JIMMA UNIVERSITY

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF GRADUATE STUDIES

FACULTY OF CIVIL AND ENVIROMENTAL ENGINEERING

CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

ASSESSMENT ON SUPPLY MANAGEMENT OF CONSTRUCTION MATERIALS IN ETHIOPIAN ROADS AUTHORITY, JIMMA DISTRICT

A thesis paper presented to the school of graduate studies; Jimma University, Jimma Institute of Technology, JIT in partial fulfillment of the requirement for the degree of Master of Science in Civil Engineering (Construction Engineering and Management)

BY

SULTAN SANO DEFO

JANUARY, 2022

JIMMA, ETHIOPIA

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Assessment On Supply Management Of Construction Materials In Ethiopia Roads Authority, Jimma District

BY

SULTAN SANO

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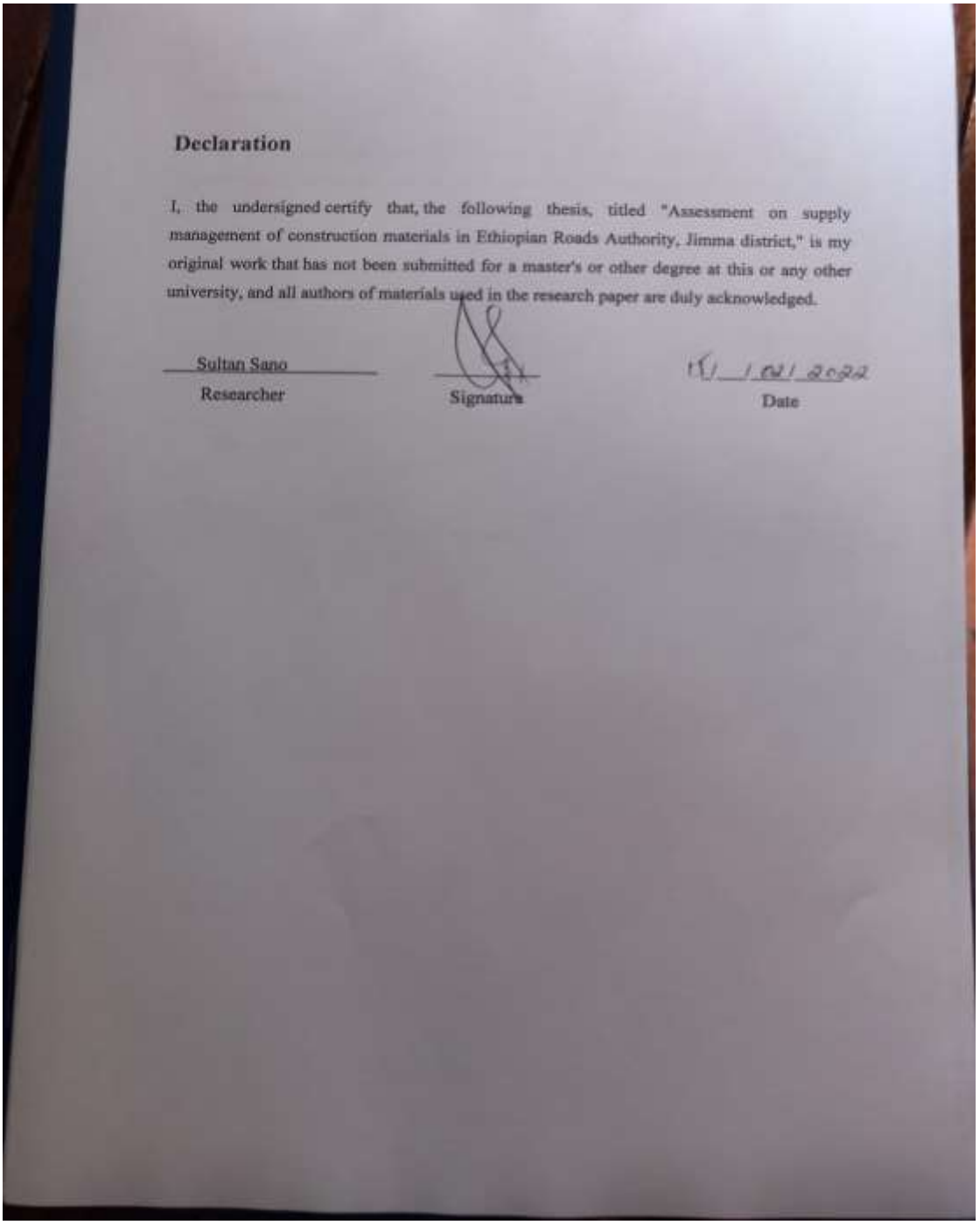

Declaration

I, the undersigned certify that, the following thesis, titled "Assessment on supply management of construction materials in Ethiopian Roads Authority, Jimma district," is my original work that has not been submitted for a master's or other degree at this or any other university, and all authors of materials used in the research paper are duly acknowledged.

Sultan Sano — Researcher

Signature

15/ 08/ 2022 — Date

Abstract

Construction sector is an icon for the drive of economy. However, its quality and performance are still under development, and the area need good management and technological support for an economic success of developing countries. One of the activities in construction projects that used to ensure the success of construction project is efficient Supply management of construction materials. Nevertheless, supply management problem of construction materials in construction project affects projects in several ways. The objective of this study was to assess supply management problem of construction materials in Ethiopian Roads Authority, Jimma district. The study included desk study, physical observation, questionnaire survey, and interview. A total of ninety questionnaire surveys were distributed to 60 Own force road maintenance, Jimma district, 15 to Jimma road network and safety management branch directorate and 15 to consultants. A total of 84 questionnaire surveys were returned: 58 (96.67 %) from Own force road maintenance Jimma District, 14 (93.33 %) from Jimma road network and safety management branch directorate and 12 (80%) from consultants. The data gathered was analyzed and interpreted using descriptive statistics method. Based on the study, the finding of study revealed that: the critical factors that most frequently contributing to Supply management problem of construction materials in Ethiopian Roads Authority Jimma District are: Planning and Scheduling problem (RII=0.83), Low speed of decision making/slow permits of government agencies (RII=0.81), Financial difficulties (RII=0.80), Price escalation (RII=0.80), Late delivery (RII=0.78), Unavailability of required materials on market (RII=0.76), Deficiency in coordination and top management support (RII=0.74), Problem in sequencing of work according to schedule (RII=0.73), and Lack of performance measurement for construction supply management (RII=0.73). The major impacts of supply management problem of construction materials on Jimma District are: Delay in project delivery (RII=0.78), Excessive cost of construction (RII=0.76), Work interruption (RII=0.75), Inefficient construction method (RII=0.74), Poor public image (RII=0.74), Poor quality construction (RII=0.73), and Low client satisfaction (RII=0.73). The recommended potential techniques to improve Supply management of construction materials in Jimma District are: Top management support (RII=0.79), Applying Balanced scorecard (RII=0.78), Applying integrated and systematic construction supply management system (RII=0.78), Free flow of information (RII=0.77), Just-in-time delivery (RII=0.76), Applying information and communication technology (RII=0.76), and Using supply chain operation reference model's performance measurement (RII=0.76). For efficient Supply management of construction materials, an integrated process is needed to ensure the projects to be finished on time, within the budget, and within the scope of contract specifications. Generally, the findings of the thesis recommended that, it would be better if the construction sector applies a modern supply management system of construction materials, and it would be good if each sector should have a site supply plan guide. Finally it is hoped that, the outcomes the thesis would help to guide the future attempts to improve supply management of construction materials in ERA, Jimma District.

Key words: Performance of supply management, Supply management efficiency, Factors contributing to supply management problem, Impacts of supply management problem, Potential techniques to improve supply management.

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First and foremost, I would like to express my gratitude to Almighty God "Allah," whose generosity, mercy, kindness, and assistance are immeasurable. Second, I would like to express my gratitude to Engineer Mamuye Busier, my respective adviser, for his invaluable counsel, continual encouragement, professional assistance, and guidance. My sincere gratitude also goes to my Co-Advisor, Engineer Kemal Ture, for his insightful suggestions and comments. Next, I would like to convey my heartfelt gratitude to Engineer Mamaru Desalegn for his invaluable cooperation and support. I would also like to express my gratitude to every one of my friends and family members who have contributed to the success of the research. In addition, I would like to extend my gratitude to the stream of Construction Engineering and Management at Jimma Institute Technology, Jimma University, for making all of the required arrangements during my stay. Finally, I would like to thank all who have worked tirelessly to make the program a reality, especially Jimma University, Jimma Institute Technology, and Ethiopian Roads Authority who is the sponsor of the program.

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Acronyms

5S	Sort, Straighten, Standardize, Shine, Sustain
5Whys	Why?, Where?, When?, Who?, What?
CCC	Construction consolidation center
CS	Cost to source
EC	Ethiopian Calendar
ERA	Ethiopian Roads Authority
GC	Gregorian calendar
ICT	Information and communication technology
JIT	Just- In- Time
JRNSMBD	Jmma Road Network and Safety Management branch directorate
OFRMJD	Own force road maintenance Jimma district
OMP	On- site market place
PDCA	Plan, Do, Check, Action
POF	Perfect order fulfillment
RFID	Radio frequency identification
RII	Relative Importance Index
SCOR	Supply Chain Operation Reference
SCT	Source cycle time
SMED	Single Minute Exchange of die
SQC	Statistical quality control
TPM	Total productive maintenance
VSM	Value Stream Mapping

CHAPTER ONE

1. Introduction

1.1 Back Ground

Construction industry contributes significantly to a country's infrastructural development in order to boost economic growth. According to Yimam (2011), construction sectors took 80% of total asset, 10% of growth development plan and over 50% fixed asset of economy of developing country. At same time, construction sector is one of the key sectors which could create employment opportunity for citizens by which they support their families (Ofori, 2006, Jekale, 2004), and it implies that, construction plays a valuable role for economic development. But in another way, even if the sector being seen as an icon for the drive of economy, its quality and performance are still under development and the area needs good management and technological support for the economic success of developing countries. Due to poor management and performance of construction sectors in developing countries, most of the construction projects are not completed in planed completion time, budget, and within scope of contract specification. A failure of fulfilling planned time, budget, and scope of contract specification leads projects to unexpected extra cost. Even sometimes, some of the projects could be terminated because of the delay that causes project extra cost (Idoko, 2008, Almohsen and Ruwanpura, 2011). Most of construction projects lose their productivity due to poor supply management in construction (controlling flow of construction inputs from point of discharge to point of installation or use (The European Construction, 1994). Supply Management is an icon for a success of construction companies. In contrary to this, inefficient supply management has a negative impact on performance and success of the sector, and it is essentially appealing when considering that construction is a process characterized by high degrees of fracture, and where the compelling integration, coordination, and management of the system, is a necessary requirement for achieving excellent results (Alfredo, S. and Boris, H., 2014). Some benefits of construction supply management are: cost reduction, competitive advantages, productivity improvement, value creation and better relationships between parties [Roth and Martin (2000); Proverbs and Holt (2000); Landry (1998) and Christopher (1992)]. Effectiveness of construction supply management is evaluated with its potential benefits to the

construction industry. In spite of the fact that construction process is diversified, Supply Management could be useful and effective in construction (O'Brien, 1999). Furthermore, construction is a process with strong fragmentation evidenced by the lack of integration of supply; a fact that makes Supply Management an enticing way to achieve integration between internal and external suppliers, designers, contractors, subcontractors and internal and external clients. On construction sites, ineffective management and poor flow of construction inputs will result ultimately in project delays and cost overruns. Agapiou et al. (1998) stated that "Managing flow of materials, assuring its quality, checking a quantity, allocating the storage areas, coordinating the overall process, triggering the orders, and updating the participants are major obstacles in construction supply management". Accordingly, ensuring material quality and quantity, proper management of storage place and coordination of activities on the site, giving on time order, providing timely information should be considered as supply management activities where problems are noticed in construction sites. Related to these problems, many researchers put an attempt that the problem with construction inputs is still the question of supply management problem in construction sectors that has not received attention as needed. The problems in supply management lead many of construction projects not to complete within time and within expected budget (Regassa, 2015). Supply management problems in construction does not only result in delayed projects but also gives a poor image of the construction industries. The study by Matouzko (2015) confirmed that "the impacts of supply management problems of construction materials are underestimated by construction companies, and it has impacts on working environment. Even some leading construction companies are not aware of how significant the impacts of supply management problems of construction materials in construction project". Therefore, this research has tried to assess supply management problem of construction materials in ERA, Jimma District, and it has recommended some potential techniques that will improve supply management of construction materials in ERA, Jimma district.

1.2 Statement of the Problem

Ethiopian road infrastructure development is very weak in quality and quantity as road infrastructures require huge amount of money, machinery, skilled manpower and high quality of management skills. As a result, a performance of road construction activities riddle the government, policy makers and regulators, international development financers, and practitioners in the field considerably. Supply management problem is being one major problem in construction sector, and these should need further research to identify its real effects, and the solutions on how to minimize the problems (Matouzko and Methanivesana, 2012). Ethiopian contractors lack efficient supply management of construction projects with the required quality, efficiency, and effectiveness; they also lack supply management expertise; as a consequence, their projects eventually end up in low quality, time consuming and high cost. Most of Ethiopian construction sectors encounter the problem of delay, cost overrun, and poor quality delivery (Regassa, 2015). Finally, the effects of supply management problem of construction materials on road construction projects are becoming commendable practices in Ethiopia in general, and in Ethiopian Roads Authority, Jimma district in particular. Delay of project delivery, Cost overruns, Loss of project efficiency, Poor quality construction, and Material loss are the effects of supply management problem of construction materials those identified as the major problems in Ethiopian Roads Authority, Jimma district. In order to optimize this, it is important to assess the causes and effects of supply management problem of construction materials in ERA, Jimma district to set a possible future ground for further development.

1.3 Research Questions

The study intended to answer the following questions:

1. What are the main contributing factors to supply management problem of construction materials in ERA, Jimma district?
2. What are the impacts of supply management problem of construction materials on ERA, Jimma district?
3. What are the potential techniques to improve supply management of construction materials in ERA, Jimma District?

1.4 Objective of the study

1.4.1 General Objective

The main objective of the thesis is, to assess supply management problem of construction materials in ERA, Jimma District.

1.4.2 Specific Objectives

1. To identify the significant factors contributing to supply management problem of construction materials in ERA, Jimma District.
2. To investigate the impacts of supply management problem of construction materials on ERA, Jimma District.
3. To determine the potential techniques to improve construction materials supply management of ERA, Jimma District.

1.5 Significance of the study

Most construction projects are not delivered within the planned schedule and expected construction costs due to problematic supply management of construction materials. When the projects have delayed, construction costs are increasing as well. Because of this, most construction projects in Ethiopia incur extra costs that suffer client, government, and community as whole. Knowing each impacts of problematic supply management of construction materials that leads construction projects to productivity lose, and ensuring the efficiency of the subject area is a crucial factor to safeguard construction projects from time and cost overrun. With having this perspective, the primary benefit of this research is, to provide additional scientific knowledge that enables the stakeholders to know the causes and effects of supply management problem of construction materials on road projects, particularly ERA, Jimma district. Moreover, it promotes to develop alternative potential techniques those improve construction materials supply management in ERA, Jimma district.

1.6 Scope and challenges of the study

The study area was limited to road projects in Ethiopian Roads Authority, Jimma district, and the research was limited to the factors affecting supply management of construction materials, the impacts of construction materials supply management problem, and the potential techniques to improve supply management of construction materials in ERA, Jimma district. During conducting the research, the researcher faced a number of problems and challenges. Some of the respondents especially consultants and regulatory body did not return the questionnaires as per the planned schedule. The collection of archival documents and project reports was very exhaustive, because, it has been difficult to obtain the accurate records in full package due to poor documentation techniques in the district and they do not provide sufficient information about the research.

CHAPTER TWO

2. Literature Review

2.1 Definition of Supply Management

Supply management is an integrated approach starting with planning and control of materials, logistics, services, and information stream from suppliers to manufacturers or service providers to the end client (Fantazy et al., 2010).

Supply management is an integration of business processes from end user through original supplies that provides products, services and information that add value to customers (Galaskiewicz, 2011; Cooper et al., 1993).

2.2 Concept and Basics of supply management within Construction projects

Over the past decades, there has been a rising accentuation on supply management as a device through which firms can achieve competitive advantage in markets.

According to Lu, D. (2011) the earliest appearance of the term 'supply management' as we know it today published in recognizable media and literatures can be followed back to the early 1980s. More absolutely, it first appeared in a Financial Times article written by Oliver and Webber in 1982 determining the range of activities performed by the organization in procuring and managing supplies. Nevertheless, the early publications of supply management in the 1980s were mainly focused on purchasing activities and cost reduction related activities. The major development and the critical increments of publications in the areas of supply integration and supplier-buyer relationship came in 1990s when the concept as we know it nowadays was sluggishly established. It is therefore clear that supply management is not one of the legacy of academic subjects existed for hundreds or thousands of years, but rather a young and even nascent subject. The survival of any business nowadays is not exclusively subordinate on its claim capacity to compete but rather on the ability to cooperate within the supply chain. What's more practical and indeed more assured way of better managing a business is to manage supplies through appropriate strategic positioning, satisfactory structural setup, collaboration, integration and leadership.

Supply management is one of the foremost viable ways for firms to enhance their accomplishment (Ou et al., 2010). The major objectives of supply management are operational cost, time and response, customer services, or profitability and margins (Nuthall,

2003). Again, the short-term objective of supply management is to enhance productivity and minimize inventory and cycle time, while the long-term objective is to improve customer satisfaction, market share, and profits (Tan, 2002). Supply management is recognized as a crucial area for information technology innovation and investment (Bowersox and Daugherty, 1995). The narrow focus of managers and adversarial relationships between logistics providers, suppliers, and customers are replaced with strategic alliances and long-term cooperative relationships, as well as viewing suppliers and customers as partners rather than adversaries, with the implementation of supply management (Tan et al., 1998) with the objective of ‘‘maximizing competitiveness and profitability for the company as well as the end-customer’’ (Lambert et al., 1998, p. 4). Figure below presents a conceptual representation of the construction supplies and the way that all of its participants interact.

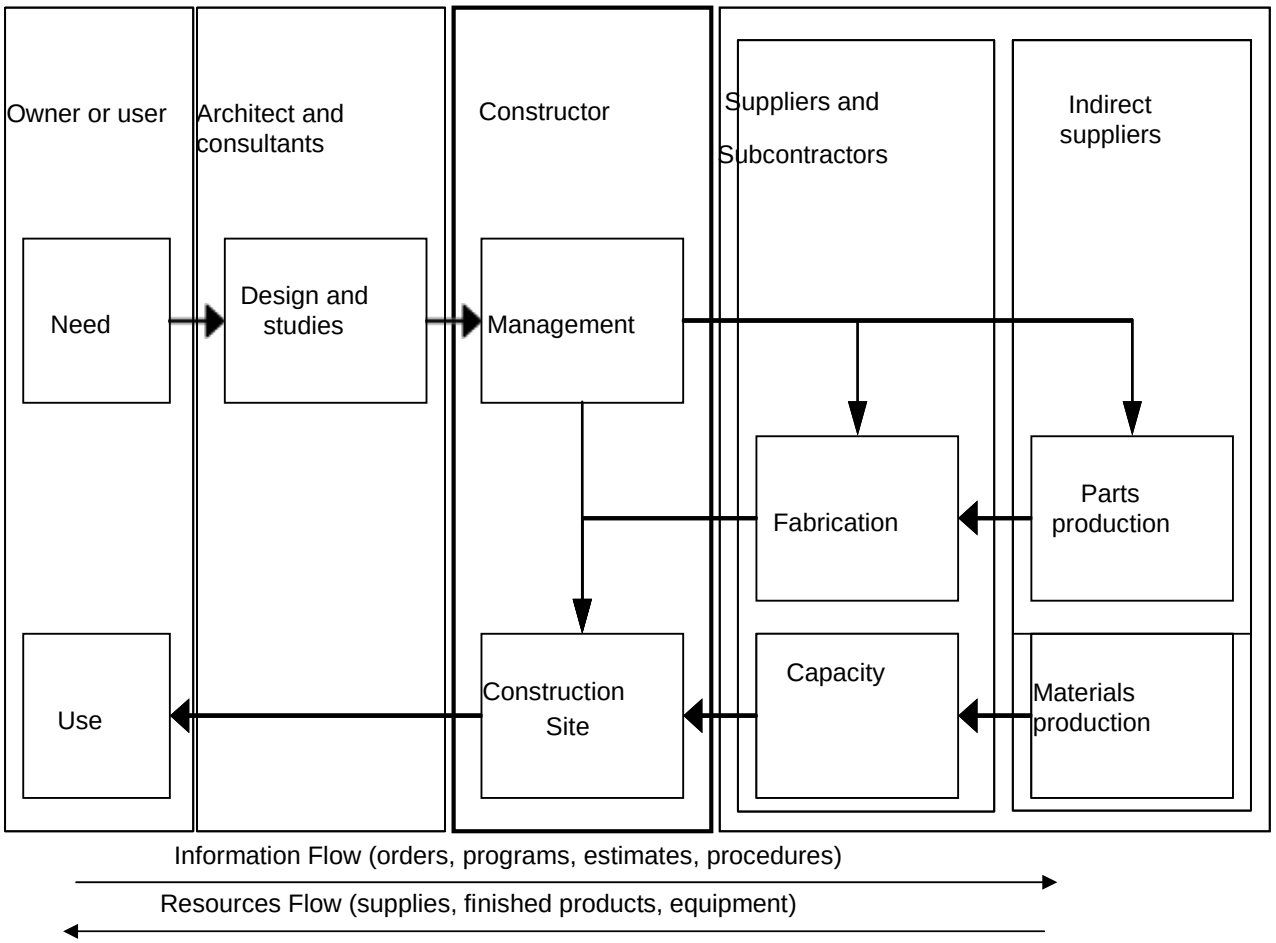

Figure 2.1 General model of the supply management in construction (adapted from Vrijhoef y Koskela, 1999)

Agapiou et al. (1998) stated that, "Managing the flow of materials, assuring its quality and quantity, allocating the storage areas, coordinating the overall process, triggering the orders, and updating the participants are major obstacles in construction supply management". The study by Matouzko, (2015) confirmed that "the impacts of supply management of construction inputs are underestimated by construction companies and it has impacts on working environment".

2.3 Supply management benefits in construction industry

[Roth and Martin (2000), Proverbs and Holt (2000), Landry (1998), and Christopher (1992)] confirmed that, Cost and waste reduction, Risk reduction with more certain final project cost, Client value, Enables long-term planning, Ongoing or repeat business (with client), Competitive advantages, Productivity improvement, Value creation and Better relationship between parties are the expected benefits of Supply Management in construction industries. Ugochukwu et al. (2012) puts the benefits of good supply management as follows:

- **Cost reduction and improving delivery**: Waste elimination, which avoids overproduction, unnecessary transportation, inventory and processing.
- **High quality**: Continuous problem search, TPM (preventive maintenance plus continuing effort to adapt, modify, and refine to promote continuous flow), 5Whys, VSM, and employee involvement, Poka yoke (mistake-proofing/inadvertent error prevention), visual control and statistical quality control (SQC), supplier.
- **Involvement in the early design stages and screening of suppliers' operations**
- **Low inventories**: Just-in-time and pull production (A production control method in which downstream activities signals their needs to upstream activities), avoiding accumulation of inventory and hence inventory costs.
- **Customer satisfaction**: achievement of customer satisfaction.
- **High flexibility (volume, product mix and delivery)**: Small lot size, supplier relations or involvement, pull production, effective communication and information sharing.
- **Optimized efficiency**: Continuous problem search, TPM, 5Whys, VSM and employee involvement.

2.4 Factors affecting performance of construction projects

Every construction site contains a diverse set of variables that influence construction operation. The nature of the factors will depend on a number of situations, such as location of the site, the nature of working environment, the potential for construction activity to affect site neighbors and social policy of the client, contractors' ability to deliver a project, ability of contractors to devise and implement a sustainable construction strategy from the start (Sullivan et al., 2011). The delivery of the equipment and materials may be affected by factors "on and off" of characteristics of construction site (Sullivan et al., 2011). According to Sullivan et al. (2011) the following factors are considered as the main problems of project performance of construction projects.

- **Physical factors: "**off site" factors such as low link/relationship/ or means of approach and "onsite" factors such as the lack of storage space or restricted access due to narrow corridors and existing structures etc.
- **Legislative factors**: the town and country planning act, environmental act, manual handling operations regulations.
- **Environmental and social factors**: the construction strategy has to consider minimizing noise, dust and disruption and construction site consider the proximity of watercourses, neighbors and exiting structures and roads.
- **Financial factors**: factors that may limit a contractor's ability to develop mechanical resources for a job.
- **Site Situation factor (i.e. congested site):** managing construction supply management is carried out in the main center of cities and towns are too difficult because of the site is congested, the street are too crowded, the storage area not available, high density of pedestrian and business activities around the site.

2.5 Factors contributing to supply management problem in construction industry

The supplies performance is influenced by various factors. Some of the main factors are supply system structure, inventory control policy, information sharing, customer demand, forecasting method, lead time and review period length described below:

- **Supply system structure**: The number of facilities, the number of stages, and the structure of the material and information flow contribute to the complexity of the system.
- **Inventory control policy**: Inventory control means to ensure that the business has the right goods on hand to avoid stock-outs, to prevent shrinkage, and to provide proper accounting. There must be an economic balance between the costs incurred and the costs saved by holding the material in stock (R. N. Boute and M. R. Lambrecht, 2009).
- **Information sharing:** Information sharing can be called as the biggest driver of performance in supplies (S. Chopra, P. Meindl, and D. V. Kalra, 2010).
- **Customer demand:** Customer demand pattern is one of the environmental factors affecting the performance of the supplies. In most industrial contexts, demand is uncertain and hard to forecast.
- **Forecasting method:** H. L. Lee, (1997) identified one of the main causes of the bullwhip effect in the supply management is the use of demand forecasting. In supply management, the members need to forecast its future demand, and it is impossible to predict demand with certainty. This uncertainty will result in distorted order quantity and via order variance amplification (X. Zhao, J. Xie, and R. S. M. Lau, 2001).
- **Lead time:** The replenishment parameters such as lead time and review period can also affect the performance of supply management (T. Kelepouris, P. Miliotis, and K. Pramatari, 2008). The time gap between the receipts of the order to delivery of the product is referred as lead time, which is the sum of order lead time and delivery lead time.
- **Review period length:** Review period length refers to the time between the successive evaluations of inventory status to determine whether to reorder or not. The optimum selection of the review period depends on the nature of the demand of the product.

Gor, D., and Pitroda, J. (2018) identified the following factors that contribute to poor supply management in the construction industry: Late and incorrect payments, Inaccurate data, engineering drawings not fitting the use, Problematic completion due to quality problems, Difficulties in finding out client's desires, changes of client's requirements, long procedures to discuss changes, Threat for substitute products, Design/Engineering interface-incorrect documents, design changes, extended wait for architect's approval or design changes, Bidding process, Deliveries not in conformance with planning, wrong and defective deliveries, long storage period, awkward packing, large shipments, Inaccurate data, information needs not met, adversarial bargaining and other changes, Subcontracted work not delivered according to main design, contract and planning, Unresolved quality problems, delayed occupation due to late completion and retention. According to Strategic Forum (2005) cited in study by Fediya (2012) and Regassa (2015), the following factors, as currently practiced, contribute to inefficient supply management in construction industry.

- **Short-term nature of construction process:** construction work is seen as a temporary work (one-off job) in which teams or organizational structure involved in one construction project is formed or built for short period of time.
- **Fragmentation of activities within the construction process**: The construction projects involve many small teams or companies (subcontractors). Several teams, such as design team and construction team, involved in construction process are fragmented in some construction projects.
- **Lack of transparency in costs:** Costing in construction is less transparent than in other industries like retail and manufacturing. The way costs are recorded does not portray the benefit of supply management in removing non-value-added activities from construction process.
- **Inadequate tracking facilities on site:** There is lack of sufficient and real-time tracking and monitoring facilities for materials and equipment on construction site. At construction site level there is no enough material tracking and controlling system to easily identify quality and quantity of materials or how much is left in stockpiling (store) area.
- **There is no clear definition of responsibility and authority for supply management, expected in supplies; in construction industry:** Most construction sectors have no well organized supply management department with good enough professionals in their construction projects.

There is lack of proper performance measurement for construction supply management: Construction supply management performance in delivery material, stock availability, timeliness of waste removal, quality and site storage quantity, material receiving time, vehicular and order cycle time are not easily measured on construction site. In general the trend of measuring supply management performances in construction sector is negligible.

Townsend (2006) stated that Supply, demand, and other challenges caused problems in the construction business. Incorrect selection criteria, discontinuous and low demand problems, inappropriate risk distribution, and frequent specification changes are all examples of demand concerns.

1. Inappropriate selection criteria: This issue refers to the practice of giving a construction contract to the contractor that offered the lowest price, regardless of the offer's merit.

2. Discontinuous and low demand problems: The economic downturn and challenging financial circumstances result in a decrease in public investment, which leads to such issues.

3. Inappropriate allocation of risk: It refers to the project's risk distribution between the main contractor and the client being unbalanced.

4. Frequent changes in specification: This issue arises as a result of the client's actions and occurs during the project's execution.

On the other side, common concerns in the construction business include fragmented industry structure, adversarial culture, insufficient investment, and bad management (Townsend, 2006).

1. Fragmented industry structure: Fragmentation refers to the size and quantity of construction organizations, as well as the diversity of trends and professionals. Contractors intend to utilize subcontractors, but subcontractors are using other sub-contractors to carry out the work.

2. Adversarial culture: This issue has been known for years and may have negative consequences for both the client and the contractor. Furthermore, this issue may result in the failure to implement the new procurement process.

3. The inadequate investment in training: In the construction business, there is a distinct absence of research and development, which may have an impact on quality.

4. Poor management: Poor management can happen at the site or corporate level, and it

can lead to poor performance.

2.6 Impacts of supply management problem on construction projects

Construction projects rely heavily on supply management. One of the most significant aspects of construction project is supply management, which can have a variety of effects on the project. Construction industry generates a significant amount of waste as a result of inadequate supply management (Strategic Forum for Construction, 2002). If there is poor construction supply management, there is no way to properly allocate and manage the resources. Moreover, inefficient supply management affects transport, storage and coordination. Budget overruns, delays, low profit margins, and numerous legal claims and counterclaims are among the issues affecting the construction business (Yeo and Ning, 2002). Waste and problems are largely generated by myopic control of the construction supplies (Vrijhoef and Koskela, 2000). On the other hand, supplies problems in construction contain Bullwhip effect, Snowball effect and Supplies disruptions.

Bullwhip effect. The bullwhip effect assumes that a small change in the customer demand will aggregate in total demand as it moves upstream towards the first suppliers. It causes waste throughout the system (e.g. overproduction, because unneeded products will end up in supplies partner's inventory) (Schniederjans et al., 2010).

Snowball effect. The snowball effect is caused by the forecasting demand, when some future time predicts a ripple but actually, it will be a constant level of demand. The amount of inventory increases from the customer forecast upstream to the manufacturer, due to inadequate planning policies involving ordering quantities, lead times, and the use of forecasting to guide production planning (Schniederjans et al., 2010).

Supplies disruptions. As global opportunities expand, supplies are expanding and thus the chances of supplies disruptions such as a war, natural disasters and political issues also increases. Therefore, it is important to be prepared and try to anticipate the disruptions and access the risks (Schniederjans et al., 2010).

Poor public image, wasteful construction processes, and poor quality are all difficulties in the construction business (Townsend, 2006).

1. Poor public image: The construction sector failed to retain and attract highly qualified and experienced workers. Furthermore, the industry is blamed for conditions such as being unhealthy, risky, uncertain, and having little work security.

2. Inefficient method of construction: To tackle this difficulty, the best way is to

integrate the design process with the construction procedure in order to retain project build ability.

3. Poor quality: According to Latham (1994), low quality is generated by a lack of clarity and simplicity in the rules for entering the construction industry, which encouraged new and experienced enterprises to enter the market, tarnishing the industry's reputation and lowering overall quality.

Construction supply management that is inefficient leads to: queue due to poorly loaded vehicles (because scheduling was not well organized), unavailability of materials on site (leading to poor time utilization), excessive stockpiling of materials with extra costs and the greater risk of deterioration and damage, lack of coordination between activities; and high proportion of damaged and returned items (The Strategic Forum for Construction supply management Group, 2005).

According to Fadiya (2012), Usman, and Muhammad (2015), Poor practices of supply management in construction projects, have the following consequences in the construction industry today.

- **Materials Loss:** improper management of supply in construction projects leads large amount of material to be lost or damaged. On site storage system and mechanism, wrong choice of selecting transporting mechanisms, having excess amount of material has been considered as the result of poor construction supply management.

- **Delay in construction project delivery**: late construction material delivery and material unavailability on the work site causes the interruption in the whole construction process, resulting delay in project delivery date.

- **Operatives/plant collision:** poor supply management system of construction project results in disorganized construction site, and leads to onsite accidents such as construction equipment/plant/ collision, and it makes the construction process to be disrupted and behind the schedule.

- **Inaccurate data:** manual documentation system and mechanism makes the difficulty of accurate data filling and convey when needed. Inaccuracy of information regarding inventory, storage location and inaccurate reports makes construction process too difficult.

- **Excessive cost of construction:** Inefficient supply management makes the cost of construction to be excessively high because excess supply of materials, theft and materials

damage are non- value-added costs

- **Poor image of the construction industry:** if supply management is not good, the image for construction sectors is not good. Because, poor supply management results in large quantity of onsite wastage, construction vehicles are not properly managed that it increases urban traffic congestion, truck accident and environmental pollution. This all contributes bad impression about the construction industry in society.

- **Poor quality construction:** if supply management is not good in construction sites, maintaining quality is difficult. Allocating less skilled labor, not properly handling materials, less coordination and communication are the factors that contribute to poor quality construction in construction projects.

- **Promotes of corruption & robbery**: luck of non appropriate storage place, hiring of not well skilled labor, onsite material production, using less quality materials and unavailability of material trucking systems are considered as main factors of inefficient supply management that contributes to corruption and robbery in construction projects.

- **Fragmentation of activities within the construction process**: There are several construction teams who are involved in one construction projects. Such as design team, construction team and supplier's team. Absence of good communication and coordination systems because of poor supply management in between those parties leads the construction process to be fragmented and untidy.

Papaprokopiou (2010) and Usman and Muhammad (2015) prove that the poor consideration of supply management in construction project may result to:

- **Traffic congestion due to trucks**: now days because of expansion of construction projects in urban areas of developing countries, there are large numbers of construction trucks moves on urban road networks. Those trucks are moving around the city for delivering to construction or moving from site. On some large construction project sites; trucks makes queue for loading or unloading of materials when arrived on the site because of poor supply management.
- **Skilled craftsmen that often use their skills for less than 50% of their time on site:** due to their involvement with non-skilled tasks such as unloading a truck or moving products around site.
- **Additional costs (unnecessary cost to the system):** all onsite wastages (project delivery

time delay, material wastage, poor coordination among parties and etc leads the construction project to extra cost (cost overrun).

- **Transportation and environmental issues**: uncontrolled construction vehicles movement in urban areas or loading or unloading material causes increase of traffic congestion that will result to pollution (increased emissions in the environment).
- **Poor quality construction:** poor construction results from disorganized construction initiatives. If the quality of materials is not properly maintained, and trained personnel are not assigned properly, the production of quality construction will definitely become more difficult, and the project will result in a bad quality output.
- **Increased project time:** construction projects will be not delivered in planed schedule if supply management was not maintained efficiently.
- **Added risks to health and safety:** improper material storing, handling on site inevitably bring additional potential hazards. Manual material handling loading or unloading (either because product is in the wrong part of the site or because the right equipment is not available) adds to the health risks to those on site.

In general, late deliveries of construction materials cause work interruption, decrease workers' productivity and loss of project efficiency. Poor communication in construction projects causes wrong delivery of materials and also ordered materials not arrive on time on construction site. Each impact on each construction processes sum up and made the project to be delayed and finally leaded the project to cost overrun**.**

2.7 Improvement in construction supply management

There aren't many scholarly researches on supply improvement as a process. Beamon (1999) presented one of the first studies linked to supply management metrics. Later, a framework that connects supplies operations and levels was presented by (Gunasekaran et al., 2004). The study brought a contribution to knowledge by relating the formal processes of supplies, namely plan, source, make/assemble, and deliver. Such processes are then evaluated under different time perspectives, from the operational, tactical and strategic level.

(Vachon et al., 2009) developed a new study by reviewing the topic of competitive priorities and metrics deployment. The study received excellent feedback and was implemented in the industry. Finally, using a multi-criteria method based on competitive priorities, a framework for measuring supply management performance in the wine industry was developed by (Garcia et al., 2012).

2.7.1 Techniques to improve construction supply management

Taking into consideration the lack of academic studies and increased show of interest of big construction companies to improve the construction supplies and to succeed an effective construction supply management, the development of a set of propositions for improving construction supply management would be helpful to develop structured approaches between construction companies and their contractors, resulting in better results for the entire supplies. The proposition of these managerial practices also promotes a different discussion in terms of supplies improvement in construction. First, these practices are focused on the strategic level, in which there is a lack of research. Second, the shift from an operational to a strategic view places supplies improvement as a corporate matter that should be taken in consideration for strategic planning purposes. The subsections below are an attempt to propose a set of managerial practices in order to improve construction supply management.

1. Suppliers' and Subcontractors' Development

The interfaces between construction companies and their contractors are continuous through the whole duration of a project. In this sense, the performance delivered by the contractors influences the overall performance of the project. Major companies related to manufacturing have developed initiatives concerned about suppliers' development. Such initiatives comprise structured programs based on training, consulting, and feedback provided to the suppliers. In general, these programs are led by the focal (major) company within the supplies, which invest capital to support these programs in order to obtain better results in terms of cost, quality, and dependability among others from its suppliers. After this period, the suppliers are ranked and some of them are conducted to a higher level of development in a new cycle.

2. Performance Measurement

Measure the performance of the processes is an ongoing challenge for companies from all sectors. Research regarding performance measurement is recent and provided frameworks that provide guidelines for managers in implementing performance measurement. Usually, the difficulties are first concentrated in defining the metrics and second in using the information provided by them for improvement. Nevertheless, the use of performance measurement systems proves to be crucial in order to face the current market competition. The use of standardized metrics to evaluate supplier performance and provide feedback is a strong technique for improving supply management. Such an approach is based on the classic PDCA cycle (Plan, Do, Check, Act), in which "Check" is solely concerned with performance

measurement and provides instructions for correcting the course of action.

3. Benchmarking

The development of benchmarking is still incipient in supply management. Benchmarking is based on best-practices exchange between companies in order to obtain improvement in their processes. Also, benchmarking can also be directed to compare the performance of metrics in order to establish goals to be reached in a determined period of time. In this sense, it would very helpful for the construction companies to promote benchmarking in their sector, considering the best practices for management and identifying the gap between their internal practices and the benchmarks. Nevertheless, the implementation of a benchmarking program is a complex initiative, requiring efforts to align expectations and develop trust within the entire supplies.

4. Knowledge Management

In a typical supply, the suppliers develop knowledge not only about their products and services but also about supply management. Even though there are many suppliers in a single supply, it is rare to observe a focal (major) company that gather knowledge from its suppliers. In this sense, clearly is established an opportunity for implementing knowledge management in supply. The establishment of an integrated platform for knowledge sharing can deliver substantial results for supply improvement, especially in construction companies that are used to have internal knowledge management practices.

5. Waste Identification and Elimination (Lessons Learnt)

Research about waste identification and elimination is still incipient. However, the adoption of practices aiming at identifying non value added activities or processes and eliminate them can improve supply management. An investigation of the processes in a detailed way can produce a total redesign of their flows and lead to optimized processes. Also, at the operations level (purchasing, stocking, handling, etc.) some efforts could be done in order to identify redundant activities and eliminate them. Because the interaction between the companies is constant and their individual results influence the overall performance of the supplies, applying this principle throughout the many tiers of the supply can provide significant benefits from a systemic standpoint.

6. Information Technology

The application of IT in supply management has significant benefits. The use of web-based information system in supply management will reduce interfacing barriers between the several parties on the supply. The information and communication technology (ICT) will improve

supplies performance, support supplies efficiency, and enable greater supplies integration. The several supply participants (i.e. Contractor, Suppliers, Subcontractors, etc.) should develop compatible IT application software and common analysis methods of the complex data.

7. Human Resource and Training

The importance of human factor is very important and qualified employees are required. In this sense, companies should periodically prepare an extensive and comprehensive training program to equip the best employees with proper training benefiting as a result the commitment and strengthen by effective training; it will lessen the supplies implementation barriers and will enhance supplies performance.

8. Just-In-Time delivery (JIT)

The JIT was developed by the Japanese automobile manufacturer system Toyota as an essential part of The Toyota Production System. The basis of this system is the absolute elimination of waste (Bertelsen and Nielsen, 1997). Moreover, authors stated that; JIT delivery is a service of regular delivery or supply of materials to the construction site without any delays. It is the mechanism of continuous supply of right quantity of material at right quality, in right time and at right place. In this case there is no as such onsite storage is needed. Therefore, risk of material damage and loss, site congestion and safety issue will be minimized.

9. Construction Consolidation Centre (CCC)

Construction Consolidation Centre is a distribution facility through which material deliveries are channeled to construction sites. It is the way of storing material from suppliers at some strategic places that will be at appropriate distance from all construction projects sites. Then from these centers materials are transported to each construction projects sites JIT deliveries systems. According to Lundesjo (2011) consolidation centers has much advantage for construction sites. Such as: reduces freight traffic to site by up to 70%, increases productivity of site labor by 30 minutes per day leading to a 6% productivity gain and reduces onsite waste by 7-15% through less material damage and shrinkage. As it was stated here; efficient supply management in construction projects can be achieved by applying construction consolidation center and through this, site congestion reduction, increase of productivity and reducing of material wastage; will be achieved.

10. Demand Smoothing

Demand smoothing is a way of looking on the project activities in the entire supply processes and identifying whether the performance can be "smoothed" to decrease transport resourced, materials and labor needed to carry out the activity. It helps to identify peaks and gaps in the materials" needs over a time period (Lundesjo, 2011). This indicates that, balancing of material, work force availability and work at hand allows to know for how long material will be enough who will be assigned on which activity and help know when another order should be made.. According demand smoothing concept, any resources should be allocated when needed at appropriate time and place. Resources are not to be excess or shortage.

11. On-site Marketplaces (OMP)

This method is the way of allowing the trade worker to bring their products on construction site and stored daily used materials (such as screw, bolts, drill bits, nuts, saw blades and etc. in a temporary ware house. Then the materials distributed to appropriate place when it is required. The major advantage with onsite market place is the guarantee of available supplies and material in the right and safe place. And also help the contractors/subcontractors not to have their own material storages on-site. Therefore; this enhance performance increase and construction cost reduction (decrease transportation cost, decrease chance of material loss etc (Lundesjo, 2011).

12. Pre-assembled and offsite fabrication

Prefabrication is a good method for smoothing construction supplies. Because of all the components used for construction is produced in factory and transported to the construction site for assembly. It ensures better quality, less material wastage, minimizes labor force cost, reduces onsite congestion and reduces construction time, lower amount of errors and decreases transport cost (Lundesjo, 2011).

13. Information and Communication Technology (ICT) Systems

ICT Systems are used to keep track and monitor materials through entire supply process (starting from production place until it is used or installed onsite). Tag systems was used to manage material deliveries with the help of different sort of information technology (bar code).Then Radio frequency identification (RFID) is used for reading of tags or barcode of that material on site for checking the material. The tag system, having relatively low cost,

allows the monitoring of material to the point of final use and can offer detail information about how is it going on site. It helps to know easily how much material was used and how much material is left in the store (Lundesjo, 2011)

14. Third Party construction supply

It is a way of involving third person, rather than supplier and consumer in supply system for making better supply management system. The main purpose of such companies is to create safe, clean and work-efficient working place by efficient and better planed supply. Therefore; contractors and subcontractors do not need to spend more time on rework and moving material within the site. Most of the material transportation is done by this third party during evening when the workers are away and cranes are available (to reduce work interruption for loading and unloading materials, to reduce onsite and urban congestion etc.). Every next working day, workers have ready material in right quantity and on the right place. It makes safer and clean construction environment (Matouzko, 2015).

15. Applying integrated/systematic construction supply management

To improve construction project delivery system, construction industry had to develop an integrated project process, which is used to integrate all essential support services associated with construction projects (Egan, 1998). The implementation of integrated construction supply management with a dedicated supply team will benefit the construction industry for four important reasons: First, it can maximize the productivity and efficiency of skilled workforce. Second; It can maximize the quality of service by enabling a trained supply service team Third, it minimize the negative environmental and social impacts that construction projects create by enabling the efficient flow of materials which can minimize the indiscriminate queuing of delivery vehicles around the construction site and minimize waste generation. Fourth, it can enhance an attainment of the highest possible standards of health and safety by minimizing collision accidents which can result from the chaotic distribution of materials on construction site (Egan, 1998). Fadiya (2012); Usman and Muhammad (2015), puts primary and support supply management functions and services for integrated construction supply system. Primary supply system function and services are: material receipt, material storage, transportation (people and material) and material handling. Support construction supply system function and services are: cleaning, first aid, fire marshalling, waste management, reception, welfare, health and safety, traffic management, security and

communication.

16. Using the Supply Chain Operations Reference (SCOR) model's performance measurements to improve construction supply system

The Supply Chain Council developed the SCOR model. In 1996, the first version was created. It's a framework for delving further into the supply system by describing and categorizing the processes that make it up, assigning metrics to those processes, and comparing them to related benchmarks. The supply chain operations reference model (SCOR) is a management tool for addressing, improving, and communicating supply system management operations within a firms as well as with its suppliers and customers (Thunberg, 2013). The purpose of SCOR model for construction sector is to find methods of improvement that can reduce costs or in any other way increase profitability or reduces the environmental impact of construction project. Plan, Source, Make, Deliver, and Return are the five primary integrated processes in the SCOR model. Most processes are evaluated from five perspectives: reliability, responsiveness, flexibility, cost, and asset value (Supply Chain Council, 2004). Construction supply management can be improved using the SCOR models predefined performance metrics related to the delivery process of the supplier and the source process at the construction site. This model was contains well-defined and standardized processes and metrics for performance measurements such as: Perfect order fulfillment (POF), Source cycle time (SCT) and Cost to source (CS) (Thunberg and Persson, 2014).

POF, SCT and CS are SCOR model metrics that are used for process improvements and performance measurements.

Perfect order fulfillment (POF): The SCOR model defines the metric POF as the number of delivered orders that meet a customer's requirements in terms of order quantity and items, delivery date/time/ place, documentation and condition as a percentage of the total number of delivered orders. What is considered perfect is agreed to by both the customer and supplier. To be considered precisely delivered, a product must be delivered in the right quantities, at the exact time and location, with the correct documents, and in the correct condition. It is not a perfect delivery if at least one of these parameters is not met (Thunberg and Persson, 2014).

Source cycle time (SCT): The aspects involved in assessing the SCT are the time it takes to identify sources of supply (if applicable), select supplier and negotiate (if applicable), schedule product deliveries, receive product, verify product, transfer product to closest inventory-holding area and authorize supplier payment. It is assessing responsiveness to

calculate the order fulfillment time, i.e. the total elapsed time for receiving an order, producing the products and delivering the products. Sourcing time increased in some construction site because ,contractors orders some materials for a long period and to get discounts, this often results in a lot of material to unload and store. Even at large construction site it is difficult to distinguish one activity from another in receiving and transferring products. Sometimes, the activity of transferring unloaded materials to the inventory area can occur at the same time as the activity of unloading (i.e. receiving) the materials. The unloaded materials may first be stored temporarily on the ground before being transferred to the inventory area (Thunberg and Persson, 2014).

Cost to source (CS): cost to make, cost to deliver, cost to plan, cost to return and cost to mitigate supply system. The aspects involved in assessing the CS are the costs of managing suppliers and material acquisition. The cost variables considered when calculating the CS for one order and all incoming deliveries. The included costs are cost to order, cost to receive, cost to verify materials, cost to transfer and cost to authorize supplier payment (Thunberg and Persson, 2014). Ugochukwu et al., (2012) summarize the techniques to improve supply management as follows: **Poka-Yoke** (Avoid workers mistakes and errors), **Just-in-time (**Deliver products and services just-in-time for the customers), **Single Minute Exchange of die (SMED)** (Setup time reduction), **Kanban** (Scheduling system that helps pulled production), **Production leveling** (Stability in the process), **Standardized work (**Improve quality and safety), **5S** (Organize the work place), **Small lot size** (Seek one-piece flow), **Supplier and employee involvement (**Build strong relationship with supplies, enhancing employee participation), **5 Whys** (Discover the root cause), **Cellular Manufacturing** (Reduce cycle time and inventories), **Value stream mapping (VSM)** (Map the current value flow and look for improvements that can be made), **Kaizen** (Continuous improvement), **Statistical quality control** (Detection of variations in the processes), **Customer involvement** (Focus on end customers' needs), **Visual Management** (Make steps in processes and information more visible).

On the other hand, Gor, D. and Dr. Pitroda, J. (2018) summarize the techniques to improve supply management as follows: Creating standardization of processes, Simplify the whole supply system process, Top management support, Manpower development, Reliability of supply, Simplify bid process, Closer links between demand and supply, Trust, Mutual interest, Free flow of information, More frequent meetings.

CHAPTER THREE

3. Methodology

3.1 Research area

The study area has focused on the Ethiopian Roads Authority, Jimma District. Jimma district was one class of governmental development organization called Ethiopian Construction Works Corporation up to the end of 2012 E.C. But, it merged to Ethiopian Roads Authority on July 08/2012, by Council of Ministers Regulation No. 248/2012. Jimma district has been established to carry out construction, maintenance, and enhancement works of roads and bridges in road network of southwest region of Ethiopia.

3.2 Study period

The research was conducted from December, 2020 to January, 2022 GC.

3.3 Research design

A descriptive and comparative research strategy was employed for this research; because, the researcher has suspected certain factors contributing to the problem of supply management of construction materials and the researcher had a little knowledge about the subject matter in ERA, Jimma district. Questionnaire and procedural framework of the research was designed based on the data obtained from literature review of the previous works. The questionnaire was structured to provide relevant information on the subject matter. It was designed into four main parts: the demographics of the organizations and respondents, the factors contributing to supply management problem of construction materials; the impacts of supply management problem of construction materials, and the potential techniques to improve supply management of construction materials in the organization. The questions were made simple in order to ensure maximum responses from the respondents. A Close follow-up was made during the process of data collection, and necessary clarification was given to the respondents during filling the questionnaire in order to minimize data collection time and to avoid confusion. The collected data was analyzed and interpreted using the descriptive statistics approach.

3.4 Study population

Study population includes: OFRMJD (Jimma-Gibe asphalt road maintenance and asphalt overlay project, Jimma – Beddelle - Metu asphalt road capital project, Gimbo - Hina Gravel road maintenance project, Jimma - Chida Gravel road maintenance project, Wachamaji - Maji Gravel road maintenance project, Projects under Gambella Section, Financial management team, Engineering service team, Supply and procurement team and Equipment maintenance and administration team), Jimma Road Networks and Safety management branch directorate, and Consultant firms of the projects.

3.5 Sample size & sampling procedure

Purposive sampling technique was used to select target respondents by classifying them into different respondent categories (OFRMJD, JRNSMBD, and Consultants staffs); to obtain acceptable answers from different perspectives and for the easiness in analysis of the perspective of construction actors toward supply management problem of construction materials in the organization. The total population size 'N' (only permanent employees) of ERA, Jimma District is 920.

The sample size for the research has been computed using equation 3.1.

$$n = \frac{N}{1+N*e^2} \text{.....Equation 3.1}$$

Where: n= Sample size

N= Total population

e= Occurrence of error

Source: Buman, (2004) Elementary statistics

Accordingly, e=100%-90%=10% (by assuming the confident interval is 90%).

$$\text{n} = \frac{920}{1 + 920 * 0.1^2} = 90$$

Therefore, the overall sampling frame of the research contains 90 participants.

3.6 Study variables

3.6.1 Dependent Variable

- Performance of supply management of construction materials

3.6.2 Independent Variable

Physical factors, Legislative factors, Financial factors, Environmental and social factors, Contractual factors, Technical factors, Administrative factors, Market factors, Structural factors, and Time factor.

3.7 Data Collection Process

According to Kumar (1999) quoted in (Abraham, 2008), data sources can be divided into two Primary and Secondary. So for this study: Questionnaire survey and interview were provided for the primary data collection while, data sources such as journals, internet sources, as well as review of related archival documents, and Monthly reports were used for the secondary data collection.

3.7.1 Primary Source of Data

3.7.1.1 Survey

One of the ways to collect primary data is a descriptive survey. Uniformed questionnaires were distributed to the target respondents to collect the primary data used to assess the subject matter. The data was collected from OFRMJD, from JRNSMBD, and from consultants of the projects. Group discussions were made to consider the willingness of the respondents to collaborate. Training was given to data collectors to handle the data carefully in order to avoid errors in the data.

3.7.1.2 Interview

Interview is one of the primary data collection methods which is a flexible and adaptive way of investigating underlying motives of the subject matter in a way that self-administered questionnaires cannot. Interview can take three forms: unstructured, semi-structured and structured (Naoum, 2007). The interview undertaken for this thesis was based on semi structured style and it was made with district manager, and procurement and supply team leader. The reason for choosing two interviewees is because; they have better knowledge and great exposure to the processes in the subject area.

3.7.2 Secondary Data Sources

Different books, journals and other internet sources, archival documents, and correspondences have been reviewed to understand the background, problems, and practices of supply management of construction materials in ERA, Jimma district. These secondary sources provide a general understanding of the subject area by presenting a wide range of ideas in the field which help to supplement other specific information obtained from the primary data sources.

3.7.2.1 Desk Study

Desk study is an investigation of available facts and figures relevant to a specific issue, often before starting a new or more detailed study (Microsoft Encarta, 2009). Therefore, the desk studies under this research were mainly carried out to obtain actual data from relevant studies, reports and documents those used to supplement the findings obtained through questionnaire and interview through in-depth analysis of subject area.

3.8 Data processing and analysis

After collecting the necessary information, data analysis was done in descriptive statistics approaches, and data processing was followed the following steps:

- Performing quality control
- Sorting
- Summarize the data on the master sheet.
- Microsoft Office Excel 2007 program was used for data analysis purpose.
- Establishing relative importance level 'RII' using equation 3.2.

$$RII = \frac{\sum W}{A*N} \ldots\ldots\ldots\ldots\ldots\text{Equation 3.2}$$

Where:

W= weight given for the responses of each factor (ranging from 1 to 5).

A= the highest weight (i.e., 5 in this case).

N= the total number of respondents

Source: Cheung et al, 2004; Iyer and Jha, 2005; Ugwu and Haupt, 2007

- Ranking of each factors, impacts, and the potential techniques were made based on RII

After analyzing, summarizing, and evaluating the collected data, the findings was organized and presented in the form of tables, figures, and texts for ease of interpretation and understanding. The response distribution on the 5 points Likert scale (Tabaje and Teka, 2015): High impact=5, Moderate impact=4, Marginal impact=3, Negligible impact =2, No impacts=1

and Not affecting=1, negligibly affecting=2, Affecting=3, moderately affecting=4 and extremely affecting=5 were used to calculate the relative importance index for each variables.

3.9 Ethical Considerations

- Jimma University, Jimma institute of technology must permit to contact the research.
- The confidentiality of the data obtained should be considered.
- The research has to be approved by an ethics review committee to ensure the study is not violating anyone and the organization.
- Before reporting the result, be sure to represent what is to be observed and told accurately.

3.10 Data Quality Assurance

Group discussions were made to avoid errors in the data to be collected through questionnaire. The questionnaire was straightforward to increase a willingness of respondents, and training was given to data collectors to handle the data carefully. The reliability and accuracy of the data was checked accordingly.

3.11 Plan for dissemination of findings

The findings of this thesis work are presented to civil and Environmental Engineering department, research, publication, and graduate studies as part of evaluation for the award of Degree of Master of Science in Civil Engineering (Construction Engineering and Management). It is publically defended in the presence of the examiners.

CHAPTER FOUR

4. Results and Discussions

4.1 Questionnaire Response Rates

As mentioned in chapter one, the sample population is composed of professionals from Consultant firms, Regulatory body (JRNSMBD), and Construction operator (OFRMJD), who are the stakeholders of road projects in ERA, Jimma District. The sample includes Resident Engineers, District Manager/Director, Project Team Leaders, and Office Engineers, Site Engineers and Foremen, and other employees in all support departments. The questionnaires were distributed to a total of 90 respondents by preparing 90 questionnaire sets. 60 questionnaires were distributed to OFRMJD staffs, 15 to Consultant firms, and 15 to JRNSMBD. 58 OFRMJD staffs, 12 consultant staff, and 14 JRNSMBD employees have returned completed forms. However, some of the questionnaires were not completed and the valid questionnaires were tabulated and shown below in Table 4.1.

Table 4.1 Type of organization, number and percentage of distributed questionnaires, received questionnaires, and the valid response of questionnaires

Organization (sample)	Number of distributed questionnaire	Number of returned questionnaire	Percentage of responses returned	Number of valid questionnaire	Percentage of valid questionnaire
OFRMJD	60	58	96.67%	56	96.55%
JRNSMBD	15	14	93.33%	10	71.43%
Consultants	15	12	80%	11	91.67%
Total	90	84	93.33%	77	91.67%

4.2 Demographic profile

Relevant socio-demographic variables of the respondents that the research covered include: Position of the respondents, Experience of the respondents in construction projects, Experience of the respondents in current organization, Education level of the respondents, and types of projects the company specialized in.

4.2.1 Description of work category of the respondents

As shown in the table 4.2 below, from the total 77 respondents who have participated in the research, 56 (73.73%) respondents have direct exposure (OFRMJD) to the problem of supply management of construction materials in ERA, Jimma district, and this makes the collected information trustworthy.

Table 4.2 Description of work category of the respondents

Description	**Frequency**	**Percentage (%)**
Own Force Road Maintenance Jimma district	56	72.73
JRNSMBD staffs	10	12.99
Consulting staffs	11	14.29

4.2.2 Position of the respondents

As it can be seen from survey result, from the total of 77 respondents who have participated in the research; 1.3% are Managers, 2.6% are Resident engineers, 16.9% are Team leaders, 33.77% are Site and office engineers, 12.99% are Construction Forman, 5.2% are Surveyors, 2.6% are Work inspectors, 12.99 are Officers and, 11.69% are others. Therefore, the profile of the respondents suggests that there is sufficient exposure to make the information acquired reliable.

Table 4.3 Position/Profession of the respondents

Position/Profession	Frequency	Percentage (%)
Manager	1	1.30
Resident engineer	2	2.60
Team leader(any field)	13	16.88
Site/office engineer	26	33.77
Construction Forman	10	12.99
Surveyor	4	5.19
Work inspector	2	2.60
Officer	10	12.99
Other	9	11.69

4.2.3 Experience of the respondents in construction project

As it can be seen from survey result, about 45.45% of respondents have more than 11 years of experience, about 20.78% have more than five years experience, and 3.89% of respondents also have worked in project manager position. Therefore, the profile and experience of the respondents suggest that there is sufficient exposure to make the information acquired credible.

Table 4.4 Experience of the respondents in construction projects (in year)

Experience (in year)	Frequency	Percentage (%)
0 to 5	20	25.97
6 to 10	16	20.78
Above 11	35	45.45

4.2.4 Experience of the respondents in the current organization

As it can be seen from survey result; about 35.065% of respondents have more than 11 years of experience in the organization, whereas 22.08% of respondents have more than five years of experience, and 27.27% of respondents also have worked from 0 to 5 years in current organization. Therefore, the profile and experience of respondents suggest that, there is sufficient exposure to make the information acquired trustworthy.

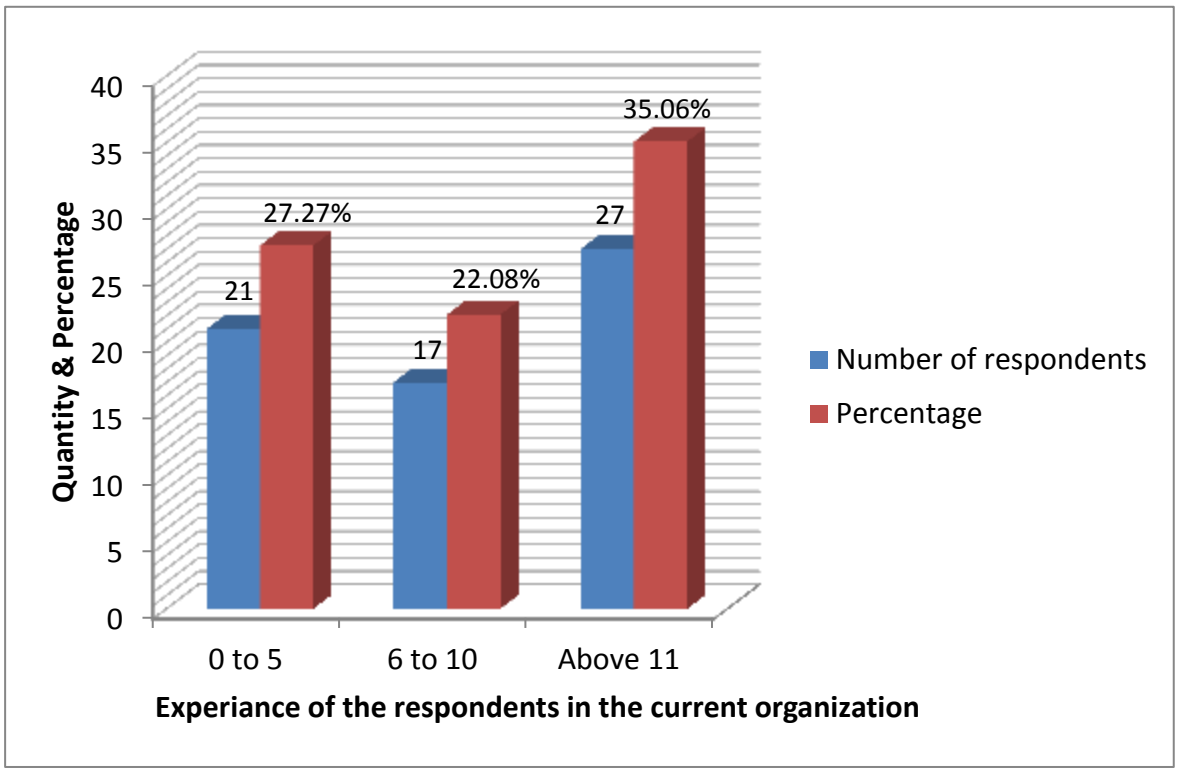

Figure 4.1 Experience of the respondents in the current organization

4.2.5 Level of Education of Respondents

As it can be seen from **Figure 4.2**, from the total of 77 respondents who have participated in the research; 2.6% have a secondary school level education, 7.80% have technical school level education, 25.97% have advanced diploma, 42.86% have bachelor degree and 19.48% have master's degree completion. It is noticed that, only a few (16.67% and 7.79%) of the respondents have primary level of education and technical training respectively. The result indicates that, there is a need to increase the chance of technical training which could contribute to improve supply management of construction materials in the district.

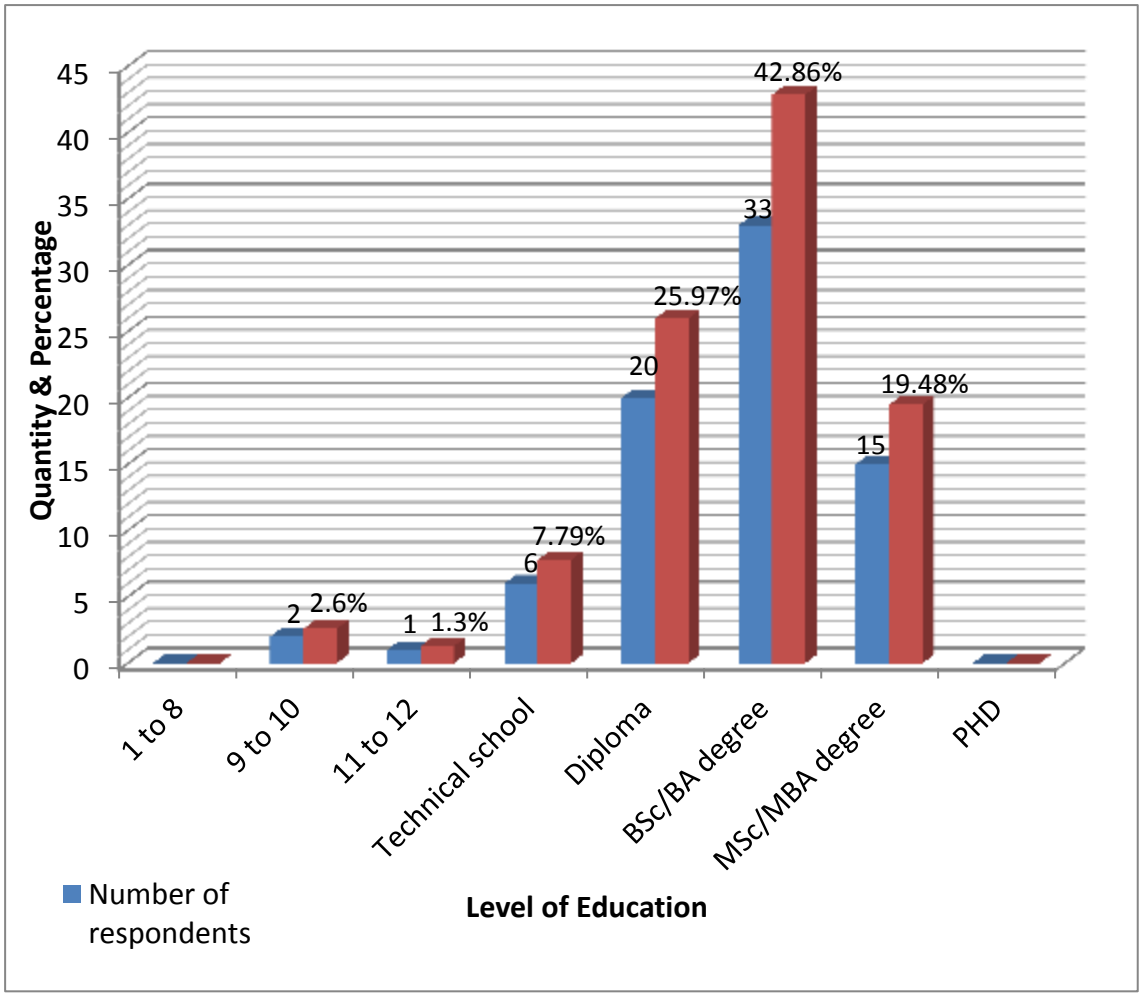

Figure 4.2 Level of education of the respondents

4.2.6 Types of projects that the company specialized in

As it can be seen from the **table below**, 89.6% of respondents believe that, the company has specialized in Gravel and Asphalt road, 68.83% of the respondents' belief was Bridge and 12.99% of the respondents' belief was rigid pavement, and 2.6% were pipeline. The result indicated that, the construction inputs sampled for the research have direct contact with the works those the company carried out, and the company performs very wide and multi-sectored projects those require modern supply management techniques to operate the works in a very good manner.

Table 4.5 Type of road projects that the company specialized in

Types of road projects	Frequency	Percentage (%)
Gravel road	69	89.61
Asphalt road	69	89.61
Bridge	53	68.83
Rigid pavement	10	12.99
Railway	0	0.00
Pipeline	2	2.60

4.3 Rank for each factors contributing to supply management problem of construction materials based on the perspective of respondents occupational category

The survey shows that, RII of each variables (38 factors contributing to supply management problems of construction materials) was calculated separately for OFRMJD, project consultants, and JRNSMBD. After RII was calculated based on respondents' perception, the final aggregate RII and Rank was given for each variables based on computed results (**Table 4.6**). As it can be seen from the table, the RII and Rank given by individuals' occupation for different variables were varying.

Table 4.6 Computed RII and Rank for each factors contributing to supply management problems of construction materials based on occupational category

Factors	OFRMJD		JRNSMBD		Consulting staff		Weighted Average	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Planning and scheduling problem	0.76	7	0.92	1	0.82	2	0.83	1
Low speed of decision making/slow permits by government agencies/slow response	0.86	2	0.92	1	0.64	12	0.81	2
Financial difficulties	0.90	1	0.84	4	0.65	10	0.80	3
Price escalation	0.79	5	0.88	3	0.73	3	0.80	4
Late delivery	0.83	3	0.84	4	0.67	7	0.78	5
Unavailability of required materials on market	0.74	10	0.68	20	0.85	1	0.76	6
Deficiency in coordination and top management support	0.80	4	0.82	6	0.62	17	0.74	7
Problem in the sequencing of work according to schedule	0.75	8	0.76	11	0.69	4	0.73	8

Lack of proper performance measurement for construction supply management	0.76	6	0.80	8	0.62	17	0.73	9
Low-quality materials	0.69	17	0.82	6	0.67	7	0.73	10
Difficulties in finding out client's desires/changes of client's requirements	0.72	15	0.78	10	0.65	10	0.72	11
Employees' motivation problem	0.73	12	0.80	8	0.62	17	0.72	12
Inappropriate allocation of risk	0.74	10	0.74	14	0.64	12	0.71	13
Incompetent workers/shortage of technical person	0.73	12	0.76	11	0.62	17	0.70	14
Lack of transparency in costs	0.75	8	0.70	16	0.64	12	0.69	15
Threat for utilizing substitute products	0.72	14	0.64	27	0.67	7	0.68	16
Poor quality and availability of regulator documentation	0.65	21	0.74	14	0.64	12	0.67	17
Review period length	0.66	19	0.64	27	0.69	4	0.67	18
Inadequate tracking facilities on site	0.67	18	0.70	16	0.62	17	0.66	19
Late and incorrect payments	0.66	20	0.68	20	0.62	17	0.65	20
Poor leadership skills of project manager and procurement administrator	0.64	22	0.70	16	0.58	29	0.64	21
Short-term nature of construction process	0.63	23	0.60	30	0.69	4	0.64	22
Deliveries not in conformance with planning and specification (wrong and defective deliveries)	0.61	25	0.76	11	0.55	34	0.64	23
Ineffective communication	0.63	23	0.68	20	0.56	31	0.62	24
Difficult condition of local climate	0.57	28	0.66	24	0.62	17	0.62	25
Reliance on few suppliers or unavailability of competent	0.52	32	0.68	20	0.64	12	0.61	26

supplier								
Poor structure in supply system	0.59	26	0.60	30	0.62	17	0.60	27
Unreliability of supply system	0.54	29	0.66	24	0.60	28	0.60	28
Absence of clear definition of responsibility and authority	0.58	27	0.58	32	0.62	17	0.59	29
Complex and too long bidding process	0.48	34	0.70	16	0.56	31	0.58	30
Inappropriate selection criteria	0.53	30	0.66	24	0.53	36	0.57	31
Access problem	0.53	31	0.56	34	0.62	17	0.57	32
Unsafe project site	0.51	33	0.56	34	0.58	29	0.55	33
Frequent changes in the specification	0.43	38	0.56	34	0.62	17	0.53	34
Lack of storage space	0.47	37	0.58	32	0.53	36	0.53	35
Subcontracted work not delivered according to the main design, contract, and planning	0.48	34	0.46	39	0.55	34	0.49	36
Poor inventory control policy	0.48	34	0.48	38	0.51	38	0.49	37
Discontinuous and low demand problems	0.39	39	0.56	34	0.51	38	0.49	38

The total aggregate, RII and Rank for each variable was calculated and presented based on the survey conducted. Accordingly, based on the respondents perspective and weight given for each variable and calculated RII; the first top ten factors have been taken as the significant factors contributing to supply management problems of construction materials in ERA, Jimma District and the last ten with lower ranks were not considered as major factors.

- Top ten factors contributing to the supply management problems of construction materials in ERA, Jimma District have been discussed as follows:

❖ Planning and scheduling problem: As shown in **Table 4.6**, the result suggested that, planning and scheduling problem with the weighted average of RII=0.83 has been ranked the first factor contributing to problematic supply management of construction materials in Jimma district. It has been selected as the first factor contributing to problematic supply management of construction materials by JRNSMBD, the 2nd by consultants, and the 7th by Own force road maintenance Jimma district. Most of the road projects in ERA, Jimma district

have not been completed on the expected time due to planning and scheduling problems of supply management of construction materials, and this shows that, planning and scheduling problems significantly affect supply management system of Jimma district, which significantly affects the performance project.

❖ Low speed of decision making/slow response/slow permits of government agency: As the research shows in **Table-4.6**, Low speed of decision making/slow response/slow permits of a government agency has been ranked the second leading contributing factor to problematic supply management of construction materials with weighted average of (RII=0.81). It has been ranked 2nd, 1st, and 12th by OFRMJD, JRNSMBD, and Consultants respectively. The result confirmed that, if supply management of construction materials is poor, the project cannot maintain its efficiency. A loss of efficiency interferes with the performance of an entire project. Because of this reason, most construction projects in ERA, Jimma District cannot be meeting the expected goal. The efficiency of construction project becomes very low when poor decision-making and the response from stakeholders is slow.

❖ Financial difficulties: As observed from the conducted survey (see **Table-4.6),** financial difficulties have been ranked the third major contributing factor to problematic supply management of construction materials with the total weighted average of (RII=0.80). It has been ranked first by OFRMJD, the 4th by JRNSMBD and, 10th by consultants. The variation in rank shows that, contractor always faces financial difficulties more than the other bodies in Jimma district as construction bodies require finances to run daily activities of the projects. Based on the results obtained, financial difficulty has been becoming a significant problem of construction projects in Jimma district. It could be caused by poor planning and forecasting of labor and material costs, coordination and communication, and late payments.

❖ Price escalation: As indicated in the result (**Table-4.6**), price escalation is one of the top contributing factors to problematic supply management of construction materials. It has been ranked fourth, based on the weighted average, RII=0.80. It has been ranked 5th, 3th, and 3rd by ORMJD, JRNSMBD, and consultants respectively. The rank given by all categories is closer to the total weighted average rank. However, the contractor is exposed to price escalation more than the left two categories. When supply management of the construction project has suffered from price escalation, a suitable method and work procedures cannot be established at a construction project. If price escalation is there, extensive project interruption could be a fact to exist on the worksite.

❖ Late delivery: The survey result (**Table-4.6**) shows that, late delivery has been ranked 5th with weighted average (RII=0.78). It shows that, there is no on-time material delivery on construction project sites as per order. It has been ranked 3rd, 4th, and 7th by OFRMJD, JRNSMBD, and consultants, respectively. The survey also showed that, project consultants are not satisfied with the delivery of materials on the project sites. Inefficiency in delivery of construction materials at the worksites implies that, there is a supply management problem of construction materials in the company. Financial difficulty, lack of transportation facility, road infrastructures problems, performance of suppliers, market inflation, the distance of the sites from material production or supply make material not to arrive on time are the major causes of late material delivery. Therefore, the result confirms that, late material delivery has been a major problem for road projects in Jimma district.

❖ Unavailability of required materials on the market: As indicated in the result (**Table-4.6**), unavailability of required materials on the market is one of the top factors contributing to supply management problem of construction materials on construction sites in Jimma district. It has been ranked sixth based on the weighted average of RII=0.76. OFRMJD, JRNSMBD, and consultants have ranked it 10th, 20th, and 1st respectively. The consultants have ranked it 1st with total weighted average (RII=0.76). Therefore, the results show that consultants feel serious about the severity of the unavailability of required materials on the market. On the other hand, OFRMJD' and JRNSMBD' rank shows that, unavailability of required materials on the market has no that much significant effect on supply management system in Jimma district.

❖ Deficiency in coordination and top management support: - As indicated in (**Table - 4.6**), the rank and weight given to this factor show that, it has been ranked 4th, 6th and 17th by OFRMJD, JRNSMBD, and consultant respectively. The result also shows that, OFRMJD and JRNSMBD have better awareness on the problem of deficiency in coordination and top management support on construction sites. According to the result, the consultants have ranked the factor as not the major problem on construction sites. Thus, the result from the study again shows that, deficiency in coordination and top management support is one of the challenging problems of supply management of construction materials in Jimma district.

❖ Problem in sequencing of works according to schedule**:** As it seen from the research results (**Table-4.6**), this factors contributing to supply management problem of construction materials has been ranked 8th, 11th, and 4th by OFRMJD, JRNSMBD, and consultant respectively, and this shows that, there is a different gap between the ranks from different

perspectives. Consultants have considered and ranked this factor as the great problem on supply management of construction materials in ERA JD; but, OFRMJD and JRNSMBD ranked it as a moderate contributing factor to poor supply management of construction materials in Jimma district. The difference shows that; - the awareness by different firms on problem in the sequencing of work according to schedule issues of construction sectors is different.

❖ Lack of proper performance measurement for construction supply management: As indicated in (**Table - 4.6**), the rank and weight given for this impact shows that, it has been ranked 6th, 8th, and 17th by OFRMJD, JRNSMBD, and consultants respectively. The result also shows that, the OFRMJD and JRNSMBD have a relatively good awareness of the lack of proper performance measurement for supply management problem of construction materials on construction sites of ERA, Jimma district. The study results again shows that, lack of proper performance measurement for supply management is one of the challenging problems for supply management of construction materials in the organization.

❖ Low-quality material/problematic completion due to quality problem: The conducted survey result (**Table - 4.6**) shows that, low-quality material/problematic completion due to quality problem has been ranked 10th with weighted average (RII=0.73). The result shows that, most construction projects suffer from low-quality material/problematic completion due to quality problems. Furthermore, it has been ranked 17th, 6th, and 7th by OFRMJD, JRNSMBD, and consultants. The rank shows that, low-quality material/problematic completion due to quality problems has been considered as the significant problems for supply management of construction materials by JRNSMBD and consultants. Low-quality material/problematic completion due to quality problem resulted from: supplies problems, unavailability of material on the market, and retailers hide material in their store to make shortage on the market and sell with the higher price. In addition, weather conditions, supplier performance, market inflation, the distance of the site from material production or supply make low quality of materials.

❖ The interview made with district manager suggested that “research on supply management of construction materials is equitable, well-reasoned, logical and on time”.

❖ Also, District manager stated “effective supply management of construction materials allows construction sectors to understand their gaps in supply at an early stage, before getting in to trouble, and often helps them to find an acceptable solution”.

❖ As explained by district manager, supply management of construction materials and

performance of construction firms are not a separate issues and the performance of construction sector cannot be imagined without supply management.

- Both interviewees forwarded that, their organization still using 70 years old extremely old American supply management system.
- Similarly, in depth interview finding showed that, factors such as: continuous price escalation of materials, deficiency in top management support, deliveries not in conformance with planning, and specification (wrong and defective deliveries), financial difficulties, late delivery, low speed of decision making/slow permits by government agencies/slow response, quality and availability of regulator documentation, supply system structure, and unavailability of required materials on market are the contributing factors that hinder supply management of construction materials in ERA, Jimma District.
- In addition, both interviewees state that, cash flow problem, complex procurement process of public organization, and limited purchase power of attorney at district level have become a big stumbling block of supply management of construction materials in their district.
- Also, district manager stated the additional factors that contribute a great deal to the bad construction materials supply management in the organization are inability to deviate from traditional practices, not updated procurement system, the tendency to steal, poor file management, boring paperwork/proliferation of paperwork, non digitalized system and incompetent purchasers.

4.4 Rank for each impacts of supply management problem of construction materials based on the perspective of respondents' occupational category

The survey conducted shows that, RII of each variable (21 impacts of supply management problem of construction materials on ERA, Jimma District) have been calculated separately for OFRMJD, project consultants, and JRNSMBD. After calculating RII and Rank based on respondents' perception, the final aggregate RII and Rank has been given for each variable based on computed results (**Table 4.7**). As can be seen from the table, the RII and Rank given by the individual occupation for different variables were varying.

Table 4.7 Computed RII and Rank for each impacts of supply management problem of construction materials based on occupational category

Impacts	OFRMJD		JRNSMBD		Consulting staff		Weighted Average	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Delay in construction project delivery	0.78	4	0.88	1	0.67	7	0.78	1
Supply system disruptions	0.82	2	0.80	4	0.69	4	0.77	2
Excessive cost of construction	0.83	1	0.82	3	0.64	11	0.76	3
Work interruption	0.78	5	0.78	6	0.71	3	0.75	4
Inefficient method of construction	0.72	10	0.74	10	0.76	1	0.74	5
Poor public image	0.75	6	0.78	6	0.69	4	0.74	6
Poor quality construction	0.80	3	0.80	4	0.60	16	0.73	7
Low Client Satisfaction	0.73	8	0.78	6	0.69	4	0.73	8
Difficult in planning and challenge in coordinating construction process	0.74	7	0.78	6	0.64	11	0.72	9
Ordered material never arrive on time	0.62	14	0.84	2	0.67	7	0.71	10
Promotes of corruption & robbery	0.73	8	0.70	12	0.67	7	0.70	11
Low concentration of workers	0.67	12	0.74	10	0.56	19	0.66	12

in their main activity								
Inaccurate data	0.59	15	0.70	12	0.67	7	0.65	13
Poor information flow	0.55	16	0.62	16	0.75	2	0.64	14
Difficulty in managing flow of materials and materials loss	0.63	13	0.60	18	0.64	11	0.62	15
Fraudulent activity	0.69	11	0.56	19	0.58	18	0.61	16
Difficulty in checking and assuring the quality of materials	0.51	18	0.64	15	0.62	14	0.59	17
Risks of health and safety	0.52	17	0.62	16	0.62	14	0.59	18
Too late material ordering	0.45	20	0.66	14	0.60	16	0.57	19
Improper allocating of storage areas	0.46	19	0.50	20	0.56	19	0.51	20
Excess ordering	0.40	21	0.44	21	0.49	21	0.44	21

The total aggregate, RII and Rank for each variable has been calculated and presented based on the survey conducted. Accordingly, based on the respondents perspective and weight given for each variable and calculated RII; the first top ten impacts of supply management problem of construction materials in ERA, Jimma District have been taken as the major problems in Jimma district, and the last ten out of the impacts with lower ranks have not been considered as major problems.

- Top ten impacts of problematic supply management of construction materials in Jimma district have been discussed as below:

❖ Delay in construction project delivery: As shown in **Table 4.7**, the result suggested that, project delay with the weighted average, RII=0.78 has been ranked the first impact of problematic supply management of construction materials in Jimma district. It has been selected as fourth impact of supply management problem of construction materials in Jimma district by Own force road maintenance Jimma district, 7th by consultants, and JRNSMBD. Most of the road projects in ERA, Jimma district have not completed at the expected time which shows that, problematic supply management of construction materials has delayed the construction projects and makes the projects not to meet the intended purpose. Poor supply management of construction materials can cause bottlenecks that strangle the life out of the project. It affects production and productivity, causing delays and adding to costs. An unexpected delay will extend the overall duration of project activities and will entail an increase in project costs. It produces time-associated cost effects that will increase resource

consumption and require extra time to reach project success.

❖ Supply system disruptions: As indicated in **Table - 4.7**, Supply system disruption has been ranked the second main impact of poor supply management of construction materials in Jimma district with the weighted average of RII=0.77. It has been ranked 2nd, 4th, and 4th by OFRMJD, JRNSMBD, and Consultants respectively.

The research again shows that, supply system disruption due to poor supply management of construction materials has been ranked second based on respondents' perspectives. The result confirmed that, if a supply management of construction materials is poor, the project cannot maintain its efficiency. A loss of efficiency interferes with a performance of an entire project. Because of this reason, most construction project is not meeting the expected goal. The efficiency of construction project becomes very low when there is disruption in supply system. Almohsen and Ruwanpura (2011) confirmed that, such loss of efficiency interferes with a performance of an entire project and reduces chances of managements meeting project quality, budget, and time objectives.

❖ Excessive ost of construction: As it can be observed from **Table-4.7,** cost overrun has been ranked third major impact of poor supply management of construction materials in ERA, Jimma District, with total weighted average of (RII=0.76). It has been ranked first by OFRMJD and the third by JRNSMBD, and eleventh by consultants. The variation in rank shows that, the contractor always needs to minimize the project costs as the cost of the project determines the productivity and profit of the contractors. The survey also shows that, cost overrun has been ranked as the third impact of poor supply management of construction materials in Jimma district. Based on the results obtained, cost overrun has been becoming the major problem for Jimma District, and it can be happened by poor planning and forecasting labor and material cost, lack of coordination, and communication.

❖ Work interruption: As indicated in the result (**Table-4.7**), work interruption is one of the top impacts of poor supply management of construction materials on construction sites in Jimma district. It has been ranked fourth, based on the total weighted average (RII=0.75). It has been ranked 5th, 6th, and 3rd by OFRMJD, JRNSMBD, and consultants, respectively. The rank given by consultants is closer to the total weighted average rank given by categories. It could be because; consultants have been assigned by the client to supervise the construction work sites in Jimma district. The consultant has the responsibility to check the work progress of construction projects in Jimma district.

However, contractors tend to maximize their benefits rather than keeping work quality and

procedure. Therefore, consultants have the responsibility of controlling the quality of construction projects. If supply system of construction project has been interrupted, there hasn't been a better method and work procedures established at a construction project. If efficient supply management of construction materials is not discovered on time, extensive work interruption could be a fact to exist on the worksite.

Generally, Poor supply management of construction materials in construction projects brings an interruption worksite.

❖ Inefficient construction method: The conducted survey result (**Table-4.7**) shows that, inefficient method of construction has been ranked 5th with weighted average (RII=0.74). The result also shows that, most of the construction projects utilize an inefficient method of construction. It has been ranked 10th, 10th, and, 1st by OFRMJD, JRNSMBD, and consultants respectively. The survey again shows that, project consultants have not feel satisfied with the method of construction that the contractor utilizes on project sites. The method of construction that has been utilized at the worksite is inefficient because of the supply management problem of construction materials found in the company. Temporary social instability and weather conditions, lack of transportation facility, road infrastructures problem, traffic congestion, supplier performance, market inflation, the distance of the site from material production or supplies makes material not to arrive on time, which again results in an inefficient construction method. One of the causes of construction delay is an inefficient method of construction. The result confirms that, in construction projects, inefficient method of construction have been a major problem in Jimma District.

❖ Poor public image: As indicated in the result (**Table - 4.7**), poor public image is one of the top impacts of poor supply management of construction materials on construction sites of Jimma District. It has been ranked sixth based on the weighted average of RII=0.74. OFRMJD, JRNSMBD, and consultants have ranked it 6th, 6th, and 4th respectively. The consultants have ranked 4th with a total weighted average of RII=0.74. Therefore the results show that, consultants have felt severe about a poor public image in road projects in ERA, Jimma District. OFRMJD and JRNSMBD rank also shows that, poor public image is one of the existing problems in construction projects under Jimma District. The construction sector is a complex sector in which maintaining a poor public image is intricate. The result from the survey also shows that, poor public image has been severely affecting construction activity in Jimma district. Poor public image resulted from theft/fraudulent activity on project site, poor quality of work, poor resource utilization, project delay, non-compliance with environmental

regulations.

❖ Poor quality construction: - As indicated in (**Table - 4.7**), the rank and weight of this impact shows; it has been ranked 3rd, 4th, and 16th by OFRMJD, JRNSMBD, and consultant respectively. The study result also shows that, poor quality construction is one of the challenging problems in construction industry. In most sites of road project in ERA, Jimma District, the quality of construction is under the standard because; contractors look its benefits by minimizing the overall project cost by using unskilled workers, using substandard materials, and reducing the ratio of materials mixed on-site to form components (like concrete work). It shows that, poor supply management of construction materials is one major problem in quality of construction projects.

❖ Low client Satisfaction**:** As can be seen from the results the research (**Table-4.7**), the impact of poor supply management of construction materials has been ranked 8th, 6th, and 4th by OFRMJD JRNSMBD, and consultant respectively. The finding shows that, the awareness by different firms on the impacts of low client satisfaction issues of construction sectors is almost similar. The result also indicated that, client satisfaction is one of the construction problems resulting from poor supply management of construction materials in ERA, Jimma District.

❖ Difficulty in planning, the challenge in coordinating the construction process, and resource/disorganized site: As indicated in (**Table - 4.7**), the rank and weight given for this impact show that, it has been ranked 7th, 6th and, 11th by OFRMJD, JRNSMBD, and consultants, respectively. The study results show that, difficulty in planning, the challenge in coordinating the construction process and resources, and the disorganized site are challenging problems resulting from problematic supply management of construction materials in ERA, Jimma District.

❖ Ordered materials never arrive on time: The survey result (**Table-4.7**) shows that, ordered materials never arrive on time has been ranked 10th with weighted average (RII=0.71). The result shows that, Jimma district has highly suffered from the problem of material delivery. It has been ranked 14th, second, and 7th by OFRMJD, JRNSMBD, and consultants, respectively. The rank showed that, material delivery has been considered as the significant problem by JRNSMBD. Most of the time, material ordered for construction projects never arrive on time, and the work had stopped for some time. When the work stops, it leads the project to delay and cost increase due to problematic supply management of construction materials, especially in the procurement of material used for construction

projects. The reason why ordered materials do not arrive on time is: supplies problem, unavailability of materials on market, retailers hide material in their store to make shortage on market and to sell with a higher price when customer has no chance to buy from other places (e.g., cement, some materials as per the specifications), brokers fabrication on the sale price of the material. Temporary social instability and weather conditions, lack of transportation facility, road infrastructures problems, traffic congestion, supplier poor performance, market inflation, and the distance of the site from material production or supply. The result also supported by Sullivan et al. (2010) that; a lot of quality time will be wasted when materials run out of stock because, construction activities may have to stop while waiting for the next delivery of materials. Baladhandayutham and Venkatesh (2012) describe that only 16 % of the incoming deliveries arrived on time. One prominent causes of construction delay are delivery lateness. It should be mentioned that, these authors regard a delivery as on time if it arrives within 60 days before the desired delivery date. It can be argued that this is quite an extensive period. Therefore, the result confirms that material delivery has been a great problem, and also, the manual process of assessing materials at the point of delivery on the construction site is time-consuming.

❖ In depth interview with district manager found that, delay in construction project delivery, supply system disruptions, excessive cost of construction, work interruption, inefficient method of construction, poor public image, poor quality construction, low client satisfaction, too late material ordering, risks of health and safety, low concentration of workers in their main activity, ordered materials never arrive on time, difficult in planning, challenge in coordinating the construction process, and disorganized site are critical short falls in the organization.

4.5 Rank for each recommended potential techniques to improve supply management of construction materials based on perspective of respondents' occupational category

The survey conducted shows that, the RII of each potential technique to improve supply management of construction materials has been calculated separately for OFRMJD, the consultants of the projects, and JRNSMBD. Finally, after calculating RII and Rank based on respondents' perception, the final aggregate RII and Rank has been given to each variable based on computed results (**Table 4.8**). As it can be seen from the table, the RII and Rank given by individual occupation for different variables were varying.

Table 4.8 Computed RII and Rank for each potential techniques to improve supply management problem of construction materials based on occupational category

Techniques	OFRMJB		JRNSMBD		Consulting staff		Weighted Average	
	RII	Rank	RII	Rank	RII	Rank	RII	Rank
Ensuring reliability of supply system	0.80	18	0.88	1	0.75	4	0.81	1
Top management support	0.85	17	0.82	3	0.69	10	0.79	2
Applying Balanced Scorecard	0.82	13	0.76	11	0.76	3	0.78	3
Applying integrated/systematic construction supply management system	0.86	1	0.78	8	0.69	10	0.78	4
Free flow of information	0.77	15	0.80	5	0.73	5	0.77	5
Just-In-Time delivery	0.82	8	0.74	16	0.73	5	0.76	6
Applying Information and Communication Technology	0.81	10	0.80	5	0.67	13	0.76	7
Using the Supply Chain Operations Reference model's performance measurements	0.83	20	0.78	8	0.67	13	0.76	8
Using statistical quality control	0.78	24	0.76	11	0.73	5	0.75	9
Using value stream mapping/Map the current value flow and look for improvements that can be made	0.82	22	0.76	11	0.67	13	0.75	10

Applying Kaizen	0.80	13	0.78	8	0.67	13	0.75	11
Setup single minute exchange of die/time reduction	0.67	36	0.76	11	0.78	2	0.74	12
Waste Identification and Elimination	0.78	30	0.72	19	0.71	8	0.73	13
Creating standardization of processes	0.78	30	0.72	19	0.71	8	0.73	14
Human Resource development	0.71	21	0.80	5	0.65	18	0.72	15
Benchmarking	0.76	14	0.72	19	0.64	19	0.71	16
Establishing Construction Consolidation Centre	0.75	16	0.74	16	0.62	24	0.70	17
Demand Smoothing	0.75	16	0.74	16	0.62	24	0.70	18
Closer links between demand and supply	0.71	23	0.70	22	0.69	10	0.70	19
Production leveling/Stabilizing the system	0.71	28	0.76	11	0.60	25	0.69	20
Supplier, Customer, and employee involvement	0.71	34	0.68	23	0.67	13	0.69	21
Establishing on-site Marketplaces	0.69	29	0.62	25	0.71	8	0.67	22
Utilizing pre-assembled and offsite fabrication	0.67	33	0.62	25	0.64	19	0.64	23
Suppliers and Subcontractors development	0.63	40	0.66	24	0.60	25	0.63	24

Based on the survey conducted, the total aggregate, RII and Rank for each variable has been calculated and presented. Accordingly, based on the respondents' perspective and the weight given for each variable and calculated RII; the first top ten potential techniques to improve supply management of construction materials in ERA, Jimma district have been taken as the major techniques to improve supply management of construction materials, and the last ten with lower rank have not been considered as the major techniques to improve supply management of construction materials in Jimma district (see **Table-4.8**).

- Top ten potential techniques to improve supply management of construction materials in Jimma district have been discussed as below:

❖ Ensuring reliability of supply system: As indicated in **Table-4.8**, Ensuring reliability of the supply system has been ranked second primary potential techniques to improve supply

management of construction materials in Jimma district with the weighted average of (RII=0.81). Based on perspective of the respondents, this research ranks the reliability of supply system the second. The result confirmed that, the efficiency of supply management of construction materials was maintained by maintaining the reliability of supply system. A loss of reliability of supply system interferes with the performance of supply management system.

❖ Top management support: As observed from **Table-4.8,** top management support has been ranked as third major potential techniques to improve supply management of construction materials with a total weighted average of (RII=0.79). The result indicates that, supply management of construction materials will be improved if a top management support will be improved well.

❖ Applying Balanced scorecard: As indicated in the result **(Table-4.8),** Applying Balanced Scorecard is one of the top potential techniques to improve supply management of construction materials in Jimma district. It has been ranked fourth, based on weighted average (RII=0.78). On the other hand, it has been ranked 13th, 11th, and 3rd by OFRMJD, JRNSMBD, and consultants. The rank given by consultants is closer to the total average weight rank given by all respondents. It could be because, consultants are primarily assigned to supervise and measure the performance of construction worksite and responsible for checking the overall work progress of the construction project. When Balanced Scorecard in supply management ignored, it is not easy to establish an efficient and effective supply management system at a construction project.

❖ Applying integrated and systematic supply management: The conducted survey result **(Table-4.8)** shows that, applying integrated and systematic supply management in road projects in ERA, Jimma District has been ranked 5th with weighted average (RII=0.78), and this shows that, applying integrated and systematic supply management has a significant role in improving the performance of supply management in ERA, Jimma District. It has been ranked 1st, 8^{th,} and 10th by OFRMJD, JRNSMBD, and consultants. The survey again showed that, OFRMJD has selected integrating and systematic construction supply management as the best technique to improve the supply management system.

❖ Free flow of information: As indicated in the result (**Table-4.8**), free flow of information is one of the top potential techniques to improve supply management system in ERA, Jimma District. It has ranked 6th, based on weighted average (RII=0.77). It has ranked 15th, 5th, and 5th by OFRMJD, JRNSMBD, and consultants, respectively. The JRNSMBD and consultants rank 5th with total weighted average (RII=0.80 & 0.73), respectively, and it shows

that, JRNSMBD and consultants have felt severe about the poor flow of information in the road projects in ERA, Jimma District. The result the research shows that, construction sector is a complex sector in which maintaining efficient supply management is difficult without promising efficient free flow of information.

❖ Just-in-time delivery: As indicated in (**Table - 4.8),** the results the study show that, late delivery is one of the challenging problems in construction projects ERA, Jimma District. The rank and weight given for Just-in-time delivery is 8^{th}, 16^{th}, and 5^{th} by OFRMJD, JRNSMBD, and consultant. Thus, OFRMJD and consultants have an awareness of the significance of Just-in-time delivery in construction sites.

❖ Information and communication technology**:** As it can be seen from the result, the absence of information and communication technology systems in the supply management process is one of the problems in construction industries. Information and communication technology system has ranked 10^{th}, $5^{th,}$ and 13^{th} by OFRMJD, JRNSMBD, and consultants, respectively. The result shows that, there are different gaps between the ranks from different perspectives. JRNSMBD has considered and ranked this technique as very important, but OFRMJD and consultant ranked it as moderately significant.

❖ Using supply chain operation reference model: As indicated in **(Table-4.8),** the rank and weight given for this improvement technique of supply management of construction materials shows 20^{th}, 8^{th}, and 13^{th} by OFRMJD, JRNSMBD, and consultants, respectively. The result shows that, OFRMJD has relatively good awareness of the importance of the SCOR system. On the other hand, the utilization of the SCOR system to improve supply management is not adopted well in ERA, Jimma District.

Moreover, the SCOR-based model performance measurement metrics also confirmed the above results.

❖ Both interviewees state that, "applying SCOR model metrics, Kaizen, and Information and communication Technology reduces the problem of construction materials supply management in the sector".

❖ Procurement and supply team leader believes that, top management support, creating standardization of processes, establishing construction consolidation centre, and waste identification and elimination plays a significant role in improving construction materials supply management of the district.

Based on Perfect order fulfillment of SCOR level one metrics and reliability attributes, if one delivered order is to be seen as perfectly delivered, the right product has to be delivered

in the right quantity, at the right time and place, with the correct documents and in the right condition. (Thunberg, 2013)

If at least one of these conditions is not met, it is not a "perfect" delivery (Micael Thunberg & Fredrik Persson, 2014). In line with this concept, the obtained results show that, the availability of ordered materials never arrives on time is RII=0.71 and material loss or damage is RII=0.62 in ERA, Jimma District confirmed that, the performance in supply management of construction materials in ERA, Jimma District included in the survey is relatively low. Furthermore, based on the concept of the employed metrics (used to measure orders that contained the right products and arrived in the correct quantity), was concluded that; there was difficulty in managing the flow of materials and difficulty in checking and assuring the quantity of materials, and it confirmed that, because of such impacts, it could be challenging to have ordered in total percentage.

Based on Delivery Performance to Customer Commit Date also used to measure orders shipped to the right geographical location and delivered on time (Orders that arrived on time and delivered in total, according to the first level 2 metric). The finding of the research showed that, ordered materials are never arrive on time (delayed), all ordered materials are never used (excess ordering), there is wrong time delivery of materials, and there is too late material ordering in ERA, Jimma District. Accordingly, orders that had not arrived on time and that were not delivered in full package showed that, there is poor performance of supply management of construction materials in projects of ERA, Jimma District.

Based Documentation Accuracy *(*this metric used to check good documentation of each only included plans for assembly. According to the result obtained, there is a gap in updating the stakeholders/inaccuracy of data (poor information flow) in projects of ERA, Jimma District.

Based In perfect condition (information on damaged material delivered), these metrics confirm that, the delivered material should be in good condition. However, the result of the research showed that, material loss or damage was one of the problems of construction project, and it proved that, the performance of supply management of construction materials in Road projects of ERA JD is low.

Based on Source cycle time of SCOR metrics, SCT assesses responsiveness to calculate the order fulfillment time, i.e., the total elapsed time for receiving an order, producing the products, and delivering the products. Sourcing time increased in some construction site because, contractors order some materials for an extended period and to get discounts, this

often results in much material to unload and store (Thunberg and Persson, 2014). In line with this concept; the result obtained from the research shows that, there is an increased time of ordering and receiving materials to the site that might be caused by materials delay, order delay, and transportation delay. Based on SCT metrics concept, supply management of construction materials in road projects of ERA, Jimma District included in the survey were comparatively low.

Based on **the cost to the source** of SCOR metrics, CS are the costs of managing suppliers and material acquisition. The cost variables are considered when calculating the CS for one order and all incoming deliveries. The included costs are the cost to order, receive, verify materials, the cost to transfer, and the cost to authorize supplier payment (Thunberg and Persson, 2014). In line with this concept and based on the result of the research; Cost overrun is one of the significant-top ten road construction projects, and this shows that, cost overrun included all costs listed in the CS concept. Furthermore, based on CS metrics, the availability of cost overrun (it could be because of the cost of the order, receive, and cost of verifying material increase) confirmed that, the status of supply management of construction materials in road projects in ERA, Jimma District is relatively poor.

In addition to this, data related to supply history of construction materials from 2017 - 2021 G.C were collected from archival documents, monthly progress report, and discussion with participants on road projects. The average planned amount that has to be invested to purchase the construction materials in five consecutive years was 203,624,081.64 birr. However, the total expenditure to procure construction materials in the five consecutive years was only 82,307,559.58 birr. The financial accomplishment of the purchase is departed from planned amount by 111,088,501.57 birr, which shows that, only 40.42% was achieved. This shows the supply management performance of construction materials in the district is extremely bad.

CHAPTER FIVE

5. Conclusion and Recommendation

5.1 Conclusion

Identification of the predominant factors those causes supply management problem is a prerequisite to minimize or to avoid the impacts of supply management problem in construction projects. The three primary objectives of this research are: to identify the critical factors contributing to supply management problem of construction materials; to investigate the impacts of supply management problem of subject area on ERA, Jimma district, and to determine the potential techniques to improve supply management of the organization. Desk study and Questionnaire survey were used to identify the existence and extent of supply management problem of the subject matter in ERA, Jimma district. Clients, consultants and contractors were asked the frequency of occurrence of the variables, their impacts on the projects, and the improvement potential techniques of the subject matter in the organization. Based on questionnaire survey and document analysis results, the findings of the research reveal prevalence of supply management problem of construction materials on road projects in ERA, Jimma district. The archival documents and questionnaire analysis indentified the most dominant factors those causes supply management problem of construction materials as: Planning and scheduling problem, RII=83%, Low speed of decision making/slow permits of Government agencies, RII=81%, Financial difficulties, RII=80%, Price escalation, RII=80%, Late delivery, RII=78%, Unavailability of required materials on the market, RII=76%, Lack of proper performance measurement for construction supply management, RII=73%, Low-quality material, RII=73%, and Employees' motivation problem, RII=72%. Both archival document and questionnaire analysis in common identify; Delay in construction project delivery, RII=78%, Supply system disruption, RII=77%, Excessive cost of construction, RII=76%, Work interruption, RII=75%, Inefficient method of construction, RII=74%, Poor public image, RII=74%, Poor quality construction, RII=73%, Low client satisfaction, RII=73%, Difficulty in planning, the challenge in coordinating construction process and resource, RII=72%, and Ordered materials never arrive on time, RII=71% as the most impacts of supply management problem of construction materials on the organization. Based on the findings the research, the potential techniques to improve supply management of construction materials in the organization those assigned a very highest weight in percentage

are: Ensuring the reliability of construction supply system, RII=81%, Top management support, RII=79%, Balanced Scorecard, RII=78%, Applying integrated and systematic construction supply management, RII=78%, free flow of information, RII=77%, Just-in-time delivery, RII=76%, Applying Information and Communication Technology, RII=76%, Using supply chain operation reference (SCOR) model's performance measurement, RII=76%, Applying statistical quality control, RII=75%. Moreover, the SCOR-based model performance measurement metrics confirmed the above results. Perfect order fulfillment (POF), Source cycle time (SCT), and cost to the source (CS) showed supply management of construction materials in ERA, Jimma District is very poor.

Generally, the study found that, poor supply management of construction materials had impacts on overall construction process and the most inquiring effects of supply management problem of construction materials in ERA, Jimma district are: increases in project cost, delay in project delivery, additional overhead expense for the contractor, and Productivity degradation.

5.2 Recommendation

The construction project is a complex and tedious process to manage every activity on the project sites. Therefore, efficient supply management of construction materials significantly reduces construction costs by reducing wastage and extra costs. Therefore, if supply management of construction materials in the construction sector is efficient, construction materials will arrive at an appropriate time, place, quantity and quality, and the construction work will not be interrupted by waiting for materials. Based the findings of the research, the following recommendations were drawn:

It would be better if each and every project sites in Jimma district practices supply management plan guide. Supply management plan guide helps to accomplish each activity according to the plan. When a practical supply management guide is followed, site wastage will be reduced; proper material storage will be maintained, and easy to locate the material on the site. Appropriate supply management of construction materials speeds up the project and improves the efficiency of the workforce. It also makes a safer and clean working environment. Sound supply management system also maintains health and safety on the construction site.

It would be good to implement the best way of improving supply management systems in the company to make every construction site productive. To do this, it is recommendable if the company should reduce site traffic movement, improving material storage place and improving sound communication systems on construction site, using prefabricated material to reduced on-site production, using construction consolidation center, applying material trucking system on-site, and finally applying SCOR model to measure supply performance in construction projects.

Furthermore, for the construction projects in congested urban centers, introducing supply chain centers and JIT can improve supply management systems in the organization, which is also used to improve urban traffic congestion.

In general, this research is limited in assessing the most factors contributing to the supply management problem of construction materials, impacts of supply management problem of construction materials, and the methods to improve supply management performance in ERA, Jimma District. It reflects only the current condition of the construction projects in the district. However, the situation of road constructions in the Jimma district is changing from time to time and different from project to project.

Therefore, assessment of supply management problem of construction materials on performance of the sector needs further study in a different context.

Thus in future, the research on supply management problem of construction materials in road projects should be done considering a more comprehensive range of road construction projects in ERA in particular and in all construction projects in Ethiopia in general.

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Appendix A. Respondents response sheet

Part I. Background and General information

1. Description of occupational category in the Organization		**Frequency**	
ERA OFRMJD	Work Execution	23	56
	Engineering Staff	18	
	Equipment maintenance and Administration staff	4	
	Financial Management	6	
	Procurement and Supply Team	5	
ERA JRNSMBD		10	
CONSULTANT	HYK	6	11
	Birhan Construction Design Consultant	5	
2. Position of the respondents in the organization			
Manager		1	
Team Leader		13	
Civil Engineer		24	
Mechainical Engineer		2	
Construction Forman		10	
Surveyor		4	
Work inspector		5	
Officer		10	
Other		9	
3. Experience in construction project			
0-5 Yrs		20	
5 -10 Yrs		16	
>10 Yrs		35	
4. Experience in your current organization			
0-5 Yrs		21	
5-8 Yrs		17	
>10Yrs		27	
5. Level of education			

None	
1-8 Yrs	
9-10 Yrs	2
11-12 Yrs	1
Technical School	6
Diploma	20
BSc/BA degree	33
MSc /MBA degree	15
PHD	
6. Type of Road Maintenance project the company specialized in	
Gravel road	69
Asphalt road	69
Bridge	53
rigid pavement	10
Pipe line	2

Part II. Factors Contributing to Supply Management Problem of Construction Materials

ERA, OFRMJD

No.	Factors	1	2	3	4	5
1	Complex and too long bidding process	13	22	9	10	2
2	Deficiency in coordination and top management support		6	3	28	18
3	Deliveries not in conformance with planning, specification, wrong and defective deliveries	3	11	26	13	3
4	Difficulties in finding out client's desires, changes of client's requirements	2	8	14	19	13
5	Discontinuous and low demand problems	28	11	4	8	3
6	In accessible site	4	29	11	8	4
7	Employees with no motivation	2	5	11	31	7
8	Financial difficulties	2	4	7	8	38

9	Frequent changes in the specification	25	12	6	8	4
10	Inadequate tracking facilities on site	1	5	28	18	4
11	Inappropriate allocation of risk		5	10	37	4
12	Inappropriate selection criteria	3	28	11	14	
13	Incompetent workers/shortage of technical person	2	4	11	34	5
14	Ineffective communication	4	6	30	11	5
15	Inefficient inventory control policy	27	2	11	10	6
16	Lack of proper performance measurement for construction supply chain management	6	5	9	9	27
17	Lack of storage space	16	17	11	7	4
18	Lack of transparency in costs	4	6	7	28	12
19	Late and incorrect payments	2	3	1	17	21
20	Late delivery	1	3	12	12	28
21	Poor leadership skills of project manager and procurement administrator	3	6	30	11	6
22	Problem in local climate conditions	3	27	9	9	8
23	Low-quality material	4	4	19	17	11
24	Low speed of decision making/slow permits by government agencies/slow response	1	4	9	10	33
25	Planning and scheduling problem		5	2	18	25
26	Price escalation	1	7	3	14	28
27	The problem in sequencing of work according to schedule	2	5	8	20	19
28	Unsafe project site	15	14	13	9	5
29	Poor quality and unavailability of regulator documentation	2	5	11	24	8
30	Unreliability of supply system	3	24	18	8	3
31	Reliance on few suppliers or unavailability of competent supplier	3	23	17	10	1
32	Review period length	1	9	19	25	2
33	Short-term nature of construction process	5	11	18	16	6
34	Subcontracted work not delivered according to the main	23	8	10	10	5

	design, contract, and planning					
35	Inefficient supply system structure	2	19	18	14	3
36	Absence of clear definition of responsibility and authority for supply system management expected in a supply system	4	26	14	10	5
37	Threat to utilize substitute products	1	3	20	30	3
38	Unavailability of required materials on the market	2	4	12	38	2

ERA, JRNSMBD

No.	Factors	1	2	3	4	5
1	Complex and too long bidding process		2	1	7	
2	Deficiency in coordination and top management support		1		2	5
3	Deliveries not in conformance with planning, specification, wrong and defective deliveries		2	2	2	4
4	Difficulties in finding out client's desires, changes of client's requirements		2	1	3	4
5	Discontinuous and low demand problems	1	3	3	3	
6	In accessible site	2	2	2	4	
7	Employees with no motivation		2		7	2
8	Financial difficulties			1	6	3
9	Frequent changes in the specification	2	4		2	2
10	Inadequate tracking facilities on site		3	1	4	2
11	Inappropriate allocation of risk		1	3	4	2
12	Inappropriate selection criteria		1	5	4	
13	Incompetent workers/shortage of technical person		1	4	1	4
14	Ineffective communication	2		2	4	2
15	Inefficient inventory control policy	3	2	4		1
16	Lack of proper performance measurement for construction supply chain management		1	1	5	2
17	Lack of storage space	2	2	2	3	1
18	Lack of transparency in costs		3	1	4	2

19	Late and incorrect payments		1	4	5	
20	Late delivery		1		5	4
21	Poor leadership skills of project manager and procurement administrator		3	2	2	3
22	Problem in local climate conditions		2	4	3	1
23	Low-quality material		1	3		6
24	Low speed of decision making/slow permits by government agencies/slow response				4	6
25	Planning and scheduling problem			2		
26	Price escalation			1	4	5
27	The problem in sequencing of work according to schedule			1	5	3
28	Unsafe project site		5	3	1	1
29	Poor quality and unavailability of regulator documentation		1	4	2	3
30	Unreliability of supply system		1	5	4	
31	Reliance on few suppliers or unavailability of competent supplier		2	3	4	1
32	Review period length		2	5	2	1
33	Short-term nature of construction process		1	5		
34	Subcontracted work not delivered according to the main design, contract, and planning		3	2	2	
35	Inefficient supply system structure		4	3	2	1
36	Absence of clear definition of responsibility and authority for supply management expected in a supply system		3	2	3	1
37	Threat to utilize substitute products		1	3	4	1
38	Unavailability of required materials on the market		3	1	5	1

CONSULTANTS

No.	Factors	1	2	3	4	5
1	Complex and too long bidding process		4	5	2	
2	Deficiency in coordination and top management support		4	3	3	1
3	Deliveries not in conformance with planning, specification, wrong and defective deliveries		4	6	1	
4	Difficulties in finding out client's desires, changes of client's requirements		2	6	1	2
5	Discontinuous and low demand problems	2	2	6	1	
6	In accessible site	1	2	3	5	
7	Employees with no motivation		1	4	5	
8	Financial difficulties		2	6	1	2
9	Frequent changes in the specification	2		7	3	
10	Inadequate tracking facilities on site		2	6	3	
11	Inappropriate allocation of risk		2	5	4	
12	Inappropriate selection criteria		4	7		
13	Incompetent workers/shortage of technical person			10	1	
14	Ineffective communication	1		10		
15	Inefficient inventory control policy	2	2	6	1	
16	Lack of proper performance measurement for construction supply management		3	6		2
17	Lack of storage space		3	7	1	
18	Lack of transparency in costs		2	6	2	1
19	Late and incorrect payments		3	5	2	1
20	Late delivery		2	5	2	2
21	Poor leadership skills of project manager and procurement administrator		2	8	1	
22	Difficult local climate condition		2	6	3	
23	Low-quality material		3	3	3	2
24	Low speed of decision making/slow permits by		3	5	1	2

	government agencies/slow response					
25	Planning and scheduling problem		1	7	1	2
26	Price escalation		1	6		4
27	The problem in sequencing of work according to schedule		1	6	2	2
28	Unsafe project site	1	1	7	2	
29	Poor quality and unavailability of regulator documentation		1	8	1	1
30	Unreliability of supply system		2	7	2	
31	Reliance on few suppliers or unavailability of competent supplier		2	5	4	
32	Review period length		1	4	6	
33	Short-term nature of construction process		1	4	6	
34	Subcontracted work not delivered according to the main design, contract, and planning	1	2	6	2	
35	Inefficient supply system structure		2	6	3	
36	Absence of clear definition of responsibility and authority for supply management expected in a supply system		2	6	3	
37	Threat to utilize substitute products			7	4	
38	Unavailability of required materials on the market		1	6	4	

Part III. Impacts of supply management problem of construction materials

ERA, OFRMJD

No.	Impacts	1	2	3	4	5
1	Delay in construction project delivery	5	3	11	11	26
2	Difficult in planning, challenge in coordinating the construction process and resource and, disorganized site.	5	4	9	24	14
3	Difficulty in checking and assuring quality of materials	4	29	12	9	2
4	Difficulty in managing flow of materials and inefficient handling of materials and/ or materials loss	4	13	24	17	1
5	Excess ordering	32	4	10	7	3
6	Excessive cost of construction	1	2	14	11	28
7	Fraudulent activity	4	7	11	32	3
8	Improper allocating of storage areas	10	32	6	7	2
9	Inaccurate data	3	18	17	16	2
10	Inefficient method of construction	2	8	10	22	13
11	Low client Satisfaction	4	9	12	10	21
12	Low concentration of workers in their main activity	2	9	17	23	5
13	Ordered material never arrive on time	5	4	9	5	34
14	Poor information flow	2	16	28	8	1
15	Poor public image	4	10	8	8	26
16	Poor quality construction	4	9	8	17	22
17	Promotes corruption & robbery	3	7	10	24	12
18	Risks of health and safety	3	21	27	5	0
19	Supply system disruptions		6	12	9	29
20	Too late material ordering	11	28	10	7	0
21	Work interruption	5	10	2	9	30

ERA, JRNMBD

No.	Impacts	1	2	3	4	5
1	Delay in construction project delivery			1	4	5
2	Difficult in planning, challenge in coordinating the construction process and resource and, disorganized site.		1	1	6	2
3	Difficulty in checking and assuring quality of materials	1	1	5	1	2
4	Difficulty in managing flow of materials and inefficient handling of materials and/ or materials loss	1	2	3	4	
5	Excess ordering	2	4	4		
6	Excessive cost of construction		2	1	1	6
7	Fraudulent activity	1	1	3	4	
8	Improper allocating of storage areas	2	2	5	1	
9	Inaccurate data		2	4	1	3
10	Inefficient method of construction		1	4	2	3
11	Low client Satisfaction		1	2	4	3
12	Low concentration of workers in their main activity		1	2	6	1
13	Ordered material never arrive on time		2		2	6
14	Poor information flow	1	2	4	1	2
15	Poor public image			4	3	3
16	Poor quality construction		1	2	2	4
17	Promotes corruption & robbery	2	1		4	3
18	Risks of health and safety	1	1	5	2	1
19	Supply system disruptions		1	2	3	4
20	Too late material ordering		2	5	1	2
21	Work interruption	1		3	1	5

CONSULTANTS

No.	Impacts	1	2	3	4	5
1	Delay in construction project delivery			9		2
2	Difficult in planning, challenge in coordinating the construction process and resource and, disorganized site.		2	7		2
3	Difficulty in checking and assuring quality of materials		1	8	2	
4	Difficulty in managing flow of materials and inefficient handling of materials and/ or materials loss		1	7	3	
5	Excess ordering	2	3	5	1	
6	Excessive cost of construction		3	5	1	2
7	Fraudulent activity		3	6	2	
8	Improper allocating of storage areas		3	7	1	
9	Inaccurate data			7	4	
10	Inefficient method of construction			4	5	2
11	Low client Satisfaction		2	4	3	2
12	Low concentration of workers in their main activity		2	9		
13	Ordered material never arrive on time		2	5	2	2
14	Poor information flow		1	6	4	1
15	Poor public image		2	4	3	2
16	Poor quality construction		1	6	2	1
17	Promotes corruption & robbery			7	4	
18	Risks of health and safety			10	1	
19	Supply system disruptions			8	1	2
20	Too late material ordering		2	7	2	
21	Work interruption			7	2	2

Part IV. Potential techniques to improve supply management of construction materials

ERA, OFRMJD

No.	Techniques	1	2	3	4	5
1	Applying integrated/systematic construction supply chain management	1	4	5	14	32
2	Benchmarking		1	14	35	6
3	Closer links between demand/ supply		4	15	30	7
4	Applying Construction Consolidation Centre		3	13	36	4
5	Creating standardization of processes		6	9	32	8
6	Demand Smoothing	2	4	14	33	3
7	Free flow of information		7	10	23	16
8	Human Resource development	2	4	9	37	3
9	Applying Information and Communication Technology Systems	3	3	10	12	28
10	Just-In-Time delivery	2	3	12	9	30
11	Applying Kaizen (Continuous improvement)	4	4	8	13	27
12	On-site Marketplaces	5	5	15	31	2
13	Applying Balanced Scorecard	3	5	8	8	32
14	Pre-assembled and offsite fabrication	4	3	20	23	5
15	Production leveling	2	4	14	32	4
16	Reliability of supply		4	12	15	24
17	Single minute Exchange of die Setup time reduction	4	5	12	17	17
18	Using statistical quality control	2	1	12	28	13
19	Supplier, Customer and employee involvement	3	4	11	35	3
20	Suppliers' and Subcontractors' Development	5	3	30	16	2
21	Top management support	1	4	7	11	33
22	Using the Supply Chain Operations Reference model's performance measurements	2	4	11	7	32
23	Value stream mapping /Map the current value flow and look for improvements that can be made	3	3	7	15	28
24	Waste Identification and Elimination	2	4	8	27	15

ERA, JRNMBD

No.	Techniques	1	2	3	4	5
1	Applying integrated/systematic construction supply chain management		1	3	2	4
2	Benchmarking		1	4	3	2
3	Closer links between demand/ supply			5	4	1
4	Applying Construction Consolidation Centre		1	3	4	2
5	Creating standardization of processes			4	1	5
6	Demand Smoothing	1		4	3	2
7	Free flow of information			4	2	4
8	Human Resource development		1	1	5	3
9	Applying Information and Communication Technology Systems		1	3	1	5
10	Just-In-Time delivery	2		1	3	4
11	Applying Kaizen (Continuous improvement)	1	1	1	2	5
12	On-site Marketplaces	2		4	3	1
13	Applying Balanced Scorecard	1		3	2	4
14	Pre-assembled and offsite fabrication	1	1	4	4	
15	Production leveling		2	1	4	3
16	Reliability of supply			1	4	5
17	Single minute Exchange of die Setup time reduction	1		2	4	3
18	Using statistical quality control	1		2	4	3
19	Supplier, Customer and employee involvement		1	6	1	2
20	Suppliers' and Subcontractors' Development			8	1	1
21	Top management support	1		1	3	5
22	Using the Supply Chain Operations Reference model's performance measurements	1		3	1	5
23	Value stream mapping /Map the current value flow and look for improvements that can be made	2		1	2	5
24	Waste Identification and Elimination		2	3	2	3

CONSULTANTS

No.	Techniques	1	2	3	4	5
1	Applying integrated/systematic construction supply chain management		2	8	1	2
2	Benchmarking		2	7		2
3	Closer links between demand/ supply		3	6	2	1
4	Applying Construction Consolidation Centre		1	5	2	1
5	Creating standardization of processes		1	7	3	
6	Demand Smoothing			4	6	
7	Free flow of information		1	6	3	2
8	Human Resource development		2	6	4	
9	Applying Information and Communication Technology Systems		1	5	2	2
10	Just-In-Time delivery		2	4	4	2
11	Applying Kaizen (Continuous improvement)		3	5	2	2
12	On-site Marketplaces			5	6	
13	Applying Balanced Scorecard		1	4	5	2
14	Pre-assembled and offsite fabrication		3	7	3	
15	Production leveling		2	5	3	
16	Reliability of supply			5	3	2
17	Single minute Exchange of die Setup time reduction			5	4	2
18	Using statistical quality control			5	5	1
19	Supplier, Customer and employee involvement			7	4	
20	Suppliers' and Subcontractors' Development			11		
21	Top management support			8	1	2
22	Using the Supply Chain Operations Reference model's performance measurements			9		2
23	Value stream mapping /Map the current value flow and look for improvements that can be made		2	5	2	2
24	Waste Identification and Elimination		1	4	5	1

Appendix B. The review of Archival Documents in the organization

1. *Construction Materials demand and supply for 2017 GC*

Description	Material	Unit	Demand	Supply	Deference	Unit rate	Total Amount demand	Total Amount Supply
Cement	OPC	Qnt	32,337.50	15,600.00	(16,737.50)	295.00	9,539,563.02	4,602,000.00
Sub Total							9,539,563.02	4,602,000.00
Aggregate	Base aggregate	m3	15,887.72	29,523.06	13,635.34	543.70	8,638,155.47	16,051,687.72
	Surface Agg.(3/4")		8,217.92	11,250.30	3,032.38	813.95	6,688,978.34	9,157,181.69
	Surface Agg.(3/8")		5,608.37	8,563.40	2,955.03	813.95	4,564,932.84	6,970,179.43
	Surface Agg. (Fine)		3,633.53	5,240.00	1,606.47	813.95	2,957,509.76	4,265,098.00
Sub Total							22,849,576.42	36,444,146.84
Asphalt	MC-3000	Kg	1,046,904.53	332,746.40	(714,158.13)	30.00	31,407,136.02	9,982,392.00
	MC-30		309,176.61	129,970.00	(179,206.61)	23.15	7,157,438.48	3,008,805.50
	AC-60/70		-	-	-	30.00	-	-
	AC-80/100		654,401.93	217,602.16	(436,799.77)	23.00	15,051,244.39	5,004,849.68
	AC 85/100		318,864.00	-	(318,864.00)	22.80	7,270,099.20	-
	RC-70	Ltr.	-	-	-	23.20	-	-
Sub Total							60,885,918.09	17,996,047.18
Reinforcement steel, Binding wire, Formwork & Mason String	Ø8 - Reinf.bar	Kg	17.98	12,357.15	12,339.17	35.00	629.37	432,500.25
	Ø12 - Reinf.bar	Kg	75.49	56,498.77	56,423.28	35.00	2,642.20	1,977,456.95
	Ø16 - Reinf.bar	Kg	-	-	-	35.00	-	-
	Ø24 - Reinf.bar	Kg	-	4,266.67	4,266.67	35.00	-	149,333.45
	Ø20 - Reinf.bar	Kg	-	3,199.50	3,199.50	35.00	-	111,982.50

Sub Total							3,271.56	2,671,273.15
Explosives	Super dynamite-80	kg	10,662.57		(10,662.57)	95.00	1,012,944.44	-
	Super dynamite-90	kg	10,662.57	12,000.00	1,337.43	95.00	1,012,944.44	1,140,000.00
	Ammonium Nitrate	kg	86,044.98	10,000.00	(76,044.98)	90.00	7,744,048.47	900,000.00
	Detonator 2*7 /Blasting caps	Each	-	100.00	100.00	67.00		6,700.00
	Detonator 2*10 /Blasting caps	Each	9,249.00	1,200.00	(8,049.00)	67.00	619,683.00	80,400.00
Sub Total							10,389,620.34	2,127,100.00
Wood and Lumber	Lumber	m3	-	19.12	19.12			-
	Eucalyptus tree	Each	-	1,240.00	1,240.00			-
Sub Total							-	-
Grand Total							103,667,949.43	63,840,567.17

2. *Construction Materials demand and supply for 2018 GC*

Description	Material	Unit	Demand	Supply	Deference	Estimated Unit Price	Total Amount Demand	Total Amount Supply
Cement	OPC/PPC	Qnt	14,804.00	4,800.00	(10,004.00)	260.00	3,849,040.00	1,248,000.00
Sub Total							**3,849,040.00**	**1,248,000.00**
Aggregate	Base course	m3	184,398.50	96,965.74	-87,432.76	543.70	100,257,464.45	52,720,272.84
	3/4		25,066.20	21,328.35	-3,737.85	813.95	20,402,633.49	17,360,210.48
	⅜		14,004.30	12,539.82	-1,464.48	813.95	11,398,799.99	10,206,786.49
	Fine		15,569.27	9,918.28	-5,650.99	813.95	12,672,607.32	8,072,984.01
Sub Total							**144,731,505.24**	**88,360,253.82**
Asphalt	MC-3000	Kg	248,000.00	65,125.62	-182,874.38	30.00	7,440,000.00	1,953,768.60

	MC-30		329,800.00	96,821.80	-232,978.20	23.15	7,634,870.00	2,241,424.67
	AC-60/70		1,713,600.00	453,171.50	-1,260,428.50	30.00	51,408,000.00	13,595,145.00
	AC-80/100		317,600.00	0.00	-317,600.00	23.00	7,304,800.00	-
	85/100		32,760.00					
	RC-70		35,400.00	73,585.00	38,185.00	23.20	821,280.00	1,707,172.00
Sub Total							**74,608,950.00**	**9,497,510.27**
Reinforcement steel, Binding wire, Formwork & Mason String	Ø8 - Reinf.bar	Kg	10,444.53		-10,444.53	35.00	365,558.55	-
	Ø12 - Reinf.bar	Kg	21,968.64		-21,968.64	35.00	768,902.40	-
	Ø16 - Reinf.bar	Kg	293.00		-293.00	35.00	10,255.00	-
	Ø24 - Reinf.bar	Kg	2,403.33		-2,403.33	35.00	84,116.67	-
	Ø20 - Reinf.bar	Kg	3,330.00		-3,330.00	35.00	116,550.00	-
	Form work	m3	344.00		-344.00	10,000.00	3,440,000.00	-
	Binding Wire Ø 1.5mm	Kg	1,000.00		-1,000.00	45.00	45,000.00	-
	Binding Wire Ø 2.5mm	Kg	350.00		-350.00	45.00	15,750.00	-
	Manson String Ø 3mm	Roll	25.00		-25.00	53.00	1,325.00	-
Sub Total							**4,847,457.62**	**4,847,457.62**
Explosives	Super dynamite-80	kg	25,000.00	0.00	-25,000.00	95.00	2,375,000.00	-
	Super dynamite-90	kg	25,000.00	8,500.00	-16,500.00	95.00	2,375,000.00	807,500.00
	Ammonium Nitrate	kg	45,000.00	15,000.00	-30,000.00	90.00	4,050,000.00	1,350,000.00
	Detonator 2*10 /Blasting caps	Each	9,249.00	0.00	-9,249.00	67.00	619,683.00	-
Sub Total							**9,419,683.00**	**2,157,500.00**
Grand Total							**237,456,635.86**	**111,263,264.09**

3. *Construction Materials demand and supply for 2019 GC*

Description	Material	Unit	Demand	Supply	Deference	Unit Price	Total Amount demand	Total Amount supply
Cement	OPC/PPC	Qnt	13,631.00	8,050.00	(5,581.00)	260.00	3,544,060.00	2,093,000.00
Sub Total							**3,544,060.00**	**2,093,000.00**
Aggregate	Base aggregate	m3	146,297.00	16,255.80	-130,041.20	543.70	79,541,678.90	8,838,278.46
	S.A (3/4)		16,071.10	14,366.35	-1,704.75	813.95	13,081,071.85	11,693,490.58
	S.A (3/8)		9,323.65	7,896.76	-1,426.89	813.95	7,588,984.92	6,427,567.80
	Fine		12,351.14	6,412.86	-5,938.28	813.95	10,053,210.40	5,219,747.40
Sub Total							**110,264,946.07**	**32,179,084.24**
Asphalt	MC-3000	Kg	248,000.00	130,060.00	-117,940.00	30.00	7,440,000.00	3,901,800.00
	MC-30		329,800.00	423,747.50	93,947.50	23.15	7,634,870.00	9,809,754.63
	AC-60/70		1,713,600.00	1,325,855.10	-387,744.90	30.00	51,408,000.00	39,775,653.00
	AC-80/100		317,600.00	194,724.05	-122,875.95	23.00	7,304,800.00	4,478,653.15
	RC-70		0.00	41,625.00	41,625.00	23.20	-	965,700.00
Sub Total							**73,787,670.00**	**58,931,560.78**
Reinforcement steel, Binding wire, Formwork & Mason String	Ø8 - Reinf.bar	Kg	10,444.53		-10,444.53	35.00	365,558.55	0.00
	Ø12 - Reinf.bar	Kg	21,968.64		-21,968.64	35.00	768,902.40	0.00
	Ø16 - Reinf.bar	Kg	293.00		-293.00	35.00	10,255.00	0.00
	Ø24 - Reinf.bar	Kg	2,403.33		-2,403.33	35.00	84,116.67	0.00
	Ø20 - Reinf.bar	Kg	3,330.00		-3,330.00	35.00	116,550.00	0.00
	Form work	m3	344.00		-344.00	10,000.00	3,440,000.00	0.00
	Binding Wire Ø 1.5mm	Kg	1,000.00		-1,000.00	45.00	45,000.00	0.00
	Binding Wire Ø 2.5mm	Kg	350.00		-350.00	45.00	15,750.00	0.00

	Manson String Ø 3mm	Roll	25.00		-25.00	53.00	1,325.00	0.00
Sub Total							**4,847,457.62**	**0.00**
Explosives	Super dynamite-80	Kg	25,000.00		-25,000.00	95.00	2,375,000.00	0.00
	Super dynamite-90	kg	25,000.00	500.00	-24,500.00	95.00	2,375,000.00	47,500.00
	Ammonium Nitrate	kg	45,000.00		-45,000.00	90.00	4,050,000.00	0.00
	Detonator 2*10 /Blasting caps	Each	9,249.00	300.00	-8,949.00	67.00	619,683.00	20,100.00
Sub Total							**9,419,683.00**	**67,600.00**
Grand Total							**201,863,816.68**	**93,271,245.02**

4. *Construction Materials demand and supply for 2020 GC*

Description	Material	Unit	Demand	Supply	Deference	Unit Price	Total Amount demand	Total Amount supply
Cement	OPC/PPC	Qnt	13,631.00	1,460.00	-12,171.00	520.00	7,088,120.00	759,200.00
Sub Total							**7,088,120.00**	**759,200.00**
Aggregate	Base course	m3	80,041.50	13,817.43	-66,224.07	543.70	43,518,563.55	7,512,536.69
	3/4		6,634.40	16,521.30	9,886.90	813.95	5,400,069.88	13,447,514.58
	⅜		240.90	7,501.92	7,261.02	813.95	196,080.56	6,106,187.78
	Fine		9,485.00	8,657.36	-827.64	813.95	7,720,315.75	7,046,658.17
Sub Total							**56,835,029.74**	**34,112,897.22**
Asphalt	MC-3000	Kg	248,000.00	0.00	-248,000.00	30.00	7,440,000.00	0.00
	MC-30		329,800.00	31,687.50	-298,112.50	23.15	7,634,870.00	733,565.63
	AC-60/70		1,713,600.00	267,267.50	-1,446,332.50	30.00	51,408,000.00	8,018,025.00
	AC-80/100		317,600.00	0.00	-317,600.00	23.00	7,304,800.00	0.00
	RC-70		35,400.00	16,875.00	-18,525.00	23.20	821,280.00	391,500.00
Sub Total							74,608,950.00	9,143,090.63
Reinforcement steel, Binding wire, Formwork &	Ø8 - Reinf.bar	Kg	10,444.53	0.00	0.00	35.00	365,558.55	0.00
	Ø12 - Reinf.bar	Kg	21,968.64	0.00	0.00	35.00	768,902.40	0.00

Mason String	Ø16 - Reinf.bar	Kg	293.00	0.00	0.00	35.00	10,255.00	0.00
	Ø24 - Reinf.bar	Kg	2,403.33	0.00	0.00	35.00	84,116.67	0.00
	Ø20 - Reinf.bar	Kg	3,330.00	0.00	0.00	35.00	116,550.00	0.00
	Form work	m3	344.00	0.00	0.00	10,000.00	3,440,000.00	0.00
	Binding Wire Ø 1.5mm	Kg	1,000.00	0.00	0.00	45.00	45,000.00	0.00
	Binding Wire Ø 2.5mm	Kg	350.00	0.00	0.00	45.00	15,750.00	0.00
	Manson String Ø 3mm	Roll	25.00	0.00	0.00	53.00	1,325.00	0.00
Sub Total							4,847,457.62	-
Explosives	Super dynamite-80	Kg	25,000.00	0.00	-25,000.00	95.00	2,375,000.00	-
	Super dynamite-90	kg	25,000.00	0.00	-25,000.00	95.00	2,375,000.00	-
	Ammonium Nitrate	kg	45,000.00	0.00	-45,000.00	90.00	4,050,000.00	-
	Detonator 2*10 /Blasting caps	Each	9,249.00	0.00	-9,249.00	67.00	619,683.00	-
Sub Total							9,419,683.00	-
Grand Total							152,799,240.35	44,015,187.85

5. *Construction Materials demand and supply for 2021 GC*

Description	Material type	Unit	Demand	Supply	Deference	Unit Price	Total Amount demand	Total Amount supply
Cement	OPC/PPC	Qnt	15,956.34	783.00	(15,173.34)	325.00	5,185,810.50	254,475.00
Sub Total							5,185,810.50	254,475.00
Crushed Aggregate	Base Agg.	m3	5480.74	11866.73	6385.99	543.70	2,979,878.34	6,451,941.10
	S.A (3/4)		7564.14	11493.08	3928.94	813.95	6,156,831.75	9,354,792.47
	S.A (3/8)		4937.74	4138.24	-799.5	813.95	4,019,073.47	3,368,320.45
	Fine		4865.88	3948.38	-917.5	813.95	3,960,583.03	3,213,783.90
Sub Total							17,116,366.59	22,388,837.92
Asphalt	MC-3000	Kg	1,087,129.92	110,000.00	-977,129.92	35.00	38,049,547.20	3,850,000.00
	MC-30		333,607.78	0.00	-333,607.78	35.00	11,676,272.30	-
	AC-60/70		782,306.03	113,690.00	-668,616.03	35.00	27,380,711.05	3,979,150.00
	AC-80/100			61368.77	61,368.77	35.00	-	2,147,906.95
	RC-70		46,166.50	14,625.00	-31,541.50	35.00	1,615,827.50	511,875.00
Sub Total							**8,722,358.05**	**10,488,931.95**
Reinforcement Steel, Binding Wire, Form work	Ø6 - Reinf.bar	kg	820.11		-820.11	60.00	49,206.60	-
	Ø8 - Reinf.bar	kg			0	60.00	-	-
	Ø10 - Reinf.bar	kg	1,223.47		-1223.47	60.00	73,408.20	-
	Ø12 - Reinf.bar	kg	149,843.48		-149843.48	60.00	8,990,608.80	-
	Ø16 - Reinf.bar	kg	4,000		-4000	60.00	240,000.00	-
	Ø32 - Reinf.bar	kg	5,001		-5001	60.00	300,060.00	-
	Form work	m^3	25		-25	10,0	250,000.00	-

						00.00		
	Binding wirw 1.5 mm	kg	2,000		-2000	100.00	200,000.00	-
Sub Total							**10,103,283.60**	
Galvanized Guard Rail		m	2,919		-2,919	400.00	1,167,600.00	-
Gabion Box	2m*1m*1m	Box	16,174	3,500	-12,674	1,840.00	29,760,160.00	6,440,000.00
Sub Total							**30,927,760.00**	**6,440,000.00**
Super dyne 80		kg	4,800		-4,800	95	456,000.00	-
Super power 90		kg						
Ammonium Nitrate Porous peril		kg	4,800		-4,800	90	432,000.00	-
Delay Detonator 2*10	2*10	Ea	2,400		-2,400	67	160,800.00	-
Sub Total						**1,048,800.00**		-
Subcontractor Requirement for Bedele Metu Lot I Construction project								
Road Traffic Marking					0			-
Thermoplastic retro -reflective Paint					0			-
(a) White lines(broken/unbroken)(100mm)		km	105.85		-105.85		8,468,000.00	-
(b) Yellow lines(unbroken)(100mm)		km	86.91		-86.91		6,952,800.00	-
(c) White Lettering and Symbols		m^2	82.5		-82.5		41,250.00	-
(d) Pedestrian crossing		No	4		-4		40,000.00	-
Sub Total							**15,502,050.00**	-
G/Total							**158,606,428.74**	**39,572,244.87**

6. Average demand and supply of construction materials in ERA, Jimma District for five consecutive years

Description	Material type	Unit	Demand	Supply	Deference	Unit Price	Total Amount demand	Total Amount supply	Amount deference
Cement	OPC/PPC	Qnt	18,071.97	9,173.27	(8,898.70)	325.00	5,873,389.71	2,981,312.10	(2,892,077.61)
Sub Total							**5,873,389.71**	**2,981,312.10**	**(2,892,077.61)**
Crushed Aggregate	Base agg.	m3	86,421.09	33,685.75	(52,735.34)	543.70	46,987,148.14	18,314,943.36	(28,672,204.78)
	S.A (3/4)		12,710.75	14,991.88	2,281.12	813.95	10,345,917.06	12,202,637.96	1,856,720.90
	S.A (3/8)		6,822.99	8,128.03	1,305.04	813.95	5,553,574.35	6,615,808.39	1,062,234.04
	Fine		9,180.96	6,835.38	(2,345.59)	813.95	7,472,845.25	5,563,654.30	(1,909,190.96)
Sub Total							**70,359,484.81**	**42,697,044.01**	**(27,662,440.80)**
Asphalt	MC-3000	Kg	575,606.89	159,483.01	(416,123.89)	30.00	17,268,206.72	4,784,490.15	(12,483,716.57)
	MC-30		326,436.88	170,556.70	(155,880.18)	23.15	7,557,013.72	3,948,387.61	(3,608,626.11)
	AC-60/70		1,184,621.21	603,571.37	(581,049.84)	30.00	35,538,636.18	18,107,141.00	(17,431,495.18)
	AC-80/100		321,440.39	157,898.33	(163,542.06)	23.00	7,393,128.88	3,631,661.51	(3,761,467.36)
	AC-80/85		175,812.00		(175,812.00)	22.80			(4,008,513.60)
	RC-70		23,393.30	36,677.50	13,284.20	23.20	542,724.56	850,918.00	308,193.44
Sub Total							**68,299,710.06**	**31,322,598.27**	**(40,985,625.39)**
Reinforcement Steel, Binding Wire, Form work	Ø6 - Reinf.bar	kg	820.11		(820.11)	60.00	49,206.60	-	(49,206.60)
	Ø8 - Reinf.bar		7,837.89	12,357.15	4,519.26	60.00	470,273.58	741,429.00	271,155.42
	Ø10 - Reinf.bar		1,223.47		(1,223.47)	60.00	73,408.20	-	(73,408.20)
	Ø12 - Reinf.bar		43,164.98	56,498.77	13,333.79	60.00	2,589,898.70	3,389,926.20	800,027.50
	Ø16 - Reinf.bar		1,219.75		(1,219.75)	60.00	73,185.00	-	(73,185.00)
	Ø20 - Reinf.bar		3,330.00	3,199.50	(130.50)	60.00			(7,830.00)
	Ø24 - Reinf.bar		2,403.33	4,266.67	1,863.34	60.00			111,800.20
	Ø32 - Reinf.bar		5,001.00		(5,001.00)	60.00	300,060.00	-	(300,060.00)
	Form work	m^3	264.25		(264.25)	10,000.00	2,642,500.00	-	(2,642,500.00)

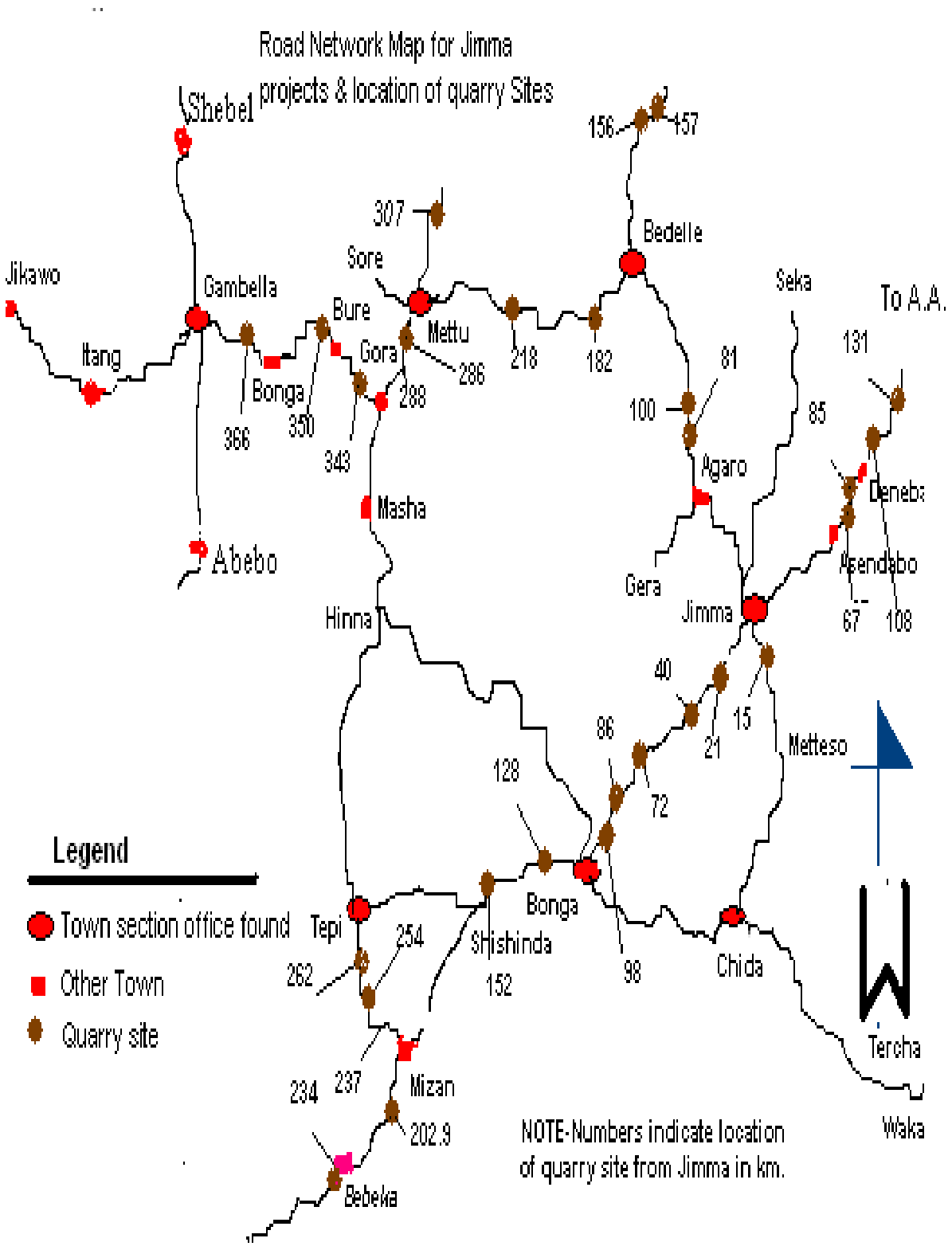
	Binding wire 1.5 mm	kg	1,512.50		(1,512.50)	100.00	151,250.00	-	(151,250.00)
Sub Total							**6,349,782.07**	**4,131,355.20**	**(2,114,456.67)**
Galvanized Guard Rail		m	2,919.00		(2,919.00)	400.00	1,167,600.00	-	(1,167,600.00)
Gabion Box	2m*1 m*1m	m^3	16,174.00		(16,174.00)	1,840.00	29,760,160.00	-	(29,760,160.00)
							30,927,760.00	-	(30,927,760.00)
Super dyne 80		kg	18,092.51		(18,092.51)	95.00	1,718,788.89		(1,718,788.89)
Super dyne 90		kg	21,415.64	7,000.00	(14,415.64)	95.00			(1,369,486.11)
Ammonium Nitrate Porous drill		kg	45,169.00	12,500.00	(32,669.00)	90.00	4,065,209.69	1,125,000.00	(2,940,209.69)
Delay Detonator 2*10		Ea	7,879.20	750.00	(7,129.20)	67.00	527,906.40	50,250.00	(477,656.40)
Sub Total							6,311,904.98	1,175,250.00	(6,506,141.09)

Subcontractor Requirement for Bedele-Metu Lot I Construction project

Description	Unit	Demand	Supply	Difference	Amount Demand	Amount supply	Amount difference
Road Traffic Marking				0		-	
Thermoplastic retro -reflective Paint				0		-	
a. White lines(broken/unbroken) (100mm)	km	105.85		-105.85	8,468,000.00	-	-
b. Yellow lines(unbroken)(100mm)	km	86.91		-86.91	6,952,800.00	-	-
c. White Lettering and Symbols	m^2	82.5		-82.5	41,250.00		
Pedestrian crossing	No	4		-4	40,000.00		
Sub-total					15,502,050	-	-
Grand Total					203,624,081.64	82,307,559.58	(111,088,501.57)

Appendix C. Road Network, Projects and Location of Quarry site

Map of Jimma District



Appendix D. Photographs

1. Photos during desk study

2. Photos during physical observation of construction site

3. Photos during physical observation of the condition of materials' store at warehouse