.64	25	Average
D2	Inappropriate materials delivery	2	11	12	17	3	0.64	25	Average
E2	Lack of competent suppliers	3	6	18	16	2	0.64	25	Average
A6	Poor quality site documentation	8	9	4	16	8	0.63	31	Average
B3	Lack of protection during unloading material	3	10	15	12	5	0.63	31	Average
E4	Poor communication between contractor and material supplier	5	7	16	11	6	0.63	31	Average
C8	Ordering errors	6	4	19	12	4	0.62	34	Average
C10	Poor financial status of a company	9	8	9	9	10	0.61	35	Average
D1	Damage to material delivery and storage	6	7	17	8	7	0.61	35	Average
G5	Unclear and inadequate details in material specification	5	7	18	10	5	0.61	35	Average
G4	Changes of materials specification during construction	4	9	18	10	4	0.60	38	Average
H3	Delay in custom clearance for imported materials	4	12	11	16	2	0.60	38	Average
A8	Severe weather conditions	6	5	24	6	4	0.59	40	Average
F3	On-site transportation difficulties	8	7	16	10	4	0.58	41	Average
H1	Bureaucratic procedure	4	12	17	9	3	0.58	41	Average
C12	Accidents due to negligence	3	16	12	12	2	0.57	43	Average
G2	Ambiguous materials specification	6	11	15	10	3	0.57	43	Average
F1	Damage material during transportation	5	11	18	9	2	0.56	45	Average

G3	Suspension of work	6	9	18	11	1	0.56	45	Average
C11	Take off error	10	8	12	11	4	0.56	45	Average
A7	Poor site layout	8	12	14	4	7	0.56	45	Average
F2	Un availability transportation to site	9	9	14	9	4	0.56	45	Average
F4	Equipment failure on site	11	8	13	10	3	0.54	50	Average
H2	Changes of government regulation	6	13	20	5	1	0.52	51	Average
	Overall impact						**0.643**		**Average**

Annex A.2. Rank in the group of factors affecting construction material management impact on building construction project cost.

Code	Factors	Impact on project cost					RII	Overall rank	Rank in group	Remark
		1	2	3	4	5				
A	**Site condition group**				**Average**		**0.64**			
A3	Improper storing methods	1	8	7	20	9	0.72	4	1	High
A1	Lack of communication between main office and site office	3	2	17	16	7	0.70	8	2	High
A4	Lack of materials storage	4	8	11	11	11	0.68	12	3	Average
A5	Lack of security personnel on site	6	9	8	11	11	0.65	23	4	Average
A2	Existence of unnecessary materials onsite	2	9	15	16	3	0.64	25	5	Average
A6	Poor quality site documentation	8	9	4	16	8	0.63	31	6	Average
A8	Severe weather conditions	6	5	24	6	4	0.59	40	7	Average
A7	Poor site layout	8	12	14	4	7	0.56	45	8	Average
B	**Planning and handling on-site group**				**Average**		**0.67**			
B5	Storing materials in faraway stores	2	7	14	14	8	0.68	12	1	Average
B2	Lack of a proper work plan	5	6	11	12	11	0.68	12	2	Average
B4	Rework due to mistakes	3	8	13	13	8	0.67	18	3	Average
B6	Wrong construction methods & improper handling on project	5	8	7	19	6	0.66	21	4	Average
B1	Insufficient instructions about handling materials onsite	2	11	15	9	8	0.64	25	5	Average
B3	Lack of protection during unloading material	3	10	15	12	5	0.63	31	6	Average
C	**Management group**				**Average**		**0.66**			
C1	Delay in progress payment by owner	2	2	13	10	18	0.78	2	1	High
C5	Inadequate qualified & experienced staff	2	9	7	16	11	0.71	5	2	High
C4	Improper study on material availability study and its source	2	3	17	15	8	0.71	5	2	High
C3	Excessive paperwork	1	5	15	18	6	0.70	8	4	High
C2	Misuse of the specification	2	7	11	17	8	0.70	8	4	High
C7	Lack of supervision	6	5	11	15	8	0.66	21	6	Average
C6	Inefficient communication in construction sites	3	10	12	13	7	0.65	23	7	Average
C9	Poor use of advanced engineering design software	5	10	11	9	10	0.64	25	8	Average
C8	Ordering errors	6	4	19	12	4	0.62	34	9	Average
C10	Poor financial status of a company	9	8	9	9	10	0.61	35	10	Average
C12	Accidents due to negligence	3	16	12	12	2	0.57	43	11	Average
C11	Take off error	10	8	12	11	4	0.56	45	12	Average
D	**Materials group**				**Average**		**0.69**			
D5	Materials price fluctuation	0	4	10	14	17	0.80	1	1	High
D7	Shortage of materials in market	2	6	12	15	10	0.71	5	2	High
D6	Poor estimation of materials	2	9	11	13	10	0.69	11	3	Average
D3	Lack of quality construction materials	5	5	13	14	8	0.67	18	4	Average
D4	Material wastage exceeding the tolerance limit	2	5	19	14	5	0.67	18	4	Average
D2	Inappropriate materials delivery	2	11	12	17	3	0.64	25	6	Average
D1	Damage to material delivery and storage	6	7	17	8	7	0.61	35	7	Average
E	**Suppliers and manufacturers' default group**				**Average**		**0.65**			
E3	Monopoly control by particular supplier	2	4	18	15	6	0.68	12	1	Average
E5	Shortage of supply of construction material required	1	6	15	20	3	0.68	12	1	Average

E1	Delay in materials delivery by suppliers	2	7	13	18	5	0.68	12	1	Average
E6	Work stoppages at factories	2	11	12	16	4	0.64	25	4	Average
E2	Lack of competent suppliers	3	6	18	16	2	0.64	25	4	Average
E4	Poor communication between contractor and material supplier	5	7	16	11	6	0.63	31	6	Average
F	**Transportation group**				**Average**		**0.55**			
F3	On-site transportation difficulties	8	7	16	10	4	0.58	41	1	Average
F1	Damage material during transportation	5	11	18	9	2	0.56	45	2	Average
F2	Un availability transportation to site	9	9	14	9	4	0.56	45	2	Average
F4	Equipment failure on site	11	8	13	10	3	0.54	50	4	Average
G	**Contractual group**				**Average**		**0.62**			
G1	Design changes	1	2	14	15	13	0.76	3	1	High
G2	Ambiguous materials specification	6	11	15	10	3	0.57	43	2	Average
G5	Unclear and inadequate details in material specification	5	7	18	10	5	0.61	35	3	Average
G4	Changes of materials specification during construction	4	9	18	10	4	0.60	38	4	Average
G3	Suspension of work	6	9	18	11	1	0.56	45	5	Average
H	**Governmental interference group**				**Average**		**0.56**			
H3	Delay in custom clearance for imported materials	4	12	11	16	2	0.60	38	1	Average
H1	Bureaucratic procedure	4	12	17	9	3	0.58	41	2	Average
H2	Changes of government regulation	6	13	20	5	1	0.52	51	3	Average

Annex A.3. Overall ranks of Factors affecting construction material management impact on building construction project time

Code	Factors	1	2	3	4	5	RII	Overall rank	Remark
G1	Design changes	0	4	11	19	11	0.76	1	high
D6	Materials price fluctuation	1	4	8	24	8	0.75	2	high
D1	Availability of specified construction materials in market	0	5	15	16	9	0.73	3	high
C5	Improper study on material availability study and its source	2	4	15	18	6	0.70	4	high
G4	Changes of materials specification during construction	3	7	10	17	8	0.70	5	high
C8	Lack of supervision	2	10	10	15	8	0.68	6	Average
D5	Poor estimation of materials	1	12	10	13	9	0.68	6	Average
A3	Existence of unnecessary materials onsite	2	8	15	13	7	0.67	8	Average
D4	Lack of quality construction materials	2	11	10	15	7	0.66	9	Average
D7	Scarcity because of the specificity	1	7	19	13	5	0.66	9	Average
D2	Inappropriate materials delivery	3	6	20	7	9	0.66	9	Average
E2	Lack of competent suppliers	4	5	13	21	2	0.65	12	Average
E3	Monopoly control by particular supplier	5	5	13	18	4	0.65	12	Average
E5	Shortage of supply of construction material required	4	4	17	18	2	0.64	14	Average
C6	Inadequate qualified & experienced staff	5	10	8	15	7	0.64	14	Average
C11	Ordering errors	4	12	11	10	8	0.63	16	Average
C4	Improper material usage	2	12	12	16	3	0.63	16	Average
C9	Mistakes and delays in project design documents	6	7	11	17	4	0.63	16	Average
E1	Delay in materials delivery by suppliers	4	11	11	14	5	0.62	19	Average
G2	Suspension of work	2	9	19	12	3	0.62	19	Average
B3	Rework due to mistakes	4	9	17	9	6	0.62	19	Average
E4	Poor communication between contractor and material supplier	7	4	17	12	5	0.62	19	Average
A1	Lack of communication between main office and site office	9	2	17	12	5	0.61	23	Average
A5	Lack of materials storage	7	5	14	17	2	0.61	23	Average
C1	Misuse of the specification	7	7	13	13	5	0.61	23	Average
C2	Excessive paperwork	4	9	17	11	4	0.61	23	Average
C7	Inefficient communication in construction sites	6	7	12	19	1	0.61	23	Average
B5	Wrong construction methods & improper handling on project	6	9	14	10	6	0.60	28	Average

D3	Damage of material on delivery and storage	3	11	16	12	3	0.60	28	Average
A6	Materials stored far from working area	3	13	12	15	2	0.60	28	Average
D8	Time lapse in testing and inspection	1	14	17	10	3	0.60	28	Average
C12	Poor procurement of construction materials	7	9	11	14	4	0.60	28	Average
E6	Work stoppages at factories	4	11	14	14	2	0.60	28	Average
H3	Delay in custom clearance for imported materials	6	9	13	14	3	0.60	28	Average
B1	Insufficient instructions about handling materials onsite	6	11	12	11	5	0.59	35	Average
G5	Unclear and inadequate details in material specification	5	12	14	8	6	0.59	35	Average
B2	Materials are damaged while handling on site	5	11	13	14	2	0.59	35	Average
C10	Poor use of advanced engineering design software	5	10	15	13	2	0.59	35	Average
A2	Poor site layout	5	13	13	9	5	0.58	39	Average
A7	Poor quality site documentation	5	9	19	9	3	0.58	39	Average
C14	Take off error	5	14	14	5	7	0.58	39	Average
F4	Equipment failure on site	6	9	16	12	2	0.58	39	Average
F3	On-site transportation problems	6	12	14	8	5	0.57	43	Average
A8	Problem with neighbors	7	12	11	11	4	0.57	43	Average
A9	Severe weather conditions	7	10	16	8	4	0.56	45	Average
H1	Bureaucratic procedure	7	10	12	16	0	0.56	45	Average
C13	Poor financial status of a company	7	14	10	9	5	0.56	45	Average
F1	Damage material during transportation	6	13	13	10	3	0.56	45	Average
B4	Storing materials in faraway stores	6	11	18	7	3	0.56	45	Average
A4	Poor security on site	8	15	11	5	6	0.54	50	Average
G3	Ambiguous materials specification	6	10	22	6	1	0.54	50	Average
C3	Accidents due to negligence	7	17	7	12	2	0.53	52	Average
F2	Transportation problems to site	8	9	20	6	2	0.53	52	Average
H2	Changes of government regulation	12	7	20	5	1	0.49	54	low
	Overall impact						**0.613**		Average

Annex A.4. Rank in the group of factors affecting construction material management impact on building construction project time

Code	Factors	Impact on Project Time					RII	Overall rank	Rank in group	Remark
		1	2	3	4	5				
A	**Site condition group**					**Average**	**0.59**			
A3	Existence of unnecessary materials onsite	2	8	15	13	7	0.67	8	1	Average
A1	Lack of communication between main office and site office	9	2	17	12	5	0.61	23	2	Average
A5	Lack of materials storage	7	5	14	17	2	0.61	23	2	Average
A6	Materials stored far from working area	3	13	12	15	2	0.60	28	4	Average
A2	Poor site layout	5	13	13	9	5	0.58	39	5	Average
A7	Poor quality site documentation	5	9	19	9	3	0.58	39	5	Average
A8	Problem with neighbors	7	12	11	11	4	0.57	43	7	Average
A9	Severe weather conditions	7	10	16	8	4	0.56	45	8	Average
A4	Poor security on site	8	15	11	5	6	0.54	50	9	Average
B	**Planning and handling on-site group**					**Average**	**0.59**			
B3	Rework due to mistakes	4	9	17	9	6	0.62	19	1	Average
B5	Wrong construction methods & improper handling on project	6	9	14	10	6	0.60	28	2	Average
B1	Insufficient instructions about handling materials onsite	6	11	12	11	5	0.59	35	3	Average
B2	Materials are damaged while handling on site	5	11	13	14	2	0.59	35	3	Average
B4	Storing materials in faraway stores	6	11	18	7	3	0.56	45	5	Average
C	**Management group**					**Average**	**0.61**			
C5	Improper study on material availability study and its source	2	4	15	18	6	0.70	4	1	High
C8	Lack of supervision	2	10	10	15	8	0.68	6	2	Average
C6	Inadequate qualified & experienced staff	5	10	8	15	7	0.64	14	3	Average

C11	Ordering errors	4	12	11	10	8	0.63	16	4	Average
C4	Improper material usage	2	12	12	16	3	0.63	16	4	Average
C9	Mistakes and delays in project design documents	6	7	11	17	4	0.63	16	4	Average
C1	Misuse of the specification	7	7	13	13	5	0.61	23	7	Average
C2	Excessive paperwork	4	9	17	11	4	0.61	23	7	Average
C7	Inefficient communication in construction sites	6	7	12	19	1	0.61	23	7	Average
C12	Poor procurement of construction materials	7	9	11	14	4	0.60	28	10	Average
C10	Poor use of advanced engineering design software	5	10	15	13	2	0.59	35	11	Average
C14	Take off error	5	14	14	5	7	0.58	39	12	Average
C13	Poor financial status of a company	7	14	10	9	5	0.56	45	13	Average
C3	Accidents due to negligence	7	17	7	12	2	0.53	52	14	Average
D	**Materials group**					**Average**	**0.67**			
D6	Materials price fluctuation	1	4	8	24	8	0.75	2	1	High
D1	Availability of specified construction materials in market	0	5	15	16	9	0.73	3	2	High
D5	Poor estimation of materials	1	12	10	13	9	0.68	6	3	Average
D4	Lack of quality construction materials	2	11	10	15	7	0.66	9	4	Average
D7	Scarcity because of the specificity	1	7	19	13	5	0.66	9	4	Average
D2	Inappropriate materials delivery	3	6	20	7	9	0.66	9	4	Average
D3	Damage of material on delivery and storage	3	11	16	12	3	0.60	28	7	Average
D8	Time lapse in testing and inspection	1	14	17	10	3	0.60	28	7	Average
E	**Suppliers and manufacturers' default group**					**Average**	**0.63**			
E2	Lack of competent suppliers	4	5	13	21	2	0.65	12	1	Average
E3	Monopoly control by particular supplier	5	5	13	18	4	0.65	12	1	Average
E5	Shortage of supply of construction material required	4	4	17	18	2	0.64	14	3	Average
E1	Delay in materials delivery by suppliers	4	11	11	14	5	0.62	19	4	Average
E4	Poor communication between contractor and material supplier	7	4	17	12	5	0.62	19	4	Average
E6	Work stoppages at factories	4	11	14	14	2	0.60	28	6	Average
F	**Transportation group**					**Average**	**0.56**			
F4	Equipment failure on site	6	9	16	12	2	0.58	39	1	Average
F3	On-site transportation problems	6	12	14	8	5	0.57	43	2	Average
F1	Damage material during transportation	6	13	13	10	3	0.56	45	3	Average
F2	Transportation problems to site	8	9	20	6	2	0.53	52	4	Average
G	**Contractual group**					**Average**	**0.64**			
G1	Design changes	0	4	11	19	11	0.76	1	1	High
G4	Changes of materials specification during construction	3	7	10	17	8	0.70	5	2	High
G2	Suspension of work	2	9	19	12	3	0.62	19	3	Average
G5	Unclear and inadequate details in material specification	5	12	14	8	6	0.59	35	4	Average
G3	Ambiguous materials specification	6	10	22	6	1	0.54	50	5	Average
H	**Governmental interference group**					**Average**	**0.55**			
H3	Delay in custom clearance for imported materials	6	9	13	14	3	0.60	28	1	Average
H1	Bureaucratic procedure	7	10	12	16	0	0.56	45	2	Average
H2	Changes of government regulation	12	7	20	5	1	0.49	54	3	Low

Appendix -4: Sample building projects

Projects	Contractors		Consultants		Clients	
	Distributed questionnaires	Received questionnaires	Distributed questionnaires	Received questionnaires	Distributed questionnaires	Received questionnaires
Project 1	2	2	1	1	0	0
Project 2	4	4	1	1	1	1
Project 3	4	3	1	1	1	1
Project 4	3	2	2	2	0	0
Project 5	3	3	1	1	1	1
Project 6	2	2	1	1	1	1
Project 7	4	3	1	0	1	0
Project 8	2	2	0	0	1	1
Project 9	1	1	0	0	0	0
Project 10	1	1	1	1	0	0
Project 11	2	1	0	0	0	0
Project 12	1	1	0	0	0	0
Project 13	1	1	0	0	0	0
Project 14	1	1	0	0	0	0
Project 15	1	1	0	0	0	0
Project 16	2	2	1	1	1	0
Project 17	1	1	0	0	0	0
Project 18	1	0	1	0	0	0
Project 19	1	0	0	0	1	0
Total	37	**31**	11	**9**	8	**5**

Appendix -5: Data reliability and validity test result

Annex A.5. Data consistency (reliability test) result.

Questionnaire Codes	C-Alpha	Remarks
6 (1-12)	0.787	Highly Reliable
7 A (1-8)	0.817	Highly Reliable
7 B (1-6)	0.838	Highly Reliable
7 C (1-12)	0.828	Highly Reliable
7 D (1-7)	0.769	Highly Reliable
7 E (1-6)	0.772	Highly Reliable
7 F (1-4)	0.765	Highly Reliable
7 G (1-5)	0.727	Highly Reliable
7 H (1-3)	0.820	Highly Reliable
8 A (1-9)	0.876	Highly Reliable
8 B (1-5)	0.809	Highly Reliable
8 C 1-14)	0.912	Highly Reliable
8 D (1-8)	0.810	Highly Reliable
8 E (1-6)	0.855	Highly Reliable
8 F (1-4)	0.866	Highly Reliable
8 G (1-5)	0.793	Highly Reliable
8 H (1-3)	0.814	Highly Reliable

Annex A.6: Validity test result.

Questionnaire Codes	Minimum t_{count}	t_{table}	Remarks
6 (1-12)	3.062	0.294	Valid
7 A (1-8)	3.449	0.294	Valid
7 B (1-6)	5.551	0.294	Valid
7 C (1-12)	1.461	0.294	Valid
7 D (1-7)	2.438	0.294	Valid
7 E (1-6)	4.287	0.294	Valid
7 F (1-4)	6.551	0.294	Valid
7 G (1-5)	2.831	0.294	Valid
7 H (1-3)	10.784	0.294	Valid
8 A (1-9)	3.3106	0.294	Valid
8 B (1-5)	5.489	0.294	Valid
8 C (1-14)	3.786	0.294	Valid
8 D (1-8)	4.739	0.294	Valid
8 E (1-6)	4.292	0.294	Valid
8 F (1-4)	7.984	0.294	Valid
8 G (1-5)	4.705	0.294	Valid
8 H (1-3)	9.614	0.294	Valid

Appendix -6: Reference T table

t_{table} (Pearson Product Moment) (Level of Significance 0.05 and 2 Tailed).

N	t_{table}	N	t_{table}	N	t_{table}	N	t_{table}
3	0.997	**23**	0.413	**43**	0.301	**63**	0.248
4	0.95	**24**	0.404	**44**	0.297	**64**	0.246
5	0.878	**25**	0.396	**45**	0.294	**65**	0.244
6	0.811	**26**	0.388	**46**	0.291	**66**	0.242
7	0.755	**27**	0.381	**47**	0.288	**67**	0.24
8	0.707	**28**	0.374	**48**	0.285	**68**	0.239
9	0.666	**29**	0.367	**49**	0.282	**69**	0.237
10	0.632	**30**	0.361	**50**	0.279	**70**	0.235
11	0.602	**31**	0.355	**51**	0.276	**71**	0.233
12	0.576	**32**	0.349	**52**	0.273	**72**	0.232
13	0.553	**33**	0.344	**53**	0.27	**73**	0.23
14	0.532	**34**	0.339	**54**	0.268	**74**	0.229
15	0.514	**35**	0.334	**55**	0.265	**75**	0.227
16	0.497	**36**	0.329	**56**	0.263	**76**	0.226
17	0.482	**37**	0.325	**57**	0.261	**77**	0.224
18	0.468	**38**	0.32	**58**	0.258	**78**	0.223
19	0.456	**39**	0.316	**59**	0.256	**79**	0.221
20	0.444	**40**	0.312	**60**	0.254	**80**	0.22
21	0.433	**41**	0.308	**61**	0.252		

(Priyatno, 2009)