Investigating the Factors Affecting Construction Material Supply Chain and Their Impact on Building Construction Projects Performance: The case of Ethiopian Construction Works Corporation

Naol Beyene Daba

A Thesis submitted to: Department of Civil Engineering, School of Civil Engineering and Architecture

Presented in Partial Fulfillment of the Requirement for the Degree of Master's in Civil Engineering (Specialization in Construction Engineering and Management)

Office of Graduate Studies

Adama Science and Technology University

January, 2024

Adama, Ethiopia

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DECLARATION AND RECOMMENDATION

Declaration

I hereby declare that this Master Thesis entitled "Investigating the Factors Affecting Construction Material Supply Chain and Their Impact on Building Construction Projects Performance: the case of Ethiopian Construction Works Corporation" is my original work. That is, it has not been submitted for the award of any academic degree, diploma or certificate in any other university. All sources of materials that are used for this thesis have been duly acknowledged through citation. It is being submitted for the partial fulfillment for the award of the degree of Master of Science in Civil Engineering (Specialization in Construction Engineering and Management) at Adama Science and Technology University school of Civil Engineering and Architecture.

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Recommendation

I/we, the advisor(s) of this thesis, hereby certify that I/we have read the revised version of the thesis entitled "Investigating the Factors Affecting Construction Material Supply Chain and Their Impact on Building Construction Projects Performance: the case of Ethiopian Construction Works Corporation" prepared under my/our guidance by Naol Beyene Daba submitted in partial fulfillment of the requirements for the degree of Master of science in Civil Engineering (Specialization in Construction Engineering and Management**).**

Therefore, I/we recommend the submission of revised version of the thesis to the department following the applicable procedures.

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I/we, the advisors of the thesis entitled **"**Investigating the Factors Affecting Construction Material Supply Chain and Their Impact on Building Construction Projects Performance: the case of Ethiopian Construction Works Corporation**"** and developed by Naol Beyene Daba, hereby certify that the recommendation and suggestions made by the board of examiners are appropriately incorporated into the final version of the thesis.

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We, the undesigned, members of the board of Examiners of the thesis by Naol Beyene Daba have read and evaluated the thesis entitled **"**Investigating the Factors Affecting Construction Material Supply Chain and Their Impact on Building Construction Projects Performance: the case of Ethiopian Construction Works Corporation**"** and examined the candidate during open defense. This is, therefore, to certify that the thesis is accepted for partial fulfillment of the requirement of the degree of master of science in Civil Engineering (Specialization in Construction Engineering and Management).

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LIST OF ACRONYMS

AA	Addis Ababa
ASTU	Adama science and Technology University
BCS	Building construction sector
BPR	Business process redesign
CII	Construction Industry Institute
CMSC	Construction Material supply chain
ECIDP	Ethiopian Construction Industry Development Policy
ECWC	Ethiopian Construction Works Corporation
GDP	Gross Domestic Product
IT	Information Technology
JIT	Just in time
MSC	Material supply chain
MSCM	Material supply chain management
MSCP	Material Supply chain Process
RII	Relative Importance Index
SCM	Supply Chain Management
SPSS	Statistical Package for Social Science
TQM	Total Quality Management

ABSTRACT

Supply chain has become a fundamental element in the construction industry to improve the efficiency and productivity in recent decades. The purpose of this research is to investigate the factors affecting construction material supply chain and their impact on building construction projects performance in Ethiopian construction works corporation is undertaking the construction of 5000 houses around kaliti neighborhood of Addis Ababa, Ethiopia. A comprehensive literature review was carried out to identify specifically concerned not only challenge factors and their impact severity on performance but also performance of construction material supply chain and building projects improving options. To achieve the intended objectives mixed design method is used. Thus, 68 questionnaires were distributed to engineers working in ECWC and Addis Ababa housing development center, contractors and sub-contractors. Relative importance index (RII) and Spearman's Rank Correlation Coefficient of concordance analysis techniques were applied by using MS Excel and SPSS V-26. Analysis result has revealed that the top five main factor affecting the performance of CMSC in BCS are stemmed: planning, management, finance, supplier, and storage and handling clusters are identified as critical factors. On other hand, the supplier and the contractor sides are the first and the second main factor affecting the performance of MSC in BCS respectively. Also, results unearthed that the major impact that influences building construction project performance on quality is as severe as high. Specifically, impact that influences building construction project performance is very high on quality with 0.844 RII results. Furthermore, from study results: effective supply chain management leadership, supply chain analytics, innovation, and knowledge sharing and risk management strategies are the main strategies for improving material supply chain process in building sector the construction environment respectively. Therefore, to come up for a deep and detailed academic and practical (by corporation) research of the improvement process in construction supply chain proves to be necessary in order to orient research developments on this topic.

Key words: *Factors, Impacts, Strategies, Improving, Performance, Construction Material Supply Chain, Building Construction.*

CHAPTER ONE

1.INTRODUCTIONS

1.1. Background of study

Throughout the world, the business environment within which construction organizations operate continues to change rapidly. Organizations failing to adapt and respond to the complexity of the new environment tend to experience survival problems. With increasing higher users' requirements, environmental awareness and limited resources on one side, and high competition for construction business market place on the other side, contractors have to be capable of continuously improving their performance (Abushaban et al. , 2009).

The current economic environment in Ethiopia has been providing opportunities for the private sector to participate actively in investment activities. Among this investment areas construction sector is the one. Construction supply chain is all the construction process, from the demand by the client, conceptual design construction and maintenance, and organization, which are involved in the construction process, such as owner, general contractor, subcontractors, suppliers, consultants, etc. CSC is not a chain of construction business with business-to business relationship but a network of multiple organization and relationship, and the flow of funds between client, contractor and supplier (Dira, 2020). Construction supply chain management assists enterprises by helping to improve competitiveness, increase profits, and have more control over the different factors and variables within the project (Al-Werikat, 2017).

A supply chain is a network of organizations and processes wherein a number of various enterprises (suppliers, manufacturers, distributors and retailers) collaborate (cooperate and coordinate) along the entire value chain to acquire raw materials, to convert these raw materials into specified final products, and to deliver these final products to customers (Ivanov et al., 2019).

The construction process is subject to the influence of numerous highly variable and often unpredictable factors. The construction team, which includes various combinations of contractors, owners, architects, engineers, consultants, subcontractors, vendors, craft and

management workers, sureties, lending agencies, governmental bodies, insurance companies, and others, changes from one project to the next (Crandall et al., 2015)

Jusoh and Kasim (2017), demonstrated material management influential factors as classified into; site condition, planning, and handling on-site, management, materials, supplier and manufacturer default, transportation, contractual and governmental interfaces.

Similarly, Patel (2015), conducted on the management of the construction material supply chains that constitute a major portion of total cost in the building. As the result shows unsuitable management of construction material affects the performance of the project due to delays in supply, price fluctuations, and lack of storage space. Ahmed (2017), also conducted on material management affecting factors on construction project delivery such as shortage of skilled manpower, the difficulty of inter-island transportation, and communication. And also, he identifies the cause of ineffective material management such as, matching price to competitors', non-qualified suppliers and unavailability of material.

There is a lack of academic studies in terms of improvement of supply chain as a process. One of the first studies related to SCM metrics (Beamon, 1999). A framework that links supply chain processes and its levels (Gunasekaran et al., 2004). The study brought a contribution to knowledge by relating the formal processes of supply chain, namely plan, source, make/assemble, and deliver. Such processes are then evaluated under different time perspectives, from the operational, tactical and strategic level. Another study was developed by (Vachon et al., 2009) by revisiting the topic of competitive priorities and the deployment of metrics. The study had a positive response and was applied in the industry. A framework for measuring logistics performance in the wine industry by applying a multi-criteria method based on competitive priorities was developed (Garcia et al., 2012).

Accordingly, this study results were filled the literature gaps associated with the limited knowledge identified during literature review by identifying critical factors affecting the performance of material supply chain; impact extent of construction material supply chain construction performance on building projects and the provision of improvement mechanisms to overcome factors and impacts in the study area which need to be addressed.

1.2. Statement of the problem

The construction industry is strongly dependent on material suppliers. In the contemporary context of market relations, especially regarding compliance with quality regulations in construction material supply. This concept refers to the improvement of the relations among suppliers and compliance in product quality between the services provided and the expectations of the client (Alemayehu, 2019).

Tagesse (2017), identified the major performance problems that most frequently occurred on construction projects such as, cost, time, quality, and other critical factors that affect performance has been identified as, escalation of material price, unavailability of resources, disagreements between owners and project parties. Ethiopian building contractors currently are suffering from slippage from schedule or work program, time overrun, cost overrun, quality related problems, low productivity, low profitability, conflicts, ambiguities and disputes in relation to performance-related problems such as delay in material ordering and receiving. And it is clearly a big problem in the building Construction sectors.

Performance of construction material supply chain was affected by a number of factors; planning, management, finance, supplier, storage and handling, staff, environment and transport. As well as performance of building projects was affected by a number of factors. Akomah and Jackson (2016), though there are number of impact performance time, cost and quality impacts are the most observable performance failures of many Ethiopian building contractors. These failures can be self-created failures or failures linked to clients' performance and other factors (external) beyond the control of contractors. A contractor's failure is usually attributed to lack of experience, lack of project management techniques, lack of site management skills and lack of cutting-edge skilled manpower. Poor performance and underperformance are no longer perceptions but realities in the industry. This is why contracts for many large-scale projects are executed by foreign owned contractors (Tawiah, 1999). Accordingly, it is necessary to know critical challenge factors and their impact to be investigated in order to improve performance problems in study area since housing construction demand is endless.

Furthermore, this study results were filled the literature gaps associated with the limited knowledge identified during literature review by identifying critical factors affecting the performance of construction material supply chain; impact extent of construction material supply chain performance on construction building projects and the provision of improvement mechanisms to overcome factors and impacts in the study area which need to be addressed.

Therefore, this paper specifically concerned not only challenge factors and their impact severity on performance but also performance of construction material supply chain and building construction projects improving options in ECWC is undertaking the construction projects of 5000 houses around kaliti neighborhood of Addis Ababa.

1.3. Research objectives

1.3.1. General objective

This study is generally aimed to investigating factors affecting construction material supply chain and their impact on building construction projects performance in Ethiopian construction works corporation.

1.3.2. Specific objectives

Particularly, the specific objectives of this study are: -

- To identify factor affecting the performance of construction material supply chain in building construction sector
- To assess the impact of construction material supply chain on the performance of building construction projects.
- To assess the strategies for improving construction material supply chain process in building construction sector.

1.4. Research questions

Based on the stated problems that have set the context of this study, general and specific objectives would be drawn to guide the data gathering and analysis of this research. This generally seeks to address the question; investigating the factors affecting construction material supply chain and their impact on building construction projects performance? Specifically, this study addressed in the following research questions;

- What are the factors affecting the performance of construction material supply chain in building construction sector?
- What are the impacts of construction material supply chain on the performance of building construction projects?
- What strategies for improving construction material supply chain process in building construction sector?

1.5. Significance of the study

The important of this research paper is expressed in the following ways. It may benefit the Ethiopia construction works corporation and the entire Ethiopian construction sector in that it may shed light on construction supply chain application, enabling them to put it into practice and demonstrate results like shortened delivery times, improved financial results, higher client satisfaction, and the development of supplier trust.

First, it may benefit the different stakeholders involving in construction projects in general and particularly for new other construction projects related to performance of construction material supply chain. Second, it helps owners, contractors, suppliers and consultants to know the factors and impact of construction material supply chain on the performance in building construction projects and the thirdly to take strategies for improving to prevent the occurrence of the problems. And finally, serves as a benchmark for further studies.

1.6. Scope and limitation of the study

1.6.1 Scope of the study

The scope of the study is limited only to construction material supply chain and tries to shade light to the problems in the building construction sector mainly focusing on ECWC is undertaking the construction of 5000 houses around kaliti neighborhood of Addis Ababa. And does not include any other sort of construction supply chain aside from what is discussed above.

1.6.2 limitation of the study

Due to different constraints such as finance and resource, the study is limited both in scope and depth. Because of the constraints questionnaire and interview were used to get responses of the company. In addition to this, information regarding suppliers in the construction supply chain

was obtained from ECWC to limitation of contact with supplier. According to this response the researcher was try to work hard for the validity of the research.

1.7. Organization of the study

This research consists of five main chapters and associated appendixes as follows:

Chapter one: Introduction: this chapter shows the background of the study, problem statement and objectives of the study, significance of the study, scope and limitation of the study.

Chapter two: Literature review of the main related both theoretical and empirical from references used in the study and review of earlier studies in the various construction supply chain

Chapter three: Research methodology: this chapter shows the methodology used in this research in order to achieve the required objectives and to answer the research questions.

Chapter four: Result analysis and discussions: this chapter shows result, description and discussion of research results. It also comprehensively interprets the findings.

Chapter five: Conclusions and recommendations.

CHAPTER TWO

2.LITERATURE REVIEW

This section presents literature review which answers the research questions of this paper on a general level and studies on factor affecting the performance of MSCM in building construction sector, impact of material supply chain management on the performance of building construction projects and options to strategies for improving material supply chain management process in building construction sector perspective. Also, it aimed to identify and fill potential gaps in the current knowledge and points out needs for more detailed studies.

2.1. Overview of literature

The construction industry is one of the largest industries in the world. This industry is an aggregation of various trades and professions that have a strong influence on the global economy. The diversity is very evident, particularly in technological societies, in the number and types of residential, commercial, industrial, and heavy construction throughout the world (Hatmoko & Scott , 2010). The term supply chain management (SCM) according to (Mensah et al., 2014) is relatively new. It was first reported in logistics literature in 1982 as an inventory management approach with an emphasis on the supply of raw materials (Mensah et al.,2014). On the other hand, Olaniyan et al.(2015), argued that the notion of supply chain management doctrine in the 60‘s actually based its view on the fact that single activity cannot assure the effectiveness of a system with chain of activities. It was further reported that a supply chain involved a network of firms, their key business processes and facilities and is considered to deliver products, services or information to a given category of end users or customers (Olaniyan et al., 2015).

The conception of SCM arose over the idea of sub – optimization which occurs to optimize its own results rather than to integrate its goals and activities with other related organization or firm to optimize outcomes of the chain (Mensah et al, 2014). According to Khalfa et al (2015), in their research work on ―procurement impacts on construction supply chains: UK experiences ‖argued that the construction industry has moved to the adoption of supply chain management philosophy without having benefitted from other philosophies earlier propounded within the industry such as just – in – time, total quality management and concurrent engineering. Mensah

et al (2014) defined it as a set of activities undertaken in an organization to promote effective management of its supply chain. Khalfa et al (2015), in their research work defined supply chain management as a network of different organizations, linked upstream and downstream in a chain, aiming to products for the end consumers through integrated process and activities. From the definition it can be deduced that components of SCM practices include supply and material management issues, operations, information sharing and customer service. According to Mensah et al (2014), the later seeks to optimize level of integration of the whole supply chain which the industry has responded. For the purpose of this research paper, the two definitions were considered since both support the integration of supply chain specifically to construction industry. However, it is noteworthy to say that there is no generally acceptable definition but there is a strong nexus and consensus among the various definitions which point in a similar direction especially with regard the construction industry.

2.2. Supply chain fundamentals

Supply chain management is the network of facilities the raw materials into intermediate goods, final products, and deliver the products to customers through a distribution system (Shukla et al., 2011). SCM also describes how the organizations to apply the supply chains to achieve strategic advantages and coordinate the requirement of the client with materials and information flows along the supply chain, till accomplishment a balance between the client satisfaction and the cost (Serpell & Heredia, 2012).

2.2.1. Supply chain management and its historical development

“Supply chain management is not a brand-new concept. Rather, it represents the third phase of an evolution that started in the 1960s with the development of physical distribution concept that focused on the outbound side of firm’s logistic system. During 1980s, logistic or integrated logistics management concept was developed in growing number across organizations. Supply chain management came into trend during 1990s and continued to be focal point for making organizations more effective in the global market place” (Coyle, et al.,2009).

Over the last decade, there has been a growing interest in the use of methods of Supply Chain (SC) for improving the performance of companies. Many industries have recognized the

importance of integrating the processes/activities of SC whereby SCM has become part of the standard business practices (Ogrinja, 2014).

According to Subbaiah et al. (2009), "Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirements". It is needed for improving operations, better outsourcing, increasing profits, enhancing customer satisfaction, generating quality outcomes, tackling competitive pressures, increasing globalization, increasing importance of E-commerce, and growing complexity of supply chains (Habib, 2011).

2.2.2. Concept of the supply chain management

There has no single definition of the above-mentioned concept. According to Deshmukh et al. (2014), SCM is a management process by which an organization controls the worldwide network of stockholders such as suppliers, retailers, and distributer through which raw material are procured, manufacture, final product and delivered to customers. The other concept which is discussed here is subcontractors and materials suppliers. The term sub-contracting has ambiguous definitions depending on the industry from which it is viewed and the terms subcontractors and suppliers are frequently used interchangeably (Vilasini et al., 2012). Specialist SCs are usually required particularly for building services works. However, beyond the need to subcontract specialist aspects of construction works, more generalized works such as reinforced concrete works, brickwork and interior works are subcontracted in a similar manner as a strategy to operate efficiently and to cope with variable work demands (Manu, 2014).

2.3 Construction supply chain management

CSC encompasses all aspect of the construction process, including client requirements, conceptual design, construction, maintenance, and organizations like owners, designers, general contractors, subcontractors, suppliers, consultants, etc. that are involved in the process. The CSC network of organizations and relationships encompasses the flow of information, the flow of materials, services, or products, and the movement of cash between the client, designer,

contractor, and supplier. It is not a chain of construction businesses with business-to-business interactions (Xue et al., 2007). The construction industry has been slower to employ the concept of supply chain management which has been embraced in other industries such as manufacturing (Love & Holt, 2000). This is due to the short-term supplier-contractor relations that are subject to vulnerability due to the temporary nature of construction projects and the one-of-a- kind nature of the product (Akintoye et al.,2000). In construction, relationships with third parties have traditionally been managed through adversarial approaches causing detrimental effects on project performance (Palacios et al.,2014. Akintan and Morledge (2013) highlights some of the industry problems such as the sector's reliance on competitive tendering and the adversarial attitudes that commonly exist between contractors and their suppliers.

2.3.1. The Construction sectors

In general, the construction sector is very fragmented, which has a negative influence on perceived low productivity, cost and time overruns, conflicts and disputes, and the claims and lengthy litigation that follow. These are widely accepted as the main reasons for the performance-related issues the sector is currently experiencing. This high degree of fragmentation has left behind a legacy of the project delivery process being viewed as being extremely inefficient in compared to other industry sectors (Trucker et al, 2001). Due to its intricate operation, the construction industry faces a number of issues. There are several jobs, professions, and organizations in this sector (Milakovich, 1995). They participate at all stages of a construction project, including feasibility, development, funding, concept development and review, estimate, detailed engineering, procurement, construction, and start-up, according to (Makui et al.,2018). The client, consultants, contractor and sub-contractors of a construction project all have a role to play in delivering a quality project. Failure of any of the parties will seriously affect the quality of the final project. Moreover, the parties have different objectives which keep them apart. MahmoodWan and Mohammed (2008), point out that the construction industry is also characterized by its non-standardization. Production processes are to some extent different from each other. Hence, no universal standard or specification can be applied to the product, which leads to difficulties in quality assurance.

2.3.2. Material management in construction

The successful execution of a project is greatly dependent on the effective management of the materials. Every business should efficiently manage the control of materials to successfully complete a project on schedule according to the terms of the contract. A significant portion of project costs go toward materials. According to some surveys, materials make up between 50% and 60% of the project's cost (Navarro et al., 2014). The idea of materials management is defined differently by many authors. However, every researcher emphasizes how crucial materials management is to the accomplishment of a project. The fundamental tenet of materials management is that all materials and/or equipment required for a project will be acquired affordably, in the required quantities, and in accordance with the required quality standards. Purchasing, expediting, and inventory management should all be integrated into the materials management process. An efficient materials management system can help a project stay within budget (Perdomo, 2004).

2.3.3. Construction supply chain

Construction is a multi-organization process, which involves owner, designer, contractor supplier, consultant, etc. It is also a multi-stage process, which includes conceptual, design, construction, maintenance, replacement. From this point of view, CSC) is all the construction process, from the demands by the client, conceptual, design, construction and maintenance and organizations, which are involved in the construction process, such as owner, designer, general contractors, subcontractors, suppliers, consultants, etc. CSC is not a chain of construction business with business-to business relationships but a network of multiple organizations and relationships, which includes the flow of information, the flow of materials services or products, and the flow of funds between client, designer, contractor and supplier (Xue et al.,2007)

2.3.4. Characteristics of construction supply chains

The construction supply chain includes participants such as contractors, subcontractors, and material suppliers. On average material, cost contributes 50% to the project cost and hundreds of material and equipment suppliers take part in the supply chain. Separately from these suppliers, activities of the construction projects are also subcontracted to specialty contractors such as designers, electrical, engineering, plumbing, etc. (I et al., 2015). Satyajeet and Kulkarni (2013), demonstrated the characteristics of construction supply chain management as, increase

contract revenues through niche marketing, decrease the total cost of construction, decrease overhead, increase other income and decrease expenses, decrease delays in deliveries of materials, equipment, and services to the project site. Also, Aloini and Dulmin (2012), demonstrated seven construction industry SCM applications based on its distinctive features which can heavily affect that application and they can be summarized under the following table 2.1.

Table 2. 1: Supply chain management application and its distinctive features.

SCM application	Distinctive features
Production systems	Construction is produced in the project through the production of industry operating within an environment of considerable complexity and uncertainty.
Customer influence	As the value of logistic parameters and its physical aspects of the final product relation, customers exercise greatly.
Fragmentation	It refers to market fragmentation, as well as process fragmentation.
Number and type of stakeholders	The main subjects are contractors, subcontractors, and suppliers. However, a typical linkage encompasses multiple organizations and relationships, including the flow of information, the flow of materials, services, and products, and the flow of funds between contractor, subcontractor, and supplier.
Buyer-supplier relationship	This is mostly transactional, strained by conflict and mistrust. In addition to this, it is widely known in the company, that in construction a tender price is the most substantial restriction used for a tender appraisal. This focus on price is the main reason for project delivery problems.
Temporary configuration	Production at a temporary site by a temporary organization leads to relationships focused on the short-term thinking, with performers attempting to leverage what they can out of the existing contract, resulting in an environment where opportunism reigns.
Change inertia	Construction organizations have a habit to be conservative stating to the need to change, because of the risks related to the procurement of projects

For this purpose, CSCM is defined as the CSC is not a real chain but a network of multiple organizations and relationships, which includes the flow of information, the flow of materials, services, or products, and the flow of funds between, contractor, subcontractors, and supplier (I et al., 2015).

2.3.5. Areas of focus, and roles of supply chain management in construction

Vrijhoef and Koskela (2000) identified four major roles of or level of implementation of SCM, dependent on whether the focus is on the supply chain, the construction site, or both. One or several SC participants could lead each level of implementation. The roles or level of implementation are not mutually exclusive, but are often used jointly.

i. The effects of the supply chain on on-site activities could be the main point of emphasis. Reducing expenses and activity times on the site is the aim. In this situation, ensuring dependable labor and material flows to the site is of utmost importance to prevent disruption of the workflow. The interaction between the website and direct suppliers can be the emphasis to achieve this. The person best suited to embrace this concentration is the contractor, whose primary concern is with site activities.

ii. The focus may be on the supply chain itself, with the goal of reducing costs, especially those relating to logistics, lead-time and inventory. Material and component suppliers may also adopt this focus.

iii. Transferring tasks from the site to earlier links in the supply chain can be the main objective.

This justification might simply be to stay away from the inherently poor conditions on site or to achieve greater concurrent activity, which is impossible with site building due to its numerous technical requirements. Reducing the overall expenses and time is the aim once more. This focus may be started by suppliers or contractors.

iv. The focus may be on the integrated management and improvement of the supply chain and the site production. Thus, site production is subsumed into SCM. Clients, suppliers or contractors may initiate this focus. The focus here is on the supply chain of a main contractor.

2.4. Supply chain management and project performance

The management practice on the supply chain in construction companies affects performance on the project. Jusoh and Kasim (2017), demonstrated material management influential factors as classified into; site condition, planning, and handling on-site, management, materials, supplier and manufacturer default, transportation, contractual and governmental interfaces. Fekadie (2019), indicated on supply chains performance variables such as integration,

reliability, responsiveness, agility, operational cost, and inventory management practice. The result of the study showed a downward supply chain is more reliable and flexible than the upstream supply chain.

Similarly, Patel (2015), conducted on the management of the construction material supply chains that constitute a major portion of total cost in the building. As the result shows unsuitable management of construction material affects the performance of the project due to delays in supply, price fluctuations, and lack of storage space. Ahmed (2017), also conducted on material management affecting factors on construction project delivery such as shortage of skilled manpower, the difficulty of inter-island transportation, and communication. And also, he identifies the cause of ineffective material management such as, matching price to competitors', non-qualified suppliers and unavailability of material.

Abraham (2016), conducted the finding of contractor's material management practice, the problem of material management in construction building sites, strategies for effective construction material management, congestion of the sites and improper placement of materials, and finally the impacts of ICT tools in material management in construction projects. Tagesse (2017), stated on the practice of supply chain management and its impacts on project performance on the company. The result of the research commonly focuses on dimensions of supply chain management practice relationships such, strategic supplier's relationship of the company, customer relationship, level of information sharing, level of information quality, and information technology on the company.

According to Sukati et al. (2015), supply chain management practice, the strategic supplier partnership, customer relationship, and information sharing, make competitive advantages and responsiveness for the organization. Furthermore, Bezabh (2017), also indicated five supply chain management practice variables (Strategic supplier relationship, customer relationship, level information sharing, internal operation, and level of information quality) that has a significant impact on the operational performance. Similarly, Skitmore (2008), determines supply chain management practice to improve awareness through the integration of trust and collaboration for the construction industry. For the relationship between supply chain management practice and customer satisfaction, information sharing has a positive and

significant relationship with customer satisfaction (Manokaran, 2019). Kumar and Kushwaha (2018), also discussed three dimensions of supply chain management practice (customer relationship, information technology, and information quality) that are important for operational performance. Waluyowati and Aisjah (2018), established long-term relationships in SMEs directly and significantly affect the use of information technology, information sharing, and integration of supply chain and supply chain performance. Besides, long-term relationships indirectly and significantly affect the performance of the supply chain through information technology, supply chain integration, and information sharing.

2.4.1. Importance of effective supply chain management

Construction Company which are affected by effective supply chain management to satisfy the customer. The outcome of the study shows major barriers to affects a successful supply chain collaboration such as technology, information, and measurement system on supply chain management (Fawcett & Magnan, 2008). And, Agus (2013), conducted on the significances of supply chain management practice, supply chain performance, and financial optimization on Construction companies. The result shows a conceptual model for the relationship between supply chain management, supply chain performance, and financial optimization. The managing of suppliers is considered one of the factors that affect the total cost of the supply chain management and therefore suppliers could help to reduce the cost and thus may contribute to improving performance through effectiveness (Ibrahim, 2014). Furthermore, Moharana et al. (2020), studied on achievement method of effective supply chain management such as information technology and information quality.

According to Kleab (2017), supply chain management is a cross-functional method that comprises managing the drive of raw materials into an organization, definite features of the core dispensation of materials into finished goods, and the movement of finished goods out of the organization and toward the end consumer. Similarly, effective supply chain management explains, the relationship of collaborative (win win), relationship which is usually found with firms' strategic suppliers, include the team component that is missing in a cooperative relationship. In collaboration, the two firms truly realize the benefits of working together to optimize outcomes for both firms. The two firms work together to develop a strategy to deliver a high-quality project on time and under budget. Strategic partners frequently share resources

and information. Therefore, a collaboration between supply chain members is critical for the improvement of its performance and competitiveness. The link between supply chain collaboration and resilience has to be fully explored. Nonetheless, there are already clear benefits of collaboration with resilience (Banomyong, 2018).

2.5. Overview of the Ethiopian construction industry

The building and construction sector is one of the largest contributors to Ethiopia's present rapid economic growth. The Ethiopian construction industry development policy, which was issued in December 2014, states that the construction industry is increasing on average by 12.43% per year and accounts for 5.3 percent of the country's overall GDP. The policy states that the government, private businesses, consultants, contractors, financial institutions, suppliers of construction inputs, owners and users of construction end products, companies that provide construction infrastructure, construction licensing and monitoring bodies, and other pertinent bodies operating in the industry are all involved in Ethiopia's construction industry. Despite being essential to addressing the nation's economic and social issues, the building industry nevertheless faces numerous difficulties. It has been noted that there is an imbalance between the inputs and services used in construction. The main role players such as contractors and consultants are limited in capacity, insufficient in number and luck business ethics to meet the needs of fast-growing industry.

The other main problem mentioned in the policy document is the lack of integration and coordination among the key role players in the industry. As a result of this some government projects face poor feasibility and incomplete design. Procedures are not put in place to test and approve the reasonability of project price, quality of design and the control of project schedule. Even though objectives are set and strategies are designed to tackle the problems so far identified in the policy, there are significant challenges prevailing in the industry.

The problems relating to poor performance and widespread underperformance in the Ethiopian construction industry are well documented and can be clearly observed on completed and ongoing construction activities. Though there are qualified owners that are leading their construction projects well, most of the larger indigenous Ethiopian contractors are owned by proprietors who have little or no formal knowledge of the construction, project or organizational

management. Such owners do not see the need to employ personnel with the technical know-how to manage their firms towards sustainable growth.

The complex and fragmented nature of construction supply chain have significant negative impacts on the construction process of projects. Impacts such as low productivity, cost and time overrun, conflicts and disputes, quality deviations, luck of trust and others frequently happen in the Ethiopian construction industry (Mengistu, 2011)

2.6. Supply chain management in the Ethiopia construction industry

It is important to see the Ethiopian industry competitive forces using the (Porter, 1985)'s five competitive forces model (Mugher Cement Enterprise, 2010). This are: first, rivalry between established firms – few years ago there were few firms and could sell easily what they could produce. This time the number of cement factories has reached to about 11 and some others will resume operations very soon. Though rivalry is not now seemingly stiff as such, it is expected to come sooner at some other time.

Second, new entrants- though the industry is capital intensive, there are major reasons that the industry may attract capable multinational companies. Government is promoting investors to enter into the construction industry due to the fact that it is becoming a bottleneck for its own infrastructural sector requirements. Economies of scale are very high as it is heterogeneous product that is produced in an integrated process. Due to this and high profit margin that the existing few companies are enjoying, it is a fertile ground to attract capable entrepreneurs.

Third, bargaining power of customers – there is a high demand and supply gap in the market. The former supersedes the latter by far. Forth, Bargaining power of the suppliers – the main raw materials like lime stone, gypsum and pumice are found in the local market and most of the cement factories own the mining fields. However, spare parts, components, fuel, packing materials and main utilities are mostly owned by few or at times with sole suppliers where most of the time the suppliers do have a strong bargaining powers. Fifth, threat for substitute products – Material such as cement does not have perfect substitute. SCM practices and challenges in different industry of Ethiopia were studied in different dissertations such as:

Endalew (2010), studied the practice of SCM for Ethiopian textile firms. It was found that, SCM practices in Ethiopian textile firms are weak and not considering SCM as a strategic tool for competition. Business managers of the textile firms didn't give attention for SCM theories and practices.

Woldemichael (2012) studied the impact of SCM practices on the organizational performances in metal and engineering industries. The result of the study shows that the implementation of SCM in this industry is weak. Also, the SCM practices don't have any relationship with organizational performances except internal lean practices.

Mengistu (2011) studied the practices of SCM in cement industries. The result of the thesis shows similar to other industries in the country i.e. the practice of SCM in cement industry is almost poor. There seems that since the demand outweighs the supply of the cement, which contributes for not using SCM as a competitive strategy.

Berhane (2007) also studied the SCM and model development study as a case study of Mesfin Industrial Engineering plc. The result of this study shows that most of the employees of the company don't have awareness of SCM. The company also don't use supply chain cost analysis rather than using the traditional accounting system. Also, there are problems in their warehouses. Besides to the above machine handling problem, ageing, poor preventive maintenance, lack of proper operation, and wear of spare parts are the main reasons for the breakage of machines in Mesfin Industrial Engineering.

Dibaba (2015) studies Practice & Challenge of SCM on 11 Ethiopian Private G-1 Road Construction Companies. Major finding shows that; on the degree of relationship across supply chain characterized by less joint product planning with suppliers, but better relationship with customers; information sharing practice of SCM in the case companies is generally moderate, but poor information sharing on material forecast with suppliers; there is poor and absence of IT & information system within the case companies. Despite the increase of empirical research available on manufacturing sectors, only limited empirical studies undertaken on construction Industry, use of units of analysis, and approaches of performance measurement also varies.

Tagesse (2017) study on supply chain management practice and impact on firm performance in the case of yotek construction plc. His study was focus on SCM practice and impact on firm

performance that determined in terms of operational and organizational performance. Woreta, (2021),test if there is a relationship between SCM practices, supply chain responsiveness, and operational performance in manufacturing industry in Bahir Dar, the study indicate first there is a positive and significant relationship between supply chain management practices and supply chain responsiveness, second supply chain management practices i. e. strategic supplier partnership, customer relationship, and information sharing has a direct positive impact on operational performance and the last the study finds the relationship between supply chain responsiveness and operational performance. The result states that supply chain responsiveness has positive and significant impact on operational performance. Mustefa (2014) also study on Supply Chain.

According to the overall challenges of supply chain management, one can say that the practices of supply chain management Ethiopian construction industry are almost poor. To use the term Supply Chain Management in the context of the current Ethiopia construction industry suggests that it is possible to adopt those practices, which have proved to be successful elsewhere, without significantly adapting them to reflect the particular nature of the industry and its culture (Mugher Cement Enterprise, 2010).

2.7. Factor affecting the performance of MSC in building construction sector

There are several factors within the scope of material management and each of these factors can give rise to potential problems. The more factors are divided, the more potential problems that exist. There are many factors which contribute to poor material management in construction projects. AparnaShruthi (2017) suggested that factors such as waste, transport difficulties, improper handling on site, misuse of the specifications, lack of proper work plan, inappropriate material delivery and excessive paperwork all adversely effect on material management. Factors related with material management can be mostly found in the following areas in local construction projects.

1. Planning and Scheduling
2. Monitoring and Controlling
3. Organization and Personnel

4. Procurement
5. Delivery
6. Storage and Storage facilities
7. Usage
8. Surplus and Waste control

Planning is a fundamental, important process for every project. Material planning, which is a key function of material management, is closely linked with project planning and control set-up. Scheduling the entire material program is essential to meeting the project timetable. Indeed, planning and scheduling are significant in terms of increasing productivity, profit and facilitating the timely completion of construction projects.

Monitoring and Controlling of all construction activities in material management are conducted to ensure the right source of materials with the exact quality, at the right time and place suitable for minimum cost construction process. It is a process in which facilities, personnel, resources and capital are monitored and controlled to a significant impact on the operations of construction projects.

Material management structure is organized in such a way that it allows for integral planning and coordination of the flow of materials, in order to use the resources in an optimal way and to minimize costs. The organization must be structured to provide for the timely performance of the work, with material personnel located at appropriate level of project management and influence the decision-making process.

Preliminary investigations for developing sources for procurement of materials are made by floating enquiry indents. It is processed by the material procurement responsible personnel for inviting quotations with samples of materials where applicable.

Delivery in terms of organizing the movement of vehicles, people and materials ensures the efficient use of workforce and production or process in construction projects. The routing of materials is one of the main causes which affect cost and time during construction.

Material storage can be defined as the provision of adequate space, protection and control of building materials and components held on site during the construction process. A good and systematic storage of materials provides better management of materials in construction.

Usage of materials is the flow component that provides for their movement and placement. Material usage can be defined as the provision of proper handling techniques either manually or mechanically for the components held on site during construction process.

All projects can expect a certain amount of surplus and waste of materials after construction. Surplus and waste materials arise at any stage of construction process from inception, right through design, construction and operation of the building facility. Hence, control of surplus and waste materials is important to successful material management.

The construction industry is also lacking efficient and responsive supply chain management which is taken as the main reason for the industry to be unproductive. A well-integrated supply chain is not put in place to avail construction inputs produced by the local manufactures or the imported ones at the right time, at the right amount, at the right quality and with the reasonable price. Neither locally manufactured construction inputs nor imported material are available at the right condition demanded by the industry. There is shortage of both manufactured and locally available construction inputs such as stone, sand and selected soil materials when compared to the demanded amount, resulting in rigorous price increase (Gelana , 2016).

2.8. Impact of construction material supply chain on the performance of building construction projects

Performance deterring factors faced during construction of projects have final effects on the initially intended project objectives: As the absence of formal agreement between parties in construction lead projects to non-completion of the work; disputes; variation matters; defective work; delay of payment and overall poor performance (Benson , 2018). Similarly, Gyamfi et al. (2018), stated that delay in project, rework, cost overrun, relational disputes, difficulty acquiring building permits as major results as they have revealed. Also, time and cost overruns are identified affecting project performance by Akanni et al. (2015), revealed that economic and

financial and political challenges had significant relationship with time overrun but challenges of social and cultural had significant relationship with cost overrun on building projects.

Moreover, the most ranked impacts of variation orders were completion schedule delay; followed by increase in project cost; and poor safety condition as the least impact of variation orders on public building projects (Yadeta, 2016). Unexpected price rise of building materials; weather; access to capital; late delivery of building materials and equipment as well as planning regulate on are the main factors contributing to time overruns of project delivery (Obalola, 2017) . Thus, based on the reviewed literatures there is limited study on impact severity of building construction projects on cost and time of material supply chain management on the performance projects which is important in preventing project failures. this is due to preventing one of the two performance factors are highly interlinked or inseparable of one to the other (Olawale, 2020).

2.8.1. Cost factors

Curt (2005) argued that the cost management system tracks current spending and commitments and predicts ultimate cost outcome. Yafiah (2013) indicates that procurement selection criteria of cost, time, quality, project characteristics and external environmental factors have effects on project performance. Fetene (2008) found that the most common effects of cost overrun were delay, supplementary agreement, adversarial relations among stakeholders, and budget shortfall of project owners which guides efforts to improve the performance of the construction industry in the future and fluctuation in price of material, cash flow and financial difficulties faced by contractors, shortage of site workers, lack of communication between parties, incorrect planning and scheduling by contractors are most severe factors while frequent design changes and owner interference are least affecting factors on construction cost performance. Amusan (2011) discovered from the analysis that factors such as contractor's in experience, inadequate planning, inflation, incessant variation order, and change in project design were critical to causing cost overrun, while project complexity, shortening of project period and fraudulent practices are also responsible. Baloyi and Bekker (2011) discovered that the increase in material cost is the single largest contributor to cost overruns for both global and local projects. Mrema and Mhando (2005) found that in most cases, malignancy of clients to assume roles of their

consultants through making decisions and changes that affect the design and the project cost has undermined the efforts to attain the intended goals. Abushaban (2009) stated that the most important factors affecting the performance of construction projects agreed by the owners, consultants and contractors were: average delay because of closures and materials shortage, availability of resources as planned through project duration, leadership skills for project manager, escalation of material prices, availability of personals with high experience and qualification and quality of equipment and raw materials in project.

2.8.2. Time factors

Time is money to owners, contractors, and users of the constructed facility. From the owner's perspective there is lost revenue by not receiving return on investment, cash flow crunch, potential alienation and loss of clients/tenants, extended interest payments, and negative marketing impacts. Aje, Odusami and Ogunsemi (2009) showed that contractors' management capability has significant impact on cost and time performance of building projects. Wiguna and Scott (2005) showed the critical risks affecting both project time and cost perceived by the building contractors were similar. They were: high inflation/increased material price, design change by owner, defective design, weather conditions, delayed payments on contracts and defective construction work. With respect to time delays the most significant contributing factor for global projects was late delay in payments while for the stadia projects design-related factors caused the most delays (Baloyi & Bakker, 2011) identified the factors that contribute substantial detrimental effect to project performance, thus affecting the integrity of the construction industry.

2.8.3. Quality factors

Curt, (2005) stated that the quality management system monitors and analyzes quality of the constructed project and predicts quality problems and issues. Typical quality measures include: (i) Quality control tests: number performed, frequency and percentage passed/failed, number of non-conformance issues, number of change requests and root causes, cost of rework, number of exceptions at turnover and cost of quality (ii) Quality Assurance Cost (cost of resources): quality assura cost as a percentage of construction cost, cost of quality and Cost of quality as percentage of construction cost. Lepartobiko (2012) stated that quality can be assured by identifying and eliminating the factors that cause poor project performance. Lack of contractor experienced

topped the quality related cause of project failure and major enablers that lead to project success are foreign experts' involvement in the project, government officials inspecting the project and very close supervision when new construction techniques are employed. A factor which leads to poor performance is the lack of accurate data on soil, weather, and traffic conditions.

Abushaban S. A. (2009) summarized from his research study the factors affecting the performance of construction projects in different groups. The main factors that listed under each group are as follows.

- Cost factors include market share of organization, cash flow of project, profit rate of project, overhead percentage of project, project design cost, material and equipment cost, project labour cost, project overtime cost, cost of rework, cost of variation orders, waste rate of materials, cost control system, escalation of material prices, differentiation of currency prices, and liquidity of organization
- Time factors include site preparation time, planned time for construction, percentage of orders delivered late, time needed to implement variation orders, time needed to rectify defects, average delay in claim approval, average delay in payments from owners to contractors, unavailability of resources, and average delay because of closures leading to materials shortage.
- Quality factors include conformance to specification, unavailability of competent staff, quality of equipment and raw materials, quality assessment system in organization and quality training/meeting.

2.9. Strategies for improving construction material supply chain process in building construction sector

Several researchers have discussed supply chain improvement in the construction industry. Voordijk and Vrijhoef (2003), conducted on improving supply chain management in construction to outcome application concept on supply chain management in construction based on a comparative study of supply chain management with aerospace. As a result, indicated that, the practice of platform assemble is a fruitful concept to be applied in the construction industry. Shahvand et al. (2013), identifies construction projects' success factors such as cost, quality, and time. Also, construction supply chain management (which manages both suppliers and

subcontractors' relationship with the general contractor) is one of the most essential approaches in the improvement of these factors in the construction industry.

Similarly, Binti (2017), conducted the improvement of main contractors and subcontractors' relationship for the implementation of the construction project. The result shows many factors (time and cost overrun factor, delay, trust, lack of quality, lack of communication, lack of safety, shortage of construction material, and skill labor) affect the relationship between the main contractor and subcontractor. The contractor company improves effectiveness in SCM in obtaining goods and services.

Some solutions stated by Ayalew et al. (2016), to fill the gap in the performances of Ethiopian construction industry context are: applying modern project management; stakeholders' collaboration; experience sharing and information capitalization; enhance project finances; training; application of construction management practices; modify regulations set by the government; allocate sufficient time for design and planning and finally building capacities of all stakeholders. Furthermore, Bredenoord (2016) has recommended that social sustainability in housing is of utmost importance and demands at least four measures: the involvement of residents in housing and urban development projects; the stimulation and facilitation of community-based initiatives; the involvement of community-based organizations with respect to the improvement of neighborhoods living conditions; and the establishment of save-and-build groups and housing cooperatives (Bredenoord, 2016).

Likewise, factors identified by Mbote and Makworo (2018), revealed were: proper supervision of the project activities and materials incorporation; sensitizing the working crew on the best practices on reduction of material wastage during construction; good quality purchases; proper procurement procedures; proper storage practices, and trained and experienced craftsmen have been rated as significant factors which can help to curb material wastage in construction of residential building frames. Also, options to minimize defects in buildings construction projects as recommended by Ahmed (2019) as: appropriate funding; proper construction management; proper communication among parties involved and teamwork must be provided and building training and education would be necessary.

Management of firms' resources is undertaken haphazardly with little or no knowledge of current developments. This does not promote growth in the construction industry (Mohammed et al., 2020). Boateng (2019) argues that a significant proportion of time and effort is spent on waste activities. In spite of the massive focus on SCM, little attention has been paid to relationships upstream from the construction site, i.e. between contractors and their and material suppliers. This may suggest a lack of clear understanding of the type of relationships associated with SCM. In order to improve the efficiency and effectiveness of construction supply chains, a fundamental change in the management of relationships between clients, contractors and sub-contractors is required (Getahun, 2012).

Although various partnering arrangements among the construction supply chain actors have been sought, practical ways to achieve integration among processes and firms was not well discussed. Taking a holistic and systemic view of the construction supply chain requires a strategic approach which may, in fact, requires more extensive implementation effort. This is not easy within a single organization, let alone across a diverse and disperse group of trading partners of the kind so typical of the construction industry. The construction literatures seem to agree upon "supply chain integration" being the core task of SCM in construction (Mengistu, 2011).

According to Gelana (2016), applying CSCM to the Ethiopian construction sector provides enormous advantages for the organizations involved in building, as it fosters a true sense of integration and teamwork. By integrating processes, organizations, and information, it can assist maximize possibilities to provide value while lowering project costs overall. The stakeholders' attitudes regarding cooperation, teamwork, and mutual gain must be significantly changed for this application.

Similarly, according to Average (2019) in Bulawayo, for low-income citizens housing construction is supported in different ways like by mobilizing construction materials; formation of extra crews to supply materials at affordable cost; negotiating with financial institutions with reasonable rate to fill financial shortages for the poor. Additionally, Abdie (2008) recommended to solve problems of low-income housing cooperatives construction projects as: government shall give technical and financial assistance like design and consultancy; arrange other non-

governmental organizations to provide assistance in the form of aid and soft loan; the design concept shall be flexible core housing which considers the financial capacity of beneficiaries.

2.10. Literature gap

There is a lack of academic studies in terms of strategies for improving material supply chain Management as a process. One of the first studies related to SCM metrics was presented by (Girum, 2017). Also, the study brought a contribution to knowledge by relating the formal processes of assess the level of awareness of supply chain management Ethiopian building contractors have and material purchasing flow structure, Contractor/supplier relationship, most frequently occurring problems facing contractors, key factors that may contribute in integrating the phases of CMSC, and recommend ways of integrating CMSC in the Building Construction Industry. As well, there is limited study focusing on housing construction projects compared with other public and private building construction projects to understand the factors, and the impact extent on quality, cost and time performances. On the other side studies associated with construction projects performances were concerned whether more on identification of factors or their overall effect on planned objectives. But there is limited source of knowledge on impact extent on quality, time and cost performances.

Taking into consideration the lack of academic studies and the increased show of interest of big construction companies to improve the construction supply chain and to succeed an effective management of the construction chain, the development of a set of propositions for improving construction supply chain management would be helpful to develop structured approaches between the construction companies and their contractors, resulting in better results for the entire supply chain.

The proposition of these managerial practices also promotes a different discussion in terms of supply chain 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 supply chain 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 chain.

Therefore, Accordingly, this study results were filled the literature gaps associated with the limited knowledge identified during literature review by identifying critical factors affecting the performance of construction material supply chain; impact extent of material supply chain management performance on construction building projects and the provision of improvement mechanisms to overcome factors and impacts in the study area which need to be addressed.

2.11. Conceptual framework

The conceptual framework establishes the link between impact of construction material supply chain and performance of construction project.

It was obtained that there were many fields and topics which are related to performance such as, construction project and performance, impacts on performance of construction projects such as client, contractor and supplier related factors. It was also able to review measurement of project performance (independent variable) and key performance indicator (dependent variable). The key performance indicators are used to evaluate performance of construction projects. These indicators can then be used for benchmarking purposes, and would be used be as a key component of any organization to move towards achieving best practice and to overcome performance problem in ECWC. Based on previous studies and literature review, the most important indicators which were studied in this research are time performance, cost performance, and quality performance. Furthermore, this paper made an attempt to identify impacts the performance of construction projects from client, contractor and supplier perspectives.

The conceptual framework in this study was used to show various variables that impacts the performance of construction projects. This is a diagrammatic representation of the study showing the relationship between the dependent variable performance of construction project and the independent variables which are: client related factor, contractor related factor and supplier related factor.

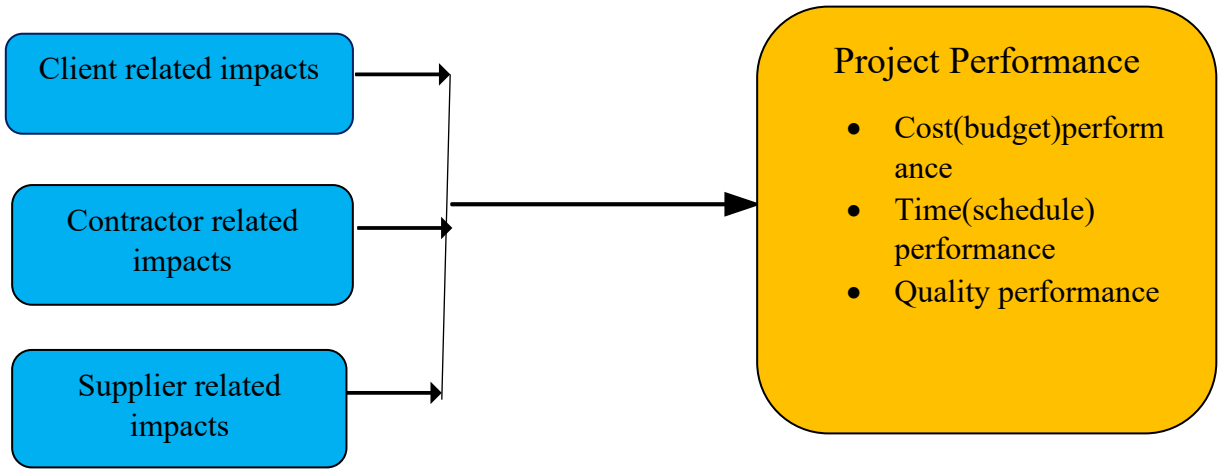

Figure 2. 1: Conceptual framework

CHAPTER THREE

3. RESEARCH METHODOLOGY

Introduction

The main purpose of the research methodology was to explain how the research has accomplished, what knowledge is required, what information is needed, and how information is collected. The research methodology consists of a description of the study area, study design, study approaches, method of data collection, an instrument for data collection, data management and analysis, validity, and reliability of the study and finally, ethical consideration was discussed on this chapter.

3.1. Description of the study area

The study area of this research is Ethiopian construction works corporation (ECWC) which is governed by the public enterprise's proclamation No.25/1992. Its supervising authority is the ministry of public enterprises and its policy making body is the board of the corporation whose members are appointed by the government selected from organizations. The headquarters of the corporation is located in the city Addis Ababa, around gurd shola, around athletics federation building. It is head by a chief executive officer (CEO). The corporation is a result of the amalgamation of three formerly independent public enterprises, namely the Ethiopian road construction corporation, Ethiopian water works construction enterprise and the Ethiopian prefabricated building parts production enterprises. The Ethiopian construction works corporation is a newly established public enterprise with the authorized capital of Birr 20.3 billion; on December 18/2015 based on council of ministers regulation No.366/2015.

ECWC was established with a mission to deliver quality construction works both domestically and overseas, to assemble construction machineries, equipment and manufacturing spare parts as well as to acquire, own and administer dams constructed by the government, collect charges from the beneficiary of such dams and launch similar development activities.

The corporation, as a contractor, has been engaged in various large-scale projects such as highway roads, water, irrigation and building construction works and has so far registered encouraging achievements accomplishing various projects.

3.2. Research design

The first phase of the research thesis included identifying and defining the problems, establishing the objectives of the study and developing the research plan. The second phase included an exhausted summary of the comprehensive literature review. The third phase included a field survey which was conducted from the viewpoint of contracting companies specifically in the building construction sector. The fourth phase focused on the careful selection of variables and questionnaire design. The fifth phase was dissemination of the questionnaire. Sixty-eight questionnaires were distributed to the research population. The sixth phase was data analysis and discussion. Simple percentage and relative importance index (RII) was used to perform the required analysis. The final phase included the conclusion and recommendations. The design intended to follow was both quantitative and qualitative mixed design as shown on figure 3.1. Thus, it is explanatory mixed research design was followed to get strong in-depth results from both methods of data collection to the intended objectives (Creswell, 2014) and (Kothari, 2004).

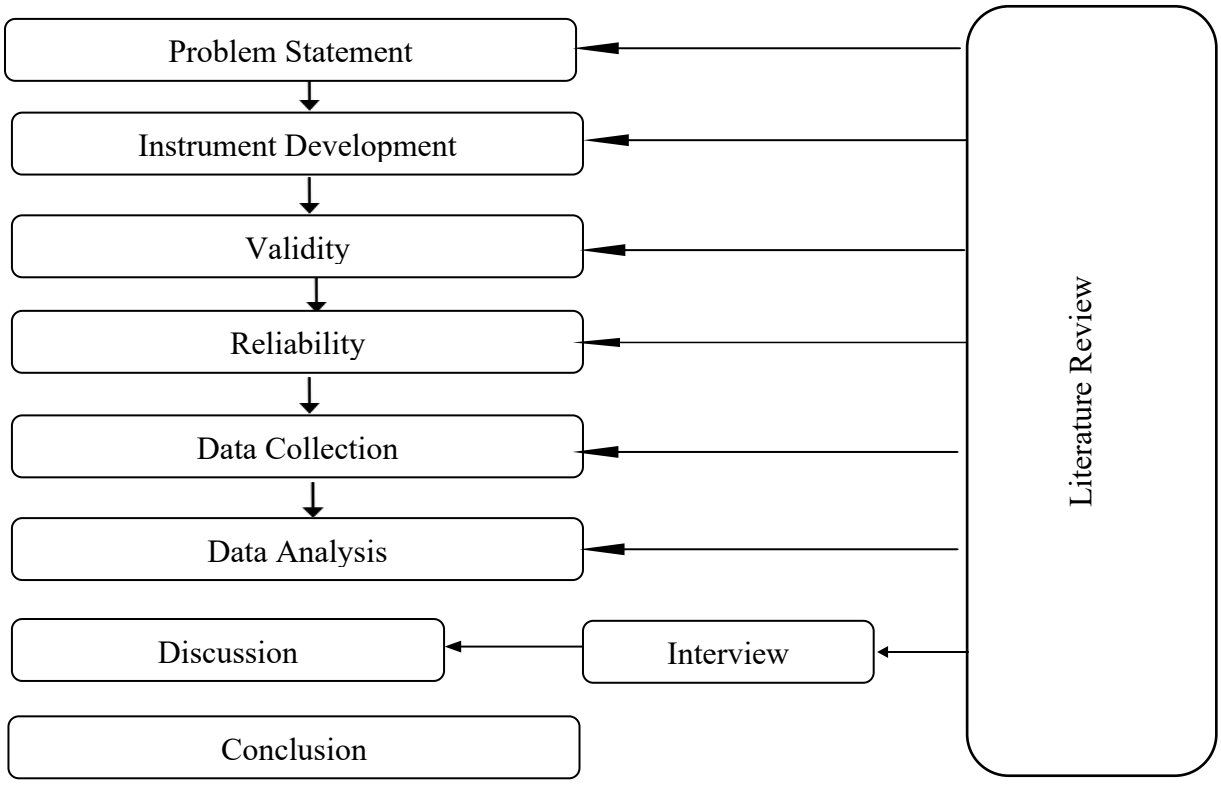

Figure 3. 1: Research design process followed

3.3 Research approaches

According to Kothari (2004) a research design is the arrangement of conditions for the collection of data and its analysis. He further illustrates that the function of research design is to serve as a frame to collect relevant evidence with minimal costs with respect to time and money. It constitutes the blueprint for collection, measurement and analysis of data.

The purpose of this research is factors affecting construction material supply chain and its impact on building construction projects performance by using mixed research approach of both quantitative and qualitative data. In other words, the researcher was able to simultaneously collect both quantitative and qualitative data, analyze the data in multidimensional and use the results to seek answers for the research problem. In this study, since the focus of the study is the description of the situation as it exists at present, a descriptive research design was employed and both qualitative and quantitative data was used.

Therefore, this research was used descriptive survey method, allow the collection of a large amount of data by using questionnaires in an economical way and it is comparatively easy to explain and understand (Saunders et al, 2009).

3.4. Data type and sources of data

Saunders, Lewis, and Thornhill (2009), define two types of data, namely primary and secondary data. According to them, a study might use either both or one of the types of data depending on the research type and data collected by the researcher. For the purpose of this research primary data was collected through standardized structured and semi-structure questionnaire and an interview. Primary data are originated by a researcher for the specific purpose of addressing the problem at hand (Malhotra, 2007). Primary data of this research are both quantitative and qualitative types. The study used quantitative data because of the need to make correlation analysis and tests of significance for the impact of construction supply chain on supply chain performance using numerical data statistical analysis.

Moreover, primary qualitative data was collected using the semi-structured questionnaires and an interview. The interview included open-ended questions. The content of the interview questions was grounded in the type of information and the results of the quantitative parts. The primary data collection method was used in the study that includes the use of a questionnaire,

(that is used to collect crucial information from selected construction professional, engineers, site engineer, suppliers, supervisor, project manager and technical groups of Ethiopian Construction works corporation and interviews. Secondary data is collected from the company's background and profiles, specific research document, related articles and journals, books, publications and reports.

3.5 Population size and techniques

In the Census Survey it was considered all perspective engineers those are directly participates in the construction material supply chain and its impact on building construction projects performance mainly focusing on ECWC is undertaking the construction of 5000 houses around kaliti neighborhood of Addis Ababa. Choosing the best and most experienced employee, the population size for conducting this research is decided to be in construction of 5000 houses projects 68 respondents from both housing development center and project site.

In this study, purposive sampling was employed to obtain the appropriate respondents and examine of site engineer, contract administration, office engineer, procurement, supply and property administration team leader, senior civil engineer, senior construction supervisor, supply & procurement manager and team leader, civil engineer, counterpart civil engineer, lead civil engineer, project manager and senior engineer. The "expert" purposive sampling was adopted to gather data from individuals that have specialized knowledge from other departments.

3.6 Method of data collection

Muhammad & Kabir (2018), stated as data collection is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes. For this study questionnaire and interview were used as the method of data collection.

3.6.1. Questionnaire

According to Abawi (2013), a data collection instrument consisted of a series of questions and other prompts to gather information from respondents. For the collection of the quantitative data, 66 questionnaire was developed. The questionnaire consisted of closed-ended items developed in line with the objectives of the research. The questionnaire has 4 sections. The first

section covers general information about the respondent. The 2nd section covers factors affecting the performance of material supply chain in building construction of ECWC. The 3rd section also covers the determine impact of material supply chain on performance of building construction projects and the 4th section strategies for improving material supply chain process in building construction sector. Finally, the aims to address the quantitative approach instrument of data collection method was a fast and easy method of collecting data and were more accurate when starting, processing, and analyzing these data.

3.6.2. Interviews

For the collection of the qualitative data, a semi-structured interview question was set. In framing the interview question the objectives were considered as discussion. Hence, the questions focus on most top ranked results from questionnaire analyzed results. During the collection of qualitative data, the interview question was conducted on the participant who was involved in the top level of a building construction project employees. The 6-interview question was prepared and applied on ECWC undertaking the construction of 5000 houses around kaliti neighborhood of Addis Ababa and their responses were used to triangulate questionnaire analysis based on their high-rank degree on factors affecting the performance of construction material supply chain in building construction of sector, impact of material supply chain on performance of building construction projects, and finally the strategies for improving construction material supply chain process.

3.7. Data analysis

Data collected from respondents was analyzed for further interpretation and discussion purposes. Accordingly, it was analyzed using both Microsoft Excel and Statistical Package for the Social Sciences (SPSS) to produce the summaries of the various responses. Microsoft Excel was used to compile data, calculate the relative importance index (RII) for each factor, impacts and strategies improving. SPSS was used to analyze others except RII's like: frequency categorization of factors, Cronbach's alpha to internal reliability coefficient, Spearman Rank's Correlation Coefficient method and Pearson's correlation test analysis of the research.

3.7.1 Relative importance index (RII)

The relative importance index method (RII) was used to determine and rank the Sub- factors affecting the performance of CMSC in BCS, major of factors affecting CMSC of building construction sector, impact of construction material Supply chain on performance of building construction projects and strategies for improving material supply chain Process in Building Construction sectors. And all analyzed by the programme MS-Excel.

The relative importance index is computed as (Cheung et al, 2004; Iyer and Jha, 2005; Ugwu and Haupt, 2007): using equation 3.1

$$RII=\frac{\sum Wi*Fi}{A*N} \quad \text{..... Equation 3.1}$$

Where:

RII is relative importance index,

i - response category index

W_i - is the weight given by respondents

F_i - is the frequency of respondent for each weight

A - is the highest weight i.e. 5

N - is the total number of respondents

3.7.2 Sperman Rank correlation coefficient method

Spearman Rank's correlation coefficient method, which values varies between -1 and +1, was used to know owners, consultants and contractors side perceptions of main and sub- factors affecting the performance of MSC in BCS, major of factors affecting MSC practice of building construction sector, impact of construction material supply chain on performance of building construction projects and strategies for improving material supply chain process in building construction sectors in 5000 houses around kaliti neighborhood building construction projects of Addis Ababa in ECWC. The Spearman's Rank correlation coefficient is computed as (Crawshaw, J. and J. Chambers, (2001)): using equation 3.2

$$r_{s} = 1 - \frac{6\sum d^2}{n(n^2-1)} \quad \text{.....Equation 3.2}$$

Where:

rs is Spearman's Rank Correlation Coefficient,

d is the difference in the factors ranks given by the respondents, and

n is the number of data pairs.

- A correlation coefficient of +1 means perfect positive correlation.
- A correlation coefficient close to 0 means no correlation.
- A correlation coefficient of -1 means perfect negative correlation

3.8. Validity and reliability

Reliability and validity are terms that refer to the quality of the measures used in a research study. Reliability refers to the internal consistency and validity refers to the accuracy of the measure.

3.8.1. Validity

Validity refers to the degree to which an instrument measures what it is supposed to be measuring. Validity has a number of different aspects and assessment approaches. There are two ways to evaluate instrument validity: content validity and statistical validity, which include criterion-related validity and construct validity.

Content Validity of the Questionnaire

Content validity test was conducted by consulting two groups of experts. The first was requested to evaluate and identify whether the questions agreed with the scope of the items and the extent to which these items reflect the concept of the research problem. The other was requested to evaluate that the instrument used is valid statistically and that the questionnaire was designed well enough to provide relations and tests between variables. The two groups of experts did agree that the questionnaire was valid and suitable enough to measure the concept of interest with some amendments.

Statistical Validity of the Questionnaire

To ensure the validity of the questionnaire, two statistical tests should be applied. The first test is Criterion-related validity test (Pearson test) which measures the correlation coefficient between each paragraph in one field and the whole field. The second test is structure validity test (Pearson test) that is used to test the validity of the questionnaire structure by testing the validity of each field and the validity of the whole questionnaire. It measures the correlation coefficient between one field and all the fields of the questionnaire that have the same level of similar scale.

3.8.2 Reliability

The reliability of the questionnaire is tested by using Cronbach's alpha or called the alpha coefficient to show the internal consistency of questionnaires as stated by (Gliem & Gliem, 2003). And, again Gliem and Gliem (2003), stated the closer the reliability coefficient of 1.0 is the better. In general, they conducted reliabilities less than 0.60 are considered as poor, those in the range of 0.60 to 0.80 are considered good and acceptable. Greener (2008), stated that reliability is required of research studies. Similarly, Drost (2004), stated that internal consistency measures consistency within the instrument and questions how well a set of items measures a particular behavior or characteristic within the test.

Cronbach's Alpha Reliability test

According to Bonett and Wright (2015), Cronbach's alpha is one of the most widely used measures of reliability in the social and organizational sciences. Current practice is to report the sample value of Cronbach's alpha reliability, but a confidence interval for the population reliability value also should be reported. Reliability analysis is concerned with the internal consistency of the research instrument.

Table 3. 1: Rule of Thumb of Cronbach's Alpha

Cronbach's Alpha	Description
>=.9	Excellent
>=.8 but< .9	Good
>=.7 but<0.8	Acceptable
>=.6 but<0.7	Questionable
>=.5 but<.6	Poor
<.6=0.5	Unacceptable

Source: (Zikmund, et al, 2010).

In this research multiple items in all constructs were used, the internal consistency/reliabilities of factors affecting the performance of construction material supply chain (MSC) in building construction of ECWC, impact of construction material supply chain on performance of building construction projects ,and strategies for improving construction material supply chain process in building construction sector were assessed with Cronbach's Alpha and the reliability values for all constructs are confirmed as greater than 0.7, which are considered acceptable. the following tables shows the summary of reliabilities of all constructs of supply chain and the average Cronbach's Alpha in the table 3.2 below shows that 0.8448 which is greater than 0.7, which confirms acceptability of the research instrument.

Table 3. 2: Represent questionnaire analysis Cronbach's Alpha coefficient test result.

Reliability Statistics		
Variables	**Cronbach's Alpha**	**No of Items**
Main factors affecting the performance of CMSC in BCS	0.818	8
Sub- factors affecting the performance of CMSC in BCS	0.818	22
major factor affecting the performance of MSC in building construction sector between client, contractors and supplier side	0.854	16
The impact of construction material supply chain on the performance of building construction projects.	0.913	10
The strategies for improving material supply chain process in building construction sector	0.821	9

3.9. Data measurement

In order to be able to select the appropriate method of analysis, the level of measurement must be understood. For each type of measurement, there is/are an appropriate method/s that can be applied and not others. In this research, ordinal scales were used. Ordinal scales as shown in the tables are a ranking or a rating data that normally uses integers in ascending or descending order. The numbers assigned (1, 2, 3, 4, 5) do not indicate that the interval between scales is equal, nor do they indicate absolute quantities. They are merely numerical labels. Based on Linker scale have the following tables.

Ordinal scale used for the measurement of rate of occurrence of performance related problems:

Table 3. 3: Rating scale for factor affecting the performance of CMSC in BCS

Item	Very Low	Low	Average	High	Very High
Scale	1	2	3	4	5

Ordinal scale used for the measurement of the impact of material supply chain management on performance of building construction projects:

Table 3. 4: Rating scale for impact of construction material supply chain on performance of building construction projects

Item	Very Low	Low	Average	High	Very High
Scale	1	2	3	4	5

Ordinal scale used for the measurement of the strategies for improving construction material supply chain process in building construction sector:

Table 3. 5: Rating scale for strategies for improving construction material supply chain process in building construction sector

Item	Extremely Unimportant	Unimportant	Somewhat Important	Important	Extremely Important
Scale	1	2	3	4	5

3.10. Ethical consideration

To collect data the ethical permission was taken from Adama Science and Technology University by official letter. The respondents were asked respectfully to receive the required information based on their willingness. Responses of respondents were kept unanimous. The researcher assured the privacy of the respondents and was confidentiality was considered in all levels of the study during information gathering stage.

CHAPTER FOUR

4. RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents the discussion and interpretation of data collected through questionnaires and interview. This part of the study provides an indication of the results and discussions found from the data analysis. The results are found from the questionnaire respondents and each part answers the research questions and achieves the objectives of the research. The tables show participants' relative importance index (RII) and rank of factor affecting the performance of CMSC, impact of construction material supply chain on the performance of building construction projects, strategies for improving construction material supply chain process and correlation between respondents in each part. And the figures show the combined RII and ranks. the discussions are drawn from the combined RII and on the top rank, major and critical variables in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa, correlations between the respondents and perceptions of the respondents in each group factors affects project performance of CMSC, impact of construction material supply chain on the performance of building construction projects and strategies for improving construction material supply chain process in building construction sector.

4.2 General respondent rate

Out of the 68 questionnaires distributed to contactors, housing development center, supplier/production team and sub-contractors, and 68 responses are received with 100% return rate in this study. The following chart shows distribution of the respondents, i.e. Contactors 21(31 %), supplier/production team 17 (25 %), housing development center 19 (28 %) and sub-contractor 11 (16 %).

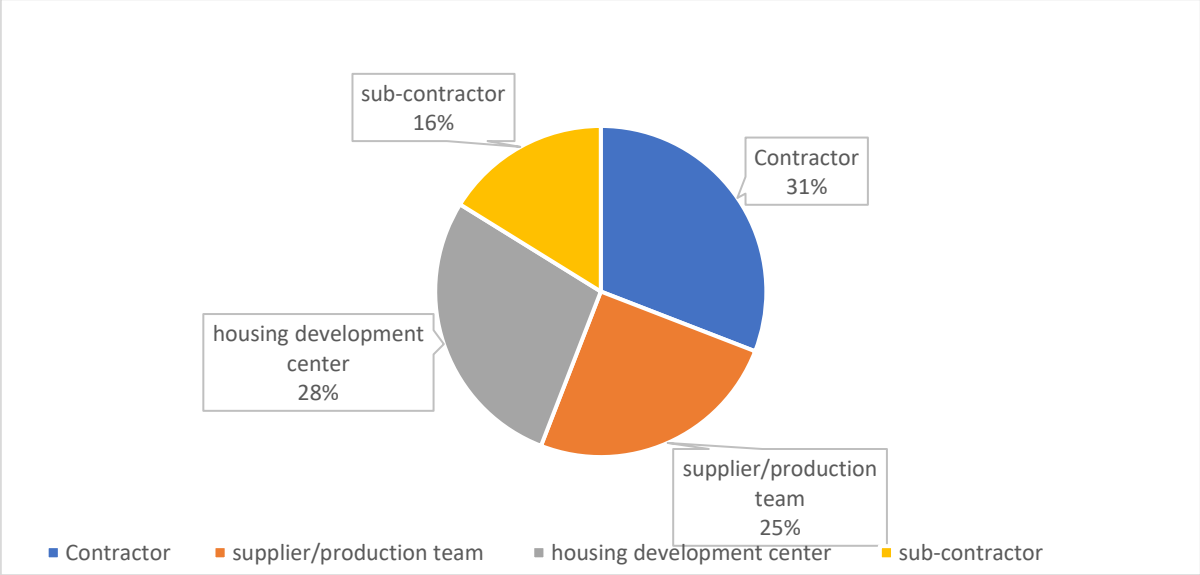

Figure 4. 1: General respondent rate

4.3. General Information of Respondent

In this thesis, the general information of the respondents is described by the employees' working position, educational status, and the general and specific working experience of the respondents. Also, this section shows the quality of personnel information that are working in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa.

4.3.1. Type of position in which they are working

For this study, 68 different levels and position contractors', supplier, AA. housing development center and sub contractors' employees have participated. Among those 11 questionnaire papers were filled and submitted by the site engineer, 9 questionnaires paper were filled and returned by the contract administration, 7 questionnaires paper were filled and returned by the office engineer, 41 questionnaires paper were filled and returned by the procurement, supply and property administration team leader, senior civil engineer, senior civil engineer, senior construction supervisor, supply & procurement manager and team leader, finally,8 questionnaires paper were filled and submitted by the civil engineer, counterpart civil engineer, lead civil engineer, project manager, senior engineer. From the above explanation site engineer was participated in the first ranking stages, the contract administration has participated in the second-ranking stage, and finally, the office engineer has participated in the third stage.

4.3. 2. The educational status of respondents

The educational status of respondents shows the degree of qualification that participants were qualified for. This study covers different educational qualified status like BSc. Degree and MSc. Degree.

Table 4. 1: Shows the educational status of respondents.

		Frequency	Percent	Valid Percent
Valid	B.Sc degree	58	85.3	85.3
	M.Sc Degree	10	14.7	14.7
	Total	68	100.0	100.0

4.3. 3. The experience of respondents

Figure 4.2 shows the years of experience for the surveyed respondents in the construction sector in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa. In the chart below which shows the characteristics of the respondents; about 25% of the respondents have 1-3 years of experience, 32% have 4-6 years, about 30% of the respondents have 7-10 years of experience, 13% have an experience above 10 years.

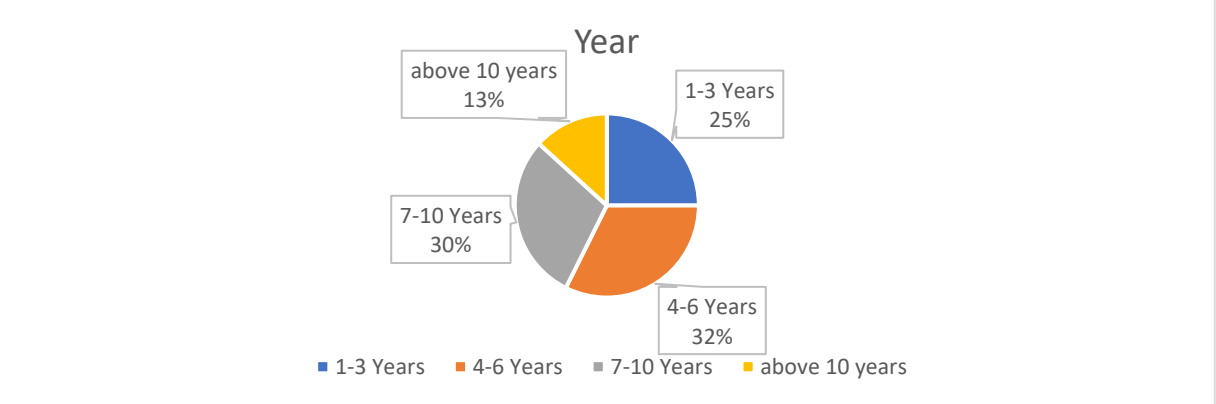

Figure 4. 2: Work experience of respondent rate

4.4. The factor affecting the performance of MSC in building construction sector

4.4.1 Factors affecting the performance of CMSC in BCS.

The results of this part of the study provides an indication of the participants' and relative importance index (RII) and rank of factors affecting the performance of CMSC in building construction sector according to all and each participant's respectively and correlation coefficients between responses of the participants.

There are totally twenty-two factors were identified that affect the performance of construction sector and each are grouped in to main eight groups' factors. And the critical factors are discussed below.

In this case, twenty-two different variables are used to measure factor affecting the performance of CMSC in building construction sector. The total Cronbach's alpha coefficient of twenty-two variables result (0.818), which indicates that all variables are acceptable for this analysis. To identify factor affecting the performance of CMSC in building construction sector, the five Likert scale ranges are used to analyze the output of responses. Also, the relative importance index (RII) is used to rank the degree of factor affecting the performance of CMSC.

Table 4. 2: RII results and rank of factor affecting the performance of CMSC

S.No	Factors affecting the performance of CMSC	RII	Rank
1	Proper cash flow control	0.894	1
2	Ensuring quality of materials	0.891	2
3	Material requirements planning	0.888	3
4	Identifying & selecting suppliers	0.868	4
5	Site work schedule	0.862	5
6	Skilled negotiation with supplier	0.859	6
7	Proper inspection & documentation of materials	0.856	7
8	Organizing& scheduling procurement	0.832	8
9	Cooperation between contractor & supplier	0.829	9
10	Use of material management software	0.824	10
11	Planning delivery of materials to site	0.818	11
12	Proper storage practices	0.815	12
13	Control of material usage & wastage	0.791	13
14	Skill & experience of material management team	0.779	14
15	Storage space available	0.776	15
16	Management of surplus material	0.774	16
17	Severe weather conditions	0.771	17
18	Safety during handling materials	0.768	18
19	Presence of shopkeeper & security personnel	0.765	19
20	Non-delay of payments	0.762	20
21	Sub-contracting	0.753	21
22	Site location & layout	0.712	22

Table 4.2 illustrates of the factor affecting the performance of CMSC in building construction sector, the above result, (RII =0.894) the proper cash flow control indicates the 1st level of factor affecting the performance of CMSC in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa. Besides, (RII=0.891) ensuring quality of materials indicate the second factor affecting the performance of CMSC in construction sector. Also, the indicated as 3rd, 4th and 5th factor affecting the performance of CMSC result in (RII =0.888) material requirements planning, (RII=0.868) Identifying & Selecting Suppliers and (RII =0.862) Site Work Schedule with respectively.

The spearman's correlation test is used to draw 5 ranked factors affecting the performance of CMSC variables to indicate the relationship between two variables. In addition to this material

requirements planning, site work schedule, identifying & selecting suppliers, skilled negotiation with supplier, determines the relationship of variables. According to Schober and Boer (2018), the value and sign of the coefficient show the strength of the association as a small, medium, large. If the strength of association starts from + ve 0.1 to 0.3 and -ve 0.1 to -0.3 has a small association between two variables. And 0.3 to 0.5 to 0.3to-0.5, has medium association, and 0.5 to 1.0, and -0.5 to -1.0.has large/ strong relationship.

Based on this, the result of the correlations indicated that there was a strong relationship between material requirements planning with the site work schedule at a correlation coefficient of (0.657) and the significance level of (0.00), that is less than 0.05, which indicates material requirements planning with site work schedule have large (strongly positive) correlation and it is statically significant at the 5% significant level. Also, identifying & selecting suppliers with skilled negotiation with supplier at a correlation coefficient of (0.593) and the significance level of (0.00) that is less than 0.05, which indicates identifying & selecting suppliers with skilled negotiation with supplier have a strong positive correlation and it is statically significant at the 5% significant level.

Therefore, overall, the above result discussion the research has thoroughly examined all the factors affecting material supply chain management in the construction sector the most important factors listed in the result are explained as follows:

Cash flow control consists of fund usage planning, budget monitoring and evaluation of the results. The proper utilization and adequate cash flow positively impact the success of a project. There must be a recognized system of procedures by which, deviations and their extent are identified.

Material requirement planning is the planning, scheduling and inventory control process used to manage the materials. Material requirements planning ensures that materials are available for construction and maintain the lowest possible material in the stores and site. It also plans construction activities, material delivery schedules and purchasing activities. Material planning is a major function of material management which is closely linked with project planning and control. Scheduling the material program is crucial to meeting the project deadline.

This entails identifying right suppliers who can provide the materials, equipment, and services required for the project. A thorough knowledge about the construction industry, procedures, materials to acquire, and all existing suppliers in the market are needed. Site visits to the supplier locations must be performed to qualify and certify suppliers and also perform background checks.

Material management professionals negotiate to create favorable terms in a new contract. Negotiation involves negotiating new terms with an existing supplier when the old contract is renewed, or discussing new terms with a brand-new vendor. Negotiations are used for determining price, payment terms, delivery procedures, production time and quality standards. The negotiations need to consider the best option for both parties involved which help to build stronger relationships with suppliers.

Thus, this research identifies the following as major factor affecting the performance of CMSC proper cash flow control, ensuring quality of materials, material requirements planning, identifying and selecting suppliers, site work schedule, skilled negotiation with suppliers, proper inspection & documentation of materials, organizing& scheduling procurement, cooperation between contractor & supplier and use of material management software.

4.4.2 Main factor affecting the performance of CMSC in BCS.

Factors affecting the performance of CMSC in BCS. From the data analysis result the main factors affecting for performance of construction material supply chain. The results of this part of the study provides an indication of the participants' and relative importance index (RII) and rank of main factors affecting the performance of CMSC in building construction sector according to all and each participant's respectively and correlation coefficients between responses of the participants.

In this case, eight different variables are used to measure main factor affecting the performance of CMSC in building construction sector. The total Cronbach's alpha coefficient of eight variables result (0.818), which indicates that all variables are acceptable for this analysis. To assess main factor affecting the performance of CMSC in building construction sector, the five Likert scale ranges are used to analyze the output of responses. Also, the relative importance index (RII) is used to rank the degree of main factor affecting the performance of CMSC. Figure

4.3 shows results of the combined RII and rank of main factor affecting the performance of CMSC. Based on the combined RII and rank shown on the figure 4.3 the discussions are made.

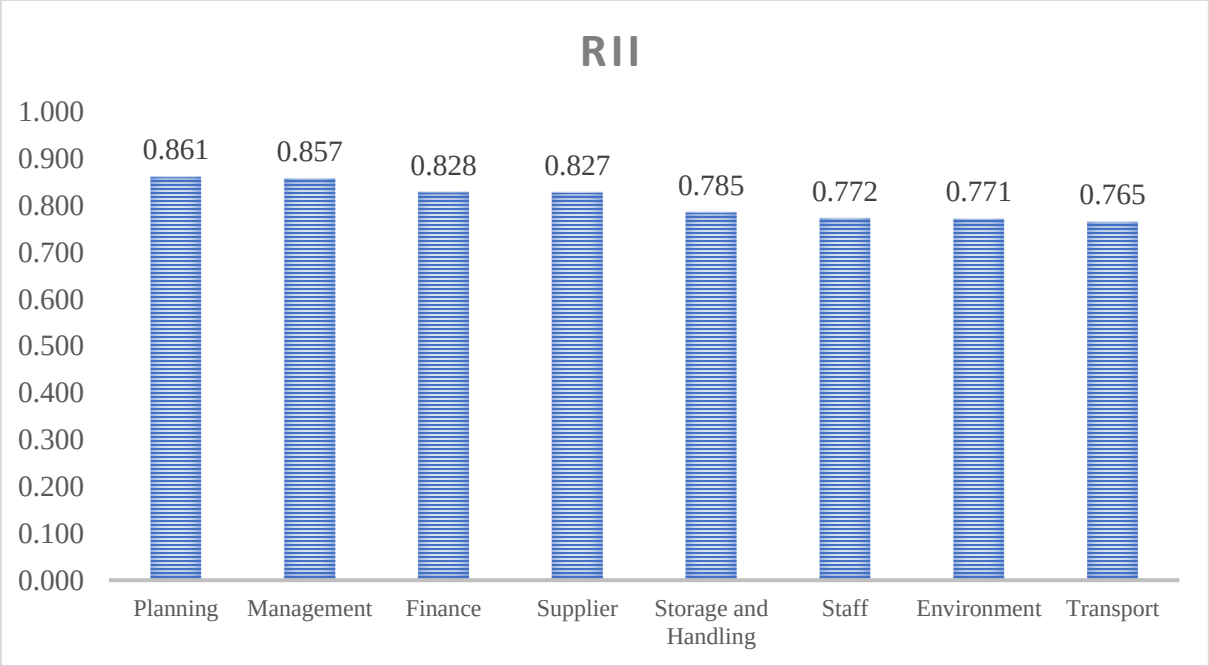

Figure 4. 3 : RII results and rank of main factor affecting the performance of CMSC

From the combined result shown on figure 4.3, the main factor affecting the performance of CMSC which have been occurs on the building construction sector are Planning, Management and Finance with a combined RII of 0.861, 0.857 and 0.828 have been the top and the critical factors that affect the performance of CMSC respectively.

The result of the correlations indicated that there was a strong relationship between finance with the storage and handling at a correlation coefficient of (0.507) and the significance level of (0.03), that is less than 0.05, which indicates finance with storage and handling have large (strongly positive) correlation and it is statically significant at the 5% significant level. Also, staff with management at a correlation coefficient of (0.716) and the significance level of (0.00) that is less than 0.05, which indicates staff with management have a strong positive correlation and it is statically significant at the 5% significant level.

On other hand , the result of the correlations indicated that there was a medium relationship between planning with the staff at a correlation coefficient of (0.493) and the significance level

of (0.04), that is less than 0.05, which indicates planning with staff have medium (medium positive) correlation and it is statically significant at the 5% significant level, supplier with finance at a correlation coefficient of (0.353) and the significance level of (0.047) that is less than 0.05, which indicates supplier with finance have a medium positive correlation and it is statically significant at the 5% significant level, supplier with staff at a correlation coefficient of (0.356) and the significance level of (0.046) that is less than 0.05, which indicates supplier with staff have a medium positive correlation and it is statically significant at the 5% significant level, supplier with transport at a correlation coefficient of (0.451) and the significance level of (0.010) that is less than 0.05, which indicates supplier with transport have a medium positive correlation and it is statically significant at the 5% significant level, supplier with storage and handling at a correlation coefficient of (0.470) and the significance level of (0.00) that is less than 0.05, which indicates supplier with storage and handling have a medium positive correlation and it is statically significant at the 5% significant level. Also, finance with transport at a correlation coefficient of (0.457) and the significance level of (0.00) that is less than 0.05, which indicates finance with transport have a medium positive correlation and it is statically significant at the 5% significant level.

Therefore, the above result discussion the research has thoroughly examined all the main factors affecting material supply chain management in the construction sector the most important main factors listed in the result are explained as follows:

A fundamental, important process for every project, material planning, which is a key function of material management, is closely linked with project planning and control set-up. there are lots of factors which have the capability for significant factor affect on improving construction planning such as consuming more time for planning before starting job, relationship between different parties, alternative plan and sufficient time, control time, revision interval and finally construction method control.

Management uses inventories and production requirements for planning and control to ensure materials are available as required to meet production schedules. Also management has been an important part of use of material management by software, proper inspection & documentation

of materials and ensuring quality of materials, material managers need to interact with a supply chain to make sure materials are delivered where they are needed at the right time.

Managing cash what entities do on a day-to-day basis to take care of the inflows and outflows of their money. Proper cash management can improve an entity's financial situation and liquidity problems. For individuals, maintaining cash balances while also earning a return on idle cash is usually a top concern. In business, companies have cash inflows and outflows that must be prudently managed in order to: meet payment obligations, plan for future payments and maintain adequate business stability.

Handling and storage of materials is another factor that must be considered because it affects construction time, requirements for labor and equipment for handling, and cost.

A such as size, degree of uncertainty, complexity, competition, type of contract and also type of client have a direct impact on the project performance. In this case there are some uncertainties such as the design before beginning the project, the unpredictable weather and also availability of labour or equipment for project.

In terms of organizing the movement of vehicles, people and materials ensures the efficient use of workforce and production or process in construction projects. The routing of materials is one of the main causes which factor affect the performance of CMSC in building construction sector.

4.5. The impact of construction material supply chain on the performance of building construction projects.

4.5.1 Impacts of the Performance construction material supply chain

There are three main that impacts of the performance construction material supply chain in building construction sector. Totally sixteen impacts were identified that performance construction material supply chain of construction sector and each are grouped in to the main three groups' impacts and the critical main impacts are discussed below.

In this case, sixteen different variables are used to measure impacts of the performance construction material supply chain in building construction sector. The total Cronbach's alpha coefficient of sixteen variables result (0.854), which indicates that all variables are acceptable

for this analysis. To assess impacts of the performance construction material supply chain in building construction sector, the five Likert scale ranges are used to analyze the output of responses. Also, the relative importance index is used to rank the degree of impacts of the performance construction material supply chain. Table 4.3 shows results of the RII and rank of impacts of the performance construction material supply chain in building construction sector between client, contractors and supplier side. Based on the combined RII and rank shown on the figure 4.4 the discussions are made.

Table 4. 3: RII results and rank of impacts of the performance construction material supply chain

S/No	Impacts of the Performance construction material supply chain	RII	Rank
1	Late and incorrect payment to suppliers	0.844	1
2	Unresolved quality problem	0.835	2
3	Access to latest information about types of materials on the market	0.821	3
4	Late payment from client requested by supplier and contractor	0.818	4
5	Deliveries not in conformance with planning	0.809	5
6	Incorrect price during bidding process	0.788	6
7	Accurate and good specifications of materials to avoid wrong ordering	0.771	7
8	Lack of attention paid to standard sizes available on the market	0.765	8
9	Design change	0.759	9
10	Extended time wait for architects/consultant approval	0.729	10
11	Delays in passing of information to the contractor on types and sizes of products to be used	0.726	11
12	Good coordination between store and construction personnel to avoid over ordering	0.709	12
13	Difficult for substitute product	0.691	13
14	Inaccurate data from project site & information needed for site	0.691	14
15	Designer ‘s unfamiliarity with alternative products	0.685	15
16	Incorrect document	0.641	16

Table 4.3 illustrates the results of the impacts of the performance construction material supply chain in building construction sector between client, contractors and supplier side. Based on the

above result, (RII =0.844) the late and incorrect payment to suppliers indicates the 1st ranked of sub factor affecting the performance of CMSC in building construction sector between client, contractors and supplier side of CMSC in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa. Besides, (RII=0.835) unresolved quality problem and (RII=0.821) access to latest information about types of materials on the market indicates the second and third sub factor affecting the performance of CMSC in building construction sector between client, contractors and supplier side with respectively.

Also, the indicated as 4th,5th, 6th,7th, 8th,9th and 10th impacts of the performance construction material supply chain in building construction sector between client, contractors and supplier side result in (RII =0.818) late payment from client requested by supplier and contractor, (RII=0.809) deliveries not in conformance with planning, (RII=0.788) incorrect price during bidding process, (RII=0.771) accurate and good specifications of materials to avoid wrong ordering, (RII=0.765) lack of attention paid to standard sizes available on the market, (RII=0.759) design change and (RII=0.729) extended time wait for architects/consultant approval in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa with respectively.

From the above results spearman's correlation test is used to draw 5 ranked sub factors affecting the performance of CMSC in building construction sector between client, contractors and supplier side variables to indicate the relationship between two variables. in addition to this late and incorrect payment to suppliers, design change, designer's unfamiliarity with alternative products, difficult for substitute product, incorrect document, delays in passing of information to the contractor on types and sizes of products to be used, late and incorrect payment to suppliers, incorrect price during bidding process, extended time wait for architects/consultant approval, inaccurate data from project site & information needed for site, good coordination between store and construction personnel to avoid over ordering, accurate and good specifications of materials to avoid wrong ordering, deliveries not in conformance with planning, unresolved quality problem, access to latest information about types of materials on the market and lack of attention paid to standard sizes available on the market in Appendix 1C, determines the relationship of variables.

Based on this, the result of the correlations indicated that there was a strong relationship between design change with the designer‘s unfamiliarity with alternative products at a correlation coefficient of (0.631) and the significance level of (0.000), that is less than 0.05, which indicates design change with designer‘s unfamiliarity with alternative products have large (strongly positive) correlation and it is statically significant at the 5% significant level and the correlations indicated that there was a strong relationship between design change with the incorrect document at a correlation coefficient of (0.557) and the significance level of (0.001), that is less than 0.05, which indicates design change with incorrect document have large (strongly positive) correlation and it is statically significant at the 5% significant level

The correlations indicated that there was a strong relationship between designer ‘s unfamiliarity with alternative products with the incorrect document at a correlation coefficient of (0.608) and the significance level of (0.000), that is less than 0.05, which indicates designer ‘s unfamiliarity with alternative products with incorrect document have large (strongly positive) correlation and it is statically significant at the 5% significant level.

In addition the correlations indicated that there was a strong relationship between incorrect document with the delays in passing of information to the contractor on types and sizes of products to be used at a correlation coefficient of (0.672) and the significance level of (0.000), that is less than 0.05, which indicates incorrect document with delays in passing of information to the contractor on types and sizes of products to be used have large (strongly positive) correlation and it is statically significant at the 5% significant level, the correlations indicated that there was a strong relationship between incorrect document with the late and incorrect payment to suppliers at a correlation coefficient of (0.519) and the significance level of (0.002), that is less than 0.05, which indicates incorrect document with late and incorrect payment to suppliers have large (strongly positive) correlation and it is statically significant at the 5% significant level, the correlations indicated that there was a strong relationship between incorrect document with the incorrect price during bidding process at a correlation coefficient of (0.617) and the significance level of (0.000), that is less than 0.05, which indicates incorrect document with incorrect price during bidding process have large (strongly positive) correlation and it is statically significant at the 5% significant level, the correlations indicated that there was a strong

relationship between incorrect document with the inaccurate data from project site & information needed for site at a correlation coefficient of (0.638) and the significance level of (0.000), that is less than 0.05, which indicates incorrect document with inaccurate data from project site & information needed for site have large (strongly positive) correlation and it is statically significant at the 5% significant level, the correlations indicated that there was a strong relationship between incorrect document with the deliveries not in conformance with planning at a correlation coefficient of (0.649) and the significance level of (0.000), that is less than 0.05, which indicates incorrect document with deliveries not in conformance with planning have large (strongly positive) correlation and it is statically significant at the 5% significant level, the correlations indicated that there was a strong relationship between incorrect document with the unresolved quality problem at a correlation coefficient of (0.711) and the significance level of (0.000), that is less than 0.05, which indicates incorrect document with unresolved quality problem have large (strongly positive) correlation and it is statically significant at the 5% significant level and the correlations indicated that there was a strong relationship between incorrect document with the lack of attention paid to standard sizes available on the market at a correlation coefficient of (0.536) and the significance level of (0.002), that is less than 0.05, which indicates incorrect document with lack of attention paid to standard sizes available on the market have large (strongly positive) correlation and it is statically significant at the 5% significant level.

Besides, the correlations indicated that there was a strong relationship between delays in passing of information to the contractor on types and sizes of products to be used with the incorrect price during bidding process at a correlation coefficient of (0.505) and the significance level of (0.003), that is less than 0.05, which indicates delays in passing of information to the contractor on types and sizes of products to be used with incorrect price during bidding process have large (strongly positive) correlation and it is statically significant at the 5% significant level , the correlations indicated that there was a strong relationship between delays in passing of information to the contractor on types and sizes of products to be used with the inaccurate data from project site & information needed for site at a correlation coefficient of (0.636) and the significance level of (0.000), that is less than 0.05, which indicates delays in passing of information to the contractor on types and sizes of products to be used with inaccurate data from

project site & information needed for site have large (strongly positive) correlation and it is statically significant at the 5% significant level and the correlations indicated that there was a strong relationship between delays in passing of information to the contractor on types and sizes of products to be used with the deliveries not in conformance with planning at a correlation coefficient of (0.719) and the significance level of (0.000), that is less than 0.05, which indicates delays in passing of information to the contractor on types and sizes of products to be used with deliveries not in conformance with planning have large (strongly positive) correlation and it is statically significant at the 5% significant level.

In same way, the correlations indicated that there was a strong relationship between late and incorrect payment to suppliers with the incorrect price during bidding process at a correlation coefficient of (0.706) and the significance level of (0.000), that is less than 0.05, which indicates late and incorrect payment to suppliers with incorrect price during bidding process have large (strongly positive) correlation and it is statically significant at the 5% significant level, the correlations indicated that there was a strong relationship between late and incorrect payment to suppliers with the deliveries not in conformance with planning at a correlation coefficient of (0.636) and the significance level of (0.000), that is less than 0.05, which indicates late and incorrect payment to suppliers with deliveries not in conformance with planning have large (strongly positive) correlation and it is statically significant at the 5% significant level, the correlations indicated that there was a strong relationship between late and incorrect payment to suppliers with the unresolved quality problem at a correlation coefficient of (0.652) and the significance level of (0.000), that is less than 0.05, which indicates late and incorrect payment to suppliers with unresolved quality problem have large (strongly positive) correlation and it is statically significant at the 5% significant level and the correlations indicated that there was a strong relationship between late and incorrect payment to suppliers with the lack of attention paid to standard sizes available on the market at a correlation coefficient of (0.726) and the significance level of (0.000), that is less than 0.05, which indicates late and incorrect payment to suppliers with lack of attention paid to standard sizes available on the market have large (strongly positive) correlation and it is statically significant at the 5% significant level.

Furthermore, the correlations indicated that there was a strong relationship between incorrect price during bidding process with the inaccurate data from project site & information needed for site at a correlation coefficient of (0.779) and the significance level of (0.000), that is less than 0.05, which indicates incorrect price during bidding process with inaccurate data from project site & information needed for site have large (strongly positive) correlation and it is statically significant at the 5% significant level and the correlations indicated that there was a strong relationship between incorrect price during bidding process with the unresolved quality problem at a correlation coefficient of (0.568) and the significance level of (0.000), that is less than 0.05, which indicates incorrect price during bidding process with unresolved quality problem have large (strongly positive) correlation and it is statically significant at the 5% significant level.

The correlations indicated that there was a strong relationship between good coordination between store and construction personnel to avoid over ordering with the accurate and good specifications of materials to avoid wrong ordering at a correlation coefficient of (0.656) and the significance level of (0.000), that is less than 0.05, which indicates good coordination between store and construction personnel to avoid over ordering with accurate and good specifications of materials to avoid wrong ordering have large (strongly positive) correlation and it is statically significant at the 5% significant level.

Also, the correlations indicated that there was a strong relationship between deliveries not in conformance with planning with the unresolved quality problem at a correlation coefficient of (0.624) and the significance level of (0.000), that is less than 0.05, which indicates deliveries not in conformance with planning with unresolved quality problem have large (strongly positive) correlation and it is statically significant at the 5% significant level and the correlations indicated that there was a strong relationship between deliveries not in conformance with planning with the lack of attention paid to standard sizes available on the market at a correlation coefficient of (0.784) and the significance level of (0.000), that is less than 0.05, which indicates deliveries not in conformance with planning with lack of attention paid to standard sizes available on the market have large (strongly positive) correlation and it is statically significant at the 5% significant level.

Finally, correlations indicated that there was a strong relationship between unresolved quality problem with the lack of attention paid to standard sizes available on the market at a correlation coefficient of (0.697) and the significance level of (0.000), that is less than 0.05, which indicates unresolved quality problem with lack of attention paid to standard sizes available on the market have large (strongly positive) correlation and it is statically significant at the 5% significant level and the correlations indicated that there was a strong relationship between access to latest information about types of materials on the market with the lack of attention paid to standard sizes available on the market at a correlation coefficient of (0.542) and the significance level of (0.001), that is less than 0.05, which indicates access to latest information about types of materials on the market with lack of attention paid to standard sizes available on the market have large (strongly positive) correlation and it is statically significant at the 5% significant level.

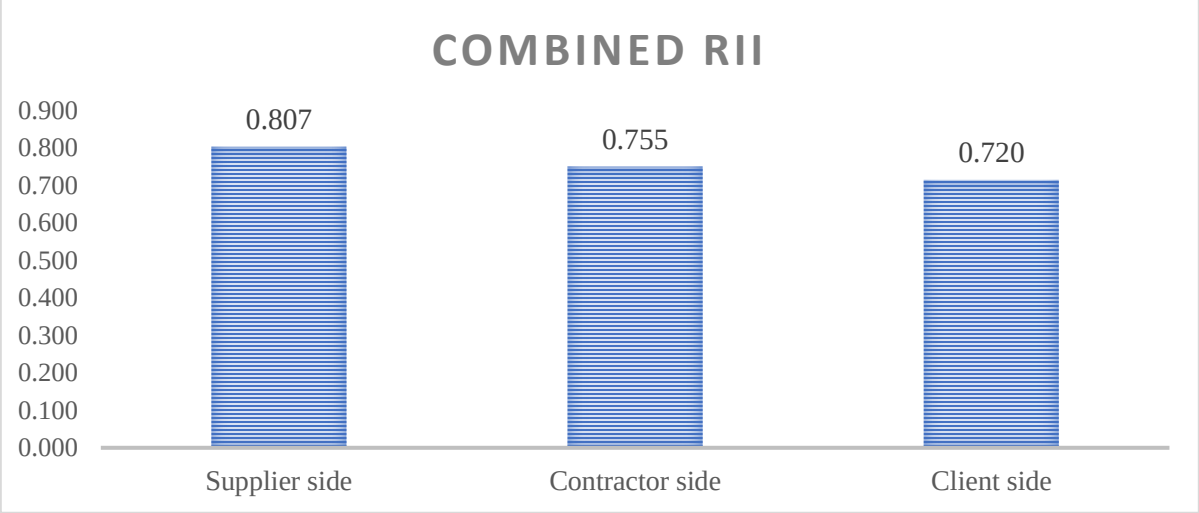

Figure 4. 4: Combined RII results and rank of main impacts of the performance construction material supply chain in building construction sector

Figure 4.4 shows that supplier side with combined RII of 0.807, contractor side combined RII of 0.755 and client side with combined RII of 0.720 have been the top and the critical main impacts of the performance construction material supply chain in building construction sector.

From the result of material supply chain management building construction sector, the critical performance factors have been of supplier side: sequencing of deliveries not in conformance

with planning, unresolved quality problem, access to latest information about types of materials on the market and lack of attention paid to standard sizes available on the market.

A figure 4.4 indicates the combined relative index table the is depicted for all the three impacts such as client side, contractor side, supplier side that is the rank is 3, 2 and 1 respectively. Therefore, the supplier side main impacts of the performance construction material supply chain in building construction sector of in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa and ranked as 1 and the contractor side and the client side are the second and third most impacts and are ranked 2 and 3 respectively.

Table 4. 4: Spearman's correlation coefficient of major factor affecting the performance of CMSC in building construction sector between client, contractors and supplier side

Spearman's correlation coefficient				
		Client side	Contractor side	Supplier side
Client side	Pearson Correlation	1	.733**	.546**
	Sig. (2-tailed)		.000	.001
	N	68	68	68
Contractor side	Pearson Correlation	.733**	1	.397*
	Sig. (2-tailed)	.000		.024
	N	68	68	68
Supplier side	Pearson Correlation	.546**	.397*	1
	Sig. (2-tailed)	.001	.002	
	N	68	68	68
**. Correlation is significant at the 0.01 level (2-tailed).				
*. Correlation is significant at the 0.05 level (2-tailed).				

Based on table 4.4, the result of the correlations indicated that there was a strong relationship between client with the contractor at a correlation coefficient of (0.733) and the significance level of (0.000), that is less than 0.05, which indicates client with contractor have large (strongly positive) correlation and it is statically significant at the 5% significant level and the correlations indicated that there was a strong relationship between client with the supplier at a correlation coefficient of (0.546) and the significance level of (0.001), that is less than 0.05, which indicates

client with supplier have large (strongly positive) correlation and it is statically significant at the 5% significant level.

Also, the result of the correlations indicated that there was a moderate relationship between contractor with the supplier at a correlation coefficient of (0.397) and the significance level of (0.002), that is less than 0.05, which indicates client with contractor have medium (moderate positive) correlation and it is statically significant at the 5% significant level

4.5.2 Performance of construction projects

Totally ten impacts were identified that impact of material supply chain management on the performance of building construction projects and each are sub-grouped in to the main three groups' performance of construction projects and the critical impacts are discussed below.

In this case, ten different variables are used to measure impact of material supply chain management on the performance of building construction projects. The total Cronbach's alpha coefficient of ten variables result (0.913), which indicates that all variables are acceptable for this analysis. To assess performance of construction projects, the five Likert scale ranges are used to analyze the output of responses. Also, the relative importance index (RII) is used to rank the degree of the performance of construction projects. Table 4.5 shows results of the RII and rank of the performance of construction projects between price/cost, quality and time. Based on the combined RII and rank shown on the figure 4.5 the discussions are made.

Table 4. 5: RII results and rank of impact of material supply chain on the performance of construction projects.

S/No.	Impacts of material supply chain on the performance of construction projects	RII	Rank
1	Improper supplier selection cause low quality products to the client	0.874	1
2	Improper supplier selection cause offering a low durable product to our client	0.862	2
3	Lack of good suppliers partnership cause difficult to provide dependable/faithful delivery	0.821	3
4	Difficult client relationship causes not to compete based on quality.	0.812	4
5	Incorrect deal with the supplier affects our prices during construction	0.797	5
6	Lack of information sharing cause not to deliver customer order on time	0.794	6
7	Lack of good customer relationship are great affect in solving customer complaints	0.788	7
8	Incorrect price-based supplier selection affects our prices offer to the client during tendering process	0.776	8
9	Incorrect collaboration with supplier increases the production cost to run the operation	0.768	9
10	Incorrect information sharing cause not to deliver the kind of products needed to the site	0.747	10

Table 4.5 illustrates the results of the impact of material supply chain on the performance of construction projects. Based on the above result, (RII = 0.874) the improper supplier selection cause low quality products to the client indicates the 1st ranked of impact of material supply chain on the performance of construction projects in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa. Besides, (RII= 0.862) and improper supplier selection cause offering a low durable product to our client indicate the second impact of material supply chain management on the performance of building construction projects.

Also, the indicated as 3rd, 4th,5th, 6th,7th, 8th,9th and 10th impact of material supply chain on the performance of construction projects result in (RII = 0.821) lack of good suppliers partnership cause difficult to provide dependable/faithful delivery, (RII = 0.812) difficult client relationship causes not to compete based on quality, (RII= 0.797) incorrect deal with the supplier affects our prices during construction , (RII= 0.794) lack of information sharing cause not to deliver customer order on time , (RII= 0.788) lack of good customer relationship are great affect in solving customer complaints , (RII= 0.776) incorrect price-based supplier selection affects our prices offer to the client during tendering process , (RII= 0.768) incorrect collaboration with supplier increases the production cost to run the operation and (RII= 0.747) incorrect information sharing cause not to deliver the kind of products needed to the site in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa with respectively.

Based on the result of the correlations indicated that there was a strong relationship between incorrect price-based supplier selection affects our prices offer to the client during tendering process with the incorrect collaboration with supplier increases the production cost to run the operation, improper supplier selection cause low quality products to the client, improper supplier selection cause offering a low durable product to our client, incorrect information sharing cause not to deliver the kind of products needed to the site, lack of information sharing cause not to deliver customer order on time, lack of good suppliers partnership cause difficult to provide dependable/faithful delivery and lack of good customer relationship are great affect in solving customer complaints have large (strongly positive) correlation and that is less than 0.05 it is statically significant at the 5% significant level.

In addition the result of the correlations indicated that there was a strong relationship between incorrect collaboration with supplier increases the production cost to run the operation with incorrect deal with the supplier affects our prices during construction, difficult client relationship causes not to compete based on quality, incorrect information sharing cause not to deliver the kind of products needed to the site and lack of information sharing cause not to deliver customer order on time have large (strongly positive) correlation and that is less than 0.05 it is statically significant at the 5% significant level.

Besides, the result of the correlations indicated that there was a strong relationship between incorrect deal with the supplier affects our prices during construction with improper supplier selection cause low quality products to the client, improper supplier selection cause offering a low durable product to our client, lack of good suppliers partnership cause difficult to provide dependable/faithful delivery and lack of good customer relationship are great affect in solving customer complaints have large (strongly positive) correlation and that is less than 0.05 it is statically significant at the 5% significant level.

Also, the result of the correlations indicated that there was a strong relationship between difficult client relationship causes not to compete based on quality with incorrect information sharing cause not to deliver the kind of products needed to the site and lack of information sharing cause not to deliver customer order on time have large (strongly positive) correlation and that is less than 0.05 it is statically significant at the 5% significant level.

The result of the correlations indicated that there was a strong relationship between improper supplier selection cause low quality products to the client with improper supplier selection cause offering a low durable product to our client, incorrect information sharing cause not to deliver the kind of products needed to the site, lack of good suppliers partnership cause difficult to provide dependable/faithful delivery, lack of good customer relationship are great affect in solving customer complaints have large (strongly positive) correlation and that is less than 0.05 it is statically significant at the 5% significant level.

Finally of the correlations indicated that there was a strong relationship between incorrect information sharing cause not to deliver the kind of products needed to the site with lack of information sharing cause not to deliver customer order on time have large (strongly positive) correlation and that is less than 0.05 it is statically significant at the 5% significant level.

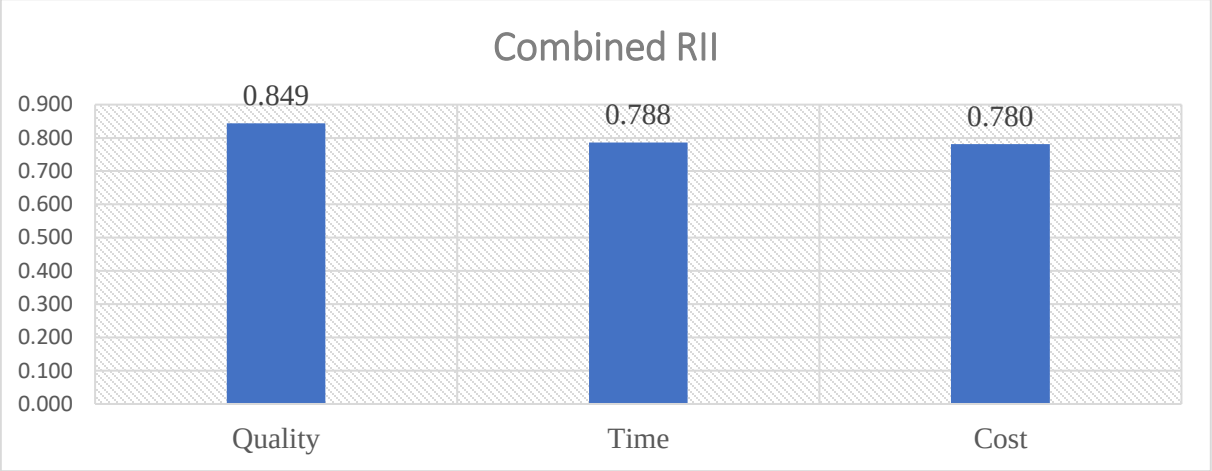

Figure 4. 5 : Combined RII results and rank of main impact of material supply chain on the performance of construction projects

Based on the above figure 4.5 indicates the combined relative important index table, the quality Combined RII of 0.849, time combined RII of 0.788 and cost Combined RII of 0.780 have been the top and the critical main impact of material supply chain on the performance of construction projects is depicted for all the three impacts such as quality, time, cost that is the rank is 1, 2 and 3 respectively. Therefore, the quality main impact of material supply chain on the performance of construction projects in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa and ranked as 1 and the time and the cost are the most impacts are ranked 2 and 3 respectively.

The figure 4.5, shows the group summarization of the main impact of material supply chain on the performance of construction projects. In all, quality impact was identified as the main impact that influences building construction project performance. A good building is the one which satisfies housing development needs. The desire of housing development after spending so much to build is to see something that is of a good quality. The ECWC therefore has a responsibility to ensure that the housing development gets just what he wants. This means that the ECWC should be able to locate the right caliber of skilled manpower with the highest desire for quality to be able to satisfy his employer. Housing development often times become disappointed in the quality of product delivered to them after making huge investments. ECWC need to be innovative because housing development requirements are becoming complex by day. Housing development have taste for good things and ECWC must aspire to meet their needs. This will

require a lot of learning and training on the part of ECWC, technical personnel and core skilled manpower to produce products of the highest quality.

Table 4. 6: Spearman's correlation coefficient of impact of construction material supply chain on the performance of building construction projects.

Spearman's correlation coefficient				
		Cost	Quality	Time
Cost	Pearson Correlation	1	.736**	.871**
	Sig. (2-tailed)		.000	.000
	N	68	68	68
Quality	Pearson Correlation	.736**	1	.666**
	Sig. (2-tailed)	.000		.000
	N	68	68	68
Time	Pearson Correlation	.871**	.666**	1
	Sig. (2-tailed)	.000	.000	
	N	68	68	68
**. Correlation is significant at the 0.01 level (2-tailed).				

Based on table 4.6, the result of the correlations indicated that there was a strong relationship between cost with the quality at a correlation coefficient of (0.736) and the significance level of (0.000), that is less than 0.05, which indicates cost with quality have large (strongly positive) correlation and it is statically significant at the 5% significant level and the correlations indicated that there was a strong relationship between cost with the time at a correlation coefficient of (0.871) and the significance level of (0.000), that is less than 0.05, which indicates cost with time have large (strongly positive) correlation and it is statically significant at the 5% significant level.

Also, the result of the correlations indicated that there was a strong relationship between quality with the time at a correlation coefficient of (0.666) and the significance level of (0.000), that is less than 0.05, which indicates quality with time have large (strongly positive) correlation and it is statically significant at the 5% significant level.

4.6. The strategies for improving construction material supply chain process in building construction sector.

There are three nine strategies were identified that strategies for improving construction material supply chain process in building construction sector and each are sub-theme in to the main three groups' strategies of improvement and the critical strategies are discussed below.

In this case, nine different variables are used to measure strategies for improving construction material supply chain process in building construction sector. The total Cronbach's alpha coefficient of nine variables result (0.821), which indicates that all variables are acceptable for this analysis. To assess strategies for improving construction material supply chain process in building construction sector, the five Likert scale ranges are used to analyze the output of responses. Also, the relative importance index is used to rank the degree of strategies for improving construction material supply chain process in building construction sector. Table 4.7 shows results of the RII and rank of strategies for improving construction material supply chain process in building construction sector. Based on the combined RII and rank shown on the figure 4.6 the discussions are made.

Table 4. 7: RII results and rank of strategies for improving construction material supply chain process in building construction sector

S/No	**Strategies for improving construction material supply chain process in building construction sector**	**RII**	**Rank**
1	Developing best practices, reengineering processes, encouraging innovation and sharing knowledge through trainings can bring solutions and improve competitiveness.	0.877	1
2	Managing by understanding and measuring the entire end-to-end supply chain system.	0.876	2
3	Leading with vision, setting priorities, leading projects effectively, and ensuring their full implementation bring expected benefits and improvement.	0.859	3
4	Ensure visibility and evidence-based decision making, supply chain managers should enhance supply chain analytics through technology and data mining	0.850	4
5	Effective leadership should foster culture of accountability, change management and integration through long-term partnerships, collaborations, and clear policies.	0.844	5
6	Strategies drive change towards sustainability and considering environmental impact.	0.841	6
7	Agile strategies allow responding effectively to emergencies and uncertainties.	0.821	7
8	Sensing operational environment will allow effective planning, demand forecasting and optimizing resources.	0.806	8
9	Supply chain risk management mitigates disruptions and encounters resistance to change.	0.788	9

Table 4.7 illustrates the results of the strategies for improving construction material supply chain process in building construction sector. based on the above result, (RII = 0.877) the developing best practices, reengineering processes, encouraging innovation and sharing knowledge through trainings can bring solutions and improve competitiveness indicates the 1st ranked of strategies for improving construction material supply chain process in building construction sector in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa. Besides, (RII= 0.876) managing by understanding and measuring the entire end-to-end supply chain system indicate the second strategies for improving construction material supply chain process in building construction sector.

Also, the indicated as 3rd,4th,5th, 6th,7th, 8th,9th and strategies for improving construction material supply chain process in building construction sector result in (RII = 0. 0.859) leading with vision, setting priorities, leading projects effectively, and ensuring their full implementation bring expected benefits and improvement, (RII=0.850) ensure visibility and evidence-based decision making, supply chain managers should enhance supply chain analytics through technology and data mining, (RII= 0.844) effective leadership should foster culture of accountability, change management and integration through long-term partnerships, collaborations, and clear policies, (RII= 0.841) strategies drive change towards sustainability and considering environmental impact , (RII= 0.821) agile strategies allow responding effectively to emergencies and uncertainties , (RII= 0.806) sensing operational environment will allow effective planning, demand forecasting and optimizing resources. , (RII= 0.788) supply chain risk management mitigates disruptions and encounters resistance to change in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa with respectively.

From the above results spearman's correlation test is used to draw 9 ranked variables to indicate the relationship between two variables. In addition to this developing best practices, reengineering processes, encouraging innovation and sharing knowledge through trainings can bring solutions and improve competitiveness, managing by understanding and measuring the entire end-to-end supply chain system, ensure visibility and evidence-based decision making, supply chain managers should enhance supply chain analytics through technology and data mining, leading with vision, setting priorities, leading projects effectively, and ensuring their full implementation bring expected benefits and improvement, effective leadership should foster culture of accountability, change management and integration through long-term partnerships, collaborations, and clear policies, strategies drive change towards sustainability and considering environmental impact, agile strategies allow responding effectively to emergencies and uncertainties, sensing operational environment will allow effective planning, demand forecasting and optimizing resources and supply chain risk management mitigates disruptions and encounters resistance to change determines the relationship of variables.

The result of the correlations indicated that there was a strong relationship among strategies drive change towards sustainability and considering environmental impact with ensure visibility

and evidence-based decision making, supply chain managers should enhance supply chain analytics through technology and data mining, developing best practices, reengineering processes, encouraging innovation and sharing knowledge through trainings can bring solutions and improve competitiveness, effective leadership should foster culture of accountability, change management and integration through long-term partnerships, collaborations, and clear policies and managing by understanding and measuring the entire end-to-end supply chain system have large (strongly positive) correlation and that is less than 0.05 it is statically significant at the 5% significant level.

In addition the result of the correlations indicated that there was a strong relationship between developing best practices, reengineering processes, encouraging innovation and sharing knowledge through trainings can bring solutions and improve competitiveness with the agile strategies allow responding effectively to emergencies and uncertainties at a correlation coefficient of (0.707) and the significance level of (0.000), that is less than 0.05, which indicates developing best practices, reengineering processes, encouraging innovation and sharing knowledge through trainings can bring solutions and improve competitiveness with agile strategies allow responding effectively to emergencies and uncertainties have large (strongly positive) correlation and it is statically significant at the 5% significant level .

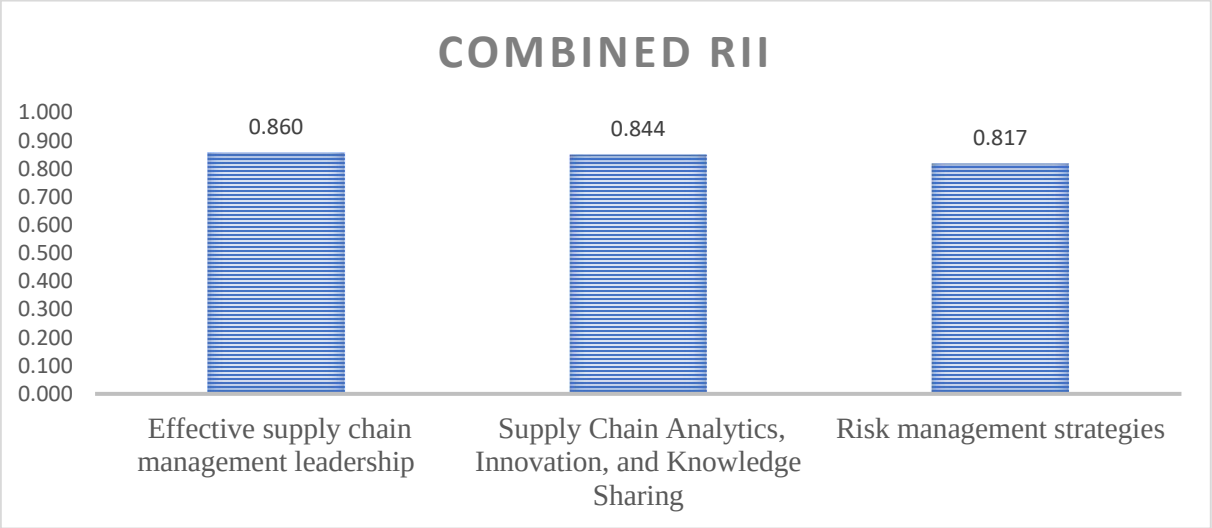

Figure 4. 6: Combined RII results and rank of main strategies for improving construction material supply chain process in building construction sector.

Based on the above figure 4.6 indicates the combined relative important index table, the effective supply chain management leadership combined RII of 0.860, supply chain analytics ,innovation, and knowledge sharing combined RII of 0.844 and risk management strategies combined RII of 0.817 have been the top and the critical strategies that of improving material supply chain management process in building construction sector is depicted for all the three strategies such as effective supply chain management leadership, supply chain analytics ,innovation, and knowledge sharing and risk management strategies that is the rank is 1, 2 and 3 respectively. therefore, the effective supply chain management leadership main strategies for improving construction material supply chain process in building construction sector of in ECWC 5000 houses around kaliti neighborhood building construction projects of Addis Ababa and ranked as 1 and the supply chain analytics, innovation, and knowledge sharing and risk management strategies are the most impacts are ranked 2 and 3 respectively.

Table 4. 8: spearman's correlation coefficient of strategies for improving construction material supply chain process in building construction sector.

Strategies for improving construction material supply chain process in building construction sector		Supply chain analytics, innovation, and knowledge sharing	Effective supply chain management leadership	Risk management strategies
Supply chain analytics, innovation, and knowledge sharing	Pearson Correlation	1	.756	.236**
	Sig. (2-tailed)		0.098	0.000
	N	68	68	68
Effective supply chain management leadership	Pearson Correlation	.756	1	.564**
	Sig. (2-tailed)	0.098		0.001
	N	68	68	68
Risk management strategies	Pearson Correlation	.236**	.564**	1
	Sig. (2-tailed)	0	0.001	
	N	68	68	68

Based on table 4.8, the result of the correlations indicated that there was a strong relationship between effective supply chain management leadership with the risk management strategies at a correlation coefficient of (0.564) and the significance level of (0.001), that is less than 0.05,

which indicates effective supply chain management leadership with risk management strategies have large (strongly positive) correlation and it is statically significant at the 5% significant level.

In addition the result of the correlations indicated that there was a strong relationship between effective supply chain management leadership with the supply chain analytics, innovation, and knowledge sharing at a correlation coefficient of (0.756) and the significance level of (0.000), that is less than 0.05, which indicates effective supply chain management leadership with supply chain analytics, innovation, and knowledge sharing have large (strongly positive) correlation and it is statically significant at the 5% significant level .

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Performance of building projects and construction material supply chain can be affected by a number of factors. Proper cash flow control, material requirement planning, site work schedule identification and selecting supplier, late and incorrect payment to suppliers, unresolved quality problem and improper supplier selection cause low quality products to the client. It is necessary to study construction phase challenge factors and their impact on performance to achieve better performance of projects.

Therefore, this paper specifically concerned not only challenge factors and their impact severity on performance but also performance of construction material supply chain and building construction projects improving options on ECWC is undertaking the construction projects of 5000 houses around kaliti neighborhood of Addis Ababa. Thus, based on the results obtained the following conclusions were drawn.

- Accordingly, the top material construction supply chain performance deterring factors are stemmed from the planning, management and financial challenge clusters. Specifically, proper cash flow control, material requirements planning, ensuring quality of materials, site work schedule, identifying and selecting suppliers, skilled negotiation with suppliers, proper inspection & documentation of materials, proper storage practices, organizing& scheduling procurement, and cooperation between contractor & supplier are the key performance challenge factor to material supply chain management on the construction building sector.
- Also, the supplier and the contractor sides are the first and the second important factor making pace of progress to be stagnant respectively. Moreover, late and incorrect payment to suppliers to is the critical challenge factor as perceived by most respondents. Others like unresolved quality problem, access to latest information about types of materials on the market and late payment from client requested by supplier and

contractor and rigidity challenges are critical factors during performance of material supply chain management in the study area.

- In all, quality impact was identified as the major impact that influences building construction project performance. The ECWC has a responsibility to ensure a quality that the housing development gets just what he wants. This means that the ECWC should be able to locate the right caliber of skilled manpower with the highest desire for quality to be able to satisfy his employer. Housing development often times become disappointed in the quality of product delivered to them after making huge investments.
- Consistently, construction material supply chain and building sector of performance strategies improving mechanisms are proposed from the study results. Accordingly, developing best practices, reengineering processes, encouraging innovation and sharing knowledge through trainings can bring solutions and improve competitiveness are selected as the top important strategy to improve construction material supply chain process in building construction sector. The next important option is managing by understanding and measuring the entire end-to-end supply chain system as an option to improve performances. These options are tended to solve problems associated with variations from initially planned objectives according to most respondents' perceptions. Also, leading with vision, setting priorities, leading projects effectively, and ensuring their full implementation bring expected benefits and strategies improvement is important for improving performance problems.

As a conclusion a deep and detailed academic and practical (by corporation) research of the improvement process in construction supply chain proves to be necessary in order to orient research developments on this topic

5.2 Recommendation

- Payments to supplier by clients should be made on time for the supplier to meet his time performance since any delay in payment can be detrimental to progress. Where suppliers are to pre-finance projects before they are reimbursed, it will be advisable for suppliers to liaise early with their bankers for financial support to enable them meet their

contractual obligations. In addition to this, supplier must employ proper cash flow forecast and spend wisely.

- Contractors must pay proper attention to specifications in order to meet client's requirements, since the quality of material and workmanship greatly influence the final output. Contractors must also utilize the right equipment to achieve required quality.
- The equipment they employ should however be well maintained to avoid constant breakdown on site as that can also influence contractors' performance. Contractors must regularly upgrade themselves and their workers to achieve high standards during production. This can be achieved by attending training programs and organizing quality control meetings and training for workers.
- In addition to these, contractors must regularly assess their quality systems to identify quality lapses which can negatively affect quality. Clients make their choices base on quality and efficiency.
- Therefore, contractors must become innovative in their operations and seek for new knowledge to make them more efficient and competitive in the market. This can be achieved by learning from industry leaders, taking some courses from time to time and investing in research works.

5.3. Recommendations for future research

This study has scope limitations as it is considered only in ECWC undertaking the building construction of 5000 houses around kaliti neighborhood of Addis Ababa. Further study of ranking the survey responses by profession and by sector would result interesting findings. Study based on project size and duration would result interesting findings.

Moreover, it is recommended to study and evaluate other types of construction projects like roads, water and building construction projects which differs from the population used in this research. Finally, based on the findings of this study in addition research can be done in other study areas on: factors affecting construction material supply chain and its impact on building construction projects performance in order to generalize findings. Also, it is possible to study and confirm the performance strategies improvement mechanisms in order to validate the

findings of this research, through time, need to elaborate, filled the drawbacks with optimization and or simulation model analysis should be a future focus of research.

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7.APPENDICES

Adama Science and Technology University

School of Civil Engineering and Architecture

Department of Civil Engineering

MSc in Construction Engineering and Management (CEM)

Dear Respondents,

Reference: - Dissertation of MSc Construction Engineering & Management I am currently undertaking a Master of Science Degree in Construction Engineering & Management at Adama Science and Technology University. In fulfillment of this dissertation, I am required to research a topic area and produce a dissertation. The topic I have chosen is "**Investigating the Factors Affecting Construction Material Supply Chain and their Impact on Building Construction Projects Performance in Ethiopian Construction Works Corporation**" project sites in Addis Ababa. Through this questionnaire, I am investigating the following: -

1. The factor affecting the performance of CMSC in building construction sector.
2. The impact of construction material supply chain on the performance of building construction projects.
3. The strategies for improving construction material supply chain process in building construction sector

The information provided will be used only for the above-mentioned specific objectives, and will be treated with strict confidence and individual firms will not be identified. The results of the study will be provided to you for the benefit. The information that you provide will be kept confidential. The accuracy, honesty, and fairness of your response will have a great impact on the outcome of the research. If you do have any questions or concerns about the study, please do not hesitate to forward the addresses mentioned below.

With my best regards

Naol Beyene Daba

Cell phone: +251911871190/0911575239

Email: naolbyn@gmail.com

Adama, Ethiopia

Investigating the Factors Affecting Construction Material Supply Chain and their Impact on Building Construction Projects Performance; the case of Ethiopian Construction Works Corporation, Questionnaire.

Section one: - Company profile Please respond to the following questions by either ticking the appropriate box or by writing your answer in the space provided.

1.1 Company establishment year: ----------

1.2 Company specialized sector and classification

☐ building Contractor (BC), Grade ……..

☐ General Contractor (GC), Grade ……..

☐ Supplier

☐ Client

1.3 Sex: ☐ Male ☐ Female

1.4 Age: ☐ 18-20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ above 51 years

1.5 Your Position ----------

1.6 Average number of employees within the last five years----------

1.7 Number of executed projects within the last five years

☐ 10 and below ☐ 11-20 ☐ 21-30 ☐ 31-40 ☐ 41-50 ☐ More than 50

1.8 Your educational status?

☐ Diploma ☐ BSc Degree ☐ MSc Degree ☐ PhD

1.9 How long have you been working in construction sector?

General Working Experience …….

Specific Working Experience …….

Section Two: - Factors affecting the performance of construction material supply chain (CMSC) in building construction of ECWC.

2.1 Below are lists of the factor affect the performance of CMSC. From your experience, please express your opinion by on how much those factors affect SCM in Ethiopian Construction works corporation. With regard to operational performance of your firm, use the following Rating Scales under the columns and please, tick (√) only one box from the given box after reading the variable.

1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

No	Main factors affecting the performance of CMSC in BCS	Sub- factors affecting the performance of CMSC in BCS	**Rating Numbers**				
			Very low (1)	Low (2)	Average (3)	High (4)	Very high (5)
1	Planning	Material requirements planning					
		Organizing& scheduling procurement					
		Site work schedule					
2	Supplier	Identifying & selecting suppliers					
		Skilled negotiation with supplier					
		Cooperation between contractor & supplier					
		Sub-contracting					
3	Finance	Proper cash flow control					
		Non-delay of payments					
4	Staff	Skill & experience of material management team					
		Presence of shopkeeper & security personnel					
5	Transport	Planning delivery of materials to site					
		Site location & layout					

6	Storage & handling	Proper storage practices					
		Safety during handling materials					
		Storage space available					
		Control of material usage & wastage					
		Management of surplus material					
7	Management	Use of material management software					
		Proper inspection & documentation of materials					
		Ensuring quality of materials					
8	Environment	Severe weather conditions					

Section Three: Impact of construction material supply chain on performance of building construction projects.

3.1 Impact of construction material supply chain

Below are lists of the impact of construction material Supply chain on performance of building construction project. From your experience, please express your opinion by on how much those Impact of CMSC on the performance in ECWC. With regard to operational performance of your firm, use the following Rating Scales under the columns and please, tick (√) only one box from the given box after reading the variable.

1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

Impact of CMSC on performance of building projects		Very Low [1]	Low [2]	Average [3]	High [4]	Very High [5]
Client side						
1	Late payment from client requested by supplier and contractor					
2	Design change					
3	Designer‘s unfamiliarity with alternative products					
4	Difficult for substitute product					
5	Incorrect document					
6	Delays in passing of information to the contractor on types and sizes of products to be used					
Contractor side						
7	Late and incorrect payment to suppliers					
8	Incorrect price during bidding process					
9	Extended time wait for architects/consultant approval					
10	Inaccurate data from project site & information needed for site					
11	Good coordination between store and construction personnel to avoid over ordering					
12	Accurate and good specifications of materials to avoid wrong ordering					
Supplier side						
13	Deliveries not in conformance with planning					

14	Unresolved quality problem					
15	Access to latest information about types of materials on the market					
16	Lack of attention paid to standard sizes available on the market.					

3.2 The performance of building construction projects

Below are lists of the impact of construction material Supply chain on performance of building construction project. From your experience, please express your opinion by on how much those Impact of CMSC on the performance SCM in ECWC. With regard to operational performance of your firm, use the following Rating Scales under the columns and please, tick (√) only one box from the given box after reading the variable.

1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

	Impact of CMSC on performance of Building project.	**Rating Scale**				
		Very Low [1]	Low [2]	Average [3]	High [4]	Very High [5]
A	**Price/Cost**					
1	Incorrect price-based supplier selection affects our prices offer to the client during tendering process.					
2	Incorrect collaboration with supplier increases the production cost to run the operation					
3	Incorrect deal with the supplier affects our prices during construction					
B	**Quality:** an organization is capable of offering product quality and performance that creates higher value for customers.					
1	Difficult client relationship causes not to compete based on quality.					
2	Improper supplier selection cause low quality products to the client					
3	Improper supplier selection cause offering a low durable product to our client					
C	**Delivery dependability/time:** an organization is capable of providing on time the type and volume of product required by customer(s).					
1	Incorrect information sharing cause not to deliver the kind of products needed to the site					

2	Lack of information sharing cause not to deliver customer order on time					
3	Lack of good suppliers partnership cause difficult to provide dependable/faithful delivery					
4	Lack of good customer relationship are great affect in solving customer complaints					

Section Four: The questionnaires here in under mentions are considered strategies to improve for construction material supply Chain Process in ECWC on building construction sector. Please rate to what extent you agree on the following. Please indicate the extent of your agreement with each statement by ticking (√) a number from 1 to 5. The scale below will be applicable:

1 = Extremely Unimportant, 2 = Unimportant, 3 = Somewhat Important, 4 = Important, 5 = Extremely Important

Strategies for improving construction material supply chain process in building construction sector		**[1]**	**[2]**	**[3]**	**[4]**	**[5]**
Theme 1: Supply chain analytics, innovation, and knowledge sharing						
Strategy 1	Ensure visibility and evidence-based decision making, supply chain managers should enhance Supply chain analytics through technology and data mining.					
Strategy 2	Sensing operational environment will allow effective planning, demand forecasting and optimizing resources.					
Strategy 3	Developing best practices, reengineering processes, encouraging innovation and sharing knowledge through trainings can bring solutions and improve competitiveness.					
Theme 2: Effective supply chain management leadership						
Strategy 1	Effective leadership should foster culture of accountability, change management and integration through long-term partnerships, collaborations, and clear policies.					
Strategy 2	Leading with vision, setting priorities, leading projects effectively, and ensuring their full implementation bring expected benefits and improvement.					
Strategy 3	Managing by understanding and measuring the entire end-to-end supply chain system.					
Theme 3: Risk management strategies						
Strategy 1	Supply chain risk management mitigates disruptions and encounters resistance to change.					
Strategy 2	Agile strategies allow responding effectively to emergencies and uncertainties.					
Strategy 3	Strategies drive change towards sustainability and considering environmental impact.					

Investigating the factors affecting construction material supply chain and its impact on building construction projects performance: the case of Ethiopian construction works corporation

Last Question: I am interested in any other comment you might have concerned factors affecting construction material supply chain and its impact on building construction projects performance. Please use the space below for any of your comment using by favorite language.

_____

_____

_____

ONCE AGAIN, I THANK YOU A LOT!!!

APPENDIX B

List of interview questions

1. How can you explain the overall construction supply chain practices/process of the company?
2. What factor affecting construction material supply chain on building construction sector in causes of contractor, client and supplier?
3. How do you select the supplier – by quality or low price/cost?
4. What are the major impacts of construction material supply chain in building construction projects by considering time, cost, and quality?
5. What are the key supply chain strategies you developed and implemented to building construction efficiencies in the Ethiopian Construction Works corporation?
6. How did you implement the supply chain strategies performance in your sector?

Appendix 1A: RII results and rank of subfactor affecting the performance of CMSC in BCS								
S/No	Sub- factors affecting the performance of CMSC in BCS	Likert scale	wi	Frequency (fi)	fi*wi	$\sum_{i=1}^{68} fi * wi$	RII	Rank
1	Material Requirements Planning	Very Low	1	0	0	302	0.888	3
		Low	2	2	4			
		Average	3	0	0			
		High	4	32	128			
		Very High	5	34	170			
2	Organizing& Scheduling Procurement	Very Low	1	2	2	283	0.832	8
		Low	2	2	4			
		Average	3	4	12			
		High	4	35	140			
		Very High	5	25	125			
3	Site Work Schedule	Very Low	1	0	0	293	0.862	5
		Low	2	2	4			
		Average	3	7	21			
		High	4	27	108			
		Very High	5	32	160			
4	Identifying & Selecting Suppliers	Very Low	1	2	2	295	0.868	4
		Low	2	0	0			
		Average	3	4	12			
		High	4	29	116			
		Very High	5	33	165			
5	Skilled Negotiation with Supplier	Very Low	1	2	2	292	0.859	6
		Low	2	0	0			
		Average	3	0	0			
		High	4	40	160			
		Very High	5	26	130			
6	Cooperation between Contractor & Supplier	Very Low	1	0	0	282	0.829	9
		Low	2	2	4			
		Average	3	5	15			
		High	4	42	168			
		Very High	5	19	95			
7	Sub-Contracting	Very Low	1	0	0	256	0.753	21
		Low	2	4	8			

		Average	3	12	36			
		High	4	48	192			
		Very High	5	4	20			
8	Proper Cash Flow Control	Very Low	1	0	0	304	0.894	1
		Low	2	0	0			
		Average	3	6	18			
		High	4	24	96			
		Very High	5	38	190			
9	Non-Delay of Payments	Very Low	1	0	0	259	0.762	20
		Low	2	9	18			
		Average	3	21	63			
		High	4	12	48			
		Very High	5	26	130			
10	Skill & Experience of Material Management team	Very Low	1	0	0	265	0.779	14
		Low	2	6	12			
		Average	3	0	0			
		High	4	57	128			
		Very High	5	5	25			
11	Presence of Shopkeeper & Security Personnel	Very Low	1	0	0	260	0.765	19
		Low	2	2	4			
		Average	3	21	63			
		High	4	32	128			
		Very High	5	13	65			
12	Planning Delivery of Materials to Site	Very Low	1	0	0	278	0.818	11
		Low	2	0	0			
		Average	3	8	24			
		High	4	46	184			
		Very High	5	14	70			
13	Site Location & Layout	Very Low	1	0	0	242	0.712	22
		Low	2	6	12			
		Average	3	18	54			
		High	4	44	176			
		Very High	5	0	0			
14	Proper Storage Practices	Very Low	1	0	0	277	0.815	12
		Low	2	0	0			
		Average	3	12	36			
		High	4	39	156			

		Very High	5	17	85			
15	Safety during Handling Materials	Very Low	1	0	0	261	0.768	18
		Low	2	2	4			
		Average	3	16	48			
		High	4	41	164			
		Very High	5	9	45			
16	Storage Space Available	Very Low	1	0	0	264	0.776	15
		Low	2	2	4			
		Average	3	19	57			
		High	4	32	128			
		Very High	5	15	75			
17	Control of Material Usage & Wastage	Very Low	1	0	0	269	0.791	13
		Low	2	0	0			
		Average	3	13	39			
		High	4	45	180			
		Very High	5	10	150			
18	Management of Surplus Material	Very Low	1	0	0	263	0.774	16
		Low	2	2	4			
		Average	3	10	30			
		High	4	51	204			
		Very High	5	5	25			
19	Use of Material Management Software	Very Low	1	0	0	280	0.824	10
		Low	2	4	8			
		Average	3	4	12			
		High	4	40	160			
		Very High	5	20	100			
20	Proper Inspection & Documentation of Materials	Very Low	1	0	0	291	0.856	7
		Low	2	0	0			
		Average	3	11	33			
		High	4	27	108			
		Very High	5	30	150			
21	Ensuring Quality of Materials	Very Low	1	0	0	303	0.891	2
		Low	2	0	0			
		Average	3	2	6			
		High	4	33	132			

		Very High	5	33	165			
22	Severe Weather Conditions	Very Low	1	0	0	262	0.771	17
		Low	2	4	8			
		Average	3	15	45			
		High	4	36	144			
		Very High	5	13	65			

Appendix 1C: RII results and rank of sub factor affecting the performance of CMSC in BCS								
S/No	Sub- factors affecting the performance of CMSC in BCS	Likert scale	wi	Frequency (fi)	fi*wi	$\sum_{i=1}^{68} fi * wi$	RII	Rank
1	Late payment from client requested by supplier and contractor	Very Low	1	0	0	278	0.818	4
		Low	2	0	0			
		Average	3	18	54			
		High	4	26	104			
		Very High	5	24	120			
2	Design change	Very Low	1	0	0	258	0.759	9
		Low	2	2	4			
		Average	3	23	69			
		High	4	30	120			
		Very High	5	13	65			
3	Designer‘s unfamiliarity with alternative products	Very Low	1	2	2	233	0.685	15
		Low	2	8	16			
		Average	3	29	87			
		High	4	17	68			
		Very High	5	12	60			
4	Difficult for substitute product	Very Low	1	0	0	235	0.691	13
		Low	2	8	16			
		Average	3	24	72			
		High	4	33	132			
		Very High	5	3	15			
5	Incorrect document	Very Low	1	10	10	218	0.641	16
		Low	2	8	16			
		Average	3	21	63			
		High	4	16	64			
		Very High	5	13	65			
6	Delays in passing of information to the contractor on types and sizes of products to be used	Very Low	1	0	0	247	0.726	11
		Low	2	10	20			
		Average	3	17	51			
		High	4	29	116			
		Very High	5	12	60			
7	Late and incorrect payment to suppliers	Very Low	1	0	0	287	0.844	1
		Low	2	4	8			
		Average	3	8	24			

		High	4	25	100			
		Very High	5	31	155			
8	Incorrect price during bidding process	Very Low	1	0	0	268	0.788	6
		Low	2	12	24			
		Average	3	14	42			
		High	4	8	32			
		Very High	5	34	170			
9	Extended time wait for architects/consultant approval	Very Low	1	0	0	248	0.729	10
		Low	2	4	8			
		Average	3	22	66			
		High	4	36	144			
		Very High	5	6	30			
10	Inaccurate data from project site & information needed for site	Very Low	1	0	0	235	0.691	13
		Low	2	12	24			
		Average	3	21	63			
		High	4	27	108			
		Very High	5	8	40			
11	Good coordination between store and construction personnel to avoid over ordering	Very Low	1	4	4	241	0.709	12
		Low	2	4	8			
		Average	3	13	39			
		High	4	45	180			
		Very High	5	2	10			
12	Accurate and good specifications of materials to avoid wrong ordering	Very Low	1	2	2	262	0.771	7
		Low	2	9	18			
		Average	3	8	24			
		High	4	27	108			
		Very High	5	22	110			
13	Deliveries not in conformance with planning	Very Low	1	2	2	275	0.809	5
		Low	2	6	12			
		Average	3	8	24			
		High	4	23	92			
		Very High	5	29	145			
14	Unresolved quality problem	Very Low	1	0	0	284	0.835	2
		Low	2	4	8			
		Average	3	16	48			
		High	4	12	48			
		Very High	5	36	180			

15	Access to latest information about types of materials on the market	Very Low	1	2	2	279	0.821	3
		Low	2	0	0			
		Average	3	12	36			
		High	4	29	116			
		Very High	5	25	125			
16	Lack of attention paid to standard sizes available on the market	Very Low	1	0	0	260	0.765	8
		Low	2	10	20			
		Average	3	9	27			
		High	4	32	128			
		Very High	5	17	85			

Appendix 2A:RII results and rank of impact of material supply chain management on the performance of building construction projects.

S/No	Impact of MSCM on performance of Building project	Likert scale	wi	Frequency (fi)	fi*wi	$\sum_{i=1}^{68} fi * wi$	RII	Rank
1	incorrect price-based supplier selection affects our prices offer to the client during tendering process	Very Low	1	4	4	264	0.776	8
		Low	2	0	0			
		Average	3	9	27			
		High	4	42	108			
		Very High	5	13	65			
2	Incorrect collaboration with supplier increases the production cost to run the operation	Very Low	1	0	0	261	0.768	9
		Low	2	6	12			
		Average	3	17	51			
		High	4	27	108			
		Very High	5	18	90			
3	Incorrect deal with the supplier affects our prices during construction	Very Low	1	0	0	271	0.797	5
		Low	2	6	12			
		Average	3	13	39			
		High	4	45	100			
		Very High	5	24	120			
4	Difficult client relationship causes not to compete based on quality.	Very Low	1	2	2	276	0.812	4
		Low	2	8	16			
		Average	3	0	0			
		High	4	32	128			
		Very High	5	26	130			
5	Improper supplier selection cause low quality products to the client	Very Low	1	0	0	297	0.874	1
		Low	2	4	8			
		Average	3	9	27			
		High	4	13	52			

		Very High	5	42	210			
6	Improper supplier selection cause offering a low durable product to our client	Very Low	1	0	0	293	0.862	2
		Low	2	4	8			
		Average	3	13	39			
		High	4	9	36			
		Very High	5	42	210			
7	incorrect information sharing cause not to deliver the kind of products needed to the site	Very Low	1	0	0	254	0.747	10
		Low	2	8	16			
		Average	3	13	39			
		High	4	36	144			
		Very High	5	11	55			
8	Lack of information sharing cause not to deliver customer order on time	Very Low	1	0	0	270	0.794	6
		Low	2	8	16			
		Average	3	8	24			
		High	4	30	120			
		Very High	5	22	110			
9	Lack of good suppliers partnership cause difficult to provide dependable/faithful delivery	Very Low	1	0	0	279	0.821	3
		Low	2	4	8			
		Average	3	8	24			
		High	4	33	132			
		Very High	5	23	115			
10	Lack of good customer relationship are great affect in solving customer complaints	Very Low	1	0	0	268	0.788	7
		Low	2	8	16			
		Average	3	11	33			
		High	4	26	104			
		Very High	5	23	115			

Appendix 2A: RII results and rank of strategies for improving construction material supply chain process in building construction sector

S/No	Strategies for improving construction material supply chain process in building construction sector	Likert scale	wi	Frequency (fi)	fi*wi	$\sum_{i=1}^{68} fi * wi$	RII	Rank
1	Ensure visibility and evidence-based decision making, supply chain managers should enhance Supply chain analytics through technology and data mining	Extremely unimportant	1	0	0	289	0.850	4
		unimportant	2	2	4			
		Somewhat important	3	5	15			
		important	4	35	140			
		Extremely important	5	26	130			
2	Sensing operational environment will allow effective planning, demand forecasting and optimizing resources.	Extremely unimportant	1	0	0	274	0.806	8
		unimportant	2	0	0			
		Somewhat important	3	12	36			
		important	4	42	168			
		Extremely important	5	14	70			
3	Developing best practices, reengineering processes, encouraging innovation and sharing knowledge through trainings can bring solutions and improve competitiveness.	Extremely unimportant	1	0	0	298	0.877	1
		unimportant	2	0	0			
		Somewhat important	3	9	27			
		important	4	24	96			
		Extremely important	5	35	175			

4	Effective leadership should foster culture of accountability, change management and integration through long-term partnerships, collaborations, and clear policies.	Extremely unimportant	1	0	0	287	0.844	5
		unimportant	2	0	0			
		Somewhat important	3	9	27			
		important	4	35	140			
		Extremely important	5	24	120			
5	Leading with vision, setting priorities, leading projects effectively, and ensuring their full implementation bring expected benefits and improvement.	Extremely unimportant	1	0	0	292	0.859	3
		unimportant	2	0	0			
		Somewhat important	3	8	24			
		important	4	32	128			
		Extremely important	5	28	140			
6	Managing by understanding and measuring the entire end-to-end supply chain system.	Extremely unimportant	1	0	0	298	0.876	2
		unimportant	2	0	0			
		Somewhat important	3	7	21			
		important	4	28	112			
		Extremely important	5	33	165			
7	Supply chain risk management mitigates disruptions and encounters resistance to change.	Extremely unimportant	1	0	0	268	0.788	9
		unimportant	2	6	12			
		Somewhat important	3	11	33			
		important	4	32	128			
		Extremely important	5	19	95			
8	Agile strategies allow responding effectively to	Extremely unimportant	1	0	0	279	0.821	7
		unimportant	2	0	0			
		Somewhat important	3	18	54			

	emergencies and uncertainties.	important	4	25	100			
		Extremely important	5	25	125			
9	Strategies drive change towards sustainability and considering environmental impact.	Extremely unimportant	1	0	0	286	0.841	6
		unimportant	2	0	0			
		Somewhat important	3	9	27			
		important	4	36	144			
		Extremely important	5	23	115			