Supply chain risk assessment in the construction industry: The case of Adama town

By
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A Thesis Submitted to Graduate Program in Logistics and Supply Chain Management

Presented in partial fulfillment of the requirements for the Degree of Masters of Art in Logistics and Supply Chain Management

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June 2020

DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted at any university for a degree.

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ACKNOWLEDGEMENTS

Above all, let all praise go to the almighty God for His unparalleled support given for me so that I perform efficiently and effectively during carrying out this thesis work and giving me internal courage and strength to accomplish.

I would like to take this opportunity to express my specia thanks to my advisor, Dr. Tariku Jebena, for his support, guidance and valuable comments throughout the development of this study and supported me at every step to compete the thesis.

I also express my gratitude for my internal examiner Assistant Professor Teklegiorgis Assefa for his critical feedbacks on the proposal of this study.

I am also indebted to the management teams and all the respondents of the construction companies in Adama town, with whom I interacted during my research, for their willingness to participate in the study and for their exceptional support and coordination throughout the data collection process.

Special thanks go to the project and logistic managers of the companies whose many fruitful discussions helped me understand my research area better.

Finally I would also like to express my heartfelt gratitude to my family and friends for their valuable support and encouragement throughout the course of the study period.

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ACRONYMS AND ABBREVIATIONS

CSCM ....Construction Supply ChainManagement

CSC… .... Construction SupplyChain

CSCM… ....Construction Supply ChainManagement

CSCRM… .... Construction Supply Chain RiskManagement

ERP… ....Enterprise ResourcePlanning

ETA.. Event TreeAnalysis

FMEA… ....Failure Mode EffectAnalysis

FTA… .... Fault treeanalysis

FMEA… ....Failure Mode and EffectAnalysis

GC… .... GeneralContractor

IT… .... InformationTechnology

ICT… ....Information and CommunicationTechnologies

ISO… ....International StandardOrganization

LCC.. Low costcountry

PMI… ....Project ManagementInstitute

PIM… ....Probability and ImpactMatrix

PMBOK ....Project management body ofknowledge

RBS .... Risk breakdownstructure

RM… ....RiskManagement

SC... SupplyChain

SCRM. ....Supply chain riskmanagement

SCM. ....Supply ChainManagement

SPSS.. Statistical Product and ServiceSolutions

SCRMP… ....Supply Chain Risk ManagementProcess

SWOT… ....Strengths, Weaknesses, Opportunities, andThreats

WBS… .... Work BreakdownStructure

ABSTRACT

The supply chain (SC) plays a key role in the construction industry.There are many risk factors that influence the progress of a supply chain, and it is problematic when the probabilities and impacts of these risk factors are not well defined. In order to reduce the impact of supply chain risk factors that may affect the progress of any construction project, it is important to predict their influence inadvance.

The objective of this study is to analyze construction supply chain management risks and their management process: The Case of Adama construction companies based on identifying and analyzing the risks that are affecting the supply chain of construction industry and the mitigation strategies employed. The study employed descriptive research. Simple random and non-probability sampling designs were employed based on the nature of the target population. Consequently, the study selected a sample of 30 individuals from a population of 280 and the data was analyzed using descriptive statistics.

The study starts by identifying typical risk issues related to a construction supply chain and making a detailed study on the risk factors assessment and management associated with the supply chain of construction projects taking a case study of construction companies in Adama. The study offers stakeholders involved in a construction project with a better understanding of risks in the supply chain of the construction sector so that they can take timely corrective actions and offset the negative impact of risk which can be useful for supply chain planning and operation.

The study identified that supply chain risks factors like price fluctuation of construction materials, financing issue, delay in production, tight project schedule, delay in material deliveries were identified as the major ones and the most common Supply chain risk management practicesintheconstructionindustrylikelongtermcollaborativerelationshippractices, increasing knowledge about risk and risk analysis practice, back up supplier arrangement practices, supply chain contingency planning practices discussed.

Key words*: Supply chain risk, Supply chain risk management process*

CHAPTER ONE

INTRODUCTION

1.1 Background

As an introduction of the study, this chapter presents: background of the study to shed some light on theoretical and empirical backgrounds in relation to supply chain risks in the construction industry and their management practices, statement of the problem, objectives of the study, research questions, scope of the study, significance of the study, limitation and organization of thestudy.

The concept of SCM has originated in the manufacturing industry with the objective to increase both efficiency and effectiveness, to achieve organizational goals, and lead to greater synergy (Harland, 1996).Since it was introduced, SCM assumed the characteristics of an evolutionary concept, increasingly enriched by innovative tools and techniques. This cumulative process concerns the totality of transactions flow among participants in order to maximize total chain profitability (Ha and Krishnan, 2008), as stated by a primary theoretical pillar, which asserts the necessity to add value faster than cost to the process (Lamming, 1996) when introducing a new business practice.

The need for significant improvements in the project performance and in profits gradually emerged also in construction (O'Brien and Fischer, 1993; Bankvall et al.,2010) suggesting to change methods in managing the supply chain (Agapiou et al.,1998). However, SCM initiatives have not made the breakthrough in construction industry yet, as the attempts to replicate the benefits obtained by supply chains in other industries still testify a lack of effectiveness and a partial and slow implementation(Akintoye et al., 2000; Love et al., 2004; Lonngren et al., 2010).

Practitioners have in fact realized partial/fragmented application, focusing on different areas/objectives depending on specific circumstances: sometimes they focused on the supply chain, other times on the construction site, others again on both of them (Vrijhoef andKoskela, 2000).

SCM application has particularly found obstacles in construction sector as a consequence of its particular context of “temporary multiple organization” (Cheng et al.,2010) and because of the difficulties in managing networks of a large number of different companies, supplying materials, components and multiple services (Briscoe et al., 2001;Dainty et al., 2007), and with adversarial relationships (Saad et al., 2002).O’Brien (1999) states that the existing manufacturing research in SCM, although useful, cannot be directly applied to a construction environment, because of the transient nature of production in constructionprojects.

Although effective SCM is a key element in reducing construction costs (Davis, 2008; Atkin et al., 1995), Crespin-Mazet and Ghauri (2007)noted that very few studies have defined what SCM means within the construction process. For this reason, first of all, I decided to choose to give a definition about construction SCM.

CSC is not a real chain but a network of multiple organizations and relationships, which includes the flow of information, materials, services or products, and funds between client, designer, contractor and supplier (Xue et al., 2007).

Construction is a multi-organization process, which involves client/owner, designer, contractor, supplier, consultant, and so on. It is also a multi-stage process, which includes conceptual activities, design, construction, maintenance, replacement, and decommission. First Crowley and Karim (1995) and later Xue et al. (2007) proposed an alternative SCM networked structure, to substitute the traditional vertical alone, in order to support partnering. This proposal seems to better fit the peculiarities of construction SC and align with the context of our discussion. Construction industry is characterized by its own distinctive features, which can heavily affect SCMapplication.

Construction is a typical project production industry operating within an environment of considerable complexity and uncertainty(Fearne and Fowler, 2006).

Construction organizations tend to be conservative referring to the need to change, because of the risks associated (Cheng et al., 2001; Love et al., 2002; Kumaraswamy et al., 2005).These peculiarities make SCM impact crucial and make SCM adoption more challenging and risky.

Because of the above characteristics, the construction supply network is very complex as well as dynamic so that risks highly increase. Managers need to identify and manage these risks in order to manage the supply network effectively and efficiently (i.e. with its limited resources). With this aim in mind, RM principles are of valuable help in order to apply the SCM approach in the constructionindustry**.**

According to Briscoe and Dainty (2005) and O'Brian et al. (2009), supply chain management is important to improve the performance of construction projects. SCM has proved to be an essential management strategy when managing projects that involve a large number of participating companies, supply components, and materials (Dainty et al., 2007). Therefore, an effective SCM is a key element for reducing costs and delays in construction projects

From the end of the 1980s the construction industry has seen the launch of a number of supply chain management (SCM) initiatives (Vrijhoef and Koskela, 2000; Akintoyeand Main, 2007; Eriksson, 2010) in order to improve internal and external efficiency, reducing waste and adding value across the entire supply chain and trying to remove their adversarial inter-organizational purchaser-supplier relationships and fragmented business processes (Saad et al., 2002; Gadde and Dubois, 2010). Because of its complexity, its supply chains are very complex too, and involve different risks and uncertainties that can lead to major problems for projects (Childerhouse&Towill, 2004).

Scholars widely recognized the importance of SCM contribution to improve company performance at different levels (strategic, tactical and operational) so shifting the focus from the internal structure to the external inter-organizational processes and relations, and so enhancing strong feedback linkages and collective learning. However, up to now, SCM implementation in the construction industry has been scattered and partial (Gadde and Dubois, 2010).SCM must be properly formulated, strategically planned, organized and executed. Thus, the adopting organizations (mainly the general contractor and its subcontractors)have to deal with managerial, organizational, relational and technological issues which must be appropriately managed in order to effectively apply SCM principles, models and techniques and to overcome the barriers to construction SC application(Palanees waran et al.,2003).

1.2 ProblemStatement

A global supply chain network that involves different firms, according to Chopra and Mendil(2007), is exposed to a variety of supply chain related risks or disruptions such as Supply delays, demand fluctuations, price fluctuations, and exchange-rate fluctuations, non delivery etc.

So, enhancing supply chain operations in such a way that supply chain risks are effectively mitigated is becoming an emerging high priority issue for today‘s supply chain managers. Being exposed to a variety of supply chain risks, however, many companies are reluctant or in a weak position to effectively practice proactive and reactive supply chain risk management approaches in a systematic and pragmatic manner.

For instance, based on a multiple case studies conducted on 7 different industries, Christopher et al (2011) found out that most companies did not have a structured management and mitigation practices covering supply chain risks. Similarly, Munyuko (2015) also indicated that despite the huge impact supply chain disruptions have on organization bottom line profits, many organizations still don‘t have a continuous supply chain risk management program where they systematically practice supply chain risk identification and mitigation activities.

The construction industry is a relevant segment of a country and world-wide economy and at the same time a complex and often underperforming sector. It is characterized with high fragmentation, low productivity, cost and time overruns, and conflicts. Very often project schedule slips, budget overruns, quality is compromised, so that claims and counterclaims problems have plagued the industry (Yeo and Ning, 2006)

As construction industries are one of the firms affected by the supply chain disruptions, it faces different supply chain risks which could have immense adverse effect on timeliness, cost and scope of projects having vital importance to the growth of the country.

Analyzing supply chain risks and investigating ways of mitigating them will contribute to the effectiveness of construction companies and ultimately significant effect on the economy of the country.

There is a crucial need to dynamically update construction supply chain risks as the construction industry is a complex industry that involves different stakeholders and includes many key activities.

With this aim, risk analysis and management appears as a valuable approach in order to prioritize the most problematic issues in complex and risky project and select adequate response actions (Finch, 2004; Khan and Burnes, 2007; IBM Global BusinessServices,2008).

The risks for each phase Construction supply chain life cycle need to be identified and quantitatively assessed, and the risk level evaluated frequently to dynamically adjust the supply chain process.

The problem is that most studies in the area of construction supply chains have been qualitative (Davis, 2008; Karim et al.,2006; Green et al., 2005), and therefore, there is a need to dynamically quantify the risk factors in order to manage supply chains effectively and efficiently.

In this work, supply chain risks with respect to construction industry are identified, analyzed and ways of managing and mitigation of 'Supply chain Risk' in a construction industry are proposed.

1.3 ResearchObjectives

1.3.1 Generalobjective

The purpose of this thesis is identifying, effectively assessing and analyzing, demonstrating ways of mitigating and managing supply chain risks in the construction industry taking a case of construction companies in Adamacity.

1.3.2 Specificobjective

The specific objective focuses on finding how supply chain risks are analyzed and be effectively managed in the construction industry.

We can classify the objective into two sub-categories

- Identifying and analysis of Supply Chain Risk in constructionindustries.

- Effective Management / Response of Supply Chain Risk in construction industries.

Thus the specific objectives can also be described with followingpoints.

- To understand construction supply chain management in the construction industry.
- To Identify ,analyze and prioritize the main risk factors negatively affecting SCM implementation in the construction industry.
- To recognize most fundamental risks and threats which are related to supply chain managementsystems
- To prioritize all identified risks by using qualitativemethods.
- To explore commonly employed methods of risk response planning and risk management practices in the mentioned industry.

The theory of the risk management process is compared to the actual practice in order to investigate similarities and differences. In other words, the main idea is to see if the construction industry is working with risk management as it is described in the literature regarding the methods and techniquespresented.

1.4 Researchquestions

To fulfill the objectives, the following research questions have been developed (formulated) to acquire these objectives:

- What are the major supply chain risks, which have high negative impact on the construction projects and ways of analysis?
- What are the major supply chain management practices and ways of evaluation ?
- What kind of mitigation and risk management strategies should be used for managing risk in construction supplychains?

1.5 Significance of thestudy

This study is important in that it attempts to enrich the theory of supply chain risk management and how such practices are important in enhancing the performance of supply chains in the construction industry and generates the need for more attention for supply chain risks and better ways of practicing supply chain risk management. This thesis provides information on practices and experience of construction supply chain risk management

Regarding academic and scientific benefits, this thesis extends the implementation of supply chain risk assessment and management approach into the industry particularly construction field by defining the main elements that need to be considered in managing its supply chain, providing the unique characteristics of construction industry, which makes the supply chain management more multifaceted and exploring the supply chain management practices towards sustainable performance.

The study lets construction project managers to focus more on the management of significant and most frequently occurring supply chain risks and effort to develop strategy.

The study also enables to understand its major gaps concerning its existing supply chain risk management practices and will come up with supply chain risk management practices which will ultimately construction industries to respond to the inevitable supply chain risks with minimal damage.

Overall, this thesis could be a future reference for theoretical and empirical studies and will help construction managers by providing the practical guideline to help construction companies in managing their supply chain risk towards effective and efficient management performs as building a better understanding on industry supply chain risk management practices towards better performance.

1.6 Scope of thestudy

The research focuses on the construction industry and is based on theories of risk analysis and management described in the literature. The scope of the study is circumscribed to assessing supply chain related risks affecting the construction industry and also the research focused on only those companies in Adama town.

Besides, the research does not deal with positive risks/opportunities/ or those risks managers deliberately face to gain more. Here, only the negative side of it is considered. Hence risk is equated with disruptions affecting supply chain operations and performance.

1.7 Limitation of thestudy

Some of the respondents in the respective firms refused to provide information in the questionnaires they were distributed with. This was because of confidentiality issue and fear of spread of information to their competitors. Hence it was tried to persuade them to provide such information by providing letter from Addis Ababa University to make identification as a student and showing student identity card. However, in other circumstances, some employees and customers had completely neglected to answer the questionnaire distributed to them which reduced the sample size. And some firms failed to submit their questionnaire on time which created inconvenience.

1.8 Organization of thestudy

This thesis includes six chapters. The first chapter is introduction which includes background, statement of the problem, objectives, research questions,significance,scope,limitation and organization.. In the second chapter, the theoretical overview (named as the literature review) and the past research on supply chain management and its application in construction industry will be explained. It includes a broad review of the previous research studies on supply chain management, construction industry, construction supply chain management and the application of risk management in construction supply chainmanagement.

In the third chapter, methodology will be explained and proper method to analyze supply chain risks and organizational performances of supply chain risk management will be discussed. The chosen methods employed in four sections of risk identification, data collection, risk analysis and response will be presented..

In the fourth chapter, all identified risk will be prioritized and categorized according to their risk score, which results from questionnaire survey. In this regard, tables and figures will be proposed in order to summarize data. It presents the questionnaire survey and checklists results from each respondent’s perspective along with the analysis performed on the raw collected data to fulfill this study’s purposes.

Results and discussions of the data analysis will be discussed and compared to the theoretical framework in chapter five. It consists of results and discussions obtained from checklists and questionnaire surveys.

Moreover, important notes found by questionnaire and interview will be discussed in details.

The most suitable approaches to mitigate and monitor significant risks will finally be presented with regard to research survey.

Summary of outcomes, recommendations drawn up in the conclusion of this study along with some recommendations for future studies have been brought in chapter 6.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Overview of supply chainmanagement

The topic's importance is due to several industry trends currently in place: increase in strategic outsourcing by firms, globalizations of markets, increasing reliance on suppliers for specialized capabilities and innovation, reliance on supply networks for competitive advantage, and emergence of information technologies that make it possible to control and coordinate extended supply chains. Several works have already been proposed in the past to improve project effectiveness/efficiency of SCM adoption. Starting from an extensive literature analysis, we classified the main SCM research areas in order to identify risk factors related to SCM adoption in construction. The aim of this paper is to analyze the factors which affect SCM implementation according to a perspective in the construction industry. This first results can support the development of an operative framework for risk factors identification and analysis which could help managers in the construction SCM (CSCM) implementation.

The SCM offers general guidelines that can be used to analyze, reengineer, properly coordinate, and constantly improve virtually the complete construction supply chain, resolving basic problems and the myopic control that have been plaguing the supply chain. This would be practically impossible to realize in the short term.

Some areas of application, which may be, and to a certain extent have been subjected to SCM, include the reduction of costs (especially logistical costs), lead-time and inventory in the supply chain. In view of the large share of these costs in construction, this focus is often fully appropriate. Secondly, the focus may be on the impact of the supply chain onsite activities. Here, the goal is to reduce site costs and duration. In this case, the primary consideration is to ensure material (and labor) flows to the site for the sake of avoiding disturbances in the workflow. Thirdly, the focus may be on transferring activities from the site to upstream stages of the supply chain. The rationale may simply be to avoid the inferior conditions of site, or to achieve wider concurrency between activities, which is not possible in site construction with its many technical dependencies. Here, the goal is again to reduce the total costs and duration.

The generic body of knowledge accrued in the framework of SCM leads to improved understanding of the characteristics of construction supply chain problems, and gives direction for action. However, the practical roles for SCM have to be developed in construction practice itself, taking into account the characteristics of construction and thespecific situation. Cooperation between research and practice may be instrumental in thisendeavor, as argued by Wegelius and Pahkala (1998)

2.1 Supply Chain management in ConstructionIndustry

Construction industry is a huge sector nowadays which deals with various stages from design and renovation to manufacture and production of construction materials. This sector is a dynamic process, usually offering high incomes for the contractors and workers, and therefore is indeed attractive. However, the seasonal and irregular nature of it often affects the yearly income of workers,significantly.

It is accepted that construction industry which is indeed competitive and risky, is a combination of science and art. That is to say, understanding the technical aspects of construction is not the key point to gain success and it is vital for construction professionals to be aware and knowledgeable of business and management aspects of this job as well. On the other hand, day-by-day technological progression and worldwide competitions in this sector cause the acceleration of development in construction management techniques, supply chain management, and risk management methods.

Consequently, increasing demand to employ new innovative expert professionals in construction management field will be an increasing trend in the coming years (Nunnally, 2004).

The application of SCM in the construction industry was the result of its accomplishment in other industrial areas (Akintoye et al., 2000; Briscoe et al., 2001;Saad et al., 2002) and began from the end of the 1980s (Vrijhoef and Koskela, 2000).Supply chains were currently been faced with the problem of unmatched ideas. This resulted in waste and different issues in steps of the supply chain, which led to an alternate step. The most significant failure at the beginning of supply chain management could be recognized as myopiccontrol.

In the framework of the construction industry, SCM might be viewed as the procedure of strategic management of data stream, methods and activities, including different systems of associations and linkages which their name are “upstream” and “downstream”, all around a project life cycle. As far as the prior, the “upstream “tasks inside construction SCM, in connection to the position of a head contractor, including construction customers and design groups, comprises of the tasks and activities resulting in procurement for manufacture on site. The “downstream “includes tasks and activities in the transfer of the construction product including construction suppliers, subcontractors, and proficient contractors linked with the head contractor. In the construction business, especially on a bigger project, which includes an important number of independent supplying organizations, the unpredictability of the system can frequently be critical (Briscoe et al., 2001).Jones and Saad (2003) stated that SCM has a keyrole.in construction in order to correct whole performances, but stayed behind at the beginning of development. One of the crucial changes that the construction industry ought to cope with in its development into SCM organizations is cognition of the suitable grade of experts in a number of fields. Adding the standards of perfect production to construction should shift the key role of design from the relevant consultant to the most suitable supplier, subcontractor or team of both. Some researchers concentrated on supply chain network. For example, Harland (1996) claimed that supply chain management is the arrangement of a network of organizations that are included in the business process.In the construction area, this network can regularly be greatly complicated, especially on large projects where the amount of independent supplying associations will run into hundreds, if not thousands. Figure 2.1 illustrates only the key members of a common construction supply chain network, with the head contractor at the center of chart. There are some links to the customer, supply agencies and expert services. The current interest is concerned on the supply relationshipbetween material suppliers, head contractor and the production subcontractors

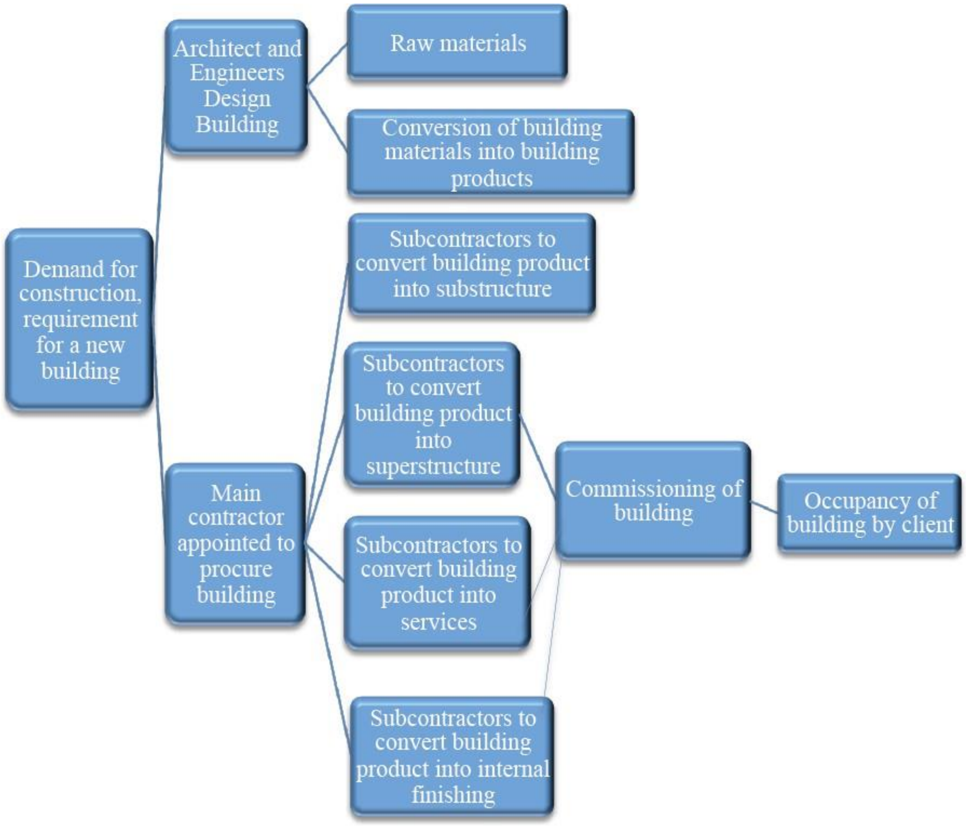

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Fig 2.1 A common construction supply chain network (Shove, 1999)

It is distinguished that supply chain combination can collect many profits for businesses. In the construction industry, more contractors have a tendency to depend on the resource of suppliers and subcontractors; in the construction supply chain, it is vital for contractors to make collaborative connections with different partners. The construction supply chain identified with the information of designing, logistics, administration science and different parts of learning, needs connection among suppliers, managers, architects, contractors, subcontractors and differentmembers.

With this regard, this makes the management in construction supply chain getting to be more complex. Different with other areas, the construction industry is moderately beginner in its methodology to the supply chain. As Egan (1998) stated, construction industry can acquire experiences from other industries. He also said that "Construction businesses are beginning to realize that their success is increasingly dependent on the organizations they supply to and buy from, and that for continued success, they need to cooperate and collaborate across customer/supplier interfaces”.Many authors and researchers emphasized that adding value and minimizing cost are significant targets in SCM. Saad et al. (2001) mentioned that adopting the methodology of SCM to construction sector needs a huge attempt. It requires developing combination in design, manufacture process and functions to connect the process in a chain paying more attention to increasing opportunities to add value and reduce cost. As this method needs an important change attitude of participants towards cooperation, mutual profits and teamwork are very important.

The next parts report the supply chain risk management from different explanations and view of supply chain, explained with several specialists. Diverse periods are characterized based on observations in each stage. Hence, particular stages are introduced in following part. Consequently, one method is picked for supply chain risk assessment.

2.2 Supply chainrisk

For this research, the term risk will be used to indicate an event with potential negative consequences, whereas the term uncertainty will be used to refer to situations where both positive and negative consequences are considered.

These trends have manifested themselves in an increase in outsourcing and off-shoring of manufacturing and R&D activities, low cost country (LCC) sourcing, and collaboration with international supplier partners. While these increase the strategic options for firms, they also increase the probability of experiencing adverse events in supply chains that significantly threaten normal business operations of firms in the supplychains.

2.3 Categorization of Supply ChainRisks

Risks in the supply chain can be categorized into internal risks and external risks. Internal risks are those that are controllable—to some extent—by supply chain members.

According to Mieghem (2011, pp. 19,20), potential internal risks can be categorized on the basis of the stages in the value chain where the negative impact may take place. Based on this view, identified risks can be categorized into the following seven categories.

The external risk is about social, environmental, political and economic uncertainties. External risks can be categorized into natural, political, regulatory, competitive and strategic risks. Natural risk refers to acts of God, such as earthquakes, fires, storms, and lightningstrikes.The internal risk is basically about internal conflict in supply chain. It is totally related to the uncertainties that affect quality, schedule and cost in the projects from main contractor to suppliers and subcontractors. The risk knowledge in the construction supply chain decreased mistakes gradually along main contractors, project managers, subcontractors and suppliers.

- **Innovation risk:** This refers to the potential negative impact that originates during the research and development phase. In the pharmaceutical industry, a new drug may not meet the efficacy, potency, or safety standards necessary, so as to be approved by the relevant governmental authority.
- **Supply Risk:** Supply risk relates to potential or actual disturbances to the flow of product or information emanating within the network, upstream of the focal company. Therefore, it is risk associated with a company's suppliers, or supplier's suppliers being unable to deliver the materials the company needs to effectively meet its production requirements/demand forecasts.
- **Demand Risk:** Demand risk relates to potential or actual disturbances to flow of product, information, and cash, emanating from within the network, between the focal companyand the market. This demand risk can be a failure on either the high or low side to accurately accommodate the level of demand.

- **Process Risk:** Processes are the sequences of value-adding and managerial activities undertaken by the company. Process risk relates to disruptions to these processes. It affects a firm’s internal ability to produce and supply goods/services, which results from the consequences of a breakdown in a core operating, manufacturing or processing capability.
- **Control Risk:** Controls are the assumptions, rules, systems and procedures that govern how an organization exerts control over the processes. In terms of the supply chain they may be order quantities, batch sizes, safety stock policies etc. Control risk is therefore the risk arising from the application or misapplication of these rules. Itincludes.
- **Environmental Risk:** Environmental risk is the risk associated with external and, from the company's perspective; Uncontrollable events. It consists of any uncertainties arising from the supply chain and environmental interactions. These may be the result of accidents, manmade or natural disasters.
- **Production risk:** Production risk stems from internal processes, such as machine failure or capacityshortage.
- **Distribution risks:** Distribution risk may occur as a result of logistics service provider failure, such as delays and damage to products duringtransportation.

2.4 Supply chain Risks in constructionprojects

Due to the nature of the construction sector, RM is a very important process here. It is most widely used in those projects which include high level of uncertainty.

There are a number of risks which can be identified in the construction industry and which can be faced in each construction project regardless of its size and scope. Among which supply chain risk is taken as one of the prominent. Because of complex nature of construction industry, its supply chains are very complex too, and involve different risks and uncertainties that can lead to major problems for projects (Childerhouse &Towill,2004)

2.5 Supply chain RiskManagement

SCRM is viewed as "the management of supply chain risk through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity". It is a process of measuring or assessing risk and then developing strategies to manage the risk. Risk management is the process of measuring or assessing risk and then developing strategies to manage the risk. Risk management is the broad activity of planning and decision making designed to deal with the occurrence of hazards or risks. Risks include both unlikely but high impact disruption risks, as well as more common volatility in demand, internal processing, and supply.

This study has focused on Ethiopian construction projects as a case. Ethiopia is a developing country and many construction projects face variety of threats such as technical, management, organizational, financial and environmental. Risk Management process constituted of two main elements; Supply chain Risk Analysis and Supply chain Risk Control, henceforth referred to risk analysis and risk control respectively. The term risk assessment is also interchangeably used in referring to risk analysis. The first process covers the identification, estimation and evaluation of risk. Proper implementation of all stages in this process will result in the recognition of potential risk events affecting supply chain.

A framework for Supply Chain Risk Management is shown in the figure below.

If a plan to mitigate or prevent a risk has been implemented, monitoring can check to see if the corresponding metrics show no signs of the risk occurring

• Obtaining various sources of risk which impacts on Supply chainoperations.

• Obtaining an effective method for managing Supply chainrisk.

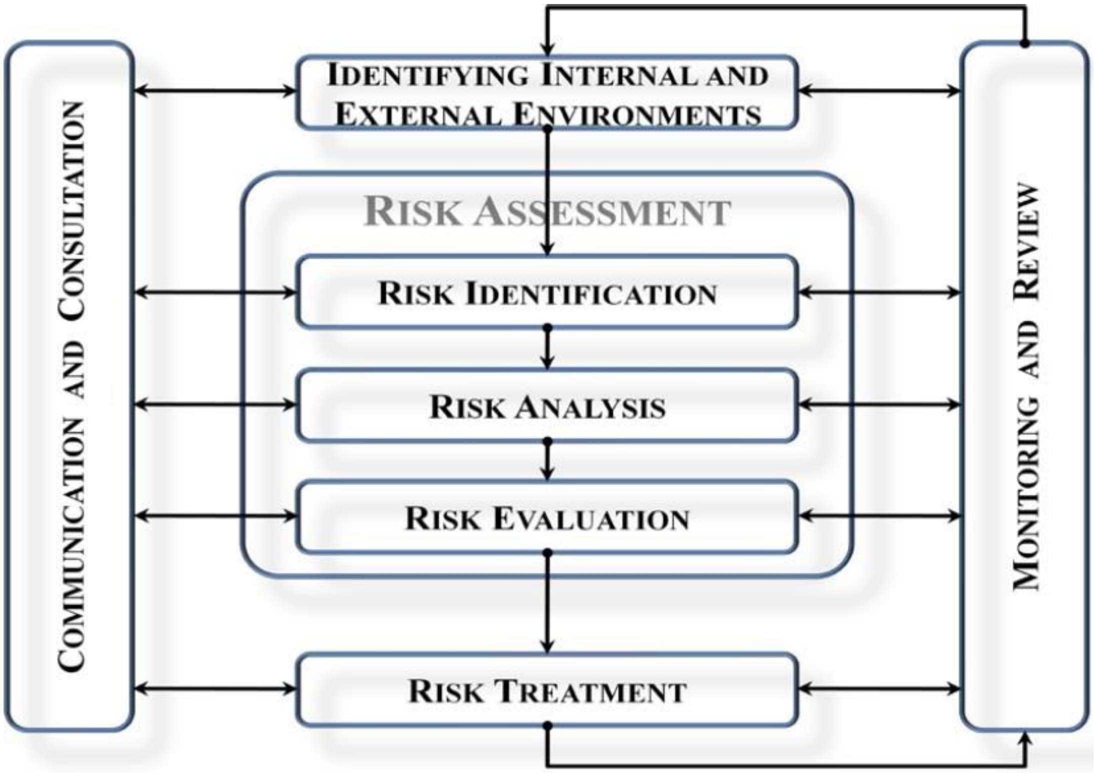

Fig 2.2: Risk Management process (Dia Bandaly 2012)

• To develop a Flow chart for Supply chain riskmanagement.

• To develop a framework strategy for Supplychain

A typical RM process goes through the following steps:

(1) Context analysis aims to define the boundaries of the RM processes in order to supportthe definition of the correct risk model approach.

(2) Risk assesement/Analysis includes Identification, Estimation and Evaluation ofrisks

Risk identification – determines potential threats (risk factors) and their impact (effects) on the project performance. A classification of projects risks according to PMBOK (2013) categorizes them based on the employed methods:

- Risk sources (by means of Risk Breakdown Structure(RBS))
- Affected area of the project (by means of Work Breakdown Structure(WBS))
- Other beneficial categories (e.g. projectphase)

When RBS is employed, the risks are categorized and their dependencies are shown and when WBS is employed, large activities are broken down into small controllable items, and connected ranked series of independent activities are created (Dallas, 2006; Maylor, et al., 2005).

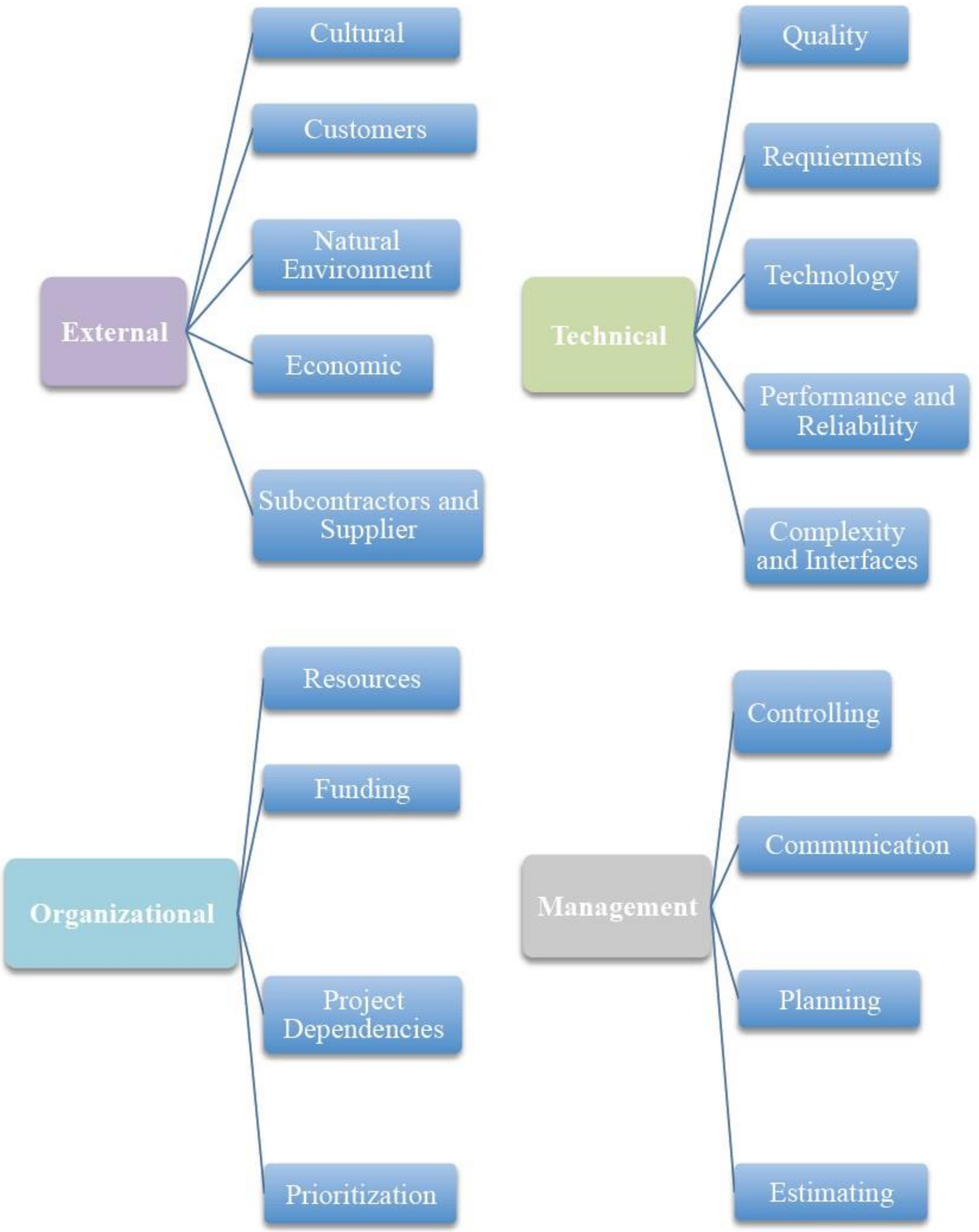

Figure 2.3: Sample of risk breakdown structure (Rajabi,2011)

Risk quantification – which aims to prioritize risk factors. It includes risk analysis which provides inputs to the risk evaluation phases(the occurrence probability of the risk factors, the links or weights to potential effects, the severity of these effects and the detection difficulty if needed).

Risk evaluation – which defines risk classes and synthesizes the risk level for each risk factor. Enterprises may use their ratings of the likelihood and consequence of risks before and after treatment to evaluate residual risk levels against acceptable risk levels, that is, their risk tolerance. If the likelihood and consequence of residual risks is found to be greater than their risk tolerance, then enterprises need to devise further risk treatments to reduce the level of residual risk. Acceptable risk levels will be unique to each organization and supply chain. They may vary by commodity, product, or service, as well as over time. Different risk-tolerance levels may be set for different levels of the organization. While generally tied to financial impact, through which risks may best be understood and compared, risks may also be tied to other corporate assets such as reputation. One leading firm even considers the consequence of potential risks by impact to stock price. One way an organization may wish to assess its risk tolerance is through a risk "frontier" graph, plotting the likelihood of events by their consequence (Figure 4.4). Enterprises may find some risks to be of such low likelihood or to have such limited consequence that they do not warrant any further treatment or consideration. Those of greater likelihood or consequence enterprises may wish to reduce through various buffering (e.g., use of multiple suppliers or safety stocks) or other mechanisms of risk avoidance or elimination. Such mechanisms may seek to reduce the likelihood, duration, or consequence of a riskevent.

Risk treatment/response concerns the selection of an effective strategy to manage the risks related to the different risk classes identified. RM strategies consist of four classic approaches: risk reduction, risk response, risk externalization and acceptance. This step of the RMP indicates what action should be taken towards the identified risks and threats. Winch (2002) claims that the lower impact the risk has, the better it can be managed.

Avoidance/prevention

If the risk is classified as bringing negative consequences to the whole project, it is of importance to review the project's aim. In other words, if the risk has significant impact on the project, the best solution is to avoid it by changing the scope of the project or, worst scenario, cancel it. There are many potential risks that a project can be exposed to, and which can impact its success (Potts, 2008). This is why risk management is required in the early stages of a project instead of dealing with the damage after the occurrence of the risk (PMI,2004).

The avoidance means that by looking at alternatives in the project, many risks can be eliminated. If major changes are required in the project in order to avoid risks, Darnall and Preston (2010) suggest applying known and well developed strategies instead of new ones, even if the new ones may appear to be more cost efficient. In this way, the risks can be avoided and work can proceed smoothly because strategy is less stressful to the users.

Cooper *et al*. (2005) list some activities that can help to avoid potential risk:

- More detailedplanning
- Alternativeapproaches
- Protection and safetysystems
- Operationreviews
- Regular inspections
- Training and skillsenhancement
- Permits towork
- Proceduralchanges
- Preventivemaintenance

Reduction/mitigation

By having an overview over the whole project it is easy to identify problems which are causing damage. In order to reduce the level of risk, the exposed areas should be changed (Potts, 2008). This is a way of minimizing the potential risks by mitigating their likelihood (Thomas, 2009). One way to reduce risks in a project is to add expenditures that can provide benefits in the long term. Some projects invest in guarantees or hire experts to manage high-risk activities. Those experts may find solutions that the project team has not considered (Darnall and Preston, 2010). Mitigation strategies can, according to Cooper *et al.* (2005), include:

- Contingency planning

- Qualityassurance
- Separation or relocation of activities andresources
- Contract terms andconditions
- Crisis management and disaster recoveryplans

Those risks which should be reduced can also be shared with parties that have more appropriate resources and knowledge about the consequences (Thomas, 2009). Sharing can also be an alternative, by cooperating with other parties. In this way, one project team can take advantage of another"s resources and experience. It is a way to share responsibilities concerning risks in the project (Darnall and Preston, 2010).

Transfer

If a risk can be managed by another actor who has a greater capability or capacity, the best option is to transfer it. Potts (2008) states that the risk should be transferred to those who know how to manage it. The actors that the risks can be transferred to are, for example, the client, contractor, subcontractor, designer etc, depending on the risk"s character. As a result this could lead to higher costs and additional work, usually called risk premium (Potts, 2008). It must be recognized that the risk is not eliminated, it is only transferred to the party that is best able to manage it (PMI, 2004). Shifting risks and the negative impacts they bring is also an option when the risks are outside the project management's control, for example political issues or labor strikes (Darnall and Preston, 2010). The situation may also consist of catastrophes that are rare and unpredictable in a certain environment. (Winch, 2002) Such risks that are beyond the management's control should be transferred through insurancepolicies.

Retention

In this case the risk must be controlled, in order to minimize the impact of its occurrence (Potts, 2008). Retention can also be an option when other solutions are uneconomical (Thomas,2009).

Table 2.1: Risk response framework (BIS research paper no145)

Risk Type	Suitable Response	Assigned to	Detail
Very High	Avoid	Executive	Hire highly strict strategies-Change plan-Immediate protection
High	Mitigate	Upper Management	Hire highly strict strategies to decrease the probability of incidence and impact-Review by manager at the beginning of project
Medium	Transfer	Upper Management	No need to change plan-Move impact of a risk to another organizations-Review by manager
Low	Transfer-Accept	Middle Management	No need to change-Continue in monitoring-In some cases move to third party
Very Low	Accept	Intermediate	Continue with current monitoring

Risks with high scores (red colored in the matrix) are those that will be transferred to the risk response stage, to be decided about, which has also been followed in this research. Moderate risks (yellow colored) require monitoring and control or/ and urgent management responsiveness. Finally, low risks (green colored) are those that should be accepted and documented for future investigations (PMI,2008).

Risk control. Principal issues in this phaseare:

- **Risk Monitoring:** Each step of RM process is a convenient milestone for reporting, reviewing and actiontaking.

PMI (2004) also states that the assumptions for monitoring and controlling are to supervise the status of the risks and take corrective actions ifneeded.

Tools and techniques used to risk monitor and control may be (PMI, 2004):

- Risk reassessment – identification of new potential risks. This is a constantly repeated process throughout the wholeproject.

- Monitoring of the overall project status – are there any changes in the project that can effect and cause new possiblerisks?
- Status meetings – discussions with risk owner, share experience and helping managing the risks.
- Risk registerupdates

By managing the whole RMP, the process can be evaluated. This is a method of creating a risk register where all risks and their management can be allocated in order to facilitate future projects (PMI, 2004). This is also a way to improve the project work, since the advantages and disadvantages will be broughtup.

- **Communication and consulting** – aims to effectively communicate hazard to the project managers and the people involved into theproject

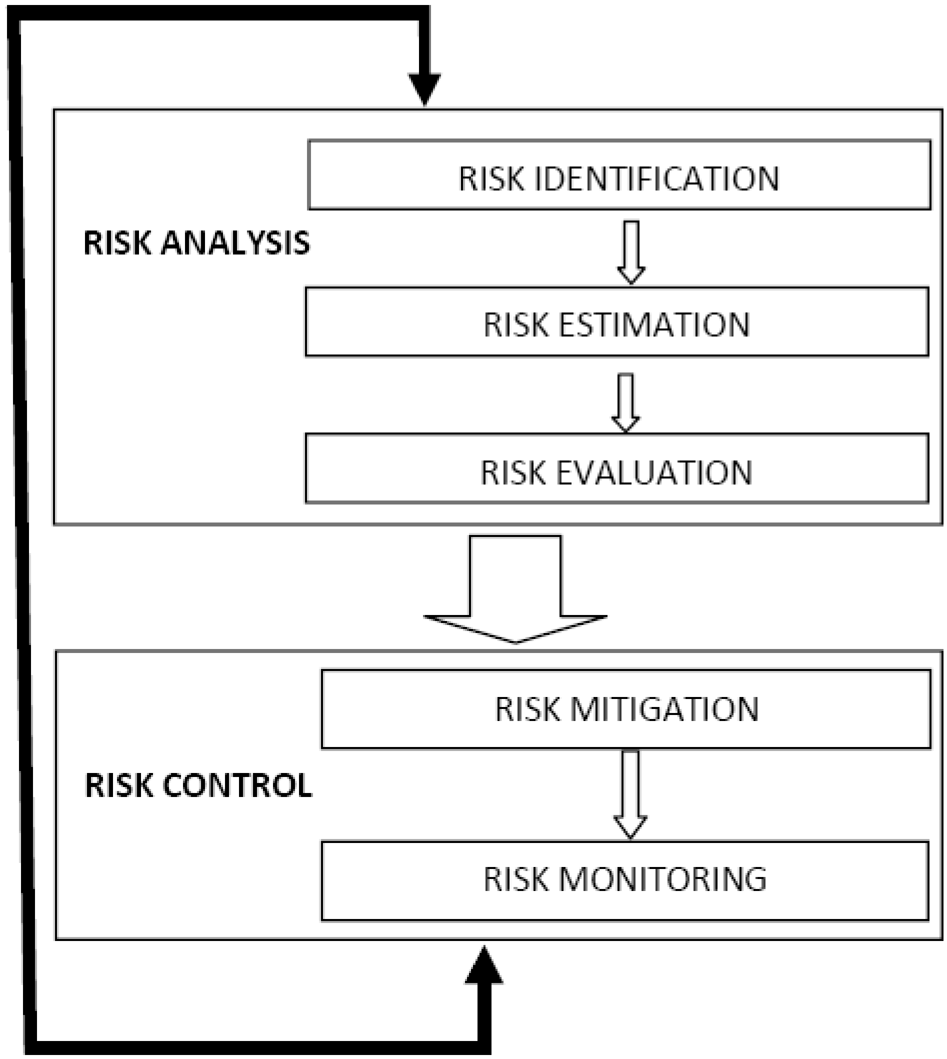

Fig 2.4: Flow chart for Supply Chain Risk Management (Olsson Fredrick,200)

Risk assessment is typically made up of two measures: Likelihood and Impact. Likelihood– measures the probability that the event will occur. The exact probability may be difficult to determine unless there is historical data that can be used to find the frequency of the event occurring. Alternatively an organization can use a subjective likelihood, or degree of belief, based on the opinions of experts. A time horizon is necessary to define the probability ina useful way (e.g., the likelihood that an event will occur in the next year or 50 years).Impact – measures the consequences on the organization if the event occurs. It can be measured directly, for example in terms of birr. It can also be measured on a scale, for example from zero to one with zero being very little negative consequence and one being a very bad consequence. Methods for measuring impact include "what-if" simulations, financial models, and opinions of teams of experts. A summary risk score can be calculated for each risk by multiplying the Impact times the Probability to get an expected value of the risk. Then risks can be ranked by risk score. Also the risks can be shown on a map or graph. An example is shownbelow.

Table 2.2: Scoring framework (National patient safety agency, 2008; Health service executive, 2009)

Probability Level	Probability Score	Detail
Very Low	1	Incident not supposed to happen
Low	2	Incident more probable than not to happen
Moderate	3	Incident can or can not happen
High	4	Incident more probable than medium level
Very High	5	Incident supposed to happen

In Table 2.3, scoring impact on critical project components are described based on PMBOK (2013), which defines relationship between numbers and major project areas. The specific qualities like very low to very high are related to each condition in different areas such as cost, time, scope and quality.

Table 2.3: Described impact score on project components (PMBOK,2013)

Impact Level	Impact Score	Detail (Impact on Cost/Time/Quality)
Very low	1	Insignificant cost and time increase/Quality degradation barely noticeable
Low	2	< 10% cost increase/< 5% time increase/Only very demanding applications are affected
Moderate	3	10-20% cost increase/5-10% time increase/Quality reduction requires to sponsor approval
High	4	20-40% cost increase/10-20% time increase/Quality reduction unacceptable to sponsor
Very high	5	> 40% cost increase/>20 % time increase/Project end item is effectively useless

Probability and impact scores are two main keys of this method. Probability and impact matrix determines which risks need detailed risk response plans. Basically, the matrix used is a 3*3 matrix, which is low, medium and high or 5*5 matrix, which is very low, low, medium, high and very high ranking. Table 2.4 shows a sample of5*5 matrix.

According to PMBOK (2013), six stages have been designated to perform a qualitative analysis correctly: risks possibility and impact evaluation, probability and impact matrix, risk data quality evaluation, risk classification and risk urgency evaluation. Each of these stages are explained briefly in the following sections.

Risk Probability and Impact Assessment

In this stage, the identified risks‟ occurrence likelihood, along with the risks potential impacts on the objectives of projects are evaluated. The objectives are such as cost, schedule, performance and quality of project, and the investigated impacts on them are including both positive opportunities and negative threats (Cooper et al., 2005). Raking the risks are done based on the impacts and probability of occurrence. Two types of ranking are employed in this stage:

Ordinal scales that describe the risks in terms of very low, low, moderate, high, very high.
Cardinal scales that allocate numbers to probability and impact of risks (i.e. 1, 2, 3, 4, and 5).
The scales should also be defined and accepted in risk management plans. In brief, it is explained that by means of checklists, questionnaires and interviews, each identified risk can be evaluated, and then level of its impact and probability can be determined (Tabanfar,2014).
According to PMBOK (2013), each risk must be prioritized in terms of risk probability and risk impact within specific project. The application of matrix assiststhe project stakeholders to analyze the risks and then prioritize them based on theirimpact on project. This method calculates risk score for each risk by multiplying therisk probability and risk impact (Westland, 2006); besides, all risks can be prioritizedbased on risk score. Then, the risks can be assigned different colors on map or graph.Each color shows the severity of risk on project. Table 2.5 illustrates risk score for identified risk with differentcolors.

Probability and Impact Matrix

Probability and impact matrix is designated to prioritize the risks. Prioritization of risks are done based on their rates (PMBOK, 2013). In the matrix, the rating and color are assigned to show the importance of each risk (Westland, 2007). The matrix‟s elements that are the risks scores as shown in equation 2.1 are multiplication of values of risks occurrence probability and its impacts.

$$Total\ risk = Risk\ Probability\ x\ Impact\ of\ risk$$

Table 2.4: A sample of probability and impact matrix (5*5 matrix)

		Threats				
Probability	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
		Impact				

- **Red**: Indicating the high risks, having high impacts on objectives and high occurrence probability.
- **Yellow condition**: Indicating the risks that are comparatively high in impact and probability.
- **Green condition**: Green label indicates the risks with low impact or low occurrence probability.

2.7 Supply chain risk management practices in the constructionindustry

We can judge whether a construction company had been practicing supply chain risk management practices with following parameters:

- **Long Term collaborative relationshippractices**

According to Chopra and Meindl (2007), building long term collaborative relationship enable supply chain members be more responsive to its internal and external customers as firms can collaborate with their suppliers in terms of information sharing, joint quality improvement programs, joint forecasting that will avoid demand and supply siderisks.

- **Increasing knowledge about risk and risk analysispractices**

According to Musa (2012), proactive risk mitigation is possible when companies identify most significant supply chain risks and categorize and document them in terms of their likely occurrence, their risk impact level and mitigation strategies etc. According to Hopp et al (2012), many firms learn the value of reducing risks only after they have suffered through a disruption. But, when possible, learning from the experience of others is much more efficient. Studying previously occurred supply chain risk incidents is one way firms can increase their knowledge of risks and mitigation strategies. Forming consortiums and sharing information with suppliers, customers, and each other, is another way to improve its staff knowledge and culture of supply chain risk management.

- **Redundant stock/extra inventory arrangementpractices**

Maintaining additional stock, according to Hugos(2003), is an effective supply chain risk management practice in reducing demand and supply side risks since stocks give slack to the supply chain. The buffer stock arrangement is however, advised for items that have a low holding cost, long lead times, single-sourced and stocks that are not prone to being outdate as pointed to by(Wilson,2007).

- **Supply chain contingency planningpractices**

One of the major supply chain risk management practice is developing and using supply chain contingency plan especially to reduce/mitigate the negative impact if supply chain risks be occurring and materializing. It is developed before the supply chain risk occurs but its implementation is when supply chain risks actually materialized. Supply chain contingency plans are very important especially in limiting if not avoiding the negative impact of supply chain risks when they actually occur. Therefore, it implies for managers to work more on contingency plans in their effort to mitigate supply chain risks.

- **Practices of transferring Supply chain risks throughInsurance**

The last but not the least practice of managing supply chain risk is transferring supply chain risks through insurance. Obviously, insurance doesn‘t avoid supply chain risks but enable companies to quickly recover from risky incidents.

Accordingly to Samuel 2017, the following factors also have significant impact

- **Supplier capacity assessment and qualification screeningpractices**
- **Back up supplier arrangementpractices**
- **Challenges of practicing supply chain riskmanagement**

Accordingly to Samuel 2017, managers face challenges with regard to the specific supply chain risk management practices discussed above: The practice of building long term relationship with suppliers, practicing knowledge improvement and sharing about risks and conducting risk analysis, keeping redundant inventory practice, the practice of supplier capacity assessment and screening, practice of developing and using contingency plans and the practice of using insurance companies

2.6 Review of related Empirical studies

The following is an attempt to summarize the main findings of some selected studies:

(Jüttner, 2005; Khanand Burnes, 2007; Wagner and Bode, 2008; Seshadri and Subrahmanyam, 2005), Tang (2006, pp. 453) proposed that SCRM is: "the management of supply chain risks through coordination or collaboration among the supply chain partners so as to ensure profitability and continuity." Whereas Christopher (2002) states that SCRM utilizes a coordinated approach among members of the SC to manage external risks so as to minimize the vulnerability of the wholeSC.

Most existing studies on SCRM are generic and focus on research areas such as: international business and operations management (Wu et al., 2006) vis-à-vis construction

Carr (2001), who employed a knowledge engineering approach to present a qualitative risk analysis framework using object modeling for managing SC risks in construction projects Wagner and Bode (2008) examined the supply chain performance along the several dimensions of supply chain related risks. They analyzed supply chain risks and their sources affecting supply chain members/firms. Based on the literature and interviews with practitioners, they compiled and empirically validated constructs for different classes of supply chain risks affecting organizations. Besides, they examined the relevance of various supply chain risk sources for strategic decision-making based on the relationship between supply chain risks and supply chain performance. They particularly founded that demand side and supply side risks have strong impact on supply chain performance as compared to the impact other supply chain risks bring. Even though the article lays the ground for supply chain managers to understand supply chain risks so that they base their strategy on identified supply chain risks, the actual practices what supply chain members should follow to mitigate supply chain risks were not discussed on the article.

Mohammed Nima (2014) also investigated Supply Chain Risk Management Implementation in Canadian Construction Industry and discussed supply chain management is nowadays well known for being an innovative method, providing new solutions to the problems, specifically in construction industry and is even more crucial, as the risks are associated with supply chain implementation, which affects the success or failure of the projects. Admittedly, implementation of supply chain risk management, even in a developed country like Canada, demands progress and a day-by-day more extensive structure.

The following points are some of the recommendations stated in the literature for future studies in thefield:

- To increase the accuracy of risk assessment, factor of time can be added to the evaluations. In otherwords,thefactorsoftimetocause(TTC)andtimetoimpact(TTI),aretwoimportant factors which are determining the speed at which a scenario leads to the primary cause and the primary impact respectively. Considering the time factor as the risk velocity, along with impacts and probability, can develop risk management in a three-dimensional form and further improve itsprocess.

- To improve the construction supply chains‟ efficiency and effectiveness, organizations which are dealing with procuring and delivering construction products can adopt BIM technology.

Darko (2016) identified Potential Critical Risks in the Construction Supply Chain – An Empirical Study in Ghana there was no statistical difference between the perceptions of the stakeholders on the ranking of the risk factors. Using the research presented, readers are able to identify potential risks in the construction SC for risk management activities and implement suitable risk mitigation.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Research approach andmethod

A research process consists of a number of sequential steps. It begins with finding the research area and formulating research questions. Further, the investigation method should be chosen along with research design and data collection techniques. Finally, the collected data is analyzed and interpreted what leads to drawing conclusions. (Bryman and Bell, 2003)

The research method is a technique for collecting data which can involve specific instruments such as self-completion questionnaires or structured interview.

As this thesis work aims to investigate supply chain risk and its management in Ethiopian construction sector (The case of construction companies in Adama town). The risk management process aims to identify and assess risks in order to enable the risks to be understood clearly and managed effectively.

The process can be mainly classified into three broad categories:

- Risk Identification.
- RiskAnalysis
- Risk Control andMitigation.

Risk Breakdown Structure (RBS) method will be applied to identify risks on this research because it surveys critical categories to find all risks that may occur in the project. This model categorizes project risks into four main groups:

1) Organizational
2) Technical
3) External
4) Management

3.2 ResearchDesign

To determine how supply chain risk management used in construction industries of Ethiopia construction companies of Adama town were used as a case study.

For the purpose of this master thesis a mixed type(qualitative and quantitative) research method has been chosen. According to Morgan and Smircich (1980) the choice of the method should be made based on the nature of the research problem. Qualitative methods are based on the facts which are socially constructed rather than objectively and are based on peoples‛‛ experience (Noor, 2008). Qualitative research is an inductive approach where theories are generated out of collected data (Bryman and Bell, 2003). Thus this method is most appropriate for this thesis since it uses people's experience and collecteddata.

A case was chosen for study as a research design. Case study is one form of research design (Bryman and Bell, 2003) and is not intended as a study of the entire organization. Its purpose is to focus on a particular issue, feature or unit of analysis (Noor, 2008) and consists of direct observation of the study (Yin,2009).

The case study in this thesis is a construction companies of Adama town.

Further to collect data, in this research, questionnaire survey was designed and written based on the knowledge of construction companies in Adama. The questionnaires were filled out by people who had responsibilities on supply chain process. Also semi- structured interviews were chosen in order to obtain most accurate answers based on the interviewees' opinion and experience to facilitate further analysis. In the semi-structured form, the interviewer prepares a number of questions that are in the general form of an interview schedule. It is standardized in order to minimize differences between interviews within one company. Moreover, the sequence of questions may vary and the follow up questions can be asked in response to some significant replies (Brymann and Bell,2003).

For the stage of risk identification and analysis, investigation of research papers published by various international journals was done to make a risk break down structure (RBS). Following risk identification and hierarchal classification using RBS, then risks were classified in accordance with four main categories namely: organizational, technical, external and management. Hence, after classifications the risks, prioritizing of risks a plan to control them will be made make. Selected method for this research is Probability and Impact Matrix, which is a method for the project group to support in prioritizingrisks.

Table 3.1: Ranges of probability

Probability Level	Probability Score	Detail
Rare	1	(1-20)% Risk event not expected to happen-Every 5 years
Unlikely	2	(21-40)% Risk event may happen every 2-5 years
Moderate	3	(41-60)% Risk event may happen every 1-2 years
Likely	4	(61-80)% Risk event may happen monthly
Very Likely	5	(81-100)% Risk event expected to happen

Table 3.2: Ranges of impact

Impact Level	Impact Score	Detail (Impact rate- Economic- Health and safety)
Trivial	1	Very low impact-Insignificant cost increase-No injury
Minor	2	Low impact- (5,000-15,000)$ cost increase-Emergency care
Moderate	3	Medium impact- (15,000-75,000)$ cost increase- Moderate injury
Major	4	High impact- (75,000-225,000)$ cost increase-Serious injury or death
Extreme	5	Very high- (More than 225,000)% cost increase- (High death frequently)

The analysis will be done with probability and impact matrix to perform qualitative risk assessment and prioritization. Probability and impact method prioritizes identified risks based on calculated risk scores. From the equation .i.e. $Risk\ score = Probaility x\ Impact$

3.3 Conceptual Framework

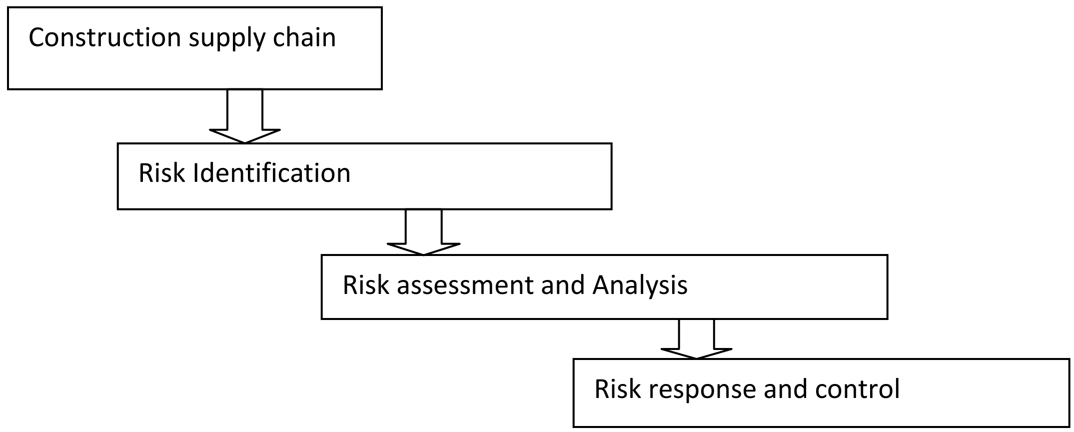

Fig 3.1 Conceptual framework (Self prepared)

3.4 Targetpopulation

The questionnaires were distributed among the target population(respondents) consists peoples who are employees (general managers, project managers, logistic managers, procurement officers, quality managers and engineers) of the 5 Grade one construction companies found in Adama city (KIDANE G.C,SEID G.C,ANWAR G.C,FE G.C, GGC G.C) (according to adama city municipality). Selection of grade one construction companies in adama town was done based on the presumption that these companies will have a researchable formal supply chain activities. As we know purposive sampling helps to focus on particular characteristics of a population that are of interest, which will best enable to answer the research questions. It is a form of non-probability sampling in which we rely on their own judgment when choosing members of the population to participate our study to access a particular subset of people, as all participants of a study are selected because they fit a particular profile. The choice of the population will be greatly influenced by the available data and the size of the population. For this research sample members are selected on the basis of their special relationship with the issue under investigation, sufficient and relevant work experience in the field, knowledge, and expertise regarding a research subject

3.5 Samplingtechnique

Sampling is related with the selection of a subset of individuals from within a population to estimate the characteristics of whole population. The two main advantages of sampling are the faster data collection and lower cost (Kish, 1965 and Robert, 2004). Each observation measures one or more properties of observable subjects distinguished as independent individuals. In business research, medical research, agriculture research, sampling is widely used for gathering information about a population.

The main reason that the researcher has decided to use purposive sampling was by assuming as they have better know-how and direct contact with the real SCRM of the construction. The sample is calculated separately by the approach used to be determining the number of respondent samples in this study is a simplified formula provided by (Kothari, 2004). Zikmund and Babin (2010) determining the sample proportion success and not success based on the experience from previous survey research response rate. Saunders, Lewis and Thornhill (2012) state that the likely response rate shall be reasonable 50% or moderately high, while Patrick (2003) referring Babie (1979), the return or success rate 50% is ‘adequate’; 60% response rate is ‘good’ and 70% rate or higher is ‘very good’. Having this experience, for this research purpose confidence of successfully collect or return rate is expected to be 70% because the respondents are currently doing their jobs in the construction company, and sample size is determined at 95% confidence level.

Census sampling method was used among all the five grade one construction companies in Adama city. According to the information found from the municipality there are five grade one contractors.

Determine the size of the sample size for the number of respondents in the five grade one construction companies (Kothari, 2004):

$$n = \frac{z^2.p.q.N}{e^2(N-1) + z^2.p.q}$$

Where:

z = z score level of confidence of the estimate (in the case of 95% = 1.96);

e = marginal error, 5%

P = proportion of the sample successfully collected (p=0.7)

q = failure of sample (1-0.7= 0.3)

N = population of the sample (280)

- Using the above formula,the sample size was found to be 30

3.6 Data Sources andTypes

The two most used data types are primary and secondary data. The primary data is the original information collected by the researcher for a specific purpose and secondary data is information collected by others. For research design and research method mentioned above, the primary and secondary data sources have used. The primary data includes questionnaires and interviews; on the other hand, secondary data sources have taken from literatures data found in books, journals and documents that have employed to generate data.

For the theoretical background, a literature study has been conducted, using both scientific articles written by professionals in the field as well as books in the area of supply chain risk management.

3.7 Data CollectionProcedures

The primary data for this study were collected by using questionnaires, structured and open ended questions.

3.7.1 Questionnaires

To accomplish the data collections, questionnaire (the primary technique for collecting the primary quantitative data which involve, age, education level, year of experience and position) was adopted from similar research paper after critically commented and reviewed in consultation with advisor, containing items measured on the 5-point Likert type and open -ended questions.

3.7.2 Interviews

In order to collect the relevant information for this study, structured interview is also used as the interviewees are few and at management level. The interview questions were first formulated. This is to focus on relevant issues and not address confidential information and free them from personal issues.

And accordingly three people were approached for interview and was conducted with people who had an active role in the supply chain from the respective offices. The interviews were held in amharic in order to obtain as much information as possible and avoid misinterpretation that could occur had the interview been held inEnglish.

3.8 Reliability and ValidityTests

3.8.1 Reliability

According to (Mugenda, 2003) reliability is a measure of the degree to which a research instrument yields consistent results or data after repeated trials. Reliability refers to the extent to which your data collection techniques or analysis procedures will yield consistent findings (Saunders et al., 2007). (Dunn, 2001) also defines reliability, as a measure's stability or consistency across time.

This study used Chronbach's alpha to assess the internal consistency of variables in the research instrument. Chronbach's alpha is a coefficient of reliability used to measure the internal consistency of the scale. Cronbac's Alpha (α); it is the most common measure of scale reliability (Field, 2006) .According to Zikmund (2010), scale with coefficient alpha between o.6 and 0.7indicate fair reliability so for this study a Chronbach's alpha score of 0.70 or higher is consider adequate to determine reliability. The Alpha value ranges from a minimum of zero to a maximum of 1.0 for a perfect score, a good measure of the alpha should be 0.70 or higher (Neuman, 2007). According to (George & Mallery, 2003) scales exhibiting a coefficient of alpha greater than 0.90 is considered to have excellent reliability, between 0.80 and 0.90 are considered to have good reliability, between 0.70 and 0.80 are considered to have acceptable reliability, alpha value between 0.60 and 0.70 indicates the reliability is questionable, when the coefficient alpha is between 0.50 and 0.60, the scale has poor reliability and the coefficient alpha is lessthan 0.50 it is unacceptable.

To ensure reliability of the instrument, a pilot study was carried out. The instrument was pretested through a pilot study before the actual data collection to enhancereliability.

The importance of pre-testing a questionnaire according to (Creswel, 1999) is to help the researcher understand the meaning of the questions to be responded and how they arrive at their response.

The researcher measured the reliability of the data using Cronbach's Alpha and that the Cronbach‟s Alpha value for final survey and was found to be between 0.8 and 0.9 according to (George & Mallery, 2003), which is good reliability. Therefore, all variables and questionnaire were acceptable for further analysis

3.8.2 **Validity -** Validity is the extent to which difference found with measuring instrument reflecting true differences among those being tested. In order to ensure the quality of the research design content and construct validity of the research will be checked. Construct validity establishing correct operational measures for the concepts being studied (John,2007).

According to (Adams et al., 2007) internal validity used to assure the research validity. To treat the internal validity of this research, a questionnaire was distributed within the same period and collected within two weeks and reasonable sample was taken from the population and questionnaire randomly and purposively distributed to participants. The major objective of the pilot test was to get feedback on the questionnaire way of preparation, wording, coherence and any other valuable comment and to incorporate any important comments and finalize the questionnaire.

3.9 EthicalConsideration

As Saunders et.al (2007) mentioned, research ethics deals with how the researcher treat those who participate in the study and how to handle the data after collection. Thus the researcher has tried to keep the privacy of the respondents by introducing clearly about the purpose of the research as it is for academic purpose only and by avoiding personal questions to protect the identity of individuals from being known by readers and also the information gathered has kept confidential. The research will respect the following ethical principles: No harm is done to participants; sufficient informed consent will be provided; Privacy will be respected; Integrity is fundamental. Records will be kept confidential and anonymity will be guaranteed during and after this paper iscompiled.

3.10 Dataanalysis

According to Kombo and Tromp, (2011), the data analysis procedure includes the process of packaging the collected information putting in order and structuring its main components in a way that the findings can be communicated easily and effectively. After the fieldwork done before analysis, all the questionnaires adequately checked for reliability and verification, editing, cleaning, coding and tabulation were carried out. The results obtained were analyzed and interpreted by using descriptive statistics included use of frequencies, means and percentile. The data presented in the form of tables, frequency, mean and percentages with description. The collected data is analyzed& interpreted in relation to the theoretical propositions. As a result, average risk scores and percentage of each risk iscalculated.

All results are calculated by SPSS Statistics software, which stands for Statistical Package for the Social Sciences. This software is a widely utilized program for statistical analysis in social sciences. SPSS is basically designed for analyzing statistical data, and as a result, it offers a great range of charts, methods and graphs. SPSS also provides more techniques of cleaning or screening the data in planning for further assessment.

SPSS is designed to make certain that the output is kept separate from information itself.

As a matter of fact, it saves all results in a separatefile, which is different from the data.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Introduction

This chapter presents the main parts of this study by interpreting; presenting and analyzing the collected data collected and discusses the findings. According to the research objectives, statement of the research problem and research questions, the presentation, analysis and detailed interpretation of the data was made.

The surveys employed use of questionnaire and an interview in collecting data on supply chain risks in the construction industry

The questions contained in the questionnaire and interview was based on review of the literature reported in chapter two.

Among the 30 questionnaires distributed to 5 companies (KIDANE G.C,SEID G.C,ANWAR G.C,FE G.C, GGC G.C) available and which accepted to set a time to fill out questionnaire. 16 respondents filled out questionnaire and answer some questions in detail. In order to figure out the respondents' knowledge about concept of supply chain risk management, as mentioned earlier some interviews were alsoperformed.

4.2 Responserate

Out of 30 questionnaires distributed only 22 of them are returned back from the respondents. The returned questionnaire was large enough to draw analysis. Actually, not all responses analyzed, one response were found incomplete and rejected from analysis.

Table 4.1: Detail of research survey

Number of Questionnaires Distributed	30
Number of Questionnaires Used in Thesis	22
Percentage of Survey Response rate	73.3%
Average Respondent's Experience	5-12yrs
Average Number of Annual Projects	1or 2(big scale)

Average Number of Workforce and Employee	56
Average Annual Financial Turnover	45 million birr

Source: survey result

Total responses analyzed was 23 (73.3%) from distributed (30) to respondents. Tsegay Abadi (2016) sited the work of Babbie (2007) as a response rate of at least 50% can be considered as adequate enough for analysis and reporting in the research. If a response rate is found 60%, it is going to be good for analysis whereas if a response rate found to be 70%, it is very good for analysis.

4.3 Demographic information of therespondents

Those respondents participated in the study have different educational background (see Table below). Most of them (>95%) were a graduate of first degree and second degree. Those who had first degree were accounts 59% out of the wholepopulation.

Table 4.2. Respondents Educational Level

Academic level	Frequency	Percent
Diploma	1	4.5
Bsc	13	59
Msc	8	36.5
Phd	Nil	

Source: survey result

On the other hand, those who had a second degree were accounts about 50% out of the total population. Diploma holders who participated in the study covered only 3% (see above Table 4.2).

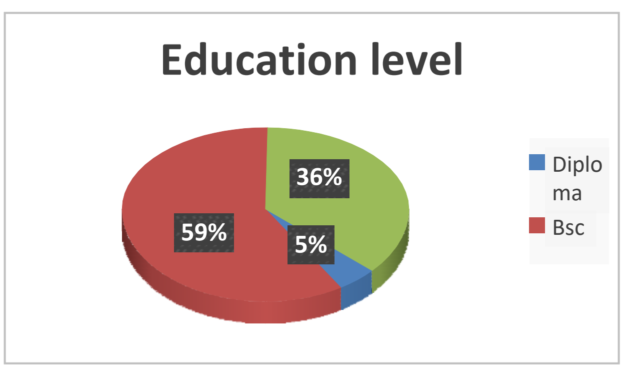

Fig 4.1: Respondent's educational level

And those who involved in this study were 77.3 %male and 22.7% female (see Table 4.3).

Table 4.3: Respondents Gender

SEX	FREQUECY	VALID PERCENT
Male	17	77.3
Female	5	22.7

Source: survey result

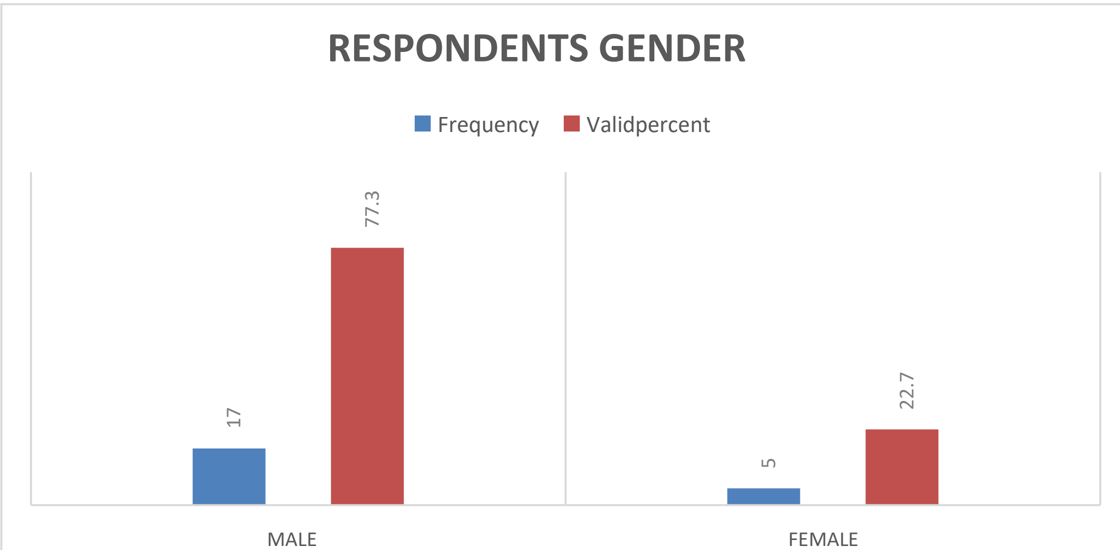

Fig 4.2: Respondent's gender

The respondents position is also summarized in the table below as follows

Table 4.4. Respondents Position

S/No	Positionstaff	Number of staff
1	General manager	1
2	Project manager	3
3	Logistic manager	4
4	Civil engineer (Structural design, contract engineer and construction)	8
5	Architect(Architectural designs)	3
6	Electrical engineer (Electrical installations)	1
7	Finance head	2

Source: survey result

The designation of the respondents shows a relatively wider Varity of professionals which are relevant to the case under analysis.

4.4 Results andfindings

After identifying the risks with respect to the four main categories (Management, External, Technical and organizational), all identified risks were analyzed by scoring each risk from 1 to 5 according to their probability and impact on the construction project. Moreover, risk score was calculated by multiplying both score of probability and impact by every respondent for each risk and all the supply chain risks were ranked and categorized based on their risk score. Consequently percentage of all risks and average risk scores are shown in different matrices, graphs and tables .The data were also located by risk map in the probability and impact matrix. And accordingly different areas such as very low to very high which show risk situation and condition identified.

Finally, the last stage is response and control. This stage used actions such as transfer, mitigate, accept and avoid in order to decreasing risks on the project.

4.4.1 Riskidentification

Particularly, RBS that were surveyed in the study were:Four Maincategories

(Management, External, Technical and organizational) and the correspondingly associated Identifiedrisks

- The following risks were identified as a management risks

Table 4.5: Identified supply chain managementrisks

Category	Identified risk	Designation
Management risks	Inadequate cost estimate	A1
	Inadequate program scheduling	A2
	Inadequate time scheduling	A3
	Tight project schedule	A4
	Increased transport cost	A5
	Increased insurance cost	A6
	Uncertain supply and demand	A7
	Labor dispute	A8
	Lack of cooperation betweenProj team	A9

- ❖ The following risks were identified as technical risks

Table 4.6: Identified supply chain Technicalrisks

Category	Identified risk	Designation
Technical risks	Lack of sufficient skilled workforce	B1
	Inexperienced labors and staff	B2
	Lack of access to modern technology	B3
	Lack of access to appropriate materials	B4
	Transport vehicle failure	B5
	Unavailability of proper vehicle	B6
	Transport material safety	B7
	Unprioritized material procurement based on schedule	B8

- ❖ The following risks were identified as organizational risks

Table 4.7: Identified supply chain Organizationalrisks

Category	Identified risk	Designation
Organizational risks	Lack of sufficient skilled manager	C1
	Financing issue	C2
	Delay in material procurement	C3
	Delay in production	C4
	Delay due to route disruption	C5
	Ignoring geographical condition	C6

- ❖ The following risks were identified as external risks

Table 4.8: Identified supply chain Externalrisks

Category	Identified risk	Designation
External risks	Natural disasters Unpredictable incidents	D1
	Supplier bankruptcy	D2
	Price fluctuation of construction materials	D3
	Product recall	D4
	Subcontractor failure	D5
	Delayed materials deliveries	D6
	Raising labor cost	D7
	Row material scarcity	D8
	Increased fuel cost	D9

4.4.2 Riskanalysis

After risk identification, risk analysis takes place as second stage. In this research probability and impact matrix is used to assess data, which shows results on a matrix table based on threat rate on project. This method is one of the suitable ways to analyze data in comparison to quantitative methods Probability and impact method prioritizes identified risks based on calculated risk scores. As a result, average risk scores and percentage of each risk were calculated.

4.4.2.1 Risk score results

The following risk scores were calculated

A. Management risk scores

The tabulated result for the risk score is as follows

Table 4.9: Management risk scores

	RS A1	RS A2	RS A3	RS A4	RS A5	RS A6	RS A7	RS A8	RS A9
MEAN	17.40909	17.04545	16.6818	17.818	16.454	7	6.22727	9.6521	6.318182
SUM	383	375	367	392	362	147	137	111	139

A. Technical risk scores

The tabulated result for the risk score is as following

Table 4.10: Technical scores

	RS B1	RS B 2	RS B 3	RS B 4	RS B 5	RS B 6	RS B 7	RS B 8
MEAN	9.04	6.954545	16.0454	11.136	4.7727	16.8181	15.3181	8.8636
SUM	199	153	353	245	105	370	337	195

B. Organizational risk scores

The tabulated result for the risk score is as follows

Table 4.11: Organizational risk scores

	Risk score C1	Risk score C2	Risk score C3	Risk score C4	Risk score C5	Risk score C6
MEAN	12.72727	19.36364	16.4090	18.136	6.1818	5.59090
SUM	280	426	361	399	136	123

C. External risk scores

The tabulated result for the risk score is as follows

Table 4.12: External risk scores

	RS D1	RS D2	RS D3	RS D4	RS D5	RS D6	RS D7	RS D8	RS D9
MEAN	5.318182	15.77273	21	3.4545	5.0909	17.4545	8.59090	5.3636	16.77273
SUM	117	347	462	78	112	384	189	118	369

4.4.2.2 Graphical description of the tabulated results

The following graphs describes the risk scores given by every respondent for each risk in the following category (Management, External, Technical and organizational)

A .**Management risk scores**

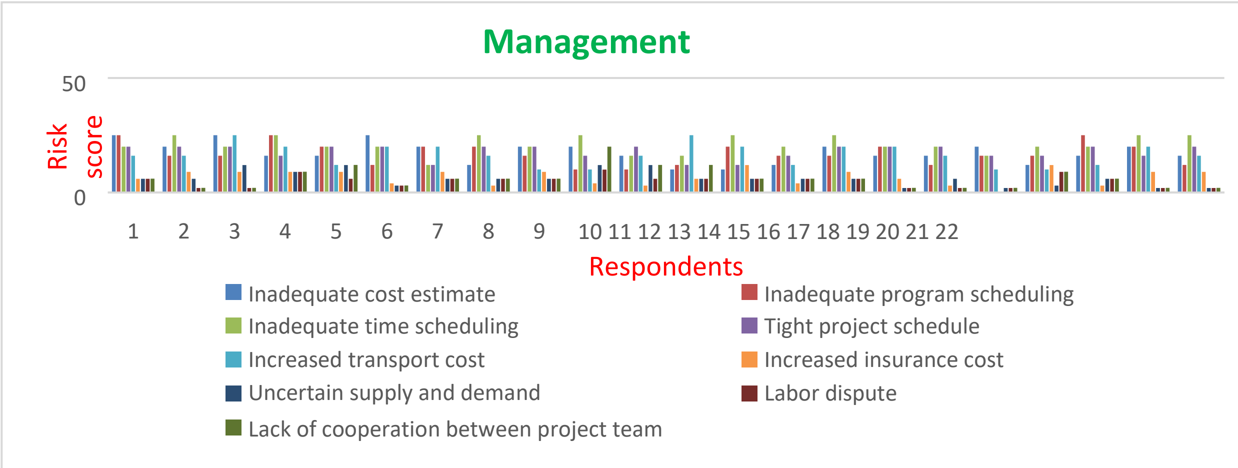

Fig 4.3a: Management riskscores

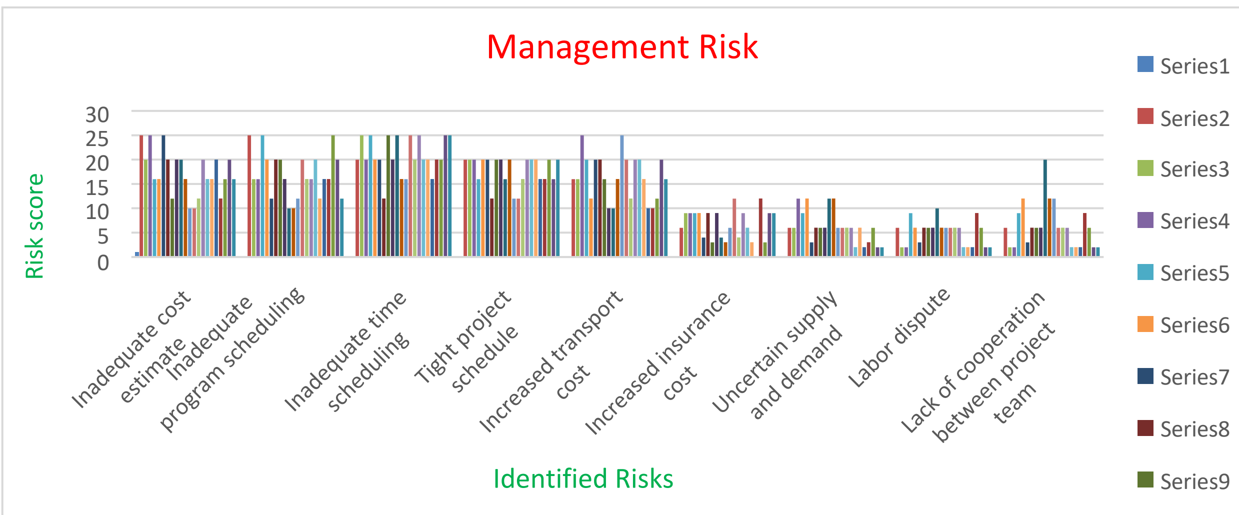

Fig 4.3b: Management risk scores

B. Technical risk scores

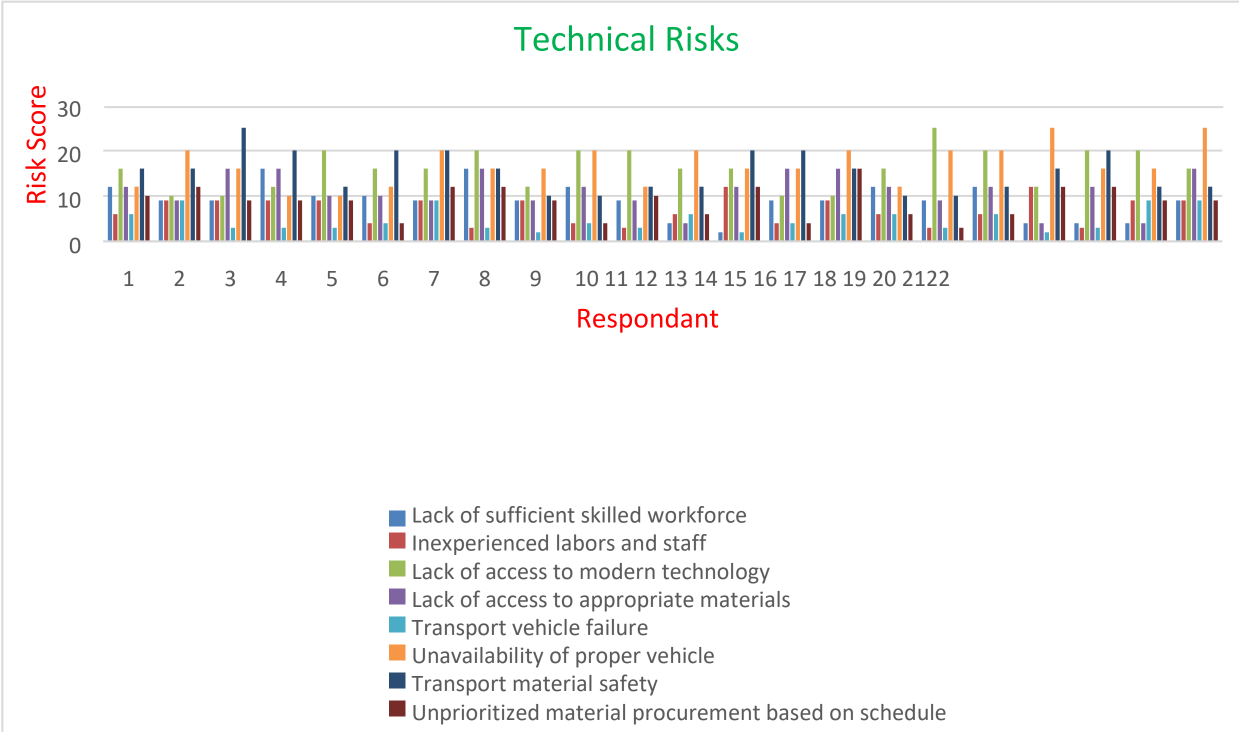

Fig 4.4a: Technical riskscores

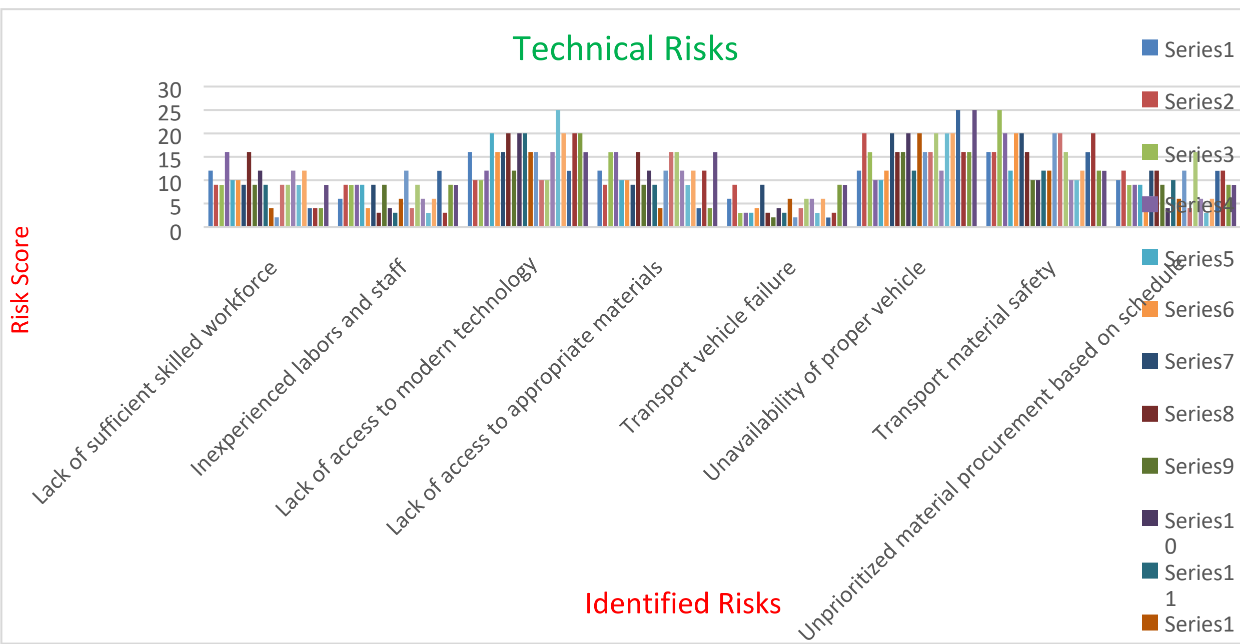

Fig 4.4b: Technical riskscores

C. Organizational riskscores

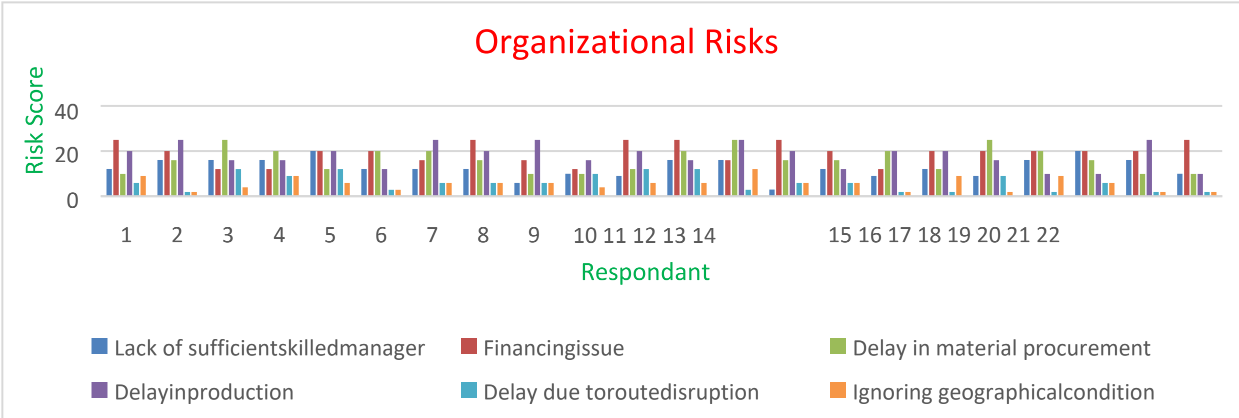

Fig 4.5a: Organizational riskscores

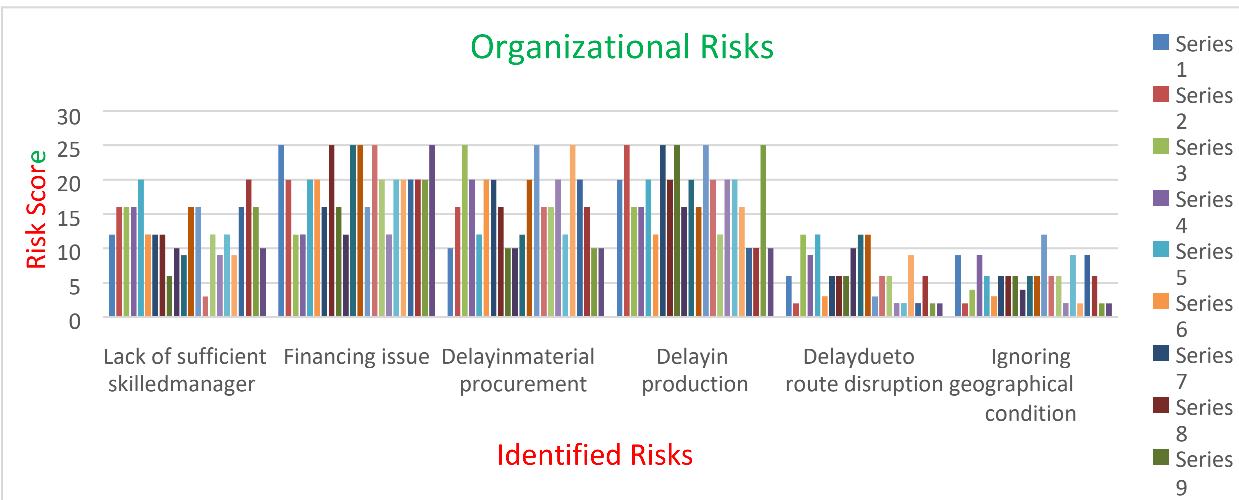

Fig 4.5b: Organizational riskscores

D. External riskscores

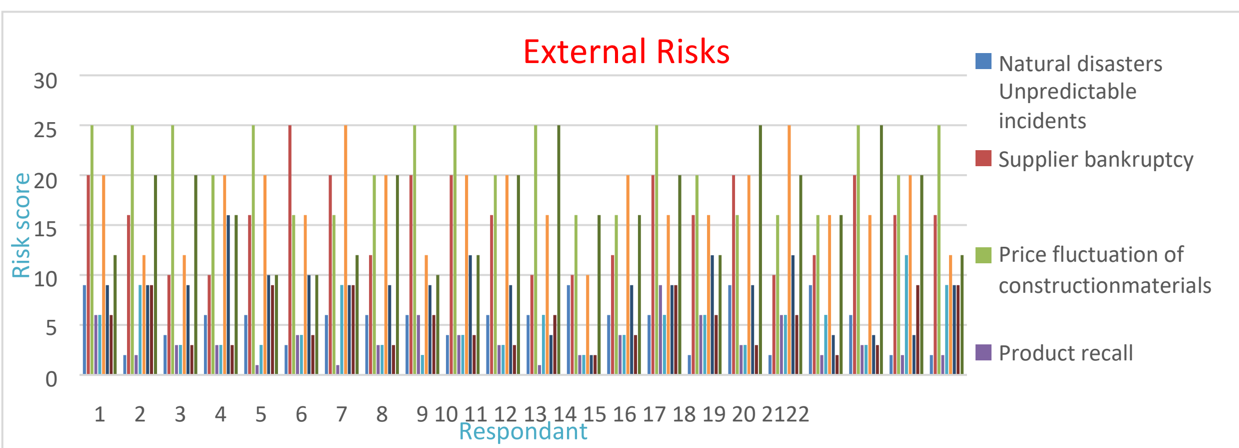

Fig 4.6a: External risk scores

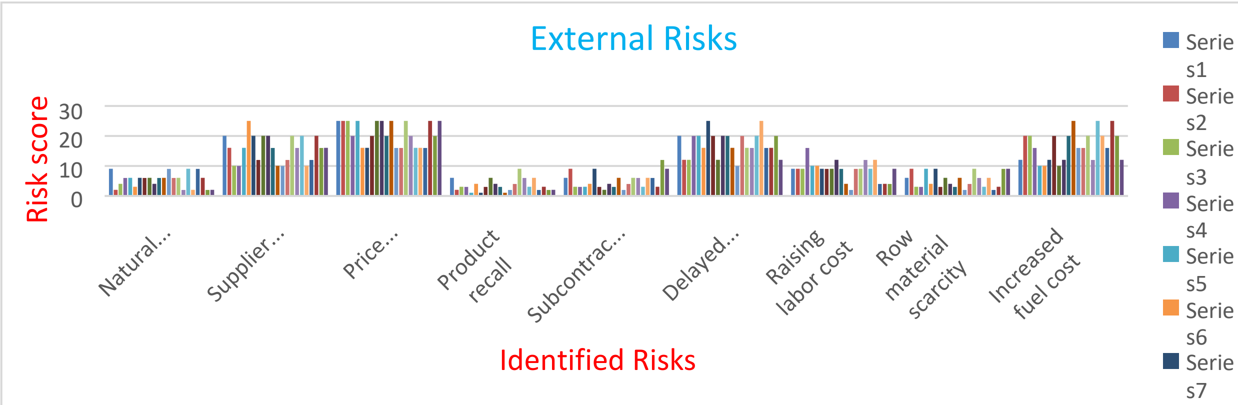

Fig 4.6b: External risk scores

4.4.2.3 Risk prioritization (with theirpercentage)

The following table prioritizes all the risks based on their mean risk score values

Table 4.13: Mean risk score values

RISK TYPE	MEAN RISK SCORE	PERCENTAGE
Price fluctuation of construction materials(D3)	**21**	**5.52**
Financing issue(C2)	**19.36364**	**4.99**
Delay in production(C4)	**18.136**	**4.76**
Tight project schedule(A4)	**17.8188**	**4.68**
Delayed materials deliveries(D6)	**17.4545**	**4.58**
Inadequate cost estimate(A1)	**17.40909**	**4.57**
A2 Inadequate program scheduling(A2)	**17.04545**	**4.48**
Unavailability of proper vehicle(B6)	**16.8181**	**4.42**
Increased fuel cost(D9)	**16.77273**	**4.40**
Inadequate time scheduling(A3)	**16.6818**	**4.38**
Increased transport cost(A5)	**16.454**	**4.32**
Delay in material procurement(C3)	**16.409**	**4.31**
Lack of access to modern technology(B3)	**16.0454**	**4.21**
Supplier bankruptcy(D2)	**15.77**	**4.14**
Transport material safety(B7)	**15.3181**	**4.02**
Lack of sufficient skilled manager(C1)	**12.72727**	**3.34**
Lack of access to appropriate materials(B4)	**11.13636**	**2.92**
Labor dispute(A8)	**9.652174**	**2.53**
Lack of sufficient skilled workforce(B1)	**9.04**	**2.37**
Unprioritized material procurementbased on schedule(B8)	**8.863636**	**2.33**

Raising labor cost(D7)	**8.590909**	**2.25**
Increased insurance cost(A6)	**7**	**1.83**
Inexperienced labors and staff(B2)	**6.954545**	**1.82**
Lack of cooperation between project team(A9)	**6.318182**	**1.66**
Uncertain supply and demand(A7)	**6.227273**	**1.63**
Delay due to route disruption(C5)	**6.181818**	**1.62**
Ignoring geographical condition(C6)	**5.590909**	**1.46**
Row material scarcity(D8)	**5.36363**	**1.40**
Natural disasters and Unpredictable incidents(D1)	**5.318182**	**1.39**
Transport vehicle failure(B5)	**5.09**	**1.33**
Subcontractor failure(D5)	**4.772727**	**1.25**
Product recall(D4)	**3.4545**	**0.9**

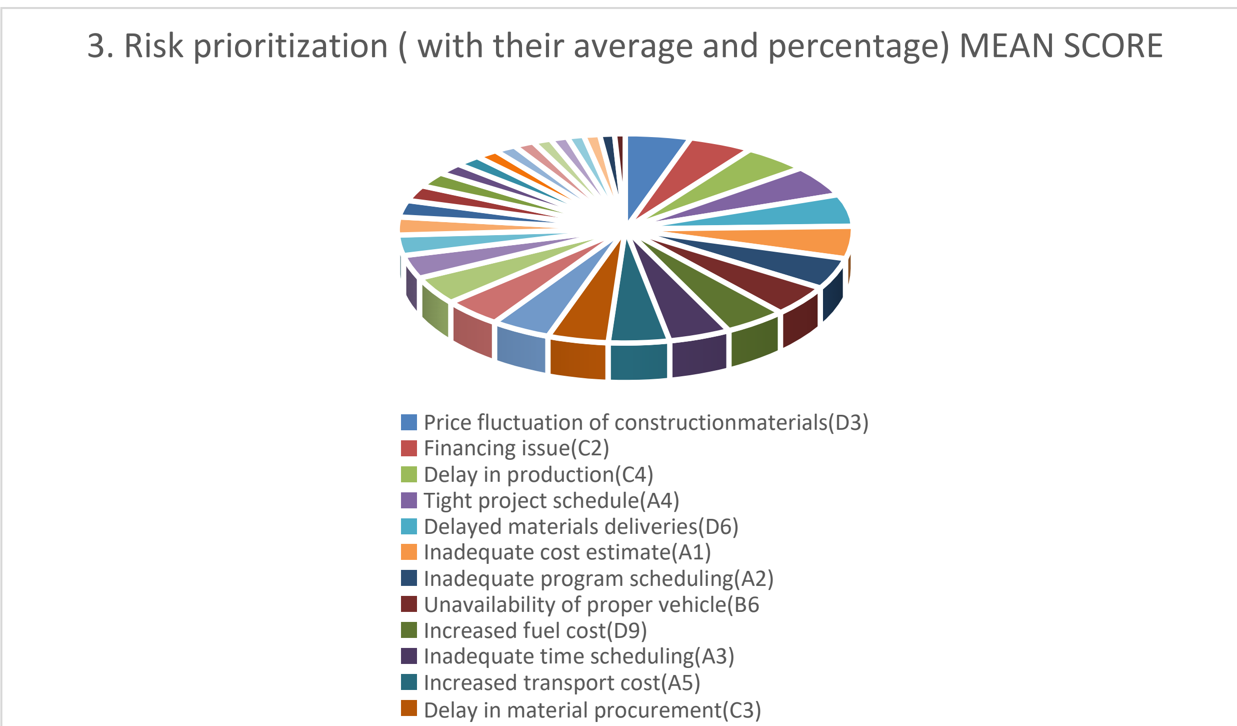

Fig 4.7a: Risk prioritization (percentage)

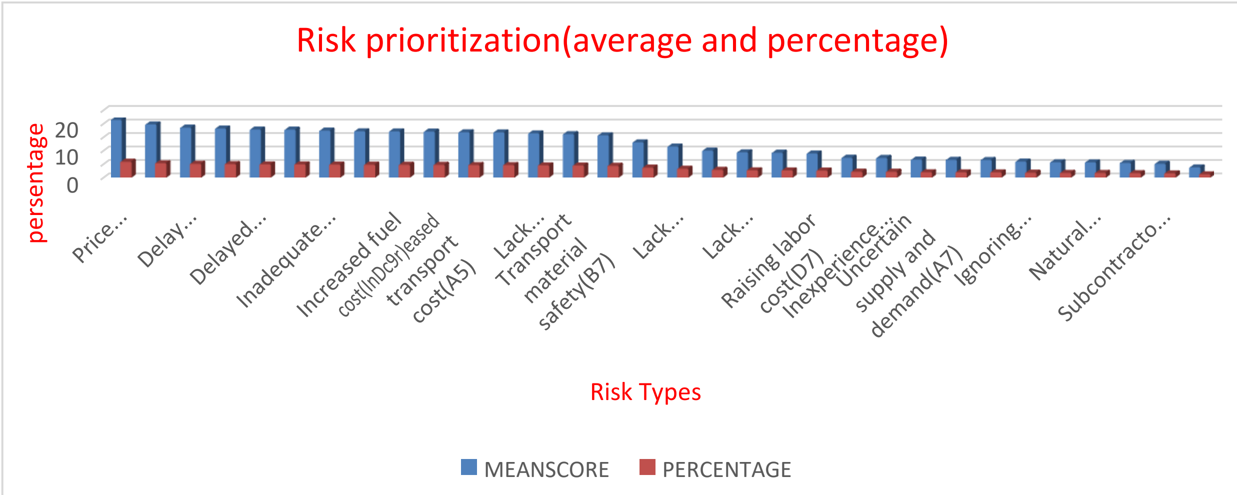

Fig 4.7b: Risk prioritization (Average)

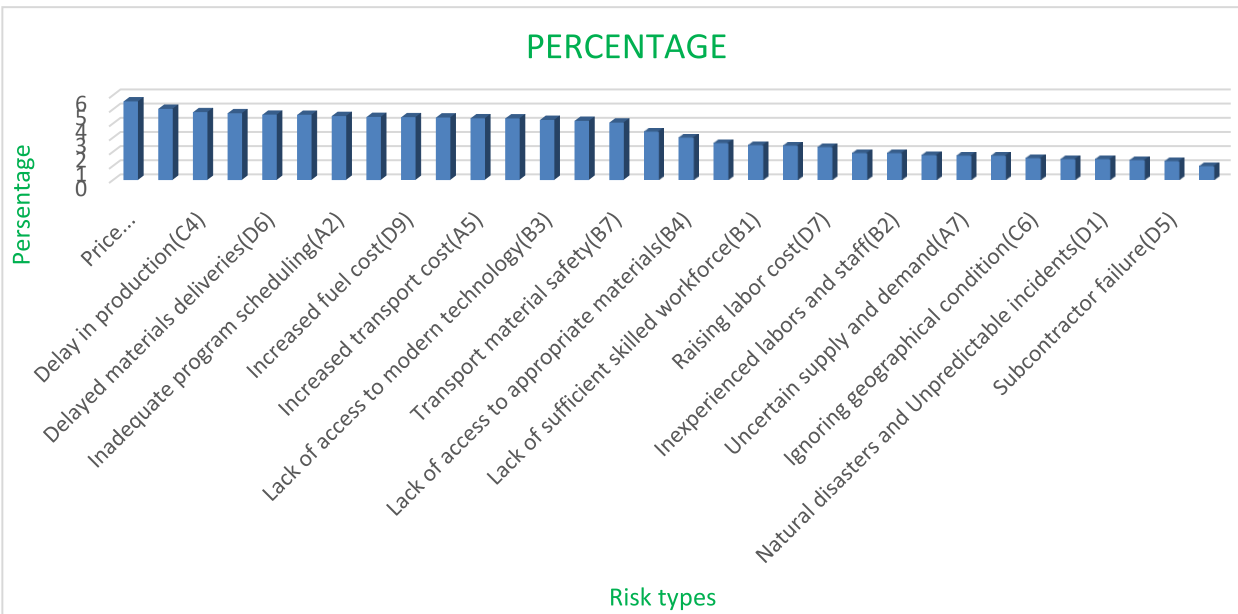

Fig 4.7c: Risk prioritization (Percentage)

4.4.2.4 **Mapping of probability and impactmatrix**.

According to PMBOK (2013), the third stage of risk process is risk response, which is used to select appropriate strategies to control risks. Depending on the result, the four appropriate methods and strategies of responding and treating the high risks which are avoiding, mitigating, transferring and accepting will be assessed for each risk factor using mapping of probability and impact matrix.

Table 4.14: Average probability and Average impact

S.N0	Risk type	Designation	Category	Average probability	Average Impact	Average Risk score
1	Inadequate cost estimate	A1	**Management**	3.6	4.8	17.40909
2	Inadequate program scheduling	A2		4.0	4.2	17.0454
3	Inadequate time scheduling	A3		3.7	4.6	16.6818
4	Tight project schedule	A4		4.2	4.2	17.8188
5	Increased transport cost	A5		3.5	4.7	16.454
6	Increased insurance cost	A6		3.4	2.1	7
7	Uncertain supply and demand	A7		3.8	1.6	6.227273
8	Labor dispute	A8		2.5	3.9	9.652174
9	Lack of cooperation between project team	A9		2.9	2.2	6.318182
10	Lack of sufficient skilled workforce	B1	**Technical**	2.8	3.2	9.04
11	Inexperienced labors and staff	B2		1.7	4.2	6.954545
12	Lack of access to modern technology	B3		4.2	3.8	16.0454
13	Lack of access to appropriate materials	B4		2.7	4.1	11.13636
14	Transport vehicle failure	B5		2.2	2.2	4.772727
15	Unavailability of proper vehicle	B6		3.7	4.6	16.8181
16	Transport material safety	B7		3.9	3.9	15.3181
17	Unprioritized material procurement based on schedule	B8		2.1	4.2	8.863636
18	Lack of sufficient skilled manager	C1	**Organizational**	3.8	3.4	12.72727
19	Financing issue	C2		4.5	4.3	19.36364
20	Delay in material procurement	C3		4.1	4.0	16.409
21	Delay in production	C4		4.7	3.9	18.136
22	Delay due to route disruption	C5		1.9	3.2	6.181818
23	Ignoring geographical	C6		2.7	2.1	5.590909

	condition					
24	Natural disasters Unpredictable incidents	D1	**External**	2.8	1.9	5.318182
25	Supplier bankruptcy	D2		4.6	3.4	15.77273
26	Price fluctuation of construction materials	D3		4.5	4.7	21
27	Product recall	D4		2.5	1.4	3.4545
28	Subcontractor failure	D5		1.3	4.1	5.090909
29	Delayed materials deliveries	D6		3.9	4.4	17.4545
30	Raising labor cost	D7		2.3	3.8	8.590909
31	Row material scarcity	D8		2.4	2.2	5.36363
32	Increased fuel cost	D9		3.6	4.7	16.77273

Risk mapping in the probability and impact matrix. And accordingly different areas such as very low to very high which show risk situation and condition identified.

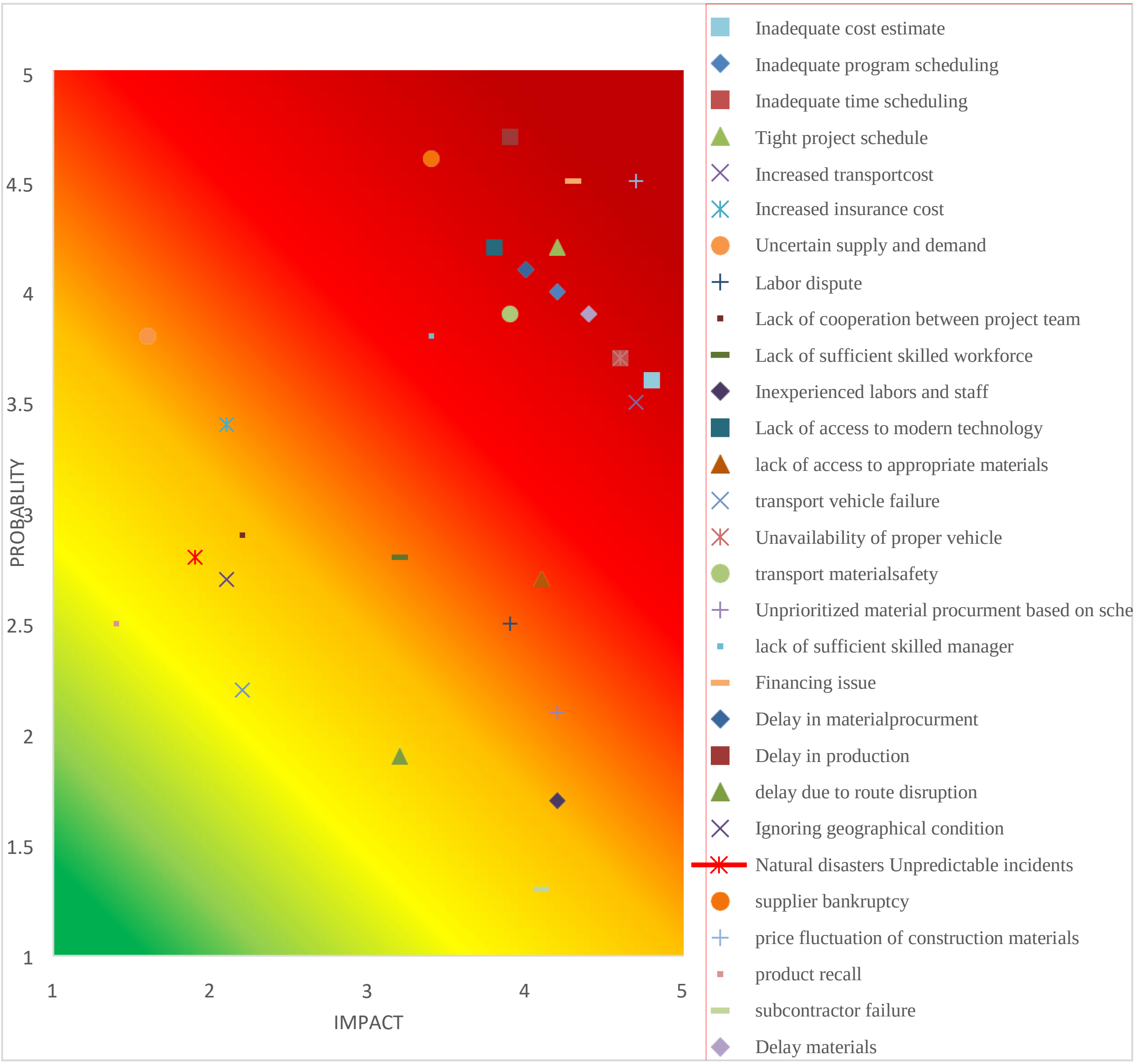

Fig 4. 8: Mapping probability and impact matrix

4.5 Supply chain risk management practiceassessment

The extent of SCRM practice was measured on a Likert scale of 0-1 where: 0= No extent, 1= Small Extent, 2= Moderate Extent, 3= Great Extent and 4= Very great Extent. So the greater the mean, the greater the extent of agreement. A mean (M) score of (0< mean<0.4) means-No extent, (0.5<mean<1.4) -to small extent, (1.5<mean<2.4)-to moderate extent, (2.5<mean<3.4) means to a great extent and a mean score (3.5<mean<4) means to a very greatextent.

Detailed results of the study are presented below:

Table 4.15: Mean values of risk management practices

S.No	Risk management practice	Mean value
1	Long Term collaborative relationship practices	**1.32**
2	Increasing knowledge about risk and risk analysis practices	**1.55**
3	Supplier capacity assessment and qualification screening practices	**2.35**
4	redundant stock/extra inventory arrangement practices	**2.97**
5	Back up supplier arrangement practices	**1.21**
6	Supply chain contingency planning practices	**1.35**
7	Practices of transferring Supply chain risks through Insurance	**2.4**

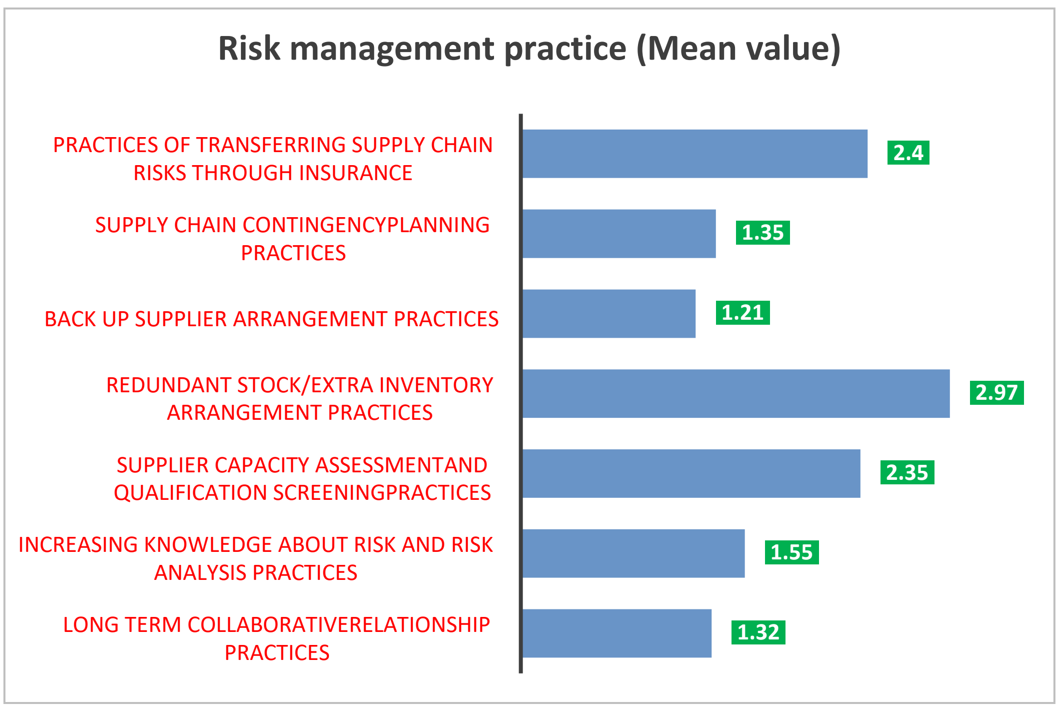

Fig 4.9: Mean values of supply chain risk management practiceS

4.6DISCUSSION AND INTERPRETATION

4.6.1 Discussion on RiskIdentification

As mentioned before, main stage of supply chain risk process is identification, which is used to create a list of potential threats that would be disruptive to any aspect of supply chain stream. There are some methods to identify risks on projects; most of which being presented earlier. This research used Risk Breakdown Structure (RBS),

As discussed before, Ethiopian construction companies can be categorized at first level of supply chain management where McCormack et al. (2004) called Ad hoc. They deal with risks as unstructured and not properly defined. However, some of companies use methods to identify risks to prevent loss and damage. Most of the experienced experts apply checklist, brainstorming and also surveying historical data to recognize threats onprojects.

4.6.2 Discussion on RiskAnalysis

The main goal of analyzing risk is prioritizing risk based on negative impact on specific project. In management category, tight project schedule has more range in comparison with other risks. In organizational category, financial issue gained highest level of risk score, while ignoring geographical condition is lowest level in thiscategory.

As observed price fluctuation of construction had highest level among all potential risks. This risk can arise from many sources. The main significant factors can be availability of the material in the marketplace, fluctuation in Ethiopian currency and the price of raw construction materials.

There are some potential risks which have high rates in this study such as financing issue, tight project schedule, inadequate time scheduling and supplier bankruptcy. These risks have got high rate of probability and impact by respondents. There are some researchers who emphasize about importance of time. For instance, Lyons and Skitmore (2004) stated that one of the significant points about risk management is time loss. Other researchers determined different risks as highest rate with negative impact on project. For example, Gajewska (2011) mentioned “cheap solutionsandnotfindingtherightcontractorhadmaximumrankedamongpotentialrisks;while

Zou et al. (2006) stated that the most problem with high impact on project is tight project schedule.

Most of respondents emphasized that traditional culture, inexperienced managers, lack of communications are also among the main problems in construction industry.

4.6.3 Discussion on RiskResponse

In accordance with Perry (1986), there are three main strategies in order to respond threats on each construction projects, which can be summarized below:

4.6.4 Mitigation

4.6.5 Transference

4.6.6 Avoidance

Table 5.1: Risk response table

Risk type	Recommended response	Responsible body	Detail
Very high	Avoid	Executive	Hire strict strategies
High	Mitigate	Upper management	Hire strict strategies and review by manager
Medium	Transfer	Upper management	Review by manager
Low	Transfer - Accept	Middle management	Continue monitoring
Very Low	Accept	Intermediate	Continue current monitoring

In order to takes proper actions, all respondents believed that all identified risks must be separately performed according to their severity of influences on project goal. To do so, those risks which are located in dark red zone must be mitigate and also avoid in some specific situation. On the other hand those risks, which are located in the middle of the matrix (red and orange zone) should also mitigate and transfer to others to take their responsibility.

For those risks that located in green and yellow zone (very low and low) should take both transference and acceptance since the severity of those risks is very low and by decreasing probability and impact we can accept them and proceed the project.

Overall, this research illustrate that most of the respondents were not familiar with supply chain risk management. Particularly, they had no idea about types of risk response based on strategic management. In some cases, after risk occurred, companies shift responsibilities to insurance to compensate loss, actually it can be transfer technique which is one of the main response techniques.

Nevertheless, some respondents mentioned that experienced experts survey checklist and historical data and then try to prevent risk occurrence. This study makes clear that lack of knowledge brings it very difficult to determinate suitable response strategy.

In Ethiopian construction industry some of these mitigation strategies may be useful. For instance, having redundant suppliers can solve and prevent many potential risks. As supplier bankruptcy results in delay and lack of access to appropriate materials. Moreover, time loss and chaos in project schedule caused by delay in material delivery. Therefore, selecting reliable supplier and also having substitute supplier is one of the main mitigation strategies in this case.

4.6.4 Discussion on risk managementpractices

4.6.4.1Long Term collaborative relationshippractices

The study result indicates that, overall, the practices of building long term collaborative relationship with key suppliers (valuing long term relationship, sharing risks with suppliers, trust based relationship building and collaborating with suppliers to be lean and responsive) were implemented to small extent(evidenced by overall mean value of 1.32) as a way of managing supply chain risks.

4.6.4.2 Increasing knowledge about risk and risk analysispractices

With regard to practices that increase the knowledge about supply chain risks and enhance supply chain risk analysis and better understanding, the respondents agreed to moderate extent as shown by the overall mean value of 1.55. Considering the increasing supply chain risks, moderate extent level of practice is not enough for effective supply chain risk mitigation. There is no also practice of keeping supply chain risk register that clearly documents expected supply chain risks together with their impact level and mitigationoption

4.6.4.3Redundant stock/extra inventory arrangementpractices

Regarding the practice of keeping extra inventory, respondents agreed that such practices are implemented to a great extent as evidenced by the overall mean value of 2.97.

4.6.4.4 Supplier capacity assessment and qualification screeningpractices

On the supply chain risk management practices of supplier capacity assessment and qualification screening, respondents agree to a moderately high extent(with mean value 2.35) that they demand proof of business continuity from suppliers before signing a contract with them.

4.6.4.5 Back up supplier arrangementpractices

The construction industry must use back up supplier arrangement practices to manage supply chain risks arising as a result of possible failures from suppliers ‘due to various reasons such as if suppliers face a situation by which they cannot supply the required items due to reasons which are out of control, for instance, if the suppliers are in war zone area or face natural disasters or faced government sanctions etc. Representative staffs from sourcing departments should visit warehouses of suppliers to check their capacity to supply and once agreed with framework agreement, and they also should send various purchase orders with the required amount of items to be supplied while the items were kept at the warehouse of suppliers, instead of at contractor's warehouse. But such practices are in its infancy and there should be a plan to continue and strengthen such practice, this is evidenced with mean value of1.21.

4.6.4.6 Supply chain contingency planningpractices

In this regard, the respondents agreed that the practice of developing and using contingency plan is implemented to small extent as evidenced by overall mean value of 1.35. The largest response variation was observed with regard to the practice of contingency plan development while small response variation received for the practice of using contingency plan to minimize loss and safeguard assets in times of risky incidents. The result reveals that the practice of developing and using contingency plan to manage supply chain risks is in its infancy.

4.6.4.7 Practices of transferring Supply chain risks throughInsurance

With regard to the practice of using insurance, the study indicates construction companies use insurance options to a moderate extent as evidenced by the overall mean value of 2.4. The practice of using insurance, to a great extent, as a key means of supply chain risk mitigation is confirmed by respondents.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The study sought to analyze Construction Supply Chain risks and Mitigation Measures. The survey categorized all potential risks based on RBS method into four main groups of management, organizational, technical and external. This chapter deals with the summary of findings, conclusions and recommendations.

5.2 Summary offindings

As presented before, the research has tried to answer the following research questions are:

- What are the major supply chain risks, which have high negative impact on the construction projects and ways of analysis?
- What are the major supply chain management practices and ways of evaluation?
- What kind of mitigation and risk management strategies should be used for managing risk in construction supplychains?

According to the supply chain maturity model (McCormack et al. 2004), five levels of maturity reveal the performance characteristics toward supply chain process. Each level affiliated with maturity stage for instance, capability, control, predictability efficiency and effectiveness. It can be argued that the Ethiopian construction industry used supply chain management for years where is ad hoc level. They cope with risk as unstructured and ill defined. Process performance is unpredictable. Client satisfaction is dramatically low. Mostly transfer strategy is selected and finding another party who is willing to take responsibility for itsmanagement.

After risk identification and analysis (using RBS and risk scores using probability and impact matrix,

- The top 5 supply chain risks were found tobe:

1. Price fluctuation of constructionmaterials
2. Financingissue
3. Delay inproduction
4. Tight projectschedule

5. Delay in materialdeliveries

- **The most common Supply chain risk management practices in the construction industry were found tobe**
  - Long Term collaborative relationshippractices
  - Increasing knowledge about risk and risk analysispractices
  - Redundant stock/extra inventory arrangementpractices
  - Supplier capacity assessment and qualification screeningpractices
  - Back up supplier arrangementpractices
  - Supply chain contingency planningpractices
  - Practices of transferring Supply chain risks throughInsurance
  - Challenges of practicing supply chain riskmanagement

5.3 Conclusion

- Based on the findings of the survey, level of Ethiopian construction companies in supply chain management was located at Ad hoc, which is determined as primary level. This level shows lack of knowledge about supply chain and its practices, the costs are high and satisfaction ispoor.
- Ethiopian construction companies apply some techniques such as checklist, brainstorming and historical data in order to identify risks having negative influence on their project. In most cases, all respondents mentioned that their companies have tendency to wait until a threat occurs within construction project and when it is happened, they would cope with the threat based on to their skills, experience andbrainstorming.
- Furthermore, selecting appropriate risk analysis is highly important to find out rank of all potential risks. This selection must be related to project conditions. It was also found that most of the respondents have not been familiar with supply chain risk management. Particularly, they had no idea about types of risk responses based on supply chain risk management. In some cases, after risk occurred, companies shifted responsibilities to insurance companies to compensate loss; which actually can be transfer technique, which is one the main responsetechniques.
- Here are some factors which interfere with supply chain risk management asfollow:
  - Absence ofKnowledge
  - Inexperiencedmanagers

- Lack of communications with high technology foreign companies which makes solutions with modern technologies and have proper relationship with high technology companies all around the world. And knowledge of managers and responsible staff in supply chain would become updated with the latest technologies and applications.

5.4 Recommendations

On the basis of the findings and conclusions reached, the following recommendations are forwarded in order to improve the Supply Chain risk Management practices: And here are some of the recommendations

- The top management should be engaged in
  - Establishing Systematic and continuous improvement supply chain risk management practices and
  - Dealing with the challenges that hinder the implementation of supply chain risk managementpractices.
  - Fulfilling all the required human, material, technological resources relevant to the effective supply chain riskmanagement
  - Improving the awareness and culture of risk management practices, need to develop a policy and manual specific to supply chain risk management by coaching staffs, providing training on supply chain risks, by establishing supply chain risk management policy and systems and empowering thestaff.
  - Preparing contingency plans before supply chain risks become materialized
- Construction companies need to work more to improve the practices of building long term collaborative relationship with its key suppliers. It needs to improve the traditional practices to a modern supply chain relationship through establishing strategic or long term relationship, contract, and continuous information sharing in order to minimize supply uncertainty and its associated supply chain risks. Because, having such long term relationship with key suppliers, companies will be benefited by obtaining its inputs with the right quality, right quantity and at the right time from such key suppliers and provide the required materials to its operation as per theirneed.
- Construction companies should do benchmarking of its supply chain operations against the best players in the country and the world.

- Construction companies should back up suppliers so as to mitigate any risky incidents in an effective way and select reliable alternative supplier and when disruption occurred. Reserving potential suppliers is also important in times of key suppliers failing to supply due to their own problems or due to reasons beyond their control.

5.5 Suggestions for FurtherResearch

This study suggests similar studies to be conducted on other supply chain risk assessment in the construction industries which included some missed gaps in this thesis due to lack of time and extra costs. Here are the following suggested points for future works

- As risk response and mitigation is very important on supply chain management future studies can focus more on novel techniques in order to speed up the process of risk response.
- Positive risks should also bestudied
- To have a full picture of the supply chain risk management practices of construction supply chain risks the entire supply chain network involving all supply chain members be better bedealt
- The study can include more construction companies which are found in other cities and locations which have more profound supply chainpractices.

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Appendices

I) Appendix A (GeneralInformation)

Respondent Profile	
Company name	
Respondent name	
Work experience	
Field of work	
The average number of annual project	
The annual financial statement	
The number of Workforce	

II) Appendix B (Management and technicalrisks)

General Information		Respondent Name:			Company			Name:					Work Experience:	Position:
		Probability Level of risk occurrence					**Impact Level of risk occurrence**						**Risk management plan**	**Assigned to**
		1	2	3	4	5	1	2	3	4	5			
A. MANAGEMENT														
A1	Inadequate cost estimate													
A2	Inadequate program scheduling													
A3	Inadequate time scheduling													

A4	Tight project schedule													
A5	Increased transport cost													
A6	Increased insurance cost													
A7	Uncertain supply and demand													
A8	Labor dispute													
A9	Lack of cooperation between project team													
B. TECHNICAL														
B1	Lack of sufficient skilled workforce													
B2	Inexperienced labors and staff													
B3	Lack of access to modern technology													
B4	Lack of access to appropriate materials													
B5	Transport vehicle failure													
B6	Unavailability of proper vehicle													
B7	Transport material safety													
B8	Unprioritized material procurement based on schedule													

III) Appendix C (Organizational and externalrisks)

General Information		**Respondent Name:**			**Company**			**Name:**					**Work Experience:**	**Position:**
		Probability Level of risk occurrence					**Impact Level of risk occurrence**						**Risk management plan**	**Assigned to**
		1	2	3	4	5	1	2	3	4	5			
C. ORGANIZATIONAL														
C1	Lack of sufficient skilled manager procurement													
C2	Financing issue													
C3	Delay in material													
C4	Delay in production													
C5	Delay due to route disruption													
C6	Ignoring geographical condition													
D. EXTERNAL														
D1	Natural disasters unpredictable incidents													
D2	Supplier bankruptcy													
D3	Price fluctuation of construction materials													
D4	Product recall													
D5	Subcontractor failure													
D6	Delayed materials deliveries													
D7	Raising labor cost													
D8	Row material scarcity													
D9	Increased fuel cost													

IV) Appendix C (Supply chain risk managementpractice)

S.No	Supply chain risk management practice	No extent	Small extent	Moderate	Great	Very Great
1	Long Term collaborative relationship practices					
2	Increasing knowledge about risk and risk analysis practices					
3	Supplier capacity assessment and qualification screening practices					
4	Redundant stock/extra inventory arrangement practices					
5	Back up supplier arrangement practices					
6	Supply chain contingency planning practices					
7	Practices of transferring Supply chain risks through Insurance					

V) Appendix D (Sampleinterview)

General Information	1. Which Position do you have in the project?
	2. How would you define supply chain in construction projects?
	3. How much are you familiar with the concept of supply chain management and supply chain risk management process?
	4. Do you formally evaluate your suppliers based on the supply chain management process?
	5. Do you perform any audit of their Risk Management process?

		6. Do you have any specific concern or comment about your supply chain exposures?
Supply Chain Risk Process	**Identification**	1. Which strategies do you apply to identify threats in construction projects? (e.g., as an individual or in the organization)
		2. What are the main threats that you encounter with them?
	Analysis	1. After identifying a number of risks on site, how would you categorize and prioritize them?
		2. Which analyzing techniques have you ever used? (For instance, Probability and Impact Matrix, FMEA, FTA,...)
	Response	1. What are the main mitigation strategies you usually take against risks?
		2. How are risks controlled within your construction projects?
		3. How should risk management be organized in construction projects?
		4. Do you have a contingency strategy for alternative supply of critical items?

VI. Risk score values

I. Management risk score									
Respondents	**Risk score A1**	**Risk score A2**	**Risk score A3**	**Risk score A4**	**Risk score A5**	**Risk score A6**	**Risk score A7**	**Risk score A8**	**Risk score A9**
1	25	25	20	20	16	6	6	6	6
2	20	16	25	20	16	9	6	2	2
3	25	16	20	20	25	9	12	2	2
4	16	25	25	16	20	9	9	9	9
5	16	20	20	20	12	9	12	6	12
6	25	12	20	20	20	4	3	3	3
7	20	20	12	12	20	9	6	6	6
8	12	20	25	20	16	3	6	6	6
9	20	16	20	20	10	9	6	6	6

10	20	10	25	16	10	4	12	10	20
11	16	10	16	20	16	3	12	6	12
12	10	12	16	12	25	6	6	6	12
13	10	20	25	12	20	12	6	6	6
14	12	16	20	16	12	4	6	6	6
15	20	16	25	20	20	9	6	6	6
16	16	20	20	20	20	6	2	2	2
17	16	12	20	20	16	3	6	2	2
18	20	16	16	16	10		2	2	2
19	12	16	20	16	10	12	3	9	9
20	16	25	20	20	12	3	6	6	6
21	20	20	25	16	20	9	2	2	2
22	16	12	25	20	16	9	2	2	2
MEAN	**17.40909**	**17.04545**	**16.6818**	**17.818**	**16.454**	7	6.22727	9.6521	6.318182
SUM	**383**	**375**	**367**	**392**	**362**	147	137	111	139

B. Technical risk scores								
Respondents	**Risk score B1**	**Risk score B2**	**Risk score B3**	**Risk score B4**	**Risk score B5**	**Risk score B6**	**Risk score B7**	**Risk score B8**
1	12	6	16	12	6	12	16	10
2	9	9	10	9	9	20	16	12
3	9	9	10	16	3	16	25	9
4	16	9	12	16	3	10	20	9
5	10	9	20	10	3	10	12	9
6	10	4	16	10	4	12	20	4
7	9	9	16	9	9	20	20	12
8	16	3	20	16	3	16	16	12
9	9	9	12	9	2	16	10	9
10	12	4	20	12	4	20	10	4

11	9	3	20	9	3	12	12	10
12	4	6	16	4	6	20	12	6
13	2	12	16	12	2	16	20	12
14	9	4	10	16	4	16	20	4
15	9	9	10	16	6	20	16	16
16	12	6	16	12	6	12	10	6
17	9	3	25	9	3	20	10	3
18	12	6	20	12	6	20	12	6
19	4	12	12	4	2	25	16	12
20	4	3	20	12	3	16	20	12
21	4	9	20	4	9	16	12	9
22	9	9	16	16	9	25	12	9
MEAN	**9.04**	6.954545	**16.0454**	11.136	4.7727	**16.8181**	**15.3181**	8.8636
SUM	**199**	153	**353**	245	105	**370**	**337**	195

C. Organizational risk scores						
Respondents	**Risk score C1**	**Risk score C2**	**Risk score C3**	**Risk score C4**	**Risk score C5**	**Risk score C6**
1	12	25	10	20	6	9
2	16	20	16	25	2	2
3	16	12	25	16	12	4
4	16	12	20	16	9	9
5	20	20	12	20	12	6
6	12	20	20	12	3	3
7	12	16	20	25	6	6
8	12	25	16	20	6	6
9	6	16	10	25	6	6
10	10	12	10	16	10	4
11	9	25	12	20	12	6

12	16	25	20	16	12	6
13	16	16	25	25	3	12
14	3	25	16	20	6	6
15	12	20	16	12	6	6
16	9	12	20	20	2	2
17	12	20	12	20	2	9
18	9	20	25	16	9	2
19	16	20	20	10	2	9
20	20	20	16	10	6	6
21	16	20	10	25	2	2
22	10	25	10	10	2	2
MEAN	12.72727	**19.36364**	**16.4090**	**18.136**	6.1818	5.59090
SUM	280	**426**	**361**	**399**	136	123

D. External risk score									
Respondents	**Risk score D1**	**Risk score D2**	**Risk score D3**	**Risk score D4**	**Risk score D5**	**Risk score D6**	**Risk score D7**	**Risk score D8**	**Risk score D9**
1	9	20	25	6	6	20	9	6	12
2	2	16	25	2	9	12	9	9	20
3	4	10	25	3	3	12	9	3	20
4	6	10	20	3	3	20	16	3	16
5	6	16	25	1	3	20	10	9	10
6	3	25	16	4	4	16	10	4	10
7	6	20	16	1	9	25	9	9	12
8	6	12	20	3	3	20	9	3	20
9	6	20	25	6	2	12	9	6	10
10	4	20	25	4	4	20	12	4	12
11	6	16	20	3	3	20	9	3	20
12	6	10	25	1	6	16	4	6	25
13	9	10	16	2	2	10	2	2	16

14	6	12	16	4	4	20	9	4	16
15	6	20	25	9	6	16	9	9	20
16	2	16	20	6	6	16	12	6	12
17	9	20	16	3	3	20	9	3	25
18	2	10	16	6	6	25	12	6	20
19	9	12	16	2	6	16	4	2	16
20	6	20	25	3	3	16	4	3	25
21	2	16	20	2	12	20	4	9	20
22	2	16	25	2	9	12	9	9	12
MEAN	5.318182	**15.77273**	**21**	**3.4545**	5.0909	**17.4545**	8.59090	**5.3636**	**16.77273**
SUM	117	**347**	**462**	**78**	112	**384**	189	**118**	**369**