ADDIS ABABA UNIVERSITY
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Decision Support Mechanism for Risk Allocation in Private Real Estate Purchase Agreements

A Thesis submitted to School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements of the Degree of Master of Science in Civil Engineering

(Construction Technology and Management)

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DECLARATION

I hereby declare that this thesis work titled "*Decision Support Mechanism for Risk Allocation in Private Real Estate Purchase Agreements"* is my own work**,** except where indicated by referencing, and that it has not been presented to other university for similar or any other degree award.

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ABBREVIATIONS

GDP – Gross Domestic Product

PFI - Privately Financed Infrastructure projects.

PMBOK – Project Management Book of Knowledge

PPP - Public–private Partnership Projects

RADM – Risk Allocation Decision Mechanism

RED – Real Estate Developer

RF – Risk Factor

R-I – Risk Impact

ABSTRACT

Real estate development is considered as one of the sectors with transaction of billions of Birr in the Ethiopian market. Real estate development contributes to the economy of the country and in alleviating housing problems. However, the sector is facing different problems. Problems that exist in real estate development make the business environment susceptible to uncertainty. Therefore, this research is aimed at identifying risk factors in private real estate development projects and their impact on project objectives, examining the current practice of risk allocation in real estate purchase agreements and providing a practical mechanism that can be used by real estate developers to allocate risks properly. Risks were identified and impact analysis was conducted. Subsequently, residential real estate purchase contracts were reviewed and it was found that most of the reviewed agreements do not include the severe risk factors. Purchase agreements currently being used lack completeness in addition to risks being misallocated. It is believed the decision support mechanism provided helps real estate developers make proper risk allocation decisions.

Key words: Decision support mechanism, Purchase agreement, Real estate, Risk, Risk allocation, Risk allocation principles, Risk impact.

1. OVERVIEW OF THE RESEARCH

1.1 Background of the Study

Real Estate Development is considered as one of the sectors with transaction of billions of birr in the Ethiopian market. Real estate contributes about 15% of the overall GDP of the country (Bewket, 13 January 2014). However, the trend of real estate development in the country shows problems that the sector faces are growing in leaps and bounds (Muluken, 15 April 2013).

Problems that exist in the real estate development makes the environment susceptible to uncertainty. An uncertain environment involves risk and compared with many other industries, the construction industry is subject to more risks due to the unique features of construction activities (Flanagan and Norman, 1993, Akintoye and MacLeod, 1997, Smith, 2003).

In construction projects, risk may be defined as the likelihood of a detrimental event occurring to the project. Since the objectives of construction projects are usually stated as targets established for function, cost, time and quality, the most important risks in construction are the failure to meet these targets. However, risks are not always associated with negative outcomes (Baloi and Price, 2003).

Risk allocation, the definition and division of responsibility associated with a possible future loss or gain, seeks to assign responsibility for a variety of hypothetical circumstances should a project not proceed as planned (Uff and Odams, 1995). As part of a risk management strategy it is commonly defined through contractual documents, such as real estate purchase contracts in the case of real estate development projects. Commonly the buyer/client and the real estate developer are the two parties who get into contractual relationship. How risk is allocated among the two can significantly affect project cost and performance (Zaghloul and Hartman, 2003).

The motive of this research is to identify risk factors in real estate development projects and their impact on project objectives, examine the current practice of risk allocation in real estate purchase agreements and provide a practical mechanism that can be used by real estate developers to allocate risks properly.

1.2 Statement of the Problem

Non-delivery of housing projects on time is one of the major problems affecting trustworthiness of real estate developers (Muluken, 15 April 2013 , Bewket, 13 January 2014). Research shows that there exists problems of land management, inadequate infrastructure, low construction capacity of developers or contractors hired for construction, poor borrowing capacity, low affordability (Eshete and Teshome, 2015), price escalation (Kiros, 2009, Paulos, 2011, Eshete and Teshome, 2015) slow and insufficient supply of land, foreign currency shortage, and shortage of housing construction materials. In addition, inflation and non-existence of long term housing finance were factors which affected the real estate market (Kiros, 2009). All these problems are risks to real estate projects since they create uncertainty.

Contract agreement is the primary vehicle for risk allocation to the construction project parties through contract conditions and clauses (Alsalman, 2012). Risk allocation is very important for project success. If risk is not allocated to the party that is best able to manage it efficiently and effectively but to party with the least amount of control and influence over risk, this is going to have an adversarial effect on the project (Alsalman, 2012).

It is important to know what risks exist in the real estate development projects and their impact on project objectives. Many different researches were done on risk prioritization. This include the

works of Hastak and Shaked (2000), (Shen et al. (2001), Thomas et al. (2003)), San Santoso et al. (2003), Zou et al. (2006), Dikmen and Birgonul (2006), Hsueh et al. (2007), Majid P. Jalal et al. (2008), Zayed et al. (2008), El-Sayegh (2008), Bu-Qammaz et al. (2009), Tavakkoli-Moghaddam et al. (2011), Dusane and Bhangale (2012), Tadayon et al. (2012), Li et al. (2013), Aboshady et al. (2013), Altoryman (2014), Addis (2014), Sohrabinejad and Rahimi (2015), El et al. (2015), and Aras and Amirhosseini (2016). These reviewed researches have covered residential projects, real estate development projects, high rise buildings, highway projects, dam construction project and modular construction. Joint ventures, Build-Operate-Transfer (BOT), and Engineering, Procurement and Construction (EPC) contracts were also considered by different authors. One of these researches, regarding building projects in Ethiopia, was done by Addis in 2014.

Similarly, researches have been done on risk allocation in construction projects. These include risk allocation models suggested by Bing et al. (1999), Bing et al. (2005), Lam et al. (2007), Majid P. Jalal et al. (2008), Favié et al. (2009), Jin and Doloi (2009), Jin and Zhang (2011), Jin and Zhang (2011), Khazaeni et al. (2012), Nasirzadeh et al. (2013), Rouhparvar et al. (2014), Issa et al. (2015), and Nasirzadeh et al. (2015) were reviewed. From these risk allocation models, some focused on PFI/PPP and some on construction projects generally. Joint-venture and multiparty projects were also areas of concern.

However, the researcher couldn't find any research paper on construction or real estate risk and its allocation in Ethiopia. Therefore, this study aims at identifying the major risks in real estate development and studying how risks are allocated in real estate purchase contracts. This study will compare risk allocation in real estate purchase agreements with allocation decision made by a decision mechanism provided in this research.

1.3 Research Questions

Research questions are formulated as follows.

1. What are the different risk factors related to real estate development projects?
2. What are the key risk allocation principles?
3. Which risk factors have a greater impact on private real estate development project cost and schedule?
4. What risks are allocated to whom (developer or client) in private real estate purchase contracts according to current practice?
5. How risks should be allocated to whom (developer or client) in private residential real estate purchase agreements?

The first and the second questions are answered by a review of relevant literature addressing risk management and risk allocation in the construction industry in general and in the real estate development in particular. The third and partly the fifth questions are answered by survey questionnaires and analysis of the survey results. The fourth question is answered by reviewing the real estate purchase agreements being used currently in the industry. Part of the fifth question is answered by development of a mechanism that aids risk allocation decision fourth question risk allocation mechanism.

1.4 Objectives of the Study

The main goal is to provide professionals working in real estate development projects a mechanism that will support them in making contractual risk allocation decision particularly in real estate

purchase agreements that can serve as an alternative way of allocating risks. The specific objectives of the study are listed below.

1. Identify risk factors related to real estate development projects.
2. Prioritize the risk factors according to their impact on project cost and schedule.
3. Evaluate risk factors against contractual risk allocation criteria.
4. Assess how risks are allocated in real estate purchase agreements of real estate development projects in Addis Ababa, Ethiopia.
5. Provide a mechanism that supports real estate developers in making contractual risk allocation decision particularly in real estate purchase agreements.

1.5 Research Methodology

The research started with a comprehensive literature review of the available work reported on risk management in construction and real estate industries and allocation of risks. The review was basically undertaken to identify risk factors associated with real estate development and risk allocation criteria. Data on the impact of identified risk factors was obtained using a questionnaire survey. The data collected were qualitative in nature and the analysis is a quantitative one. The impact assessment was conducted with the use of Fuzzy Set Theory and the risks are ranked according to their impact on project schedule and cost. The risk factors were also evaluated against risk allocation criteria identified from literature. The next step was the review of real estate purchase contract documents in order to understand the current contractual risk allocation practice in residential real estate development since they indicate the risk management strategy of developers. Finally, a risk allocation mechanism based on risk allocation principles is proposed

and the output of the tool is compared with contractual risk allocation in residential real estate purchase agreements.

1.6 Significance of the Research

Real estate development as a business venture dates back about quarter of a century in Ethiopia and the industry is suffering from various difficulties due to different factors. Risks associated to Real Estate Developments affect projects negatively and this is not an issue that can be ignored. Risk allocation is one of the approaches deployed in risk management and it is important for project success. Therefore, this study will be a stepping stone by giving a broader insight on risks and their impact on project objectives, mainly cost and schedule. Furthermore, it can serve as a risk allocation decision aid for practitioners and real estate development companies in Addis Ababa. It is believed this could help the companies move towards a better risk management practice.

1.7 Scope and Limitation of the Research

This research deals with contractual risk allocation in private real estate purchase contracts by focusing on residential real estate development firms working in Addis Ababa, Ethiopia who build or have builders build housing projects and control the process of development from the beginning to end. Real estate agents and developers who sell houses or apartments after construction is completed are not included in the study.

Since the risks associated to real estate projects have high scope, aspects concerning the real estate market are not addressed in order to focus on real estate associated risks with reference to construction risk management.

1.8 Organization of the Research

This thesis is divided into five chapters. Chapter One is an overview of the research and Chapter Two is the review of previous research works. Chapters Three presents design of the research, and the methodologies applied for data collection and analysis. Chapter Four covers results and discussion with decision support mechanism of risks allocation in real estate purchase contracts. The last chapter covers the main conclusions and recommendations of the research, and indicates the way forward for future research.

2. LITERATURE REVIEW

2.1 Introduction

This chapter presents a thorough conceptual and empirical review of relevant literature on real estate development, risk management and risk allocation. The research focused mainly on thesis works, conference proceedings and articles published in academic journals specialized in construction engineering and management, project management, risk management, systems engineering, engineering management, and management science. Reports and newspapers were also reviewed in addition.

The electronic databases used for searching research works were Science Direct, Web of Science, ABI-Inform Complete (Proquest), Business Source Premier (EBSCO) and Emerald Insight. Google Scholar search engine was utilized to support the review of published literature. Addis Ababa University's electronic library was also used for accessing local thesis works together with few hard copies. The key words used in the search were construction risk, project risk, construction risk management, risk modelling, risk allocation and real estate risk. Yet, different combinations of them were used to ensure the extensiveness of the search.

This chapter consists of four sections. The first section defines real estate development and gives a general overview of real estate development in Addis Ababa, Ethiopia. The second section defines and discusses risk and risk management, identifies risks related to real estate development through a comprehensive review of literature and covers risk prioritization methods used and suggested by different authors. The third section covers principles and approaches to risk allocation mainly with regard to contracts and review of risk allocation models. Lastly summary

of the literature review is presented by discussing the gap in the literature and highlighting the need for this research.

2.2 Real Estate Development

2.2.1 Real Estate Development in General

As Khedekar and Dhawale (2015) put it, the term real estate stands as land, including the air above and the ground below it and any buildings or structures on it. It covers residential housing, commercial offices trading spaces such as theatres, hotels and restaurants, retail outlets, industrial buildings such as factories and government buildings. Real estate involves the purchase, sale, and development of land, both residential and non-residential buildings. The main players in real estate market are the developers, builders, real estate agents, tenants, buyers, etc., and the activities of real estate sector encompasses the housing and construction sector (Khedekar and Dhawale, 2015). Isaac, Balchin and Chen (2000: 320) define development with respect to real estate or property as a process of conversion (development or redevelopment) of land from one use to another (Truneh, 2013).

Real estate development is linked with specialization in the sense that a person develops land and property for sale or rent (Truneh, 2013). Wiegelmann (2012) cited Wilkilson and Reed (2008:2) adopted the definition that real estate development is "a process that involves changing or intensifying the use of land to produce buildings for occupation."

A developer can be defined as the person or firm that is actively involved in the development process and takes the risks and receives the rewards of development (Truneh, 2013). Developers

can be distinguished by their product categories which are residential, commercial and special use (Wiegelmann, 2012).

2.2.2 Private Residential Real Estate Development in Ethiopia

Private real estate development started during the Haile Selassie Regime. The Bole Housing Project was one of the private housing projects which was undertake by a company known as Continental Homes, Eth. P.L.C. This company built 'The Bole Homes' near the Haile Selassie Airport (currently known as Bole International Airport). The pamphlet of this project shows the undertaking of this housing project was jointly guaranteed by the Government of Ethiopia and the United States.

Private development of houses as a formal commercial activity was abolished by the Government during the Derg Regime (Libanos, 2005). But real estate development as commercial housing started again during the regime of Ethiopian People's Revolutionary Democratic Front (EPRDF) after the adaption of free market economy in 1991 (Eshete and Teshome; 2015, Truneh, 2013).

A number of investors have involved in the development of real estate in Ethiopia. According to the data from Addis Ababa City Administration Land Management and Construction Licensing Authority which was collected in the 2011/2012 fiscal year, 124 investors have received business licenses to work in the real estate development sector of Addis Ababa (የቤቶች ልማት, 2012).

Real Estate development is considered as one of the sectors with transaction of billions of birr in the market. Real estate contributes about 15% of the overall GDP of the country (Bewket, 13 January 2014). However, the trend of real estate development in the country shows problems that the sector faces are growing (Muluken, 15 April 2013).

Researches concerning real estates in Ethiopia mainly in Addis Ababa show the real estate development sector faces different problems and challenges. Eshete and Teshome (2015) examined the performance, challenges and prospects of real estate financing in Addis Ababa with a micro and macro outlook. The result of their research shows problems of land management, inadequate infrastructure, low construction capacity of developers or contractors hired for construction, poor borrowing capacity, price escalation, and low affordability are some of the challenges and shortcomings of real estate development in Addis Ababa. Kiros (2009) also assessed and described the factors affecting the real estate market and shares similar results with Eshete and Teshome (2015). Kiros stated that there exists a slow and insufficient supply of land, foreign currency shortage, shortage and price escalation of housing construction materials. In addition, inflation and non-existence of long term housing finance were factors which affected the real estate market. He outlined that there is a considerable decline in sales and that housing prices are less affordable in the market. Similarly, research done by Paulos (2011) on private residential real estate developers shows price escalation and devaluation of birr are major challenges.

Findings of Paulos (2011) also show that a major delay in handing over was a point most real estate developers agreed. Price escalation and shortage of construction materials, and lack of adequate finance were the major causes to the delay. Adverse climatic conditions and unavailability of skilled labors were also found to have a significant causes of delay.

Non-delivery of housing projects on time is one of the major problems affecting trustworthiness of real estate developers (Muluken, 15 April 2013; Bewket, 13 January 2014). Only 15 of them have completed the houses and transferred houses to the hands of their clients and four of them

were kicked out while the rest are still with incomplete houses for up to ten years (Bewket, 13 January 2014).

As per the report of Land Administration and Building Permit Authority of the City Administration, the usual excuses mentioned as major challenges by developers are delay in handing over of the site on the part of the City Administration, delay in provision of infrastructure, price escalation of building materials and lack of finance (Truneh, 2013). According to experts and developers, the major problems were delays in the original timetable due to lack of available accessible land, finances obtained from clients for housing projects being used for other purposes and the shortage of experienced and organized professional teams to handle such huge investments (Muluken, 15 April 2013).

Delays affect not only the clients but also developers themselves since delay causes rise in initial cost which was originally estimated by the contractors for a specific project in relation to inflation, foreign currency exchange and other issues. Still, clients mostly become the primary victims of the delay incurred since they are definitely expected to cover the additional cost. Whereas, real estate developers also argue that some of them may become bankrupt, forcing them out of the market. Insufficient fund is also an issue which contributed in a major way to delays for long periods because customers are the only sources of finance in real estate projects (Muluken, 15 April 2013).

The Government is going to pass a new real estate development and transaction proclamation, which highly favors real estate buyers by providing guarantees to customers, requiring real estate developers to deliver homes on time (Meron, 05 June 2012; Muluken, 15 April 2013). Even if a

draft proclamation is developed by the Ministry of Urban Development and Construction (MoUDC), the proclamation is not official yet. Still, it is understood that real estate developers should be conscious about their project schedule. Not only because of the proclamation but also because not meeting project phases and delivery deadlines has cost implications (Muluken, 15 April 2013). Therefore, since risks have impact, developers need to manage risks and minimize their impact on project objectives and their business as a whole.

2.3 Risk and Risk Management

2.3.1 Definition of Risk

Risk has been defined differently in reviewed literatures. Most definitions of risk have focused on the negative side of risks such as losses or damages which is the downside of it (Schieg, 2006). This definition which signify the negative aspect has been connoted as a traditional view of risk (Simon et al., 1997; Hillson, 2002; Teneyuca, 2001; Zhang et al., 2006; Wiegelmann, 2012; Khedekar and Dhawale, 2015).

Some literatures encompassed both the possibility of downside/loss and upside risk /gain, i.e. uncertainties that could have a beneficial effect on achieving objectives (Williams, 1995; Hillson, 2002; Ward and Chapman, 2003; A. Faridi and El-Sayegh, 2006; Lam et al., 2007; Wiegelmann, 2012; PMI, 2013; Renuka et al., 2014; El et al., 2015). Schieg (2006) presented a theoretical meaning of risk, as a positive or negative deviation of a variable from its expected value. Fisk and Reynolds (2011) put a similar meaning of risk.

Though risk has both upsides and downsides, only the downside of risk is to be considered in this study. This is because problems which exist in the real estate development sector might affect both

clients and developers negatively, and it is the prior objective this research to provide a way to allocate risk which can help in minimizing the effects of risks.

2.3.2 Risk and Uncertainty

Risk and uncertainty might be found being used interchangeable in different literatures. However, PMBOK describes risk through the notion of uncertainty, risk has its origins in the uncertainty present in all projects. "Project risk is an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality" (PMI 2013: 310) which shows these two phenomena are not synonymous.

According to Al-Bahar (1990), uncertainty represents the probability that an event occurs which entails how likely an event is to occur, i.e., the chance of the event occurring. Renuka et al. (2014) Alsalman (2012) and Al-Bahar (1990) defined risk as exposure to the consequences of uncertainty. Similarly, Khedekar and Dhawale (2015) defined risk as exposure to the possibility of loss or gain, as a consequence of the uncertainties associated with pursuing a particular course of action. Olsson (2007) and Hillson (2004) put risk as a measurable uncertainty and uncertainty as an immeasurable risk, which implies that, when measurable, an uncertainty is to be considered as risk. Byrne (1996) defines risk as a term appropriate for situations where it is possible to define probability distributions for probable outcomes and uncertainty as a term that better suits situations where such probability distributions cannot be made. This definition clearly indicates the distinction between risk and uncertainty, stating risk is measurable and quantifiable, and that uncertainty is not measurable and cannot be quantified (Alsalman, 2012). These definitions highlight the distinction between the two terms which is related to its quantification (Wiegelmann, 2012; KarimiAzari et al., 2011).

2.3.3 Risk Management

Risk management is defined in different ways by authors. Edwards and Bowen (1998) and El et al. (2015) defined risk management as a systematic approach to dealing with risk. According to Uher (2003) risk management is "a systematic way of looking at areas of risk and consciously determining how each should be treated. It is a management tool that aims at identifying sources of risk and uncertainty, determining their impact, and developing appropriate management responses. " Risk management is also defined as a scientific approach of identifying, anticipating and minimizing the possible adverse impacts on the projects (Koirala, 2014).

Risk management is also presented as a process in reviewed literature. To name a few, Koirala (2014) defined risk management as a set of processes concerned with conducting risk management planning, risk identification, risk analysis, response planning, and monitoring and control on a project. Thompson and Perry (1992) and El et al. (2015) presented risk management as a systematic process of identifying, analyzing, and responding to project risk, and it includes maximizing the probability and consequences of positive attributes and minimizing the probability and consequences of attributes adverse to project objectives.

A risk management process typically comprises establishment of context, risk identification, risk analysis, risk evaluation and risk response (Perry and Hayes, 1985; Edwards and Bowen, 1998; Uff and Odams, 1995; Lyons, 2003; Wiegelmann, 2012; Mead, 2007; Lam et al., 2007; Wysocki, 2011; Berkeley et al., 1991; Flanagan and Norman, 1993). It establishes a strategy to avoid losses and use available chances or rather chances potentially arising from risks and influence risk decision-making (Edwards and Bowen, 1998; Raftery, 1994; Flanagan and Norman, 1993; Baloi and Price, 2003; Schieg, 2006). This means recognizing potential risks and circumventing a threat

by averting, evading or reducing their negative effects (Schieg, 2006; Mead, 2007) and realizing potential opportunities (Mead, 2007).

Zavadskas et al. (2010) share a similar view that risk management is a process of defining sources of uncertainty (risk identification), estimating the consequences of uncertain events/conditions (risk analysis), and generating response strategies in the light of expected outcomes and finally, based on the feedback received on actual outcomes and risks emerged, carrying out identification, analysis and response generation steps repetitively throughout the life cycle of an object to ensure that the project objectives are met.

Each PMI knowledge area in itself contains some or all of the project management processes. For example, project risk management includes (PMI, 2008):

- Risk management planning;
- Risk identification;
- Risk analysis;
- Risk response planning;
- Risk monitoring and control.

i. Risk Management Planning

Risk management planning is a process of defining how to conduct risk management activities for a project. It is a very important process for the success of a project and therefore, the process should begin as a project is conceived and should be completed during project planning (PMI, 2013).

ii. Risk Identification

Risk identification is the first and perhaps the most important step in the risk management process (Wang and Chou, 2003) for the very reason that, without identifying a risk, it is impossible to analyze, assess, or control it (Wiegelmann, 2012). Risks should be identified if they are to be. In practice, the primary aim should be to identify the key, critical, important risks in the project so that they can be analyzed and an appropriate response can be determined because considering every risk is wasteful, inefficient and doomed to failure (Andi, 2006).

Risk identification attempts to identify the source and type of risks including the recognition of potential risk event conditions in the construction project and the clarification of risk responsibilities (Wang and Chou, 2003). Risk identification develops the basis for the next steps: analysis and control of risk management (Carbone and Tippett, 2004).

iii. Risk Analysis

Risk analysis is the systematic assessment of decision variables which are subject to risk and uncertainty. Risk analysis aims at taking the inherent uncertainty of costs (or duration) of individual activities or elements within a project when assessing the anticipated final cost of a particular scheme. This enables the project director to evaluate the likelihood of meeting budget or time limits (Mack, 1995). It comprises the establishment of probabilities of occurrence of adverse events; the setting of assumptive bounds to associated uncertainties; and the measurement of the potential impact of risk event outcomes (Edwards and Bowen, 1998) in a qualitative or in a quantitative way (Gehner et al., 2006).

There exist numerous risk analysis techniques that are described in the context of project and construction management, such as sensitivity, scenario, or stochastic analysis, the expected-monetary-value method, risk-adjusted-discount rate method and real options (Gehner et al., 2006).

iv. Risk Response

Risk can be transferred, accepted, managed, minimized, or shared, but cannot be ignored (Latham, 1994). Risk response is a process of developing options an actions to enhance opportunities and to reduce threats to project objectives (PMI, 2013). It aims at deciding whether or not to accept the total of risks in a project (Gehner et al., 2006).

Risk response is a decision supported by a risk analysis (Gehner et al., 2006). The decision is based on the willingness to knowingly take risks (Simon et al., 2000). One can take measures to risk according to the four general types of risk response methods: avoidance, reduction, transfer, and acceptance of a risk (Gehner et al., 2006). According to Chapman (1997), mitigating actions are normally based on classical approaches such as: risk avoidance/ mitigation, risk sharing, risk transfer or risk acceptance providing a suitable contingency. Once risk is accepted, there are three main approaches for risk allocation, either to retain the risk, transfer it or share it (Alsalman, 2012).

The risk mitigation actions are discussed here below.

a) Risk avoidance

Risk avoidance, prevents any risks from materializing by reducing their likelihood to nil. Given an existing risk, risk avoidance implies the intentional exclusion of potential opportunities (Haller, 1986). Risk avoidance will generally apply only where a risk represents a significant exposure

potential when using alternative management measures and if it exceeds the risk appetite of an organization (Wiegelmann, 2012).

b) Risk reduction

Risk reduction is the prevention or limitation of loss by decreasing the likelihood of a disturbance occurring and its significance is called risk reduction (Haller, 1986). Risk reduction measures are called reactive measures. They are for risks that do not appear suddenly, which rather emerge over a period of time. Risk reduction measures may be taken even after the risk has materialized (Wiegelmann, 2012).

c) Risk transfer

Risk transfer is an action of transferring business implications of risks to external risk bearers (Laster, 1999). It does not eliminate the cause of risk but only passes the implications of risks on to third parties. Risk transfer can also be done by spreading the implications across multiple partners, with not only the risk but also the profit being shared among the partners or by entirely ; transferring the risk to third parties entirely (Wiegelmann, 2012).

The shifting of risk is the safest type of risk management; however, it is associated with relatively high costs and limited applicability. Certain risks, for example, may be transferred to suppliers or customers by way of contractual arrangements (Wiegelmann, 2012).

Contractual exclusions, limitations of liability, indemnity clauses, risk transference, guarantees, performance bonds and insertion of a risk premium are within mitigation strategies particularly risk transference (Mead, 2007).

d) Risk retention

Risk retention involves a voluntary and involuntary assumption of possible risk implications (Laster, 1999). Relevant risks and their possible impact on the investment decision are deliberately accepted with the risk appetite of the investor being taken into consideration (Wiegelmann, 2012).

v. Risk Monitoring and Control

Risk monitoring is a process examining to what extent operation adheres to the planned standards across all units and functions. It determines whether the established goals have been met, risk management complies with risk policy, the organization is efficiently designed and a corresponding risk culture is in place, and whether responsibilities have been clearly defined. It is done by gathering and analyzing data through key indicator analysis and benchmark comparisons, among others, and reported both internally to the responsible functions and externally to its stakeholders (Wiegelmann, 2012).

Risk control is intended to actively influence the risks identified and assessed in order to manage all significant loss exposures through the targeted use of risk management measures (Wiegelmann, 2012). It is a process of implementing risk response (PMI, 2013).

2.3.4 Risks Related to Real Estate Development Projects

Risk management has become increasingly important for any commercial organizations operating in today's environment (Mead, 2007; Groton et al., 2010; Wiegelmann, 2012) where risks are inherent (Mead, 2007). It is important that risks identified, understood, anticipated, assessed, analyzed, and to learn to manage risks (Groton et al., 2010; Wiegelmann, 2012). "Failure to

accurately identify and make appropriate allowance for risks being assumed under complex commercial and contractual arrangements can have terrible consequences" (Mead, 2007).

The construction business is risky like any other business (El-Sayegh, 2008; Taroun, 2014). Risks are inherent in all construction projects (M. Motiar and M.M, 2002; Dey and Ogunlana, 2004; El-Sayegh, 2008) because the construction industry is one of the most dynamic, risky, challenging, and rewarding fields (Sterman, 1992; Kangari, 1995; Uher and Loosemore, 2004; Zeng et al., 2007). Flanagan and Norman (1993) argued that the construction industry is subject to more risks and uncertainties than any other industry. Dey and Ogunlana (2004) have the same opinion.

There is no risk free construction project (Lam et al., 2007). Construction projects are always unique (Oyegoke, 2006; Pheng and Chuan, 2006) and are built only once (Zavadskas et al., 2010). In addition, construction involves numerous stakeholders and long production durations (Zou et al., 2007) which increase the susceptibility for uncertainty.

The outcomes of all construction projects can potentially be affected adversely by a large number of risks (Loosemore and McCarthy, 2008). The construction process is complex and characterized by a number of uncertainties which make many construction projects fail to achieve their time, cost and quality goals (Mohammad and Jamal, 1991; Zhang et al., 2006; Zeng et al., 2007; Zavadskas et al., 2010; Baloi and Price, 2003; Banaitiene and Banaitis, 2012). Project risks may even cause construction project a total failure (Banaitiene and Banaitis, 2012).

Risks and uncertainty are inevitable in the construction industry. Incorporating risk management concepts into construction practice is important for managing uncertainty and risk (KarimiAzari et al., 2011), for the enhancement the performance of a project (Nasirzadeh et al., 2008) and for

the successful delivery of a project (Zou et al., 2006). However the construction industry is not with a good reputation of coping with risk. Many projects fail to meet deadlines, cost targets, and specifications (Dey and Ogunlana, 2004).

The real estate development business shares the risky nature of construction as well. Risks and uncertainties are associated with all projects in real estate development like any other commercial activity. As mentioned earlier, these risks and uncertainties can strongly influence all related progresses at all stages of the entire lifecycle of properties (Chen and Khumpaisal, 2009).

Wiegelmann (2012) says as best applied to the real estate development industry, the definition of risk is but not limited to an element of uncertainty aligned with expectations and objectives of a real estate development organization within a specified time horizon and budget differentiating between negative (threat) and positive (opportunity) aspects of risk. Yet, it is the downside of risk this research is concerned with.

As discussed before, construction projects life cycle is full of various risks (Zavadskas et al., 2010). Risks raise from a number of different sources (Oyegoke, 2006; Pheng and Chuan, 2006; Zavadskas et al., 2010). Construction site, the size and complexity of construction objects, technology being used, speed of construction, and political, economic and social conditions are to be mentioned (Zavadskas et al., 2010; Dey and Ogunlana, 2004) .

Risk classification is a significant step in the risk management process, as it helps structure the diverse risks affecting a construction project (Zou et al., 2006). There are different ways of risk classification recommended in literature (Tah et al., 1993; Zou et al., 2006; Baloi and Price, 2003; El-Sayegh, 2008; Zavadskas et al., 2010).

Some classifications are related to project phases (e.g. design, construction and operation), others with the environment of the project (e.g. political, economic, environmental, and financial) or related levels where the risk occurs (e.g. macro level and micro level) (Issa et al., 2012).

Classifying according to their sources, positive/negative, estimated cost or likely impact, likelihood of occurrence, or countermeasures required is also an approach (Baloi and Price, 2003). It is also common to classify project risks into sets of classifications like dynamic/static, corporate/individual, internal/external, positive/negative, acceptable/unacceptable and insurable/non-insurable (Baloi and Price, 2003). Risks may also differentiate between strategic and operational risks (Wiegelmann, 2012).

Another approach of project risk classification is pure risk versus speculative risk (Vaughan, 2003, Alsalman, 2012). Pure risk involves situations that can only end in a loss and speculative risks on the other hand are situations that might end in a loss or a gain. Pure risks are more static due to their nature while speculative risks are dynamic and changing (Alsalman, 2012).

Baloi and Price (2003) mentioned most categorizations considered the source criteria as the most important. According to this criteria, a broad classification of construction project risks could be: technical, construction, legal, natural, logistic, social, economic, financial, commercial and political. Risks can also be categorized into dynamic/static, corporate/individual, internal/external, positive/negative, acceptable/unacceptable and insurable/non-insurable.

External risks are those that are prevalent in the external environment of projects and are relatively non-controllable and so there is the need to continually scan and forecast these risks and in the context of a company's strategy. External risks are due to inflation, currency exchange rate

fluctuations, technology change, major client induced changes, politics, climate, weather condition and major accidents or natural disasters. Internal risks are relatively more controllable and vary between projects and cover uncertainties due to labor, plant, material and subcontractor, resources and the site conditions (Renuka et al., 2014).

Renuka et al. (2014) included the different categorizations used by many authors in review of literature. Many researchers classified risk factors into different types depends on the nature of risk such as Physical, Environmental, design, Financial, Contractual / legal, Construction, Political, Management, Natural hazards, Safety and Delay risk (Mustafa and Al-Bahar, 1991; Akinci and Fischer, 1998; Dey, 2002; Ghosh and Jintanapakanont, 2004; Wiguna et al., 2005; Wang et al., 2004; Rezakhani, 2012; Goh et al., 2012).

Tah and Carr (2001) suggested a two level hierarchy classification of project risks two levels being external and internal risks. Flanagan and Norman suggested three ways of classifying risk: based on consequence, type, and impact of risk. Chapman (2006) grouped risks into four subsets: environment, industry, client and project. Shen-fa and Xiao-ping (2009) grouped project risks into six according to the nature of the risks, i.e. financial, legal, management, market, policy and political, as well as technical risks. suggested three levels for project risk classification: external, project, and internal levels along with the source of each level (Alsalman, 2012). Rezakhani (2012) classified the risk factors into external, legal and internal. External risk was sub divided into two subsets: unpredictable/ uncontrollable, predictable/ uncontrollable and Internal risk was sub divided into two subsets: Non-technical/ controllable, Technical / controllable (Renuka et al., 2014). Khedekar and Dhawale (2015) classified risks in real estate projects considering

stakeholders who involve in projects and the groups are lender's perspective of Risks, developer's perspective of risks, government's perspective of risks and contractor's perspective of Risks.

For the purpose of this research, the author has adopted a simplified classification based on nature of risks. Four categories are selected and these are Economic and financial, Technical and Environmental, Governmental and Political, and Legal and contractual. Nature of risk is used as a selection criteria assuming it helps consider the concerns of real estate purchasing agreement between a real estate developer and the buyer/client than other criteria mentioned earlier whether the risks under the selected categories are pure/speculative, static or dynamic, controllable/uncontrollable. Forty two risk factors identified from numerous researches done on real estate and construction projects varying in type, size and delivery systems etc. are collected and are grouped according the four classifications adopted in this research as shown in Table 2.1. The classification and the risk factors included herein are those which could possibly be the concerns for both parties, the developer and the client/buyer, and could be included in purchase agreements.

Table 2.1 Risk Factors from Literature

No	Risk Factors	Author
Economic and Financial		
1	Exchange rate fluctuation	Al-Bahar (1990), Mustafa and Al-Bahar (1991), Edwards and Bowen (1998), Bing et al. (1999), Ökmen (2002), Baloi and Price (2003), Dey and Ogunlana (2004), FSA (2005), Morledge et al. (2006), FSB (April 2007), Hsueh et al. (2007), El-Sayegh (2008), Bu-Qammaz et al. (2009), Mojtahedi et al. (2010), Fu-zhou and Hong-yuan (2011), Hartmann et al. (2011)), Banaitiene and Banaitis (2012), Aboshady et al. (2013), Yoon et al. (2014), El et al. (2015).
2	Inflation rate fluctuation	Al-Bahar (1990), Kangari (1995), Edwards and Bowen (1998), Bing et al. (1999), M. Motiar and M.M (2002), Ökmen (2002), Baloi and Price (2003), Vaughan (2003), Bing et al. (2005), Andi (2006), Zhang et al. (2006), Lam et al. (2007), Hossen (2007), Hsueh et al. (2007), Loosemore and McCarthy (2008), El-Sayegh (2008), Bu-Qammaz et al. (2009), Mojtahedi et al. (2010), Hartmann et al. (2011), Khazaeni et al. (2012), Banaitiene and Banaitis (2012), Nasirzadeh et al. (2013), Aboshady et al. (2013), Renuka et al. (2014), Yoon et al. (2014).
3	Interest rate fluctuation	Edwards and Bowen (1998), Ökmen (2002), Baloi and Price (2003), (FSA, 2005), Nabarro and Key (2005), FSA (2005), Bing et al. (2005), Gehner et al. (2006), FSB (April 2007), Frodsham (2007), Hsueh et al. (2007), Sagalyn (2009), Hartmann et al. (2011), Fu-zhou and Hong-yuan (2011), Banaitiene and Banaitis (2012), Aboshady et al. (2013), Yoon et al. (2014), El et al. (2015).
4	Tax rate increase	Ökmen (2002), Baloi and Price (2003), Bing et al. (2005), Hossen (2007), Mojtahedi et al. (2010), Banaitiene and Banaitis (2012), Aboshady et al. (2013), Yoon et al. (2014), (El et al., 2015).
5	Increase in customs	Aboshady et al. (2013)
6	Increase in oil price	Mojtahedi et al. (2010)

7	Construction material price escalation arising above the estimated allowances	Baloi and Price (2003), Zou et al. (2006), Zou et al. (2007), Hsueh et al. (2007), Hossen (2007), El-Sayegh (2008), Aboshady et al. (2013), Kuo and Lu (2013), El et al. (2015).
8	Changes in labor costs	Ökmen (2002), Baloi and Price (2003), Hsueh et al. (2007), Hossen (2007), Nasirzadeh et al. (2013), Kuo and Lu (2013), Aboshady et al. (2013).
9	Financial failure of any party	Kangari (1995), M. Motiar and M.M (2002), Ökmen (2002), Andi (2006), Loosemore and McCarthy (2008)
10	Bankruptcy	Hsueh et al. (2007), Rasool et al. (2012).
11	Availability of local labor	Al-Bahar (1990), (Kangari, 1995), Edwards and Bowen (1998), Ökmen (2002), Zou et al. (2006), Zou et al. (2007), Lam et al. (2007), M. Motiar and M.M (2002), Danter (2007), Hsueh et al. (2007), Hossen (2007), El-Sayegh (2008), Zayed et al. (2008), Loosemore and McCarthy (2008), Khazaeni et al. (2012), Yildiz et al. (2014), Yoon et al. (2014), El et al. (2015).
12	Availability of material	(Kangari, 1995), Edwards and Bowen (1998), Ökmen (2002), M. Motiar and M.M (2002), Andi (2006), Zhang et al. (2006), Zeng et al. (2007), Hsueh et al. (2007), Loosemore and McCarthy (2008), Khazaeni et al. (2012), Yildiz et al. (2014), Yoon et al. (2014).
Technical and Environmental		
13	Weather conditions (wind, temperature, rain, and so forth)	Edwards and Bowen (1998), M. Motiar and M.M (2002), Ökmen (2002), Baloi and Price (2003), Bing et al. (2005), Zhang et al. (2006), Lam et al. (2007), Hossen (2007), Hsueh et al. (2007), El-Sayegh (2008), Zayed et al. (2008), Mojtahedi et al. (2010), Fu-zhou and Hong-yuan (2011), Hartmann et al. (2011), PMI (2013), Li et al. (2013), Renuka et al. (2014), Yoon et al. (2014), El et al. (2015).
14	Natural disaster (flood, earthquake, landslide, fire, and so on)	Al-Bahar (1990), Mustafa and Al-Bahar (1991), Kangari (1995), Edwards and Bowen (1998), Ökmen (2002), M. Motiar and M.M (2002), Vaughan (2003), Bing et al. (2005), Zhang et al. (2006), Andi (2006), Zayed et al. (2008), Loosemore and McCarthy (2008), Fu-zhou and Hong-yuan (2011), Zhao et al. (2011), Hartmann et al. (2011), Hartmann et al. (2011),

		Banaitiene and Banaitis (2012), Rasool et al. (2012), Kuo and Lu (2013), Yoon et al. (2014), Renuka et al. (2014), El et al. (2015).
15	Subsurface conditions	Edwards and Bowen (1998), Ökmen (2002), Baloi and Price (2003), Bing et al. (2005), Zhang et al. (2006), Andi (2006), Lam et al. (2007), Hossen (2007), Zayed et al. (2008), Loosemore and McCarthy (2008), Hartmann et al. (2011), Khazaeni et al. (2012), Li et al. (2013), Yoon et al. (2014), El et al. (2015).
16	Poor site condition (location, accessibility of site, etc...)	Al-Bahar (1990), Mustafa and Al-Bahar (1991), Kangari (1995), M. Motiar and M.M (2002), Baloi and Price (2003), Lam et al. (2007), Zeng et al. (2007), Yoon et al. (2014), El et al. (2015).
17	Change of client's interest in design	El-Sayegh (2008), Aras and Amirhosseini (2016)
18	Change of client's interest in type of construction material and in other related things	Aras and Amirhosseini (2016)
19	Quantity variations	Kangari (1995), M. Motiar and M.M (2002), Lam et al. (2007), Loosemore and McCarthy (2008), Hartmann et al. (2011), Khazaeni et al. (2012)
20	Lack of readily available utilities on site	Zou et al. (2006), Zou et al. (2007)
21	Availability of infrastructure	Yildiz et al. (2014)
22	Damage to Structure	Al-Bahar (1990), Mustafa and Al-Bahar (1991),
23	Unpredicted technical problems in construction	El-Sayegh (2008)
24	Impact of adjacent buildings	Fu-zhou and Hong-yuan (2011), Li et al. (2013).
Governmental and Political		
25	Delay in permits and licenses	Al-Bahar (1990), Bing et al. (2005), Hsueh et al. (2007), Hossen (2007), El-Sayegh (2008), Zayed et al. (2008), Kuo and Lu (2013), Yoon et al. (2014), Yoon et al. (2014), El et al. (2015).
26	Political interference	Yoon et al. (2014)
27	Bribery and Corruption	Hsueh et al. (2007), El-Sayegh (2008), Bu-Qammaz et al. (2009), Yoon et al. (2014), El et al. (2015).
28	Custom and import restrictions	Bing et al. (1999)

29	Relocation of projects due to development plans	Fu-zhou and Hong-yuan (2011), Khedekar and Dhawale (2015).
Legal and Contractual		
30	Vagueness of purchasing agreement/contract clauses	Yildiz et al. (2014)
31	Inappropriate risk allocation in purchasing agreement/contracts	Ward and Chapman (2003), Khedekar and Dhawale (2015).
32	Purchasing agreement/contract errors	Hartmann et al. (2011), Yildiz et al. (2014).
33	Delay in meeting milestone deadline	Bing et al. (2005), Gehner et al. (2006), Zayed et al. (2008), Zhao et al. (2011), Gohar et al. (2012).
34	Occurrence of claim and dispute	M. Motiar and M.M (2002), Zou et al. (2006), Zou et al. (2007), Zayed et al. (2008), Zhao et al. (2011).
35	Delays in resolving contractual issues	M. Motiar and M.M (2002), Andi (2006), El-Sayegh (2008).
36	Delays in resolving disputes	M. Motiar and M.M (2002), Ökmen (2002), Andi (2006), El-Sayegh (2008), Hartmann et al. (2011), Khazaeni et al. (2012).
37	Breach of contracts	Hsueh et al. (2007)
38	Communication between project parties	Bing et al. (1999), Ward and Chapman (2003).
39	Changes in laws, regulations, and policies	Al-Bahar (1990), Mustafa and Al-Bahar (1991), (Kangari, 1995), M. Motiar and M.M (2002), Ökmen (2002), Bing et al. (2005), Gehner et al. (2006), Andi (2006), Zhang et al. (2006), Lam et al. (2007), Hossen (2007), Hsueh et al. (2007), Loosemore and McCarthy (2008), El-Sayegh (2008), Hartmann et al. (2011), Banaitiene and Banaitis (2012), Khazaeni et al. (2012), Li et al. (2013), Yoon et al. (2014), (El et al., 2015).
40	Changes in requirements for permits and their approval	Al-Bahar (1990)
41	Inconsistency in government policies, laws, and regulations	Bing et al. (1999)
42	Existing codes and regulations	Edwards and Bowen (1998), M. Motiar and M.M (2002).

2.3.5 Risk Prioritization

Risk prioritization helps to identify risks that matter and to support decision-making and consideration of possible responses from individual risks or particular outcomes (Association, 2008). Risks can be prioritized with respect to project cost separately from project schedule or they can be prioritized based upon the combined impacts. Prioritizing risks helps determine which risks are high-cost and significant schedule delaying risks to a project (Parsons, 2004).

Researches have been done on risk prioritization by different researchers. Table 2.2 shows the methods used for risk prioritization and the type of construction projects and delivery methods they are applied on. The reviewed researches have covered residential projects, high rise buildings, highway projects, dam construction project and modular construction are. Joint ventures, Build-Operate-Transfer (BOT) and Engineering, Procurement and Construction (EPC) contracts were also considered in reviewed researches. One research, done by Aboshady et al. (2013), covered risks in Egyptian real estate development projects.

Different approaches have been adopted for prioritizing risk, and these include Risk Significance Index, Factor Analysis, Relative Importance Index, Probability-Impact Matrix, Fuzzy Techniques, Delphi Technique, Analytic Hierarchy Process, Analytic Network Process, Analytical Neural Network, Utility Theory, Technique for Order of Preference by Similarity to Ideal Solution, and Decision-Making Trail and Evaluation Laboratory.

The top ranked risks in the researches include political and financial risks, design related risks, availability of material and labor, contractor and sub-contractor related risks, delay, construction planning, coordination and control, and many other.

Table 2.2 Risk Prioritization Methods and Top Ranked Risks

Author	Method	Application	Top Ranked Risks
Hastak and Shaked (2000)	Analytic Hierarchy Process (AHP)	Construction	Societal conflicts, monetary inflation, market suitability for advanced technology, problems in technology transfer and implementation, and type of partnership
Shen et al. (2001)	Risk Significance Index	Sino-Foreign construction joint ventures in China	Cost increase due to changes of policies, improper project feasibility study, project delay, inadequate forecast about market demand and improper selection of project location
San Santoso et al. (2003)	Factor Analysis	High rise building construction in Jakarta	Change orders, problems in coordination of sub-contractors, slow payment by client, incomplete design scope and delay in material and shop drawing approval
Thomas et al. (2003)	Fuzzy-Delphi Technique	Build-Operate-Transfer (BOT) road projects - Indian	Administrative delay in land acquisition, delay due to litigation/agitation, delay due to increase in cost of land acquisition, delay due to non-availability of land and delay in financial closure due to delay in debt syndication
Zou et al. (2006)	Risk Significance Index	Construction projects	Tight project schedule, design variations, inadequate scheduling, excessive approval procedures in administrative government departments and variations by the client
Dikmen and Birgonul (2006)	Analytic Hierarchy Process (AHP) and Risk Breakdown Structure	International construction projects	Instability of political conditions, societal conflict/public unrest, poor performance of joint venture partner, strict quality requirements and immaturity of legal system
Hsueh et al. (2007)	Analytical Hierarchy Process (AHP) and Utility Theory	Construction joint ventures in China	Cost increase due to changes of policies, improper project feasibility study, project delay, inadequate forecast about market demand and improper selection of project location
Zayed et al. (2008)	Analytic Hierarchy Process (AHP) Risk Index Model	Chinese highway projects	Dependence on major power and hostilities with neighboring country or region (political), problems in technology transfer and implementation, current market volume in competency and financing difficulties because of tax or capital movement restrictions
Majid P. Jalal et al. (2008)	Fuzzy Set Theory	Iran's Dam construction Projects	With a priority winning a project rather than execution with a bidding lower tender price
El-Sayegh (2008)	Relative Importance Index (RII)	UAE construction industry	Owners' delayed payment to contractors ,owners' unreasonably imposed tight schedule, owners' improper intervention , change of design required by owners and lack of scope of work definition by owner

Bu-Qammaz et al. (2009)	Analytic Network Process (ANP)	International constructionprojects	Vagueness of contract clauses, poor performance of client, immaturity and (or) unreliability of legal system, poor performance of partners and change in regulations
Tavakkoli-Moghaddam et al. (2011)	Fuzzy Logic - Multiple Criteria Group Decision Matrix (MCGDM)	EPC Projects	International relations, delay in equipment delivery to site, critical weather conditions, subcontractor interfaces and ambiguity in project cash injection
Tadayon et al. (2012)	Non-parametric Test (mean)	Large Construction Projects in Iran	Financial, construction and demand and product risks
Dusane and Bhangale (2012)	Risk Factor Analysis	Residential Construction Projects	Delays in construction project, completion, cost and financial
Li et al. (2013)	Fuzzy Analytic Hierarchy Process (AHP)	Modular construction	Site condition, temperature, material and drawing quality, availability and skill of labor, drawing quality and supply time, construction planning, coordination and control, and condition of construction equipment
Aboshady et al. (2013)	Fuzzy Fault and Event Tree	Egyptian real estate development projects	Loss due to inflation, increase in price of raw materials and cost of equipment, currency devaluation and exchange rate fluctuation, and increase in borrowing interest rate
Addis (2014)	Probability-Impact Analysis	Ethiopian building construction projects	Financial difficulties, poor contract management, availability of material, low bid price and inaccurate time estimates
Altoryman (2014)	Relative Importance Index (RII)	Construction projects in Kuwait and Bahrain	*Kuwait*: Cost estimation accuracy, revising / approving design documents, shop drawings and sample materials, data collection and survey before design, material delivery and complete documents and drawings of projects *Bahrain:* Contractor's experience, cost estimation accuracy, material delivery, availability of construction materials in market and decision making process.
El et al. (2015)	Analytic Hierarchy Process (AHP)	Construction projects	Political, engineering and design, site location, contractor related and project management
Sohrabinejad and Rahimi (2015)	Fuzzy Analytical Neural Network, DEMATEL and TOPSIS	Construction Project Case Study	Inflation, change in managerial methods, delays in executive plan execution and human resource turnover
Aras and Amirhosseini (2016)	Fuzzy Logic	Case Study - Construction Project of Iran	Failure to welcome customers from project, change managers and officials associated with the project, changes in the design specification and scope of work, complexity of project and non-performance of contractual obligations and the provisions for meetings

According to the findings of Addis (2014), the top ranked risks in Ethiopian building construction projects are financial difficulty and poor contract management. Availability of material, low bid price and inaccurate time estimates were also found to have high impact on project objectives. Addis considered different project delivery methods and analyzed the level of risk in each delivery system. Addis' result shares similar risk factors with the works of Zou et al. (2006), Zayed et al. (2008), Majid P. Jalal et al. (2008), Tadayon et al. (2012), Dusane and Bhangale (2012), Aboshady et al. (2013), Altoryman (2014) and El et al. (2015).

2.4 Risk Allocation

Risk exists wherever the future is unknown (Fisk and Reynolds, 2011). The nature and extent of risks may change, new risks may emerge and existing risks may change in importance and any such changes may also aggravate or ease some other risks as a project progresses. (M. Motiar and M.M, 2002). Managing risks systematically and proactively is important (Kumaraswamy et al., 2001).

Risks play a significant role in business decision making (Wiguna et al., 2005; Taroun, 2014). Risks should be identified and a way to determine how to deal with those risks and the changing environment of risk by planning the risk response should be planned (Mubarak, 2015). Risk allocation is a major process of the risk response (Alsalman, 2012) .

2.4.1 Definition of Risk Allocation

Risk allocation always occurs in any situation where more than one party is responsible for the implementation of a project (Zaghloul and Hartman, 2003; ACEC, 2005). Risk allocation is a process of identifying risks and determining how they fairly share among project stakeholders (Kia and Tohidi, 2002). It is the decision of which party or parties should bear the consequences of

risks, if they occur in the project (Wibowo and Mohamed, 2008; Uff and Odams, 1995). The risk allocation process can be performed qualitatively and quantitatively (Rouhparvar et al., 2014).

Risk allocation is an important issue (El-Sayegh, 2008; Zaghloul and Hartman, 2003). It can affect the success of the project by impacting project performance and the total construction costs (Zaghloul and Hartman, 2003; Levitt et al., 1980; Lam et al., 2007; Kia and Tohidi, 2002). A fair risk allocation is essential for the successful completion of a project (Mubarak, 2015; Zayed et al., 2008; Roumboutsos and Anagnostopoulos, 2008). It is the goal of risk management to minimize the total cost of risk to a project, not necessarily the costs to each contracting party separately (CII, 1993; Alsalman, 2012). Companies can expect that their projects will have fewer claims, reduced costs and timely completion by advocating fair risk allocation (Rahiman, 2006; Kia and Tohidi, 2002; Zaneldin, 2006; Groton et al., 2010).

Different adjectives have been used to define the nature and quality of the kind of risk allocation. that achieves maximum economic efficiency and some of them are "ideal," "optimum," "wise," "smart," "balanced," "appropriate," "reasonable," "sensible," "equitable," and "fair." Groton et al. (2010) argues these terms have been criticized as being either too vague, too subjective, too judgmental, or too weak in a competitive business world. Groton et al. (2010) concluded that the most accurate adjective to use is the word "realistic," because the true test of the quality of risk allocation provisions is the relationship they bear to the realities of the particular construction project and their impact on maintaining a productive working relationship among the relevant parties.

Alsalman (2012) used the adjective "optimal" defining optimal risk allocation as the decisions to allocate risk factors to a party or parties (shared) such that the allocation minimizes the negative impacts on explicit and measurable project performance indicators such as project cost; project schedule; project quality; or any other explicit measurable project indicator, at the time and circumstances of making that decision. Ke et al. (2011) defined optimal risk allocation as not passing all risks to one project party, but seeking a solution minimizing the total management costs of project parties involved.

The ultimate goal of optimal allocation of risk is promotion of project implementation in terms of time and cost without sacrificing quality. It is the allocation of risk to the party who has the best position to reduce, control and prevent high risk and conventional balance prevents the reduction of risk and its effects (Kia and Tohidi, 2002).

Although adjectives are used to express the nature and quality of the kind of risk allocation, this research will not adopt any adjectives for the same purpose. Rather principles that should be followed to ensure the efficiency and effectiveness of contract clauses explained in section 2.4.3 are applied.

2.4.2 Risk Allocation in Contracts

Risk allocation is done in three approaches; by retaining, transferring, and/or sharing of risks (Alsalman, 2012). Mostly, risk allocation is conducted through contract in construction industry (Alsalman, 2012; Nasirzadeh et al., 2015). The fundamental function of contract conditions would be to allocate obligations to each of the contracting parties (Uher and Davenport, 2009) with contractual provisions and clauses (Alsalman, 2012). Common contractual clauses used to

distribute risk include indemnification provisions, warranties, schedule related requirements (including the imposition of liquidated damages), and the ability to withhold payment (DLAPiper, 2015).

SuretyLearn (2014:8) cited Justin Sweet's (Law Professor) definition of good contract.

> "A good contract clearly informs each party what it must do and to what it is entitled. It also informs each party of its rights if the other party does not perform as promised. It anticipates the likely problems and resolves them clearly and in a way that strikes the parties as reflecting a proper allocation of risks and responsibilities."

It a challenging task to decide what the equitable risk allocation is such that the goal is effectively accomplished. Even if there are standard and general conditions of contract, it is argued problems might arise due to the fact that nature and extent of risks tend to be project-specific in today's high-risk scenarios. Rahman and Kumaraswamy (2002) claim that adoption of tailor-made contract strategies is more desirable (Lam et al., 2007).

Willingness of a party and awareness to bear the risk will affect its response to risk (Ward et al., 1991). However, the decision itself depends on the level of information regarding future situation and on the risk appetite of the company since it is a key factor in evaluating strategic options. According to COSO (2009), risk appetite is the degree of uncertainty an enterprise is willing to accept. Risk appetite of an organization varies with its strategy as well as evolving conditions in its industry and markets (Wiegelmann, 2012).

The party which drafts the contract might tend to contractually pass the responsibility for most of the risks to the other party (Lam et al., 2007). Most likely such action has unfavorable results for

both transferees and transferors (Levitt et al., 1980; Pipattanapiwong, 2004). Unfair shifting of risk, transferring of all responsibility on a party that is not generally expected to control that risk, can result in that party having to spend resources looking for ways to stay alive in the project, usually to the detriment of the project itself (Alsalman, 2012).

According to Jannadia et al. (2000), as a result of unfair risk transfer, the RED will build a contingency into the price to cover the risk; or, the RED will not have a contingency and will face financial problems. Both occurrences affect the project negatively. This is because high contingencies make the total price of the property higher and the price might not be competitive in the market. Not having a contingency, REDs face lower profit margins in addition to other financial problems.

In contractual relation, parties may be bound by a general agreement that does not reflect their understanding if clear information is not given (Jennings, 2013). This shows that completeness of information is very important for parties to be aware of the general agreement that they are bounded by and are obliged to fulfill.

Efficiency and effectiveness of contract clauses can only be comprehended when both contracting parties have the same understanding of risk allocation and risk management accountability. In the absence of such clear contractual provisions, the contractual parties may have disagreement toward risk accountability. This may lead to mismanagement of a risk by assuming that the risk or its consequences are not their responsibility. Mismanaged risks may cause project execution inefficiencies and ultimately project cost increases (Hartman and Snelgrove, 1996).

2.4.3 Risk Allocation Principles

There are a number of principles that should be followed to ensure the efficiency and effectiveness of contract clauses (Loosemore et al., 2006). Various risk allocation principles had been suggested by a number of researchers such as (Abrahamson, 1973; Abrahamson, 1984; Casey, 1979; Kuesel, 1979; Barnes, 1983; Thompson and Perry, 1992) and many others. Adopting these principles as the basis for allocating risks is useful in reaching an equitable decision.

Mead (2007) mentioned the set of principles of allocating obligations and/or risks for construction was projects expounded by the international construction lawyer Max Abrahamson, referred to as "the Abrahamson principles". The Abrahamson principles suggest that risk should be allocated to a party if (Mead, 2007; Zhang et al., 2006; Uher and Davenport, 2009):

1. The risk is within the party's control/If the risk is of loss due to his own willful misconduct or lack of reasonable efficiency or care;
2. The party can transfer the risk, for example through insurance, and it is economically beneficial to deal with the risk in this fashion
3. The preponderant economic benefit of controlling the risk lies with the party in question
4. To place the risk upon the party in question is in the interests of efficiency, including planning, incentive and innovation
5. If the risk eventuates, the loss falls on that party in the first instance and it is not practicable, or there is no reason under the above principles, to cause expense and uncertainty by attempting to transfer the loss to another.

Risk allocation principles suggested by different researchers is listed here below.

1. Whether the party can bear the risk at the **lowest cost -** (Kerf, 1998; Kia and Tohidi, 2002, Ng and Loosemore, 2007; Fisk and Reynolds, 2011; Mubarak, 2015)
2. Whether the party has the **necessary desire** to take the risk - (Loosemore et al., 2006; Ng and Loosemore, 2007)
3. Whether the party is able to **control** the chance of the risk occurring - (Kerf, 1998; Loyd, 2001; Kia and Tohidi, 2002; Loosemore et al., 2005; Committee, 2001; Lam et al., 2007; Pipattanapiwong, 2004; Fisk and Reynolds, 2011; Mubarak, 2015)
4. Whether the party is able to **foresee** the risk - (Kia and Tohidi, 2002; Lam et al., 2007)
5. Whether the party is able to **manage** the risk in the case of occurring - (Kerf, 1998; Committee, 2001; Loyd, 2001; Kia and Tohidi, 2002; Pipattanapiwong, 2004; Lam et al., 2007)
6. Whether the party is best able to **assess** the risk - (Kia and Tohidi, 2002; Lam et al., 2007)
7. Whether the party has the **capability and resources** to deal with the risk consequences/**sustain** - (Loyd, 2001; Committee, 2001; Kia and Tohidi, 2002; Pipattanapiwong, 2004; Ng and Loosemore, 2007; Lam et al., 2007)
8. Whether the party has the **necessary resources** to cope with them eventuating - (Kerf, 1998; Loosemore et al., 2006)
9. Whether the **premium** charged by the transferee is likely to be reasonable and acceptable - (Committee, 2001; Kia and Tohidi, 2002; Pipattanapiwong, 2004; Loyd, 2001; Lam et al., 2007)
10. Parties accepting them risk should be able to charge an appropriate premium - (Loosemore et al., 2005; Ng and Loosemore, 2007; Fisk and Reynolds, 2011)

11. Whether the party will benefit from bearing the risk - (Kia and Tohidi, 2002; Lam et al., 2007)
12. Whether the party is fully aware of these risks - (Loosemore et al., 2005; Ng and Loosemore, 2007)
13. Whether, if the risk is transferred, it leads to the possibility of risks of different nature being transferred back to the employer - (Committee, 2001; Loyd, 2001; Pipattanapiwong, 2004; Mubarak, 2015)
14. Allocation of the risk to the party who is best able to undertake it financially - (Fisk and Reynolds, 2011)
15. Whether the party has the greatest ability to diversify the risk - (Kerf, 1998)

These principles serve as risk allocation criteria in making risk allocation decision. In addition to the principles, some authors considered which party should carry the risk if it cannot be controlled is important (Committee, 2001; Loyd, 2001; Pipattanapiwong, 2004).

Lam et al. (2007) adopted seven risk allocation criteria in developing risk allocation model for traditional construction contracts. These criteria are whether the party is able to foresee the risk, assess the possible magnitude of consequences of the risk, control the risk chance of occurring, manage the risk in case of occurring, sustain the consequences if the risk occurs, whether the party will benefit from bearing the risk and whether the premium charged by the risk receiving party is considered reasonable and acceptable for the payer. Lam's criteria encompass all the principles identified from literature one way or another.

This research adopts all Lam's criteria for risk allocation, namely whether the party is able to foresee the risk, assess the possible magnitude of consequences of the risk, manage the risk in case

of occurring and sustain the consequences if the risk occurs. The rest three are not included in the allocation criteria the risk allocation mechanism provided here in this research adopted. It is the assumption of this research that the control of the risk chance requires a risk management practice in real estate development and this might not be the reality. Whether the premium charged is considered reasonable and acceptable is not included because it is not within the scope of this research. The reason for the exclusion of whether the party will benefit from bearing the risk is excluded because this research focuses on the downside of risk.

2.4.4 Risk Allocation Models

"Models are used as a prime means of coping with complexity." (Kossiakoff et al., 2011:263) There are several risk allocation models suggested in reviewed literature. Here below in Table 2.2 the reviewed models are listed with their specific feature, methodology used for modelling and the area or project type they are applied to. The modelling methods used are Fuzzy Logic, Artificial Neural Networks, Utility theory, Analytical Hierarchy Process (AHP), Delphi technique and System Dynamics.

From these risk allocation models some focused on PFI/PPP and some on construction projects generally. Joint-venture and multiparty projects were also areas of concern. Risk allocation models focusing on real estate purchasing agreements were not found by the researcher.

As it can be seen from the allocation models review table, fuzzy techniques are used by five authors. They are also used for risk prioritization by six authors as shown in Table 2.2. Therefore, it would be beneficial to elaborate fuzzy techniques briefly since they are the most frequently used method for modelling and because fuzzy set theory is used for data analysis in this research.

Table 2.3 Risk Allocation Models Suggested by Authors

Author	Objective and Method	Application
Bing et al. (2005)	Identify preferred risk allocations in PPP/PFI projects in the UK	PPP/PFI construction projects
Lam et al. (2007)	Quantitative based analysis by using fuzzy logic	Between the owner and the contractor in a traditional contract arrangement
Majid P. Jalal et al. (2008)	Fuzzy risk allocation model to client and contractor in accordance with FIDIC General Conditions of Contract in traditional contracts(DBB), Design Build contracts (DB) and EPC\turnkey contracts	Dam construction projects in Iran
Favié et al. (2009)	Model for risk allocation	Joint-venture
Jin and Doloi (2009)	Model risk allocation - Fuzzy Set Theory	PFI construction projects
Jin and Zhang (2011)	Artificial Neural Network (ANN) models for modelling risk allocation decision making	public–private partnership (PPP) projects,
Alsalman (2012)	Identify barriers to optimal risk allocation	Construction projects
	Provide optimal risk allocation decision support model with the use of Utility function	
Khazaeni et al. (2012)	Quantitatively address the balanced allocation of risks based on a Fuzzy Analytical Hierarchy Process (AHP) method	for complex and multi-party contract strategy
Nasirzadeh et al. (2013)	System dynamics based approach for risk allocation to determine the optimum risk allocation strategy both qualitatively and quantitatively	Construction projects
Rouhparvar et al. (2014)	Quantitative risk allocation approach by integrating fuzzy logic and bargaining game theory to find the equitable risk allocation between the client and the contractor.	Construction projects
Issa et al. (2015)	Simple risk allocation mechanism based on Delphi method by the expert's judgment	Construction projects in Yemen
Nasirzadeh et al. (2015)	System dynamics simulation scheme and fuzzy bargaining game theory based risk allocation model to determine the contractor and client costs at different percentages of risk allocation	Construction projects

As defined by Chan et al. (2009:1241), "fuzzy techniques refer to all fuzzy concepts, which include fuzzy set, fuzzy logic, and hybrid fuzzy techniques (those that combining fuzzy set/fuzzy logic with other techniques), such as fuzzy neural network, neurofuzzy, fuzzy reasoning, fuzzy expert system, fuzzy analysis, and fuzzy clustering."

Fuzzy is a branch of modern mathematics introduced by Zadeh in 1965 (Pedrycz and Gomide, 2007; Chan et al., 2009) "to model vagueness intrinsic in human cognitive process and to solve ill-defined and complicated problems because of ambiguous, incomplete, vague, and imprecise information that characterize the real-world system." (Chan et al., 2009) As Chan et al. (2009) argues, it is generally accepted that two fundamental fuzzy concepts are fuzzy set and fuzzy logic. Both deal with a different type of uncertainty that probability theory deals with, which are vagueness and imprecision.

"Fuzzy set is a method for capturing vagueness, uncertainty, imprecision, embedded human knowledge, human behavior, and intuition." (Sachs and Tiong, 2009) Fuzzy sets work with shades of gray (not just black or white) and help consider the natural language which is fuzzy in nature (Chan et al., 2009). Linguistic variables with varying grades are used to model uncertainty inherent in natural language (Zimmermann 2001).

Fuzziness is lack of precise boundaries of a collection of objects and, the manifestation of imprecision and a particular type of uncertainty which arise due to the lack of knowledge and incomplete information (Pedrycz and Gomide, 2007). In the fuzzified world, a fuzzy set can have graded or partial membership (Byrne, 1995). Membership functions are used to represent linguistic variables. Values between 0 and 1 can be used to indicate the degree of membership to a set, 0

indicating non-membership of a particular fuzzy set and 1 indicating full membership (Byrne, 1995).

Fuzzy logic is a reasoning system that uses fuzzy sets (Chan et al., 2009). Fuzzy logic is used to handle the concept of partial truth and true values between "completely true" and "completely false." (Zimmermann, 2001) It is a data analysis methodology applied to generalize any specific theory from "crisp" to "continuous." (Chan et al., 2009) Its functioning is based on mathematical tools (Chan et al., 2009). Fuzzy logic enables computing with words where words are used instead of numbers (Sachs and Tiong, 2009).

"The procedure that converts raw data from the practical world into membership values of corresponding fuzzy subsets is known as Fuzzification. The fuzzy mathematic operations are implemented, producing membership values belonging to the output variables. Defuzzification is followed to convert the values to a single output action giving a clear indication to the human user" (Lam et al., 2007:487).

2.4.5 Contractual Issues in Real Estate Projects in Addis Ababa

Article 2876 of the Civil Code of Ethiopia states that if a party undertakes to deliver to the other party a house, a flat or another building which does not yet exist, then this is a contract of work and labor relating to immovable and not a contract of sale (Ethiopia, 1960). In this case, there shall be an evidence of where the contractor has undertaken work to the knowledge of the client or received an advance from the client (Article 3020 of the Civil Code). This shows it is not a must for a contract of work and labor to be a written agreement.

On the other hand, for the delivery of an already existing property, Article 2877 of the Civil Code states a contract sale of an immovable shall be of no effect unless it is made in writing (Ethiopia, 1960). The sale of real estate property which exists during the sale should be done in writing. Therefore, a written property purchasing agreement is used for the transaction which define the relationships and obligations of the two contracting parties, the developer and the buyer/client. However, as per this researcher's preliminary study on the use purchasing agreement, it seems all developers use a written agreement whether the property is existing or not during the time the developer and the buyer enter into a contract agreement.

As discussed is section 2.1.2, the real estate development in Addis Ababa is facing different problems and challenges. Although this is the fact, this doesn't mean the problems cannot be addressed. Paulos (2011) argues most of the causes of delay stated by developers are not beyond the control of the developers since they could foresee them during planning process or could handle it by contractual clauses.

Even if contractual clauses and proper administration of contracts are important, real estate development projects are facing problems in these regards. Paulos (2011) identified although there is delay in delivery due to the mentioned and other reasons developers are facing, surveyed customers of developers did not receive any compensation from the developer. Apology is the only thing they were offered by developers.

Finings of Paulos (2011) show that time extension is not the only issue in client-developer contractual relationship. Price adjustment is found to be what most developers do considering price escalation of some construction inputs and devaluation of birr. Most of these developers make

consultants approve the adjustment and few of them get approval. However, customers usually refuse to accept the adjustment as some developers stated. This is another cause of delay in handing over.

Price adjustment as a result of escalating prices of construction material affects not only new orders to come, but also the ability of customers/buyers to pay remaining installment payments (Kiros, 2009). This might lead to terminations of contract before delivering the homes unless clients agree to new terms and conditions which include a new price and can result in customers taking their seller to court to get the homes they had paid for (Tadeos, Jul 14, 2012). Developers who faced shortage of finance to complete projects caused terminations of contract for customers who do not agree to new terms and conditions which include new price (Selam, 2016).

Unwarranted termination of contract due to reasons such as price adjustment is an unethical deed. It is also not supported by the law. The Ethiopian Civil Code (Art. 1764) states a contract shall remain in force notwithstanding that the conditions of its performance have changed and the obligations assumed by a party have become more onerous than he foresaw. The researcher believes price escalation is foreseeable and therefore buyers have the right not to accept price adjustments by developers. A client with a terminated contract as a result of disagreement on price adjustment can sue the developer but the case will have to pass through an elongated judicial process. This is what happened to the clients of May Real Estate when this developer adjusted price. It is when the clients wrote a warning to the developer stating that they don't accept the price adjustment this developer notified clients that the contract is terminated (Cassation, 2015). The clients sued the developer and went through a long judicial process.

Paulos (2011) concluded there is a problem in the performance of contract due to the absence of independent contract administration who can decide on different issues between the developer and the client. In addition, he also stated that the absence of standard condition of contract for the sale of residential properties developed by developers is a problem. These issues cause more problems which are commonly related to price adjustment, extension of time and rectifying defects.

2.5 Gap in Reviewed Literature

Researches concerning real estates in Ethiopia mainly in Addis Ababa focused on problems and challenges the sector is facing. Non-delivery of housing projects on time is one of the major problems of real estate developers (Paulos, 2011; Muluken, 15 April 2013; Bewket, 13 January 2014). Other issues that exist in the sector are problems of land management, inadequate infrastructure, low construction capacity of developers or contractors hired for construction, poor borrowing capacity, low affordability (Eshete and Teshome, 2015), price escalation (kiros, 2009; Paulos 2011; Eshete and Teshome, 2015) slow and insufficient supply of land, foreign currency shortage, shortage of housing construction materials. In addition, inflation and non-existence of long term housing finance were factors which affected the real estate market (Kiros, 2009).

The researcher believes although these researches which identified the major problems are relevant sources which help in having an insight on the factors which are affecting real estate development, there is still a clear need for study on how uncertain these problems make the real estate development environment and how these risk factors are likely to occur, and on their impact explicitly.

Developers need to manage these and other risks which are inherent in real estate development and minimize their impact on project objectives and their business as a whole. It is argued most of the causes of delay stated by developers are not beyond the control of the developers since they could foresee them during planning process or could handle it by contractual clauses (Paulos, 2011).

It is the fundamental function of contract clauses to allocate obligations to each of the contracting parties (Uher and Davenport, 2009) with contractual provisions and clauses (Alsalman, 2012). Yet, it is a challenging task to decide what the equitable risk allocation is such that the goal is effectively accomplished. Even if there are standard and general conditions of contract, it is argued that problems might arise due to the fact that nature and extent of risks tend to be project-specific in today's high-risk scenarios. Rahman and Kumaraswamy (2002) claim that adoption of tailor-made contract strategies is more desirable (Lam et al., 2007).

It has been explained in the review of risk allocation models that there are several risk allocation models suggested in reviewed literature on different types of construction projects and different project delivery methods. Nonetheless, risk allocation models focusing on real estate purchasing agreements could not be found by the researcher.

In summary, it can be concluded that a gap exists in literature regarding risk and risk allocation in real estate development in Addis Ababa, Ethiopia. Therefore, this study aims to identify the major risks in real estate development and their impact on project objectives, and study the current practice of risk allocation in residential real estate purchasing contracts. It also attempts to provide a practical mechanism that can be used by real estate developers to allocate risks properly.

3. RESEARCH DESIGN AND METHODOLOGY

3.1 Research Design

This chapter delineates the activities of the research, how the research was conducted and what steps were taken to realize the objectives of the study. The main goal of this paper is to provide a mechanism for risk allocation in real estate purchase agreements as a decision support tool by addressing the concerns of risk allocation. The study focuses on the main contract/agreement for the purchase of a real estate and the risk allocation between real estate developers/seller and the client/buyer.

Given the objective of this study, risk factors and risk allocation criteria were extracted from reviewed literature as discussed in section 2.3.4 and shown in Table 2.1. The risk factors are related to construction projects in general and to market oriented residential real estate development projects in particular. As outlined in Figure 3.1, these risk factors were measured and evaluated through a structured questionnaire survey. The next step was the review of real estate purchase contract documents in order to understand the current contractual risk allocation practice in residential real estate development since they indicate the risk management strategy of developers. Finally, a risk allocation mechanism based on risk allocation principles is proposed and the output of the mechanism is compared with contractual risk allocation residential real estate purchase contracts. Findings of the survey are analyzed, summarized and are reported in the next chapter.

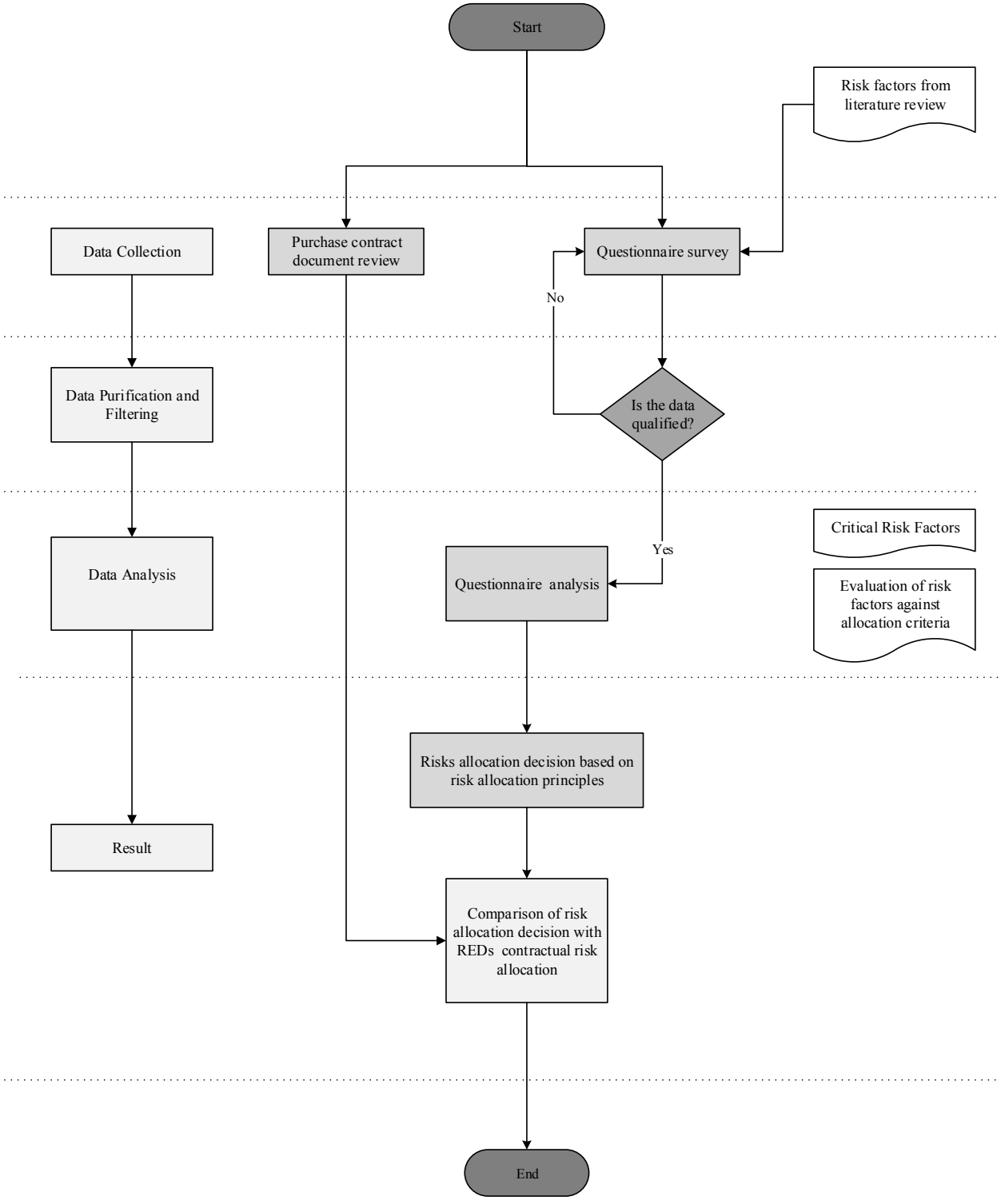

Figure 3.1 Data Collection and Analysis Flow Chart

3.2 Research Population

Compiling a potential list of participant commercial real estate developers registered and developing housing units in Addis Ababa was the first step in the data collection process. Real estates which delivered at least one housing project had to be selected so assuming they would have a relevant experience to share. However, information on which real estate has delivered or not was not available so it had to be checked by calling (phone) all the registered and currently working on projects and a door to door survey because some real estates gave wrong information through phone call regarding the selection criteria. Thus, 74 were approached from a list of 134 real estates with addresses publicized on different online databases such as www.2merkato.com, Yellow Pages Africa and www.ethioconstruction.com. The rest 60 couldn't be approached with their given address. Of the approached real estates, only 13 of them were found to satisfy the selection requirement, that they should have delivered at least one housing project which made the population size 13.

3.3 Types of Data and Tools of Data Collection

This section explains the selected data collection methods which are adopted within this research. During the study of relevant literature, lack of empirical data was noted within the context of the formulated issue. A broad analysis of risk factors and their impact on real estate development project schedule and cost would therefore appear to be important in order to have broad-based insights that could lead to the understanding of the importance of proper risk allocation. For this purpose, a standardized questionnaire survey was initiated in order to obtain the required data.

Literature review was used to identify risks related to construction projects in general and in commercial real estate projects specifically. The risk factors extracted from literature are 42 in

number. The next step would be obtaining data which allows prioritize the risk factors with regard to their impact on project schedule and cost. This could be satisfied by collecting existing data from project information or by collecting new data from study subjects. Assuming project information on risk which could satisfy the concerns of the research would not be available, a survey is selected as a data collection method.

A questionnaire survey was chosen as the most effective method to meet the objective of this study through pursuing the opinions and experiences of professionals and practitioners involved in real estate development projects. This selected data collection tool is believed to be the most adequate for this research considering oral survey would not be feasible due to the fact that the risk factors are large in number. In addition, measuring the impact of risk factors on schedule and cost, and evaluating the risk factors against risk allocation criteria would be too much to handle with an oral survey. A written survey was considered to be more efficient than an oral survey since it was possible to structure the survey to a higher degree.

This study is based on a survey conducted among residential real estate developers through pursuing the opinions and experiences of professionals and practitioners involved in real estate development projects. Thus, qualitative data is expected from the questionnaire survey.

The questionnaire had three sections. The first section explored a general organizational information on REDs and the second section explored about the survey respondents. The third section was the main section of the questionnaire in which risk factors were measured and evaluated, and in the final section, respondents were enquired to include additional risk factors which were not included in the survey.

For the main section, respondents were asked to measure the probability of occurrence of risk factors and their impact on project cost and schedule, and also to measure risk factors against risk allocation criteria based on their experience and opinions. They were asked to assign the probability of occurrence of risk factors by responding to a Likert agreement scale of 1 to 5, where 1= Very Unlikely (VU), 2 = Unlikely (U), 3 = Moderate (M), 4 = Likely (L) and 5 = Very Likely (VL). The same scale was used for measuring risk factors against risk allocation criteria. The scale used to measure impact of risk factors on project cost and schedule was also 1 to 5, where 1= Insignificant (I), 2 = Minor (MI), 3 = Moderate (MO), 4 = Major (Ma) and 5 = Catastrophic (C). A 5 scale Likert agreement was chosen assuming it would be easy for respondents to give their opinion in a structured way with options which are not too few or too many to choose between. A sample questionnaire is attached in Appendix D.

For the purpose of understanding the current contractual risk allocation in residential real estate development, reviewing the purchase agreement is obviously the best option because it reflects the practice in black and white how the developers use contract clauses as risk response strategy.

3.4 Data Collection Procedure

The next task after preparing the questionnaire was a pilot testing and modification of the questionnaire which was done by obtaining insights from 1 project risk management expert and 1 contractor. Real estates were not included in the pilot test be because the population size is small and it would have been at the cost of losing a participant. Collection of contract documents and questionnaire survey was done from early February 2016 up to Mid-March 2016.

One point to be noted here is that a written survey is somehow disadvantageous because there is virtually no control over the circumstances under which the questionnaires are completed. The design of a questionnaire therefore required a high level of care and consideration in order to minimize these problems. Altogether it made the survey count on personal contacts and networks for a better participation of respondents.

3.5 Data Processing and Methods of Analysis

3.5.1 Data Processing

It was stated before that the study used two data collection methods or sources, questionnaire survey and purchase agreements. The response rate was somehow lower than expected. On the questionnaire survey, a total of 13 survey questionnaires were distributed. One of the real estates couldn't participate in the survey stating the firm has no relevant experience in risk management and one real estate stated they cannot give data because they don't practice risk management in a level which enables them give data for the research. All the rest 11 participants responded to the questionnaires even if there were some incomplete parts. Besides, it is seven real estates which agreed to give sample contract document stating it is a very confidential document and it serves as a competitive edge for their business. Two of the real estates agreed to tell the contents of their standard contract agreement orally but enough information could not be gathered because there was a problem in remembering all the contents while listing.

Profile of the real estate developers and the respondents are included in Appendix B and C respectively.

The processing of data began with entering the responses from the survey questionnaires into a Microsoft Excel work book and then coding the responses of the survey participants to reflect based on their experience and opinions with Likert agreement scale using: 1= Very Unlikely (VU), 2 = Unlikely (U), 3 = Moderate (M), 4 = Likely (L) and 5 = Very Likely (VL) for probability of occurrence of risk factors s and for measuring risk factors against risk allocation criteria. Similarly, the response on impact of risk factors on project cost and schedule was also 1 to 5, where 1= Insignificant (I), 2 = Minor (MI), 3 = Moderate (MO), 4 = Major (Ma) and 5 = Catastrophic (C).

Data from the survey were summarized and are presented using tables in Appendix E.

3.5.2 Methods of Data Analysis

This sub-section covers the processing and analysis of the collected data starting with the challenges encountered in data collection.

The main aim of this research is to provide professionals working in real estate development projects a mechanism that will support them in making risk allocation decision particularly in real estate purchase agreements that can serve as decision support. The first attempt of this research was to identify risk factors related to real estate development projects.

As explained earlier, the 42 risk factors were related to real estate development were identified. The likelihood of occurrence of risk factors and impact on project cost and schedule were measured by survey participants. The purpose is to prioritize the risk factors according to their impact on project cost and schedule so that the vital risk factors could be identified.

3.5.2.1 Risk Prioritization

In situations where there is no statistical or detailed and appropriate information, opinions of experts could be used instead. Fuzzy set theory helps quantify these linguistic terms which are fuzzy in nature (Bakhshi and Touran, 2014). As discussed in literature review, fuzzy set theory uses linguistic variables and membership functions with varying grades to model uncertainty inherent in natural language. It allows the use of linguistic variables whose values are not numbers but words or sentences in a natural or artificial language which are less specific than numerical ones.

The responses from the survey questionnaires were qualitative expert opinions. For each variable, the fuzzy sets are defined on some relevant universal set, which is often an interval of real numbers.

Let the linguistic variables for "Likelihood of Occurrence" in this research be 'X' and let the Languages be 'L'. Then the fuzzy set L (X) will be

L (Likelihood of Occurrence) = {Very Unlikely, Unlikely, Moderate, Likely, Very Likely}.

The same is true for impact.

L (Impact) = {Insignificant, Minor, Moderate, Major, Catastrophic}

The risk factors included in the questionnaire were 42 categorized into four, namely Economic and Financial, Technical and Environmental, Governmental and Political, and legal and contractual. Eight respondents completed the measurement of likelihood of occurrence and risk impact. Most of the respondents did not complete the measurements of risk factors under the category Governmental and Political, and the last two risk factors under legal and contractual. Therefore,

these risk factors are not included in the analysis. The steps followed for analysis are included here below.

i. Establish response frequency table and divide the count with the number of responses.

To show with an example, the response count on likelihood of occurrence is 0 - VU, 4 – U, 2 – M, 1 – L and 1- VL. The number of responses is 8 and all the values under each linguistic variable will be divided by eight. The same will be done for impact on schedule and cost. The responses and the frequency of responses for each risk factor are included in Appendix E.

Table 3.1 - Frequency of Responses

VU	**U**	**M**	**L**	**U**
1	**2**	**3**	**4**	**5**
0	4	2	1	1
0	0.5	0.25	0.125	0.125

ii. Normalize (Divide all by the maximum value)

All the values in the last raw of the frequency table will be divided by the maximum value, 0.5.

Table 3.2 - Normalization of Responses

VU	**U**	**M**	**L**	**U**
1	**2**	**3**	**4**	**5**
0	0.5	0.25	0.125	0.125
0.00	1.00	0.50	0.25	0.25

iii. The next step is to approximate the curves to triangular membership function with a visual analysis. However, the relative error between the approximate and actual values has to be calculated, and it has to be checked whether the error lies within a certain confidence interval. In cases where there are more options of approximation for the normalized responses, the best approximation can be selected by calculating the error and the one with lesser error can be selected. Figure 3.2 shows the triangular approximation of the curves of normalized values.

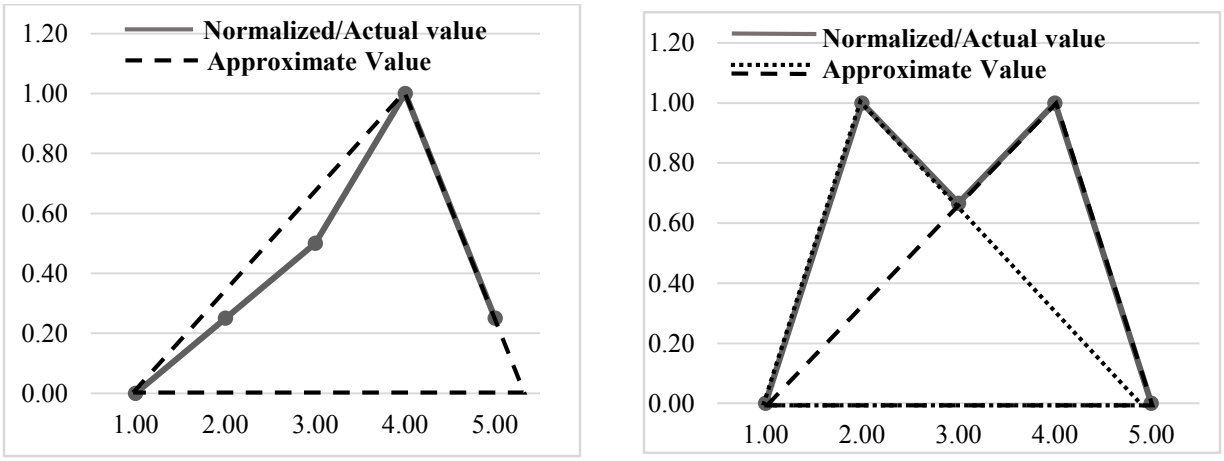

Figure 3.2 Triangular Approximation

Error and confidence interval are calculated for all normalized responses of each risk factors. The formula used for error and confidence interval calculation are shown below.

$$Error = \frac{/Actual\ Value - Approximate\ Value/}{Actual\ Value}$$ .....Equation 3.1 (Carlson, 2002)

Table 3.3 – Error Calculation

Item	**VU**	**U**	**M**	**L**	**U**
Scale	1	**2**	**3**	**4**	**5**
Actual Value	0.00	1.00	0.50	0.25	0.25
Approximate Vale	0.00	1.00	0.67	0.33	0.00
Error	0	0	0.3333	0.3333	1
Average error = Σ Error/5	0.27				

$$Confidence\ Interval = \bar{x} \pm z\sigma \quad \text{Equation 3.2 (Šafr, 2014)}$$

Where, $\bar{x}$ = mean of the actual normalized values

σ = standard deviation of the actual normalized values

z = confidence coefficient

The desired confidence level has to be chosen before calculating the confidence coefficient. The most commonly used confidence levels are 90%, 95% and 99%. The confidence coefficient is calculated with 95% confidence level in this research for likelihood of occurrence, and for impact on cost and time. The result shows that all errors lie within the confidence intervals. For cases where there are two or more approximation options, the approximate value with the lesser error is taken. The normalized and approximate values, and the calculated errors and confidence intervals are included in Appendix E.

iv. Multiplication

R-I is a multiplication function. Now to get the risk impact on schedule, likelihood of occurrence is multiplied with impact on schedule.

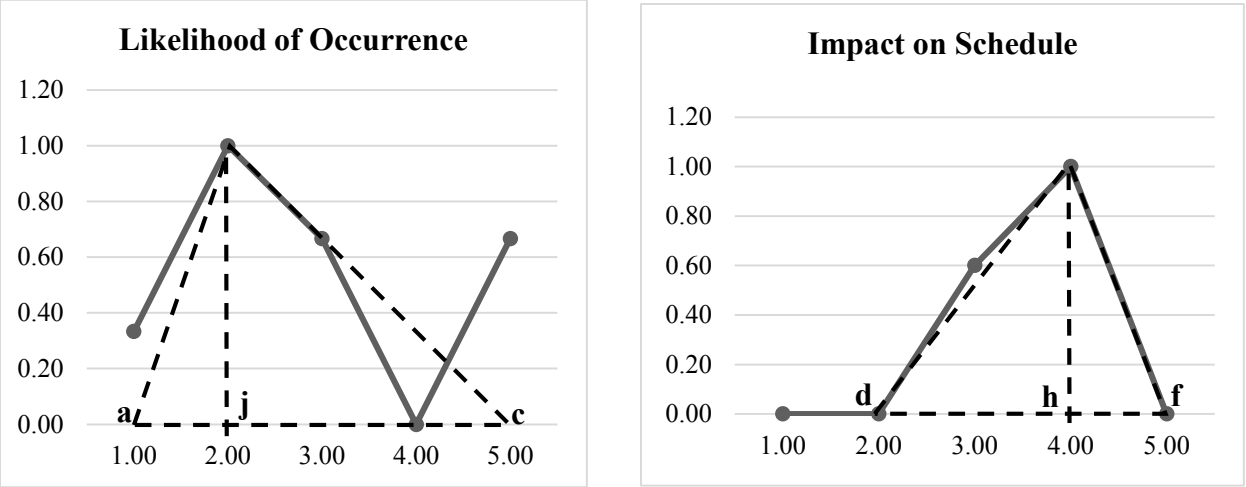

Figure 3.3 Triangular Membership Function

This research is a data driven one since there is no an expert system supplied with consensus values of transition from variable to variable.

Therefore, in order to carry out algebraic operations of the fuzzy numbers, the α-cut method is used for interval analysis. An α-cut of a fuzzy set A, denoted by Aα, is a set consisting of the elements of the universe whose membership values are equal to or exceed a certain threshold level where α ε {0,1} (Pedrycz and Gomide, 2007).

$$A\alpha = [(j - a)\alpha + a,\ (j - c)\alpha + c] \quad \text{.....[Equation 3.3] (Pedrycz and Gomide, 2007)}$$

$$B\alpha = [(h - d)\alpha + d, (h - f)\alpha + f] \quad \text{.....[Equation 3.4] (Pedrycz and Gomide, 2007)}$$

When the two (A=likelihood of occurrence and B=impact on schedule) are multiplied with the above values in the graphs/triangle, then multiplication will be as follows.

$$A\alpha = [(2-1)\alpha + 1, \quad (2-5)\alpha + 5] = [\alpha + 1, -3\alpha + 5]$$

$$B\alpha = [(4-2)\alpha + 2, (4-5)\alpha + 5] = [2\alpha + 2, -\alpha + 5]$$

$$A\alpha * B\alpha = (\alpha + 1, -3\alpha + 5) * (2\alpha + 2, -\alpha + 5)$$

$$= [\min \{2\alpha^2 + 4^{\alpha} + 2, 3\alpha^2 + -20\alpha + 25\}, \max \{2\alpha^2 + 4^{\alpha} + 2, 3\alpha^2 + -20\alpha + 25\}]$$

where $\alpha \varepsilon (0, 1)$

Thus, assuming 85% confidence interval ($\alpha = 0.85$), the two equations give the Max and Min value and this maximum which is the Risk Magnitude (RM) interval.

$$A\alpha * B\alpha = [6.845, 10.1675]$$

RM interval = [6.845, 10.1675]

Both likelihood of occurrence and impact on schedule have five values so the scale will be 5*5. Therefore, the minimum value of the multiplication is 1 and maximum value is 25. After calculating the risk magnitude interval, the minimum and the maximum value will be added and divided by two and gives the risk magnitude value. This average value will be then divided by 25 and the obtained value is the relative value which is the risk magnitude. The calculation is as follows.

Central value of the interval = (6.845 + 10.1675)/2 = 8.505

The relative value/Risk Magnitude = 8.505/25 = 0.3402

Risk magnitude is calculated for all the risks except for those risk factors in which responses are not given on. The results of the analysis are included in section 4.1.

3.5.2.2 Evaluation of Risk Factors against Contractual Risk Allocation Criteria

Respondents were asked to measure risk factors s against risk allocation criteria responding to a Likert agreement scale of 1 to 5, where 1= Very Unlikely (VU), 2 = Unlikely (U), 3 = Moderate (M), 4 = Likely (L) and 5 = Very Likely (VL). The data is used evaluate risk evens against contractual risk allocation criteria.

Eight respondents completed the measurement of risk factors against risk allocation criteria. Weight analysis was conducted to measure the risk evens. The risk allocation criteria used to measure were whether the risk factors are Foreseeable, Assessable, Manageable, and Sustainable. Most of the respondents did not complete the measurements whether the risk factors are sustainable. In addition, of the 42 risk factors included in the questionnaire most of the respondents did not complete the measurements of risk e factors under the category Governmental and Political, and the last two risk factors s under legal and contractual. Therefore, these risk factors and whether the risk factors are sustainable are not included in the analysis.

The weight analysis was conducted by counting the number of responses, that how much of the 5 scales are there for each risk factors. The scale which outweighed the count from the eight responses is taken as the final evaluation result of the risk factors. However, not all risk factors get to be assigned foreseeable, assessable and manageable because there isn't a response that outweighed the rest in some risk factors. The detailed analysis is included in Appendix F.

3.5.2.3 Current Risk Allocation in Real Estate Purchase Agreements

Sample residential real estate purchase agreements were collected form 7 real estate developers and the documents were assessed to explore how risks are allocated. The detailed review result is tabulated and presented in section 4.3.

3.6 Ethical Considerations

The researcher is responsible for maintaining the confidentiality of the data and for any errors that might have been committed in this study. The researcher would like to state that identity of respondents and data collected form any real estate developer is not and will not be exposed.

4. RESULTS AND DISCUSSION

The previous chapter covered the analysis methods and the steps followed. This chapter will present, discuss, and summarize the results of the research.

4.1 Risk Prioritization

The responses from the survey questionnaires on the likelihood of occurrence of risks, and impact on time and cost were analyzed with the use of fuzzy set theory as shown in sub-section 3.5.2 and Appendix E. The results of the analysis are shown here below in Figure 4.1 and 4.2., and Table 4.1 and 4.2.

Not meeting milestone deadline and communication problems between developer and client are found to be risks with the greatest impact on project schedule. Lack of readily available utilities on site, exchange rate fluctuation, increase in inflation rate, in customs (on imported goods) and in oil price, price escalation of construction material, and change in labor cost are factors with similar level of impact on schedule. These factors also have high impact on schedule.

Risk factors with similar and with a bit lower but still with a significant impact are interest rate fluctuation, financial failure of any party, availability of material, change of client's interest in design, quantity variations and availability of infrastructure.

In the case of project cost, exchange rate fluctuation and increase in inflation rate have the greatest impact according to the survey result. Increase in oil price, price escalation of construction material, change in labor cost and not meeting milestone deadlines also have a great impact on project cost.

Financial failure of any party (buyer or developer), change of client's interest in design, quantity variations, and availability of infrastructure follow the fore listed factors in having impact on project cost.

Figure 4.1 - Impact On Schedule

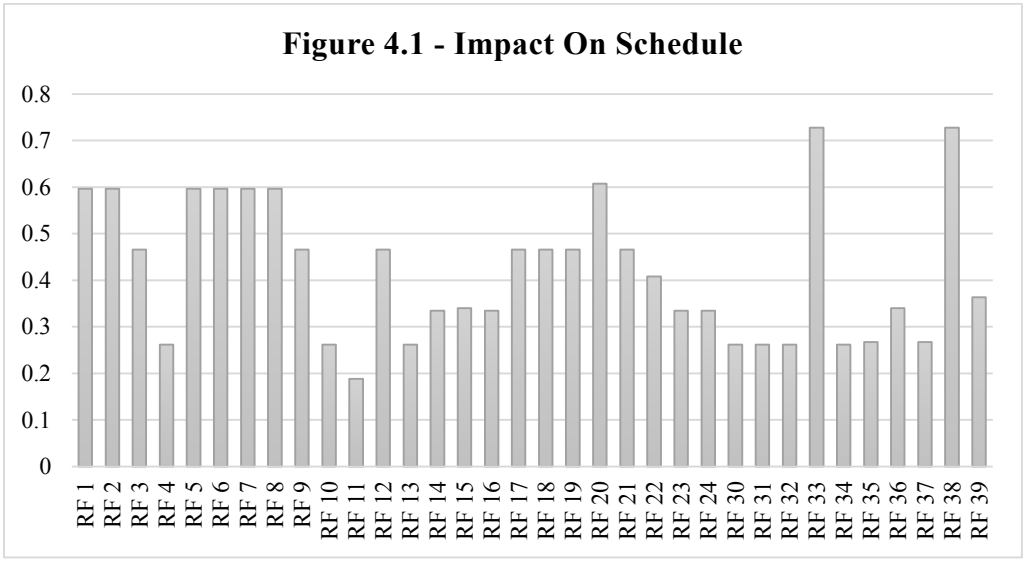

Figure 4.2 - Impact on Cost

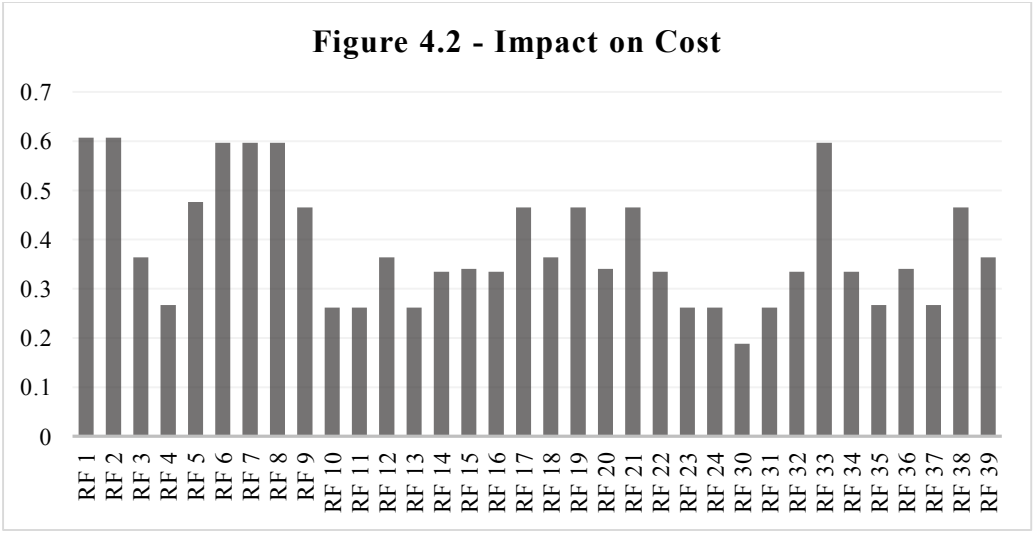

Table 4.1 Risk factors ranked according to their impact on schedule

Rank	RF #	Risk Factor	Risk Magnitude	Rank	RF #	Risk Factor	Risk Magnitude
1	RF 33	Not meeting milestone deadline clause	0.7274	6	RF 39	Changes in laws, regulations, and policies	0.3636
1	RF 38	Communication between project parties (client, consultant and developer)	0.7274	7	RF 15	Subsurface conditions (geotechnical)	0.34025
2	RF 20	Lack of readily available utilities on site	0.60715	7	RF 36	Delays in resolving disputes	0.34025
3	RF 1	Exchange rate fluctuation	0.5965	8	RF 14	Natural disaster	0.3347
3	RF 2	Increase in inflation rate	0.5965	8	RF 16	Poor site condition (location, accessibility of site, etc...)	0.3347
3	RF 5	Increase in customs (on imported goods)	0.5965	8	RF 23	Unpredicted technical problems in construction	0.3347
3	RF 6	Increase in oil price	0.5965	8	RF 24	Impact of adjacent buildings	0.3347
3	RF 7	Construction material price escalation arising above the estimated allowances	0.5965	9	RF 35	Delays in resolving contractual issues	0.26715
3	RF 8	Changes in labor costs	0.5965	9	RF 37	Breach of contracts	0.26715
4	RF 3	Interest rate fluctuation	0.4656	10	RF 4	Tax rate increase	0.2616
4	RF 9	Financial failure of any party (client or developer) - project specific	0.4656	10	RF 10	Bankruptcy	0.2616
4	RF 12	Availability of material	0.4656	10	RF 13	Weather conditions	0.2616
4	RF 17	Change of client's interest in design	0.4656	10	RF 30	Vagueness of purchasing agreement/contract clauses	0.2616
4	RF 18	Change of client's interest in type of construction material and in related things	0.4656	10	RF 31	Inappropriate risk allocation in purchasing agreement/contracts	0.2616
4	RF 19	Quantity variations	0.4656	10	RF 32	Purchasing agreement/contract errors	0.2616
4	RF 21	Availability of infrastructure	0.4656	10	RF 34	Occurrence of claim and dispute	0.2616
5	RF 22	Damage to Structure	0.4078	11	RF 11	Availability of local labor	0.1885

Table 4.2 Risk factors ranked according to their impact on cost

Rank	RF #	Risk Factor	Risk Magnitude	Rank	RF #	Risk Factor	Risk Magnitude
1	RF 1	Exchange rate fluctuation	0.60715	6	RF 20	Lack of readily available utilities on site	0.34025
1	RF 2	Increase in inflation rate	0.60715	6	RF 36	Delays in resolving disputes	0.34025
2	RF 6	Increase in oil price	0.5965	7	RF 14	Natural disaster	0.3347
2	RF 7	Construction material price escalation arising above the estimated allowances	0.5965	7	RF 16	Poor site condition (location, accessibility of site, etc...)	0.3347
2	RF 8	Changes in labor costs	0.5965	7	RF 22	Damage to Structure	0.3347
2	RF 33	Not meeting milestone deadline clause	0.5965	7	RF 32	Purchasing agreement/contract errors	0.3347
3	RF 5	Increase in customs (on imported goods)	0.47625	7	RF 34	Occurrence of claim and dispute	0.3347
4	RF 9	Financial failure of any party (client or developer) - project specific	0.4656	8	RF 4	Tax rate increase	0.26715
4	RF 17	Change of client's interest in design	0.4656	8	RF 35	Delays in resolving contractual issues	0.26715
4	RF 19	Quantity variations	0.4656	8	RF 37	Breach of contracts	0.26715
4	RF 21	Availability of infrastructure	0.4656	9	RF 10	Bankruptcy	0.2616
4	RF 38	Communication between project parties (client, consultant and developer)	0.4656	9	RF 11	Availability of local labor	0.2616
5	RF 3	Interest rate fluctuation	0.3636	9	RF 13	Weather conditions	0.2616
5	RF 12	Availability of material	0.3636	9	RF 23	Unpredicted technical problems in construction	0.2616
5	RF 18	Change of client's interest in type of construction material and in other related things	0.3636	9	RF 24	Impact of adjacent buildings	0.2616
5	RF 39	Changes in laws, regulations, and policies	0.3636	9	RF 31	Inappropriate risk allocation in purchasing agreement/contracts	0.2616
6	RF 15	Subsurface conditions (geotechnical)	0.34025	10	RF 30	Vagueness of purchasing agreement/contract clauses	0.1885

4.2 Whether the Risk Factors are Foreseeable, Assessable and Manageable

A weight analysis of responses from the survey questionnaires on whether the risk factors are foreseeable, assessable and manageable was conducted as shown in sub-section 3.5.2 Appendix F. The results of the analysis are shown in Table 4.3.1.

Regarding foreseeability, exchange rate fluctuation, increase in inflation rate, price escalation of construction material, quantity variation, lack of readily available utilities on site and availability of infrastructure were found to be likely foreseeable. On the other hand, increase in customs and tax rate, subsurface conditions, impact of adjacent building, inappropriate risk allocation, occurrence of dispute and delays in resolving disputes were claimed to be unlikely foreseeable. Vagueness of contract agreement and error in clauses were unlikely foreseeable.

Similarly, the results on whether the risk factors are assessable and manageable are shown in Table 4.3.1. Interest rate fluctuation, exchange rate fluctuation, availability of local labor and material, poor site condition, availability of infrastructure, change of client's interest in design, change of client's interest in design, lack of readily available utilities on site, change of client's interest in type of construction material and communication between project parties are likely assessable. Tax rate increase, subsurface conditions (geotechnical) and impact of adjacent buildings were found unlikely assessable.

Concerning manageability, Increase in inflation rate, poor site condition, change of client's interest in design are availability of local labor and material were found likely manageable. On the contrary, not meeting milestone deadline clause and tax rate increase were found unlikely manageable.

To show some of the risk factors which have the same result on the three allocation criteria, construction material price escalation is likely foreseeable, assessable and manageable. The same is true for quantity variations. Tax rate increase, subsurface conditions, inappropriate risk allocation in contracts, occurrence of claim and dispute, delays in resolving disputes and contractual issues are unlikely foreseeable, assessable and manageable. Increase in oil price, weather conditions, damage to structure, breach of contracts and changes in laws, regulations, and policies are moderately foreseeable, assessable and manageable.

As explained in sub-section 3.5.2., the weight analysis was conducted by counting the number of responses. However, not all risk factors were assigned foreseeable, assessable and manageable because there wasn't a response that outweighed the rest in some risk factors. Risk factors with incomplete evaluation result are presented in Table 4.3.2.

Table 4.3.1 Whether the Risk Factors are Foreseeable, Assessable and Manageable

No.	Risk Factors	RF #	Foreseeable	Assessable	Manageable
1	Interest rate fluctuation	RF 1	M	L	M
2	Tax rate increase	RF 4	U	U	U
3	Increase in customs	RF 5	U	M	M
4	Increase in oil price	RF 6	M	M	M
5	Construction material price escalation arising above the estimated allowances	RF 7	L	L	L
6	Changes in labor costs	RF 8	M	M	M
7	Weather conditions (wind, temperature, rain, and so forth)	RF 13	M	M	M
8	Subsurface conditions (geotechnical)	RF 15	U	U	U
9	Poor site condition (location, accessibility of site, etc...)	RF 16	L	L	L
10	Change of client's interest in design	RF 17	M	L	L
11	Quantity variations	RF 19	L	L	L
12	Lack of readily available utilities on site	RF 20	L	L	M
13	Availability of infrastructure	RF 21	L	L	M
14	Damage to Structure	RF 22	M	M	M
15	Impact of adjacent buildings	RF 24	U	U	M
16	Vagueness of purchase agreement/contract clauses	RF 30	VU	M	VU
17	Inappropriate risk allocation in purchase agreement/contracts	RF 31	U	U	U
18	Purchase agreement/contract errors	RF 32	VU	M	VU
19	Occurrence of claim and dispute	RF 34	U	U	U
20	Delays in resolving contractual issues	RF 35	U	U	U
21	Delays in resolving disputes	RF 36	U	U	U
22	Breach of contracts	RF 37	M	M	M
23	Changes in laws, regulations, and policies	RF 39	M	M	M

Table 4.3.2 Risk Factors with Incomplete Evaluation Result

No.	Risk Factors	RF #	Foreseeable	Assessable	Manageable
1	Exchange rate fluctuation	RF 1	**L**	**L**	
2	Increase in inflation rate	RF 2	**L**		**L**
3	Financial failure of any party (client or developer) - project specific	RF 9	**U**		
4	Bankruptcy	RF 10			**VU**
5	Availability of local labor	RF 11		**L**	**L**
6	Availability of material	RF 12		**L**	**L**
7	Natural disaster (flood, earthquake, landslide, fire, and so on)	RF 14	**U**		
8	Change of client's interest in type of construction material and in other related things	RF 18	**M**	**L**	
9	Unpredicted technical problems in construction	RF 23		**L**	**M**
10	Not meeting milestone deadline clause	RF 33	**U**		**U**
11	Communication between project parties (client, consultant and developer)	RF 38		**L**	

4.3 Current Risk Allocation in Real Estate Purchase Agreements

Contract documents were collected form 7 real estate developers. All of them stated that they use a standard format of contract agreement. The general information on the REDs from the questionnaire shows the developers do not assess risk as a formal procedure of project planning except for checking cost overrun which is only done by two of them.

The collected documents were assessed to explore how risks are allocated in real estate purchase agreements of real estate development projects in Addis Ababa, Ethiopia. The contract documents consist of written clauses and provisions which specify the interests and obligations of contracting parties. 21 risk factors were identified from the agreements and it is indicated whether the developers have considered them in their standard agreement by putting "yes and "no". This is shown in Table 4.4.

From the risk factors identified, failure of client to pay, termination of contract, occurrence of dispute and change in laws/regulations/policies are considered and included in all reviewed purchase agreements. Force majeure, RED not meeting deadline and defect are also considered by all except by one of the REDs. To the reverse, design error is considered only by one developer.

Foreign currency shortage, change in labor cost and tax rate increase are included in the purchase agreements of 5 REDs. Exchange rate fluctuation, change in labor cost, increase in oil price, change in tariffs issued by government, eviction, plot area variation, damage on the property, construction by client after delivery and change of client's interest in design are factors included in purchase agreements, some in three and some in four.

Increase in inflation rate has a great impact on time and cost, ranking third and second respectively in the impact analysis. However, it is not included in any of the reviewed purchase agreements. Unpredicted technical problems in construction, change of client's interest in type of construction material and in other related things, subsurface conditions (geotechnical), and availability of construction material and local labor are also not included in reviewed agreements.

From the identified 42 risk factors, not all are expected to be included in contract documents. These factors are poor site condition, bankruptcy, vagueness of purchase agreement/contract clauses, inappropriate risk allocation in purchase agreement/contracts, delays in resolving contractual issues, errors in contracts and communication between parties. They are included in the analysis to analyze their risk magnitude. Design error and plot area variation are factors identified from purchase agreements that are not included in the analysis.

Table 4.5 shows which risk is allocated to whom and how the risks are allocated is assessed from the review of purchase agreements.

To see how price escalation of construction material, exchange rate fluctuation, foreign currency shortage, and increase in oil price and change in labor cost are allocated by the three REDs, one RED stated price will be adjusted considering the fluctuation whether it is an increase or a decrease. Another RED stated the client shall pay the additional cost.

Table 4.4 Risk Factors in Real Estate Purchase Agreements

No.	Factors	RED 1	RED 2	RED 3	RED 4	RED 5	RED 8	RED 13
1	Failure of client to pay	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2	Price escalation	Yes	No	Yes	No	Yes	No	Yes
3	Exchange rate fluctuation	No	No	Yes	No	Yes	Yes	Yes
4	Foreign currency shortage	No	No	Yes	No	No	No	Yes
5	Change in labor cost	No	No	Yes	No	No	No	Yes
6	Increase in oil price	No	No	Yes	No	Yes	No	Yes
7	Change in tariffs issued by government	No	No	Yes	No	No	Yes	Yes
8	Eviction	No	No	Yes	Yes	No	No	Yes
9	Defect	No	Yes	Yes	Yes	Yes	Yes	Yes
10	Force majeure	No	Yes	Yes	Yes	Yes	Yes	Yes
11	RED not meeting deadline	Yes	Yes	Yes	No	Yes	Yes	Yes
12	Plot area variation	No	No	No	Yes	Yes	No	Yes
13	Quantity variations	No	No	No	No	No	Yes	Yes
14	Design error	No	No	No	No	Yes	No	No
15	Damage on the property	Yes	No	No	Yes	Yes	Yes	No
16	Construction by client after delivery	Yes	Yes	No	No	No	Yes	Yes
17	Termination of contract	Yes	Yes	Yes	Yes	Yes	Yes	Yes
18	Tax rate increase	No	No	Yes	Yes	Yes	Yes	Yes
19	Change of Client's interest in design	No	No	Yes	Yes	Yes	No	Yes
20	Change in laws/regulations/policies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
21	Occurrence of dispute	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4.5 Risk Allocation in Purchase Agreements

No.	Factors	RED 1	RED 2	RED 3	RED 4	RED 5	RED 8	RED 13
1	Failure of client to pay	Client	Client	Client	Client	Client	Client	Client
2	Construction material price escalation arising above the estimated allowances	RED	No	Will be notified in writing to the client if it makes delivery on the specified time difficult, will be decided on with the client	No	reduce price or increase considering the escalation	No	Client pays the additional cost
3	Exchange rate fluctuation	No	No		No	reduce price or increase considering the fluctuation	Client	
4	Foreign currency shortage	No	No		No	reduce price or increase considering the fluctuation	No	
5	Change in labor cost	No	No		No	No	No	
6	Increase in oil price	No	No		No	reduce price or increase considering the fluctuation	No	
7	Change in tariffs issued by government	No	No	Client	No	No	Client	Client
8	Eviction	No	No	RED if it is before delivery	RED	No	No	RED until ownership confirmation certificate is given to the buyer
9	Defect	No	1 year guarantee for construction defect	1 year guarantee	1 year guarantee	1 year guarantee	1 year maintenance guarantee	1 year guarantee
10	Force majeure	No	Yes	Yes	Yes	Yes	Yes	Yes

11	RED not meeting deadline	RED unless the delay occurred due to force majeure						
12	Plot area variation	No	No	No	Yes	Yes	No	Yes
13	Quantity variations	No	No	No	No	No	Yes	Yes
14	Design error	No	No	No	No	Yes	No	No
15	Damage on the property	RED is if it is caused by the developer	No	No	Client is responsible if it occurs during finishing work done by the client	RED if it is before delivery	Not the RED if it is due to natural causes, improper use by client or any other reason the RED is not responsible for	No
16	Construction by client after delivery	Forbidden if it changes the exterior design	Allowed with the permission of the RED	No	No	No	Yes	Yes
17	Termination of contract	Yes						
18	Tax rate increase	No	No	Client	No	No	Client	Client
19	Change of Client's interest in design	No	No	Allowed until construction of substructure ends	Allowed with the permission of the RED	Allowed with the permission of the RED	No	Allowed until structural concrete work is completed
20	Change in laws/regulations, and policies	All relevant laws of the country shall apply						

According to the review, all the REDs which included clauses regarding defect guaranteed a 1 year defect liability.

In case of not meeting milestone deadline, the RED shall bear it unless it is caused due to force majeure. What needs to be noted here is that the type of force majeure differs from developer to developer. What the developers consider as force majeure are listed here below.

- RED 2 – As stated in the Ethiopian Civil Code Article 1792 and 1793
- RED 3 - War, social unrest, man-made happenings, natural disasters, foreign currency shortage, foreign currency devaluation, price escalation and shortage of construction materials and equipment, transport problem due to increase in oil price and increase in labor cost
- RED 4 – It does not specify what factors are considered as a force majeure
- RED 5 – It does not specify what factors are considered as a force majeure
- RED 8 – Issues related to government legislations, rules and regulations or natural disasters
- RED 13 – conditions stated in the Ethiopian Civil Code article 1792 and 1793 as well as lack of electricity supply, price escalation of construction materials and the like, that prevents the real estate developer to handover the house to the client within the agreed time period.

According to the Ethiopian Civil Code Article 1792, force majeure results from an occurrence which the debtor could normally not foresee and which prevents him absolutely from performing his obligations. Cases of force majeure could be (Art. 1973):

(a) The unforeseeable act of third party for whom the debtor is not responsible; or

(b) An official prohibition preventing the performance of the contract; or

(c) A natural catastrophe such as earth quake, lightning or floods; or

(d) International or civil war; or

(e) The death or a serious accident or unexpected serious illness of the debtor.

However, an increase or reduction in the price of raw materials necessary for the performance of the contract; or the enactment of new legislations whereby the obligations of the debtor become more onerous shall not be deemed to be cases of force majeure unless otherwise expressly agreed (Art. 1794**)**.

As it can be seen from how the REDs considered force majeure in their contract document, it is only two REDs which included price escalation and other similar factors as a force majeure. Only one RED included enactment of new legislations as a force majeure.

4.4 Risk Allocation Decision Support Mechanism

Providing a mechanism that supports in making contractual risk allocation decision for real estate development projects particularly in real estate purchase agreements is the main aim of this research. The two parties in which risk is to be allocated to are real estate developer and client. The steps followed to satisfy this objective are:

i. Conduct risk-impact analysis: The result of the risk impact analysis presents the risk factors and their rank according to their impact on time and cost.

ii. Measure whether they are foreseeable, assessable and manageable: All the risk factors ranked were measured against risk allocation criteria as shown in Table 4.1, 4.2 and 4.3.

iii. Set a rule for allocation decision:

Proposition 1: If Risk Factor *X* is unlikely foreseeable by the RED, unlikely assessable by the RED and unlikely manageable by the RED, then the risk should be allocated to the client - adopted from allocation rule established by Lam et al. (2007).

Proposition 2: If Risk Factor *X* is likely foreseeable by the RED, likely assessable by the RED and likely manageable by the RED, then the risk should be allocated to the RED (adopted from allocation rule established by Lam et al. (2007).

Proposition 3: If the Risk Factor's foreseeability, assessablity and manageability are combination of moderate, likely, and unlikely, then the risk should be shared.

iv. Make a decision: a flow chart is used to represent the how the mechanism helps make risk allocation decision as shown in Figure 4.1.

The allocation decision was made following the above procedure and the result is Table 4.6. The results of the decision making were compared to how real estate developers allocated the above risk factors in their standard purchase agreement. The comparison is presented in Table 4.7. Here it has to be stated that risk allocation decision is not made for risk factors with incomplete evaluation result. Due to this, critical risk factors such as exchange rate fluctuation and increase in inflation rate could not be allocated. Availability of local labor and material were also not allocated.

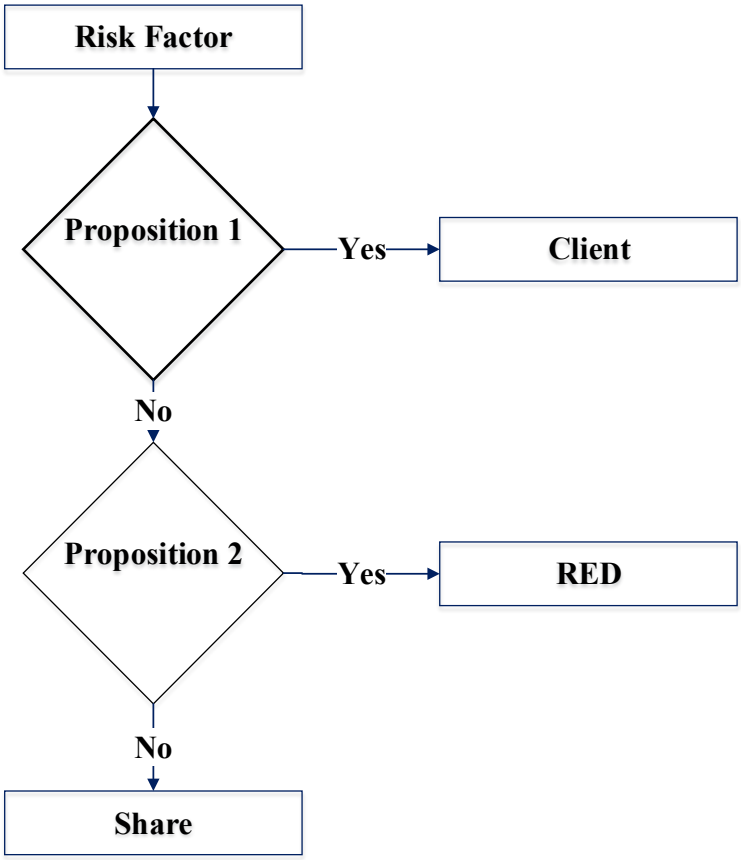

Figure 4.3 Risk Allocation Decision Making Flow Chart

Table 4.6 Risk Allocation Decision

No.	Risk Factors	RF #	Foreseeable	Assessable	Manageable	Risk Allocation Decision
1	Interest rate fluctuation	RF 1	M	L	M	Share
2	Tax rate increase	RF 4	U	U	U	Client
3	Increase in customs	RF 5	U	M	M	Share
4	Increase in oil price	RF 6	M	M	M	Share
5	Construction material price escalation	RF 7	L	L	L	RED
6	Changes in labor costs	RF 8	M	M	M	Share
7	Weather conditions (wind, temperature, rain, and so forth)	RF 13	M	M	M	Share
8	Subsurface conditions (geotechnical)	RF 15	U	U	U	Client
9	Change of client's interest in design	RF 17	M	L	L	Share
10	Quantity variations	RF 19	L	L	L	RED
11	Lack of readily available utilities on site	RF 20	L	L	M	Share
12	Availability of infrastructure	RF 21	L	L	M	Share
13	Damage to structure	RF 22	M	M	M	Share
14	Impact of adjacent buildings	RF 24	U	U	M	Share
15	Changes in laws, regulations, and policies	RF 39	M	M	M	Share

The decision making flow chart (Figure 4.3) shows the results of the mechanism are three allocation decisions, Client, RED or Share. The result of the mechanism shows tax rate increase and subsurface conditions (geotechnical) should be allocated to a client. Construction material price escalation and quantity variations are suggested to be allocated to the RED.

Increase in oil price, changes in labor costs, weather conditions (wind, temperature, rain, and so forth), damage to structure and changes in laws, regulations, and policies are all moderately foreseeable, assessable and manageable. These risk are suggested to be shared between the two parties. Here, further decision is required which is on the amount and how to be shared between the two parties. However, this is not within the scope of this study.

The results of the decision mechanism have some similarities with Lam's risk allocation decision. Changes in laws and regulations and availability of labor are both suggested to be shared by both the decision mechanism of this research and Lam's model result. The rest of the risk factors considered in this research and Lam's paper are different.

4.5 Comparison of Risk Allocation in Purchase Agreements and by Decision Mechanism

The comparison between how developers allocated risks and the decision making mechanism shows a difference in allocation of price escalation, change in labor cost and increase in oil price as shown in Table 4.7. The result of the decision mechanism suggests price escalation to be allocated to the RED, and change in labor cost and increase in oil price to be shared. It is three developers that considered these factors as explained earlier. To recall, one RED stated price will be adjusted considering the fluctuation whether it is an increase or a decrease and another RED

stated the client shall pay the additional cost. The third RED's agreement states if the above factors make delivery on the specified time difficult, they will be notified to the client and will be decided on with the client. Increase in oil price and changes are moderately foreseeable, assessable and manageable. Price escalation of construction material was found to be likely foreseeable by the developer according to the result of the survey and it suggested to be allocated to the RED.

Change of Client's interest in design, change in tariffs issued by government (specifically change in customs), change in laws/regulations and damage on the property are also suggested to be shared. Change of Client's interest in design is allowed with the permission of the RED until completion of a phase of construction, substructure and structural concrete work. Change in tariffs issued by government is allocated to clients in purchase agreements. Regarding change in laws/regulations, all seven purchase agreements stated all relevant laws of the country shall apply. This includes changes in laws.

Here it is important to restate that from the risk factors identified, failure of client to pay, termination of contract and occurrence of dispute included in all reviewed purchase agreements. Even if it needs more exploration, one can argue that inclusion of these factors by all developers can be an indication for the greater possibility of occurrence of dispute due to failure of client to pay which could be before or after adjustment of price, leading to termination of contract as a result. In any way, these clauses give the power to the developer in the contractual relationship and this makes clients be disadvantaged and bear the risk of losing their time and money. Even if most developers say they would pay back the money the buyer paid when contract is terminated

with a penalty deducted, the paid back money will not have the same value with the value it had before.

Damage on the property is suggested to be shared between the two parties in this paper. The sharing is to consider the causes which could be improper use of property by the client or developer's fault. Four agreements have considered this factor and three of them stated it is the developer who will be responsible if the damage occurs before delivery or if it is caused by the developer. Although all developers give a one year guarantee for construction defect, problems which occur after a year will be the responsibility of client even if they occur due to developer's fault. This s a clause which is protective for developers but not a fair one for clients because delivery of housing units is not processed after quality inspection is conducted by an impartial body. Clients cannot be sure about the quality of the property they buy and all they could have is trust on the developer.

Table 4.7 Comparison of Risk Allocation Decision by the Mechanism and Risk Allocation in Purchase Agreements

No	Factors	Risk Allocation Decision	RED 1	RED 2	RED 3	RED 4	RED 5	RED 8	RED 13
1	Construction material price escalation arising above the estimated allowances	RED	RED	No	Will be notified in writing to the client if it makes delivery on the specified time difficult, will be decided on with the client	No	Reduce price or increase considering the escalation	No	Client pays the additional cost
2	Change in labor cost	Share	No	No		No	No	No	
3	Increase in oil price	Share	No	No		No	Reduce price or increase considering the fluctuation	No	
4	Quantity variations	RED	No	No	No	No	No	Yes	Yes
5	Damage on the property	Share	RED is if it is caused by the developer	No	No	Client is responsible if it occurs during finishing work done by the client	RED if it is before delivery	Not the RED if it is due to natural causes, improper use by client or any other reason the RED is not responsible for	No
6	Termination of contract	Share	Yes						
7	Tax rate increase	Client	No	No	Client	No	No	Client	Client
8	Change of Client's interest in design	Share	No	No	Allowed until construction of substructure ends	Allowed with the permission of the RED	Allowed with the permission of the RED	No	Allowed until structural concrete work is completed
9	Change in laws, regulations, and policies	Share	All relevant laws of the country shall apply						

4.6 Summary and Discussion of Results

The aim of this study was to provide professionals working in real estate development projects a mechanism that will support them in making contractual risk allocation decision particularly in real estate purchase agreements that can serve as an alternative way of allocating risks in real estate purchase agreements.

Different risk factors related to real estate development projects and key risk allocation principles were identified through review of thesis works, reports, newspapers and conference proceedings and articles published in academic journals. As indicated in Chapter One of this study, the second major objective was to prioritize the risk factors identified from literature according to their impact on project cost and schedule by collecting data from real estate developers. The data collected were qualitative and Fuzzy Set Theory was used to change the linguistics of the qualitative data into numbers with meanings. Unavailability of quantitative data documented for a long period time which could at least show the risk experience is a shortcoming of the collected data.

The result shows that the top ranked risks are; not meeting milestone deadline, communication between project parties, lack of readily available utilities on site, exchange rate fluctuation, increase in inflation rate, customs and oil price, price escalation of construction material, and change in labor cost have high impact on project time.

Interest rate fluctuation, financial failure of any party, availability of material, change of client's interest in design and in type of construction material, quantity variation, and availability of infrastructure are factors with significant impact on project schedule.

Regarding cost, exchange rate fluctuation and increase in inflation rate have the greatest impact. Increase in oil price, price escalation of construction material, change in labor cost and not meeting milestone deadlines also have a great impact on project cost. The factors with the lowest impact are availability of local labor, weather conditions, unpredicted technical problems in construction, impact of adjacent buildings, inappropriate risk allocation in contract and vagueness of contract clauses.

Inflation and delay in project schedule were also found to be top ranked risks in some researches done on risk prioritization. Inflation was top ranked in the works of Hastak and Shaked (2000), Aboshady et al. (2013) and Sohrabinejad and Rahimi (2015). Delay in project schedule is also top ranked by Shen et al. (2001), Hsueh et al. (2007) and Dusane and Bhangale (2012). The rest of the severe risks were not found similar with the results of reviewed literature. As compared to the result of Addis (2014) on risk ranking, only availability of material was found to be a common risk with this paper's result.

Furthermore, the risk factors considered in the risk prioritization were evaluated against three risk allocation criteria which are whether the risk factors are foreseeable, assessable and manageable. The result of this evaluation was used for risk allocation decision in developing the decision support.

The most severe risk, not meeting milestone deadline was found unlikely foreseeable and manageable. Exchange rate fluctuation is likely foreseeable and assessable and so is increase in inflation rate were found to be likely foreseeable and manageable. Price escalation is likely

foreseeable, assessable and manageable and increase in oil price is moderately foreseeable, assessable and manageable.

On the other hand, inappropriate risk allocation, occurrence of dispute and delays in resolving disputes were claimed to be unlikely foreseeable. Vagueness of contract agreement and error in clauses were found unlikely foreseeable.

In order to achieve the fourth objective which is review of the current practice, contract documents were collected form real estate developers. All of them stated that they use a standard format of contract agreement. Risk factors were identified form the purchase agreements and examined whether the developers have considered them in their standard agreement. 21 risk factors were extracted from the sample agreements. From the seven REDs, it is only three which included more than 15 risk factors. Two included less than ten and the res two considered half of the total identified risk factors.

From the risk factors identified, failure of client to pay, termination of contract, and change in laws, regulations, and policies are considered and included in all reviewed purchase agreements. Force majeure, RED not meeting deadline and defect are also considered by all except by one of the REDs. To the reverse, design error is considered only by one developer.

Foreign currency shortage, change in labor cost and tax rate increase are included in the purchasing agreements of 5 REDs. Exchange rate fluctuation, change in labor cost, increase in oil price, change in tariffs issued by government, eviction, plot area variation, damage on the property, construction by client after delivery and change of client's interest in design are factors included in purchasing contracts, some in three and some in four.

Increase in inflation rate, which one of the severe risk factors is not included in any of the reviewed purchasing agreements. Unpredicted technical problems in construction, change of client's interest in type of construction material and in other related things, subsurface conditions (geotechnical), and availability of construction material and local labor are also not included in reviewed purchasing agreements. Design error and plot area variation are factors identified from purchasing agreements that are not included in the risk impact analysis.

Price escalation of construction material, exchange rate fluctuation, foreign currency shortage, increase in oil price and change in labor cost were considered by three contractors only even if these factors have a high impact on both project schedule and cost. One RED stated price will be adjusted considering the fluctuation whether it is an increase or a decrease. Another RED stated the client shall pay the additional cost.

Here it has to be noted that price escalation of construction material were found to be likely foreseeable by the developer according to the result of the survey. The third one stated if these factors make delivery on the specified time difficult, they will be notified in writing to the client and will be decided on with the client.

Not meeting milestone deadline is the top ranking risk and all REDs stated they shall bear it unless it is caused due to force majeure. What needs to be clear here is that the type of force majeure differs from developer to developer.

Only two developers stated force majeure is defined according to the conditions stated in the Ethiopian Civil Code article 1792 and 1793. According to the Ethiopian Civil Code Article 1792, force majeure results from an occurrence which the debtor could normally not foresee and which

prevents him absolutely from performing his obligations. These occurrences could be the unforeseeable act of third party for whom the debtor is not responsible, an official prohibition preventing the performance of the contract, natural catastrophe or international or civil war; or the death or a serious accident or unexpected serious illness of the debtor.

The Civil Code states an increase or reduction in the price of raw materials necessary for the performance of the contract; or the enactment of new legislations whereby the obligations of the debtor become more onerous shall not be deemed to be cases of force majeure unless otherwise expressly agreed (Art. 1794**)**.

Price escalation is a severe risk and was found likely foreseeable, assessable and manageable. Including price escalation as a force majeure protects developers from the unlikely foreseeable, assessable and manageable side of it. In addition, it makes clear clients will be obliged to allow the RED ask for time extension and cover the additional cost for the performance of the contract and the delivery of the project. However, it is only three REDs considered price escalation and from the REDs considered force majeure in their contract document, it is only two REDs which included price escalation and other similar factors as a force majeure. Only one RED included enactment of new legislations as a force majeure.

All the reviewed contracts are adhesive contracts which do not give room for negotiation between the developer and the client. In addition, most of the reviewed purchasing agreements do not include at least the severe risk factors. This could be because the developers do not assess risk as a formal procedure of project planning except for checking cost overrun which is only done by two of them. It also might be the result of company marketing strategy.

The fifth objective was realized by developing a mechanism which helps make risk allocation decision by considering whether the severe risks are foreseeable, assessable and manageable. Providing a mechanism that supports in making contractual risk allocation decision for real estate development projects particularly in real estate purchasing contracts is the main aim of this research. The two parties in which risk is to be allocated to are real estate developer and client. The steps followed are:

i. Conduct risk-impact analysis
ii. Measure whether they are foreseeable, assessable and manageable
iii. Set a rule for allocation decision
iv. Make a decision

A risk allocation decision was made following these steps. The results of the decision making were compared to how real estate developers allocated the above risk factors in their standard purchasing agreement. It was explained before that risk allocation decision is not made for risk factors with incomplete evaluation result. Due to this, critical risk factors such as exchange rate fluctuation and increase in inflation rate could not be allocated. Availability of local labor and material were also not allocated. The risk factors which were both allocated to a party by the mechanism and included in purchasing agreements were only nine.

The decision making flow chart shows the results of the mechanism are three allocation decisions, Client, RED or Share. The result of the mechanism shows construction material price escalation and quantity variations are suggested to be allocated to the RED. Increase in oil price, changes in labor costs, weather conditions (wind, temperature, rain, and so forth), damage to structure and

changes in laws, regulations, and policies are all moderately foreseeable, assessable and manageable.

These risk are suggested to be shared between the two parties. Here, further decision is required which is on the amount and how to be shared between the two parties.

All analyzed risk factors have impact on time and cost. It has to be decided what to be shared, that is cost, time or both. For risk factors with different result on the three evaluation criteria, the mechanism helps not only in making decision, but also helps determine when and how to share the risks, whether it is they are not foreseeable, assessable, manageable or a combination of two allocation criteria.

The comparison between how developers allocated risks and the decision making mechanism shows a difference in allocation of price escalation, change in labor cost and increase in oil price. Even though some severe risks are considered in the purchasing agreements, some contracts allocated risks to the client while they are in a position to foresee, assess and manage the risks. Again this could be due to company strategy or lack of information on risks but it show misallocation.

It is considering the following problems which were identified in this research that a decision mechanism is provided. These are

- Developers using standard purchase agreements for different projects with different features
- Developers not assessing risk

- Misallocation of risks and purchase agreements lacking completeness,

Although developers had made decisions and allocated risks in purchase agreements, circumstances could be different enough that past decisions are may not be the right decision choices. Therefore, to consider the dynamic nature of risk and projects' unique features, developers can use the decision mechanism as shown on Figure 4.4. Outcomes of previous decisions can be evaluated and future decisions can be made based on the feedback.

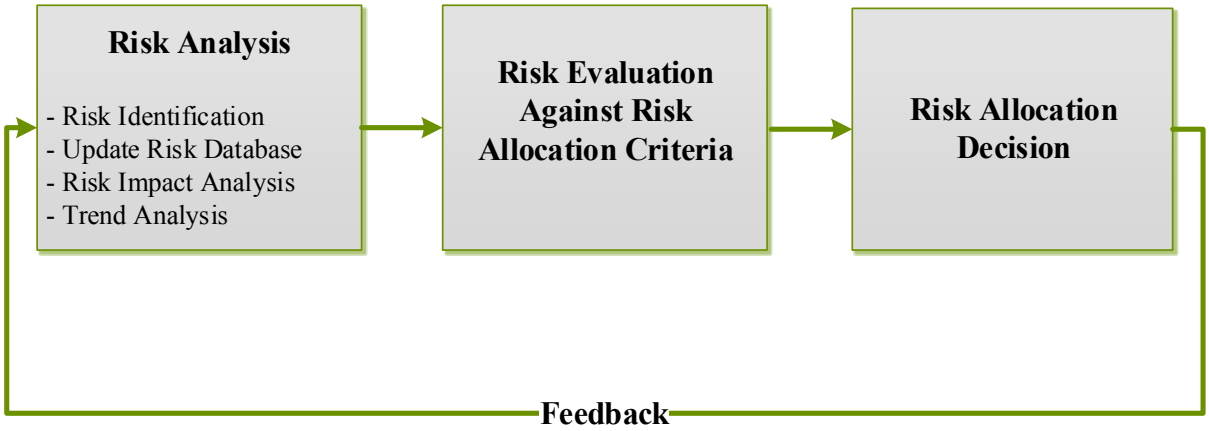

Figure 4.4 Risk Allocation Decision Support Mechanism

5. CONCLUSIONS AND RECOMMENDATIONS

Real Estate Development is considered as one of the sectors with transaction of billions of birr in the market in Ethiopia. The sector contributes not only to the economy of the country and but also helps in alleviating housing problems. However, the problems the real estate development sector is facing make the environment susceptible to uncertainty. This makes the real estate development environment involve risk.

Risk allocation is one way of mitigating risk that exists in an uncertain environment. Risk allocation is very important for project success. Risks should be allocated to the party that is best able to manage it efficiently and effectively through contract conditions and clauses. Real estate purchase agreements are commonly used to allocate risks between buyers and developers.

The aim of this research was to identify risk factors in real estate development projects and their impact on project objectives, examine of the current practice of risk allocation in real estate purchase agreements and provide a practical mechanism that can be used by real estate developers to allocate risks properly. The findings of the study were summarized in the previous chapter. This chapter presents conclusions and recommendations.

5.1 Conclusions of the Study

The conclusions from the results of each objective are presented as follows.

1. Not meeting milestone deadline, exchange rate fluctuation, increase in inflation rate and in oil price, and price escalation of construction material have high impact on surveyed private real estate development projects' time and cost.

2. All the risks with high risk impact such as price escalation, exchange rate fluctuation and increase in inflation increase are found foreseeable except not meeting milestone deadline which is found unlikely foreseeable and manageable and increase in oil price rate is moderately foreseeable.

3. Most of the reviewed purchase agreements of private real estate developers in Addis Ababa do not include at least the severe risk factors. It is concluded that purchase agreements currently being used lack completeness in addition to risks being misallocated.

4. All the reviewed contracts are adhesive contracts which do not give room for negotiation between the developer and the client. Clients do not have protection against being disadvantaged by developers adjusting price, extending delivery time or terminating the purchase contract. Of course, they can sue developers but most probably they have to pass through an elongated judicial process which causes more loss of time and money. In addition, clients cannot be sure about the quality of the property they buy since delivery of housing units is not processed after quality inspection is conducted by an impartial body. In general, all they could have is trust on the developer. Therefore, it can be concluded that clients are highly susceptible to being disadvantaged through the contractual relationship they have with developers.

5. The provided decision mechanism helps in allocating risks between the two parties, the developer and the buyer. It helps determine when and how to share the risks. It also helps developers consider the dynamic nature of risk and uniqueness of projects, and manage to allocate risks properly.

5.2 Recommendations of the Study

1. Purchase agreements currently being used lack completeness in addition to risks being misallocated. This implies a caution for both parties because unfair shifting of risk might result in the RED to build a contingency into the price to cover the risk; or, the RED will not have a contingency and will face financial problems. Higher contingencies make the total price of the property high and REDs could face lower profit margins in addition to other financial problems. The adversarial impact is not only on cost but on time and quality also. This affects the reputation and the competitiveness of the developer in the market. The researcher believes the purchase agreements currently being used need to be revised in order for the risk allocation to be effective and efficient considering the risk appetite of the company. Of course, this has to be preceded with proper risk planning, identification and analysis.

2. Purchase agreement is more important than it seems. It is advisable that buyers consider how risks and different obligations are allocated in addition to the type and price of property.

3. It would be good if impartial consultants or contract administrators get involved in private real estate development projects so that a proactive action could be taken to minimize the impact of risks, and issues that arise between developers and clients could be managed in a better way. It is also advisable that there could be inspection of built housing units before they are transferred to clients in order to protect clients from the impact of latent defects.

5.3 Direction for Future Research

Having the results of the study, the researcher recommends for clients' perspective on real estate purchase agreements to be studied in the future. It is also recommended that the interrelationship between the existing risk factors be studied. Studying the practice of foreign real estate developers working locally and comparing it with the practice of the local firms could also be considered as a future research direction

REFERENCES

A. FARIDI & EL-SAYEGH, S. 2006. Significant factors causing delay in the UAE construction industry. *Journal of Construction Management and Economics,* 24.

ABOSHADY, A., MARZOUK, M. & ELBARKOUKY, M. 2013. A fuzzy risk management framework for the Egyptian real estate development projects. Building Solutions for Architectural Engineering: Architecture Engineers Institute Conference, American Society of Civil Engineers, State College, Pennsylvania, United States.

ABRAHAMSON, M. 1973. Contractual risks in tunnelling: how they should be shared. *Tunnels and Tunnelling, November***,** 587-598.

ABRAHAMSON, M. 1984. Risk management. *Int Construct Law Rev,* 1**,** 241–64.

ACEC 2005. Enlightened Risk Allocation. The American Council of Engineering Companies and the associated general contractors of America.

ADDIS, M. 2014. *A Study on Construction Contract Risk Management Practices in Ethiopian Building Construction Projects.* AAU.

AKINCI, B. & FISCHER, M. 1998. Factors affecting contractors' risk of cost overburden. *Journal of Management in Engineering,* 14**,** 67-76.

AKINTOYE, A. S. & MACLEOD, M. J. 1997. Risk analysis and management in construction. *International journal of project management,* 15**,** 31-38.

AL-BAHAR, J. A. C., K 1990. Systematic risk management approach for construction projects. *Journal of Construction Engineering and Management,* 116**,** 533-546.

ALTORYMAN, A. S. 2014. Identification and assessment of risk factors affecting construction projects in the Gulf region: Kuwait and Bahrain.

ALSALMAN, A. A. 2012. Construction risks allocation: Optimal risk allocation decision support model.

ANDI 2006. The importance and allocation of risks in Indonesian construction projects. *Construction Management and Economics,* 24**,** 69-80.

ARAS, S. A. & AMIRHOSSEINI, Z. 2016. Identify and prioritize risks of construction projects based on fuzzy logic (Case Study: Construction Project of Iranian Investment and Sustainable Development Company). *Modern Applied Science,* 10**,** 197.

ASSOCIATION, P. M. 2008. Prioritizing Project Risks: A Short guide to useful techniques. Buckinghamshire: Latimer Trend and Company.

BAKHSHI, P. & TOURAN, A. 2014. An overview of budget contingency calculation methods in construction industry. *Procedia Engineering,* 85**,** 52-60.

BALOI, D. & PRICE, A. D. 2003. Modelling global risk factors affecting construction cost performance. *International Journal of Project Management,* 21**,** 261-269.

BANAITIENE, N. & BANAITIS, A. 2012. *Risk management in construction projects*.

BARNES, M. 1983. How to allocate risks in construction contracts. *International Journal of Project Management,* 1**,** 24-28.

BERKELEY, D., HUMPHREYS, P. & THOMAS, R. 1991. Project risk action management. *Construction Management and Economics,* 9**,** 3-17.

BEWKET, A. 13 January 2014. *Real estate in Ethiopia growing by 25% | Role of private real estate companies in Ethiopia* [Online]. MACROPOLIS. Available: http://www.marcopolis.net/real-estate-in-ethiopia-growing-by-25-role-of-private-real-estate-companies-in-ethiopia.htm.

BING, L., AKINTOYE, A., EDWARDS, P. J. & HARDCASTLE, C. 2005. The allocation of risk in PPP/PFI construction projects in the UK. *International Journal of project management,* 23**,** 25-35.

BING, L., TIONG, R. L.-K., FAN, W. W. & CHEW, D. A.-S. 1999. Risk management in international construction joint ventures. *Journal of construction engineering and management,* 125**,** 277-284.

BU-QAMMAZ, A. S., DIKMEN, I. & BIRGONUL, M. T. 2009. Risk assessment of international construction projects using the analytic network process. *Canadian Journal of Civil Engineering,* 36**,** 1170-1181.

BYRNE, P. J. 1996. *Risk, uncertainty and decision-making in property,* UK, E. & FN Spon.

CARBONE, T. A. & TIPPETT, D. D. 2004. Project risk management using the project risk FMEA. *Engineering Management Journal,* 16**,** 28-35.

CARLSON, G. A. 2002. Experimental Errors and Uncertainty.

CASEY, J. J. Identification and nature of risks in construction projects—a contractor's perspective. Construction Risks and Liability Sharing, 1979. ASCE, 17-23.

CASSATION 2015. Casation File No. 95780. Ethiopian Federal Supreme Court, Cassation Bench.

CHAN, A. P., CHAN, D. W. & YEUNG, J. F. 2009. Overview of the application of "fuzzy techniques" in construction management research. *Journal of construction engineering and management,* 135**,** 1241-1252.

CHAPMAN, C. 1997. Project risk analysis and management—PRAM the generic process. *International Journal of Project Management,* 15**,** 273-281.

CHAPMAN, C. 2006. Key points of contention in framing assumptions for risk and uncertainty management. *International Journal of Project Management,* 24**,** 303-313.

CHEN, Z. 2007. *Multicriteria Decision-making for the Sustainable Built Environment: Proceedings of the 2006 Whiteknights Workshop on MCDM*, University of Reading.

CHEN, Z. & KHUMPAISAL, S. 2009. An analytic network process for risks assessment in commercial real estate developmentnull. *Journal of Property Investment & Finance,* 27**,** 238-258.

CII 1993. Allocation of Insurance Related Risks and Costs on Construction Projects. University of Texas at Austin, Austin, TX, USA: Construction Industry Institute(CII).

COMMITTEE, C. I. R. 2001. *Construct for excellence: report of the construction industry review committee*, Construction Industry Review Committee.

COSO, C. O. S. O. O. T. T. C. 2009. Strengthening enterprise risk management for strategic advantage. *World Wide Web: http://www. coso. org (accessed July 1, 2013)*.

DANTER. 2007. A sample lodging analysis in the City of Grove, Ohio. Available: www.danter.com/PRODUCT/samplodg.pdf [Accessed December 30, 2007].

DEY, P. K. 2002. Project risk management: a combined analytic hierarchy process and decision tree approach. *Cost Engineering,* 44**,** 13-27.

DEY, P. K. & OGUNLANA, S. O. 2004. Selection and application of risk management tools and techniques for build-operate-transfer projects. *Industrial Management & Data Systems,* 104**,** 334-346.

DIKMEN, I. & BIRGONUL, M. T. 2006. An analytic hierarchy process based model for risk and opportunity assessment of international construction projects. *Canadian Journal of Civil Engineering,* 33**,** 58-68.

DLAPIPER. 2015. Real estate investment in the US: The legal perspective. Available: www.dlapiperrealworld.com/export/.../real.../Italy-Investor-Guide.pdf [Accessed March 7, 2016].

DUSANE, M. M. & BHANGALE, P. P. 2012. Assessment of risk and its application for residential construction projects: a case study.

EDWARDS, P. J. & BOWEN, P. A. 1998. Risk and risk management in construction: a review and future directions for research. *Engineering, Construction and Architectural Management,* 5**,** 339-349.

EL-SAYEGH, S. M. 2008. Risk assessment and allocation in the UAE construction industry. *International Journal of Project Management,* 26**,** 431-438.

EL, M. S. B. A. A., EL NAWAWY, O. A. M. & ABDEL-ALIM, A. M. 2015. Identification and assessment of risk factors affecting construction projects. *HBRC Journal*.

ESHETE, Z. S. & TESHOME, K. W. 2015. Performance, challenges and prospects of real estate financing in Addis Ababa: Micro-and Macro Economic Implications. *Management,* 1**,** 1-9.

ETHIOPIA 1960. Civil code of the Empire of Ethiopia of 1960. Addis Ababa: [Berhanena Selam Print. Press of H.I.M. Haile Selassie I].

FAVIÉ, R., KAFA, A. & MAAS, G. 2009. Risk allocation in joint ventures. *Construction Facing Worldwide Challenges***,** 1-7.

FISK, E. R. & REYNOLDS, W. D. 2011. *Construction project administration*, Pearson Higher Ed.

FLANAGAN, R. & NORMAN, G. 1993. *Risk management and construction,* London Blackwell.

FRODSHAM, M. Risk management in UK property portfolios: A survey of current practice. London: Investment Property Forum. Retrieved December, 2007. 2007.

FSA. 2005. Strengthening capital standards. Available: www.fsa.gov.uk/pubs/cp/cp05_03.pdf [Accessed May 16, 2016].

FSB April 2007. Financial stability report. The Financial Stability Board, Bank of England.

FU-ZHOU, L. & HONG-YUAN, G. 2011. The risk assessment model of BT construction engineering project financing. *Systems Engineering Procedia,* 1**,** 169-173.

GEHNER, E., HALMAN, J. & DE JONGE, H. Risk management in the Dutch real estate development sector: a survey. 6th International Postgraduate Research Conference, 2006. 6-7.

GHOSH, S. & JINTANAPAKANONT, J. 2004. Identifying and assessing the critical risk factors in an underground rail project in Thailand: a factor analysis approach. *International Journal of Project Management,* 22**,** 633-643.

GOH, C. S., ABDUL-RAHMAN, H. & ABDUL SAMAD, Z. 2012. Applying risk management workshop for a public construction project: Case Study. *Journal of Construction Engineering and Management,* 139**,** 572-580.

GOHAR, A. S., KHANZADI, M. & FARMANI, M. 2012. Identifying and evaluating risks of construction projects in fuzzy environment: a case study in Iranian construction industry. *Indian Journal of Science and Technology,* 5**,** 3593-3602.

GROTON, J., SMITH, R. J. & RISK ALLOCATION SUB-COMMITTE, C. C. A. C. 2010. Realistic risk allocation allocating each risk to the part best able to handle the risk. *CPR*.

HALLER, M. 1986. *Risiko-Management—Eckpunkte eines integrierten Konzepts*, Springer.

HARTMAN, F. & SNELGROVE, P. 1996. Risk allocation in lump-sum contracts-concept of latent dispute. *Journal of construction engineering and management,* 122**,** 291-296.

HARTMANN, A., LOVE, P. E., CHAN, J. H., CHAN, D. W., LAM, P. T. & CHAN, A. P. 2011. Preferred risk allocation in target cost contracts in construction. *Facilities,* 29**,** 542-562.

HASTAK, M. & SHAKED, A. 2000. ICRAM-1: Model for international construction risk assessment. *Journal of Management in Engineering,* 16**,** 59-69.

HILLSON, D. 2002. Extending the risk process to manage opportunities. *International Journal of project management,* 20**,** 235-240.

HILLSON, D. 2004. *Effective opportunity management for projects: Exploiting positive risk*, CRC Press.

HOSSEN, F. A. 2007. Project cost risk assessment: an application of project risk management process in Libyan construction projects Available: www.jeaconf.org/.../f337e0ea-ceba-42ea-88a1-79f1badd71cb.pdf [Accessed 27-January-2016].

HSUEH, S.-L., PERNG, Y.-H., YAN, M.-R. & LEE, J.-R. 2007. On-line multi-criterion risk assessment model for construction joint ventures in China. *Automation in Construction,* 16**,** 607-619.

ISSA, D., EMSLEY, M. & KIRKHAM, R. Reviewing risk allocation for infrastructure PFI: between theory and practice. Procs 28th Annual ARCOM Conference, 2012. Association of Researchers in Construction Management, , 1219-1231.

ISSA, U. H., FARAG, M. A., ABDELHAFEZ, L. M. & AHMED, S. A. 2015. A risk allocation model for construction projects in Yemen. *Civil and Environmental Research* 7**,** 78-88.

ISAAC, D., BALCHIN, P. N. & CHEN, J. 2000. *Urban economics: a global perspective,* New York, Palgrave Macmillan.

JANNADIA, M. O., ASSAF, S., BUBSHAIT, A. & NAJI, A. 2000. Contractual methods for dispute avoidance and resolution (DAR). *International Journal of Project Management,* 18**,** 41-49.

JENNINGS, M. 2013. *Real estate law*, Cengage Learning.

JIN, X.-H. & ZHANG, G. 2011. Modelling optimal risk allocation in PPP projects using artificial neural networks. *International journal of project management,* 29**,** 591-603.

JIN, X. H. & DOLOI, H. 2009. Modeling risk allocation in privately financed infrastructure projects using fuzzy logic. *Computer-Aided Civil and Infrastructure Engineering,* 24**,** 509-524.

KANGARI, R. 1995. Risk management perceptions and trends of US construction. *Journal of Construction Engineering and Management,* 121**,** 422-429.

KARIMIAZARI, A., MOUSAVI, N., MOUSAVI, S. F. & HOSSEINI, S. 2011. Risk assessment model selection in construction industry. *Expert Systems with Applications,* 38**,** 9105-9111.

KE, Y., WANG, S. & CHAN, A. P. 2011. Equitable risks allocation of projects inside China: analyses from Delphi survey studies. *Chinese Management Studies,* 5**,** 298-310.

KERF, M. 1998. *Concessions for infrastructure: a guide to their design and award*, World Bank Publications.

KHAZAENI, G., KHANZADI, M. & AFSHAR, A. 2012. Fuzzy adaptive decision making model for selection balanced risk allocation. *International Journal of Project Management,* 30**,** 511-522.

KHEDEKAR, S. & DHAWALE, A. 2015. Qualitative risk assessment and mitigation measures for real estate projects in Maharashtra. *International journal of Technical Research and Applications*.

KIA, S. H. & TOHIDI, A. R. 2002. Risk Allocation in engineering construction contracts. M*anagement,* 20**,** 12.

KIROS, A. 2009. *Factors affecting the real estate market: the case of Addis Ababa city.* ADDIS ABABA UNIVERSITY.

KLIR, G. & YUAN, B. 1995. *Fuzzy sets and fuzzy logic*, Prentice hall New Jersey.

KOIRALA, M. P. 2014. Risks in housing and real estate construction project. *Journal of the Institute of Engineering,* 10**,** 34-44.

KOSSIAKOFF, A., SWEET, W. N., SEYMOUR, S. & BIEMER, S. M. 2011. *Systems engineering principles and practice*, John Wiley & Sons.

KUESEL, T. R. Allocation of risks. Construction risks and liability sharing, 1979. ASCE, 51-60.

KUMARASWAMY, M., DULAIMI, M., LOVE, P. & MOTAIR, M. 2001. Synergising construction procurement and operational innovations through a product focused paradigm.

KUO, Y.-C. & LU, S.-T. 2013. Using fuzzy multiple criteria decision making approach to enhance risk assessment for metropolitan construction projects. *International Journal of Project Management,* 31**,** 602-614.

LAM, K. C., WANG, D., LEE, P. T. K. & TSANG, Y. T. 2007. Modelling risk allocation decision in construction contracts. *International Journal of Project Management,* 25**,** 485-493.

LASTER, D. S. 1999. The conventional approach to risk management. New York.

LATHAM, M. 1994. Constructing the Team: joint review of procurement and contractual arrangements in the UK construction industry, Department of the Environment. HMSO, London, United Kingdom.

LEVITT, R. E., LOGCHER, R. D. & ASHLEY, D. B. 1980. Allocating risk and incentive in construction. *Journal of the Construction Division,* 106**,** 297-305.

LI, H. X., AL-HUSSEIN, M., LEI, Z. & AJWEH, Z. 2013. Risk identification and assessment of modular construction utilizing fuzzy analytic hierarchy process (AHP) and simulation. *Canadian Journal of Civil Engineering,* 40**,** 1184-1195.

LIBANOS, S. 2005. *The role of real estate development and public engagement in the housing problem of Addis Ababa.* MA, Addis Ababa University.

LOOSEMORE, M. & MCCARTHY, C. 2008. Perceptions of contractual risk allocation in construction supply chains. *Journal of Professional Issues in Engineering Education and Practice,* 134**,** 95-105.

LOOSEMORE, M., RAFTERY, J. & REILLY, C. 2006. *Risk management in projects*, Taylor & Francis.

LOOSEMORE, M., RAFTERY, J., REILLY, C., & HIGGON, D. 2005. *Risk management in projects,* London, Taylor and Francis.

LOYD, L. 2001. The background to the conference on whose risk, The Grove Report. *International Construction Law Review,* 18**,** 302-311.

LYONS, T. 2003. *Project risk management in the construction industry: a review*, Australian Institute of Quantity Surveyors.

M. MOTIAR, R. & M.M, K. 2002. Risk management trends in the construction industry: moving towards joint risk managementnull. *Engineering, Construction and Architectural Management,* 9**,** 131-151.

MACK, S. W. 1995. Risk analysis in construction: a paradigm shift from a hard to soft approach. *Construction management and economics,* 13**,** 385-392.

MAJID P. JALAL, GHODDOSI, P. & HOSSEINALIPOUR, M. 2008. Development of a fuzzy risk assessment and contractual allocation model for Iran's dam construction projects. *Construction in Developing Countries***,** 366-375.

MEAD, P. 2007. Current trends in risk allocation in construction projects and their implications for industry participants. *Construction Law Journal,* 23**,** 23.

MERON, T. 05 June 2012. Ethiopia to Enact New Real Estate Law. *Addis Fortune*.

MOHAMMAD, A. & JAMAL, A. 1991. Project risk analytic assessment using the hierarchy process. *IEEE Trans Eng Manage,* 38**,** 46-52.

MOJTAHEDI, S. M. H., MOUSAVI, S. M. & MAKUI, A. 2010. Project risk identification and assessment simultaneously using multi-attribute group decision making technique. *Safety Science,* 48**,** 499-507.

MORLEDGE, R., SMITH, A. & KASHIWAGI, D. 2006. Design and Build. Building Procurement. Oxford: Blackwell Publishing Ltd.

MUBARAK, S. A. 2015. *Construction project scheduling and control,* Hoboken, New Jersey, Published by John Wiley & Sons, Inc., .

MULUKEN, Y. 15 April 2013 Real Estate: Where lies its problem? *Capital*.

MUSTAFA, M. A. & AL-BAHAR, J. F. 1991. Project risk assessment using the analytic hierarchy process. *Engineering Management, IEEE Transactions on,* 38**,** 46-52.

NABARRO, R. & KEY, T. 2005. Performance measurement and real estate lending risk. *Real estate indicators and financial stability***,** 70-90.

NASIRZADEH, F., AFSHAR, A. & KHANZADI, M. 2008. System dynamics approach for construction risk analysis. *International Journal of Civil Engineering,* 6**,** 120-31.

NASIRZADEH, F., KHANZADI, M. & REZAIE, M. 2013. System dynamics approach for quantitative risk allocation. *International Journal of Industrial Engineering and Production Research,* 24**,** 237-246.

NASIRZADEH, F., ROUHPARVAR, M., ZADEH, H. M. & REZAIE, M. 2015. Integrating system dynamics and fuzzy bargaining for quantitative risk allocation in construction projects. *Scientia Iranica. Transaction A, Civil Engineering,* 22**,** 668.

NG, A. & LOOSEMORE, M. 2007. Risk allocation in the private provision of public infrastructure. *International Journal of Project Management,* 25**,** 66-76.

ÖKMEN, Ö. 2002. Risk analysis and management of construction projects tendered under design-build (turnkey) contract system. *Yüksek Lisans Tezi*.

OLSSON, R. 2007. In search of opportunity management: Is the risk management process enough? *International Journal of Project Management,* 25**,** 745-752.

OYEGOKE, A. S. 2006. Construction industry overview in the UK, US, Japan and Finland: a comparative analysis. *Journal of Construction Research,* 7**,** 13-31.

PARSONS, T. G. T., ALI; P.E. AND GOLDER ASSOCIATES 2004. Risk Analysis Methodologies and Procedures. *In:* TRANSPORTATION, F. T. A. U. S. D. O. (ed.).

PAULOS, B. 2011. *Study on Private Residential Real Estate Development in Addis Ababa.* M.Sc., Addis Ababa Universit, Addis Ababa Institute of Technology.

PEDRYCZ, W. & GOMIDE, F. 2007. *Fuzzy systems engineering: toward human-centric computing*, John Wiley & Sons.

PERRY, J. G. & HAYES, R. 1985. Risk and its management in construction projects. *Proceedings of the Institution of Civil Engineers,* 78**,** 499-521.

PHENG, L. S. & CHUAN, Q. T. 2006. Environmental factors and work performance of project managers in the construction industry. *International Journal of Project Management,* 24**,** 24-37.

PIPATTANAPIWONG, J. 2004. *Development of multi-party risk and uncertainty management process for an infrastructure project.* Kochi University of Technology.

PMI, P. M. I. 2008. *A guide to the project management body of knowledge (PMBOK Guide)* [Online]. Newtown Square, Pa.: Project Management Institute. Available: http://www.books24x7.com/marc.asp?bookid=29854.

PMI, P. M. I. 2013. *A guide to the project management body of knowledge : (PMBOK® guide),* Newtown Square, Pa., Project management institute.

RAFTERY, J. 1994. *Risk analysis in project management,* London, E & FN Spon.

RAHIMAN, N. B. A. 2006. *Managing Constructionproject Risks; Case Study: Contractors in Johor Bahru.* Universiti Teknologi Malaysia.

RAHMAN, M. & KUMARASWAMY, M. 2002. Risk management trends in the construction industry: moving towards joint risk management. *Engineering, Construction and Architectural Management,* 9**,** 131-151.

RASOOL, M., FRANCK, T., DENYS, B. & HALIDOU, N. 2012. Methodology and tools for risk evaluation in construction projects using Risk Breakdown Structure. *European Journal of Environmental and Civil Engineering,* 16**,** s78-s98.

RENUKA, S., UMARANI, C. & KAMAL, S. 2014. A Review on critical risk factors in the life cycle of construction projects. *Journal of Civil Engineering Research,* 4**,** 31-36.

REZAKHANI, P. 2012. Classifying key risk factors in construction projects. *Buletinul Institutului Politehnic din lasi. Sectia Constructii, Arhitectura,* 58**,** 27.

ROSE, M. 2001. Risk versus Uncertainty, or Mr. Slate versus Great-Aunt Matilda. Available: http://www.econlib.org/library/Columns/Teachers/riskuncertainty.html [Accessed February 25, 2011].

ROUHPARVAR, M., ZADEH, H. M. & NASIRZADEH, F. 2014. Quantitative risk allocation in construction projects: A Fuzzy-Bargaining Game Approach. *International Journal of Industrial Engineering,* 25**,** 83-94.

ROUMBOUTSOS, A. & ANAGNOSTOPOULOS, K. P. 2008. Public–private partnership projects in Greece: risk ranking and preferred risk allocation. *Construction Management and Economics,* 26**,** 751-763.

SACHS, T. & TIONG, R. L. 2009. Quantifying qualitative information on risks: development of the QQIR method. *Journal of Construction Engineering and Management,* 135**,** 56-71.

ŠAFR, J. 2014. Quantitative data analysis. UK FHS Historical Sociology.

SAGALYN, L. 2009. Real estate risk and the business cycle: evidence from security markets. *Journal of Real Estate Research*.

SAN SANTOSO, D., OGUNLANA, S. O. & MINATO, T. 2003. Assessment of risks in high rise building construction in Jakarta. *Engineering, Construction and Architectural Management,* 10**,** 43-55.

SCHIEG, M. 2006. Risk management in construction project management. *Journal of Business Economics and Management,* 7**,** 77-83.

SELAM, Y. G. 2016. *Experience and prospects of private residential real estate development in Alleviating Housing problems in Addis Ababa.* M.Sc., Addis Ababa University, Addis Ababa Institute of Technology.

SHEN-FA, W. & XIAO-PING, W. 2009. The rule and method of risk allocation in project finance. *Procedia Earth and Planetary Science,* 1**,** 1757-1763.

SHEN, L., WU, G. W. & NG, C. S. 2001. Risk assessment for construction joint ventures in China. *Journal of Construction Engineering and Management,* 127**,** 76-81.

SIMON, M., HOUGHTON, S. M. & AQUINO, K. 2000. Cognitive biases, risk perception, and venture formation: How individuals decide to start companies. *Journal of Business Venturing,* 15**,** 113-134.

SIMON, P., AND, H. D. & NEWLAND 1997. Project risk analysis and management guide. Norwich Norfolk: The Association for Project Management.

SMITH, N. J. 2003. *Appraisal, risk and uncertainty*, Thomas Telford.

SOHRABINEJAD, A. & RAHIMI, M. 2015. Risk determination, prioritization, and classifying in construction project case study: Gharb Tehran Commercial-Administrative Complex. *Journal of Construction Engineering,* 2015.

STERMAN, J. D. 1992. System dynamics modeling for project management. *Unpublished manuscript, Cambridge, MA*.

SURETYLEARN 2014 Introduction to construction risks and contracting practices. NASBP

TADAYON, M., JAAFAR, M. & NASRI, E. 2012. An assessment of risk identification in large construction projects in Iran. *Journal of Construction in Developing Countries,* 17**,** 57-69.

TADEOS, A. Jul 14, 2012 Ethiopia: How buying a real estate home in Addis can be a nightmare you could do without. *nazret.com* [Online]. Available from: http://nazret.com/blog/index.php/ethiopia-how-buying-a-real-estate-in-addis-can-be-a-nightmare-you-could-do-without?blog=15.

TAH, J. & CARR, V. 2001. Knowledge-based approach to construction project risk management. *Journal of computing in civil engineering,* 15**,** 170-177.

TAH, J. H., THORPE, A. & MCCAFFER, R. 1993. Contractor project risks contingency allocation using linguistic approximation. *Computing systems in engineering,* 4**,** 281-293.

TAROUN, A. 2014. Towards a better modelling and assessment of construction risk: Insights from a literature review. *International Journal of Project Management,* 32**,** 101-115.

TAVAKKOLI-MOGHADDAM, R., HASHEMI, H. & MOUSAVI, S. 2011. *A fuzzy comprehensive approach for risk identification and prioritization simultaneously in EPC projects*, INTECH Open Access Publisher.

TENEYUCA, D. 2001. Organizational leader's use of risk management for information technology. *Information Security Technical Report,* 6**,** 54-59.

THOMAS, A., KALIDINDI, S. N. & ANANTHANARAYANAN, K. 2003. Risk perception analysis of BOT road project participants in India. *Construction Management and Economics,* 21**,** 393-407.

THOMPSON, P. & PERRY, J. G. 1992. *Engineering construction risks: A guide to project risk analysis and assessment implications for project clients and project managers*, Thomas Telford.

TRUNEH, F. 2013. *Institutional interfaces and actors' behavior in transitional real estate Markets of Addis Ababa (Ethiopia).* Erasmus University Rotterdam.

UFF, J. & ODAMS, A. M. 1995. *Risk, management and procurement in construction*, Centre of Construction Law and Management.

UHER, T. 2003. *Programming and Scheduling Techniques,* Sydney, UNSW Press.

UHER, T. & LOOSEMORE, M. 2004. *Essentials of construction project management,* Sidney, Austrailia, University of New South Wales Press.

UHER, T. E. & DAVENPORT, P. 2009. *Fundamentals of building contract management*, UNSW Press.

VAUGHAN, E. J. V. A. T. 2003. *Fundamentals of Risk and Insurance*, John Wiley & Sons, United States of America.

WANG, M.-T. & CHOU, H.-Y. 2003. Risk allocation and risk handling of highway projects in Taiwan. *Journal of management in Engineering,* 19**,** 60-68.

WANG, S. Q., DULAIMI, M. F. & AGURIA, M. Y. 2004. Risk management framework for construction projects in developing countries. *Construction Management and Economics,* 22**,** 237-252.

WARD, S. & CHAPMAN, C. 2003. Transforming project risk management into project uncertainty management. *International Journal of Project Management,* 21**,** 97-105.

WARD, S., CHAPMAN, C. & CURTIS, B. 1991. On the allocation of risk in construction projects. *International Journal of Project Management,* 9**,** 140-147.

WIBOWO, A. & MOHAMED, S. 2008. Perceived Risk Allocation in Public-Private-Partnered (PPP) Water Supply Projects in Indonesia. *Construction in Developing Countries***,** 349-356.

WIEGELMANN, T. W. 2012. *Risk Management in the Real Estate Development Industry*. Bond University, Australia.

WIGUNA, I. P. A., SCOTT, S. & KHOSROWSHAHI, F. Nature of the critical risk factors affecting project performance in Indonesian building contracts. 21 st Annual ARCOM Conference, SOAS, University of London, Association of Researchers in Construction Management, 2005. 225-35.

WILKINSON, S., REED, R. & CADMAN, D. 2008. *Property development*, Routledge London.

WILLIAMS, T. 1995. A classified bibliography of recent research relating to project risk management. *European Journal of Operational Research,* 85**,** 18-38.

WYSOCKI, R. K. 2011. *Effective project management: traditional, agile, extreme*, John Wiley & Sons.

YILDIZ, A. E., DIKMEN, I., BIRGONUL, M. T., ERCOSKUN, K. & ALTEN, S. 2014. A knowledge-based risk mapping tool for cost estimation of international construction projects. *Automation in Construction,* 43**,** 144-155.

YOON, Y., TAMER, Z. & HASTAK, M. 2014. Protocol to enhance profitability by managing risks in construction projects. *Journal of Management in Engineering,* 31**,** 04014090.

ZAGHLOUL, R. & HARTMAN, F. 2003. Construction contracts: the cost of mistrust. *International Journal of Project Management,* 21**,** 419-424.

ZANELDIN, E. K. 2006. Construction claims in United Arab Emirates: Types, causes, and frequency. *International Journal of Project Management,* 24**,** 453-459.

ZAVADSKAS, E. K., TURSKIS, Z. & TAMOŠAITIENE, J. 2010. Risk assessment of construction projects. *Journal of Civil Engineering and Management,* 16**,** 33-46.

ZAYED, T., AMER, M. & PAN, J. 2008. Assessing risk and uncertainty inherent in Chinese highway projects using AHP. *International Journal of Project Management,* 26**,** 408-419.

ZENG, J., AN, M. & SMITH, N. J. 2007. Application of a fuzzy based decision making methodology to construction project risk assessment. *International Journal of Project Management,* 25**,** 589-600.

ZIMMERMANN, H.-J. 2001. *Fuzzy set theory and its applications,* Dordrecht, The Netherlands., Kluwer.

ZHANG, S., ZHANG, L. & GAO, W. 2006. Risk allocations in construction contracts: A Comparison of China's Standard Form of Construction Contract and FIDIC Conditions of Contract for Construction. *Surveyors Times,* 15**,** 35-41.

ZHAO, Y., LIU, X. & ZHAO, Y. 2011. Forecast for construction engineering risk based on fuzzy sets and systems theory. *Systems Engineering Procedia,* 1**,** 156-161.

ZOU, P. X., ZHANG, G. & WANG, J.-Y. Identifying key risks in construction projects: life cycle and stakeholder perspectives. Pacific Rim Real Estate Society Conference, 2006.

ZOU, P. X., ZHANG, G. & WANG, J. 2007. Understanding the key risks in construction projects in China. *International Journal of Project Management,* 25**,** 601-614.

የቤቶች ልማት. 2012. የአገር አቀፍ የሪል ስቴት ልማት የሕግ ማዕቀፍ ለመቅረጽ የተዘጋጀ የመነሻ ጥናት. በከተማ ልማትና ኮንስትራክሽን ሚኒስቴር የመኖሪያ ቤቶች ልማትና የመንግሥት ህንፃዎች ኮንስትራክሽን ቢሮ, ስትራቴጂና የሕግ ጉዳዮች መምሪያ, አዲስ አበባ.

APPENDIX A – RESEARCH POPULATION

No.	Name of Real Estate Developer
1	Aser Real Estate
2	Ayat Real Estate Development Enterprise
3	AZ Real Estate
4	Country Club Developers Real Estate PLC
5	Enyi Real Estate
6	Flintstone Engineering
7	Gift Real Estate
8	Haile & Alem International PLC
9	Nasew Real Estate PLC
10	Sunshine Real Estate
11	Tracon Trading PLC
12	Yotek Construction
13	Zenebe Firew Real Estate

APPENDIX B – ORGANIZATIONAL INFORMATION OF SURVEYED REAL ESTATE DEVELOPERS

No.	Developer	Experience in the Real Estate Development	Number of Executed Projects in the Last 5 Years	Type of Projects	Whether the RED Assesses Risk	Risk Assessment Method
1	RED 1	5 -10 Years	1 project with different phases	Villa and Apartment	Yes	Checking primarily estimated against actual selling price (cost overrun), by checking demand on market on both quality and price of house
2	RED 2	5 -10 Years	4 - 5 projects	Villa and Apartment	No	
3	RED 3	5 -10 Years	7 - 9 projects	Villa	No response	
4	RED 4	3 - 5 Years	2 projects or less	Villa and Apartment	Yes	Studying the real estate market based on customers interest in the type and design purpose of the house built in Addis Ababa
5	RED 5	5 -10 Years	5 - 7 projects	Villa and Apartment	Yes	
6	RED 6	12 Years	25 projects		No	
7	RED 7	No response				
8	RED 8	5 -10 Years	2 projects or less	Villa and Apartment	Yes	
9	RED 9	Could not be approached for data collection				
10	RED 10	No response				
11	RED 11	5 -10 Years	3 - 5 projects	Apartment	No	
12	RED 12	5 -10 Years	3 - 5 projects	Villa and Apartment	Yes	checking primarily estimated against actual selling price (cost overrun)
13	RED 13	> 10 Years	3 - 5 projects	Villa and Apartment	No	

APPENDIX C – RESPONDENTS PROFILE

No.	Developer	Position	Educational Background	Work Experience in Real Estate Development (including construction industry)
1	RED 1	Construction Department Head	B.Sc. in Civil Engineering	21 Years
2	RED 2	Technical Manager	M.Sc. in Civil Engineering	15 Years
3	RED 3	Architect	M.Sc. in Architecture	5 -10 Years
4	RED 4	Project Coordinator	B.Sc. in Civil Engineering	5 -10 Years
5	RED 5	Architect	B.Sc. in Urban Planning and Architecture	1 - 3 Years
6	RED 6	Project Manager	B.Sc. in Civil Engineering	5 -10 Years
7	RED 8	Senior Office Engineer	B.Sc. in Civil Engineering	5 -10 Years
8	RED 11	Site Engineer	B.Sc. in Civil Engineering	1 - 3 Years
9	RED 12	Design and Supervision Department Head	M.Sc. in Civil Engineering (Structural)	5 -10 Years
10	RED 13	Senior Marketing Officer	Diploma in Marketing	5 -10 Years

APPENDIX D – SURVEY QUESTIONNAIRE

Cover letter

February 17, 2016

Dear Sir or Madam,

I am a graduate student in Construction Technology and Management at Addis Ababa University, Addis Ababa Institute of Technology (AAiT) at the School of Civil and Environmental Engineering. I am conducting a survey on Risk Allocation Decision in Real Estate Purchasing Contracts for my Master's Thesis. The purpose of the study is to provide a decision support mechanism for risk allocation in real estate purchasing agreements by examining key risk factors in the sector. The model to be provided is expected to support the decision making in risk allocation.

I would like to invite you to take part in this research. With your participation, I hope I will understand, identify, explore and rank the major risk factors in the sector. I am asking you to look over the questionnaire and, if you choose to do so, please complete the questionnaire.

The survey should only take about 15 -20 minutes of your time. Your answers are anonymous, DO NOT put your name on the survey. All answer will be kept confidential. Only group results will be presented or documented, not individual answers. Your help with this research is strictly voluntary. You do not have to answer any questions you don't want to. Return of an answered survey will indicate your consent to participate in this study.

If you have questions or concerns, please contact me at (+251) 911861232, milkahag@gmail.com. If you have any questions regarding your rights as a research participant, please contact the School of Civil and Environmental Engineering through (+251) 11-1-23-24-37 or info@ceng.aait.eu.et. Thank for your time and consideration.

Sincerely,

Milka Hagos

Post-Graduate Student

GUIDELINES FOR COMPLETING THE QUESTIONNAIRE

- Only one answer is required for each question
- For questions which require an opinion, there is a grid of boxes to show grades of opinion. Please mark the box which most closely fits your opinion.
- If you do not understand a question or it is unclear please omit the question and move on to the next.

1. Risk

Risk is an uncertain event or condition, if it occurs, has an effect on at least one project objective. Objectives can include cost, time scope and quality. A risk may have one or more causes and, if it occurs, it may have one or more impacts. A cause may be a requirement, assumption, constraint, or condition that creates the possibility of negative or positive outcomes.

2. Risk Management

Risk management includes the process of conducting risk management planning, identification, analysis, response planning, and monitoring and control on a project. The objectives of project risk management are to increase the probability and impact of positive events, and decrease the probability and impact of negative events in the project.

3. Risk Assessment

The risk assessment helps in risk management by measuring, conducting quantitatively and qualitatively in order to estimate the significance level of the industrial risk factors to the project and then to estimate of the risk of the potential factors to project success.

4. Risk allocation

It is the definition and division of responsibility associated with a possible future loss or gain, seeks to assign responsibility of agreeing parties (the real estate developer and the client) for a variety of hypothetical circumstances that might affect the project in proceeding as planned. Responsibilities are commonly defined through contractual documents as part of a risk management strategy.

5. Input Variables for Risk Allocation decision

Foreseeable

Whether the party (real estate developer) is able to foresee or predict the risk.

Assessable

Whether the party (real estate developer) is able to assess or measure the possible magnitude of consequences of a risk.

Manageable

Whether the party (real estate developer) is able to exercise best control on minimizing or avoiding the materialization of the risk or manage the risk (minimize the severity, extra cost and delay) once the risk occurs in case of occurring.

Sustainable

Whether the party (real estate developer) is able to sustain or bear the consequences if the risk occurs.

PART I: ORGANIZATIONAL INFORMATION

1. **Experience of the organization in real estate development (Years)?**

   1 year or less ☐ 1 – 3 years ☐

   3 – 5 years ☐ 5 – 10 years ☐

   Other _____

2. **Number of executed projects in the last 5 years**?

   2 Projects or less ☐ 3 - 5 Projects ☐

   5 - 7 Projects ☐ 7 - 9 Projects ☐

   Other _____

3. **Type of project (mark both boxes if your company delivers both)**

   Villa ☐

   Apartment ☐

4. **Does your company assess project risk?**

   Yes ☐ No ☐

   If your answer is yes, please list down the techniques you use for assessment.

_____

_____

_____

_____

_____

_____

PART II RESPONDENT'S PROFILE

1. **The position of the respondent?**

Sales Person ☐ Office Engineer ☐

Project Manager ☐ Architect ☐

Other _____

2. **Experience and Educational Qualifications**

Education level: _____

Working Experience in years (In the sector): _____

1 year or less ☐ 1 – 3 years ☐

3 – 5 years ☐ 5 – 10 years ☐

Other _____

Working Experience in years (In current position): _____

1 year or less ☐ 1 – 3 years ☐

3 – 5 years ☐ 5 – 10 years ☐

Other _____

3. **Professional background**

Civil Engineer ☐ Architect ☐

Quantity Surveyor ☐ Other _____

PART III - RISK FACTORS' OCCURRENCE, IMPACT AND MEASUREMENT OF RISK FACTORS AGAINST RISK ALLOCATION CRITERIA

The table below contains different risk factors categorized into four major categories. Please assign the likelihood of occurrence, impact and measure the factors against the five risk allocation criteria foreseeable, assessability, manageable and sustainable. All allocation criteria are measured from developer's point of view.

For likelihood of occurrence and measuring against the five risk allocation criteria

1 = Very Unlikely
2 = Unlikely
3 = Moderate
4 = Likely
5 = Very Likely

For Impact Assessment

1 = Insignificant
2 = Minor
3 = Moderate
4 = Major
5 = Catastrophic

No.	Risk Category	Risk Events	Likelihood of Occurrence	Risk Allocation Criteria																						Risk Impact									
				Foreseeable					Assessable					Manageable					Sustainable					Impact on Project Schedule					Impact on Project Cost								
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	I	MI	MO	MA	C	I	MI	MO	MA	C
1	Economic and Financial	Exchange rate fluctuation																																		
		Increase in inflation rate																																		
		Interest rate fluctuation																																		
		Tax rate increase																																		
		Increase in customs																																		
		Increase in oil price																																		
		Construction material price escalation arising above the estimated allowances																																		
		Changes in labor costs																																		
		Financial failure of any party (client or developer) - project specific																																		
		Bankruptcy																																		
		Availability of local labor																																		
		Availability of material																																		

2	**Technical and Environmental**	Weather conditions (wind, temperature, rain, and so forth)																																							
		Natural disaster (flood, earthquake, landslide, fire, and so on)																																							
		Subsurface conditions (geotechinical)																																							
		Poor site condition (location, accessibility of site, etc..)																																							
		Change of client's interest in design																																							
		Change of client's interest in type of construction material and in other related things																																							
		Quantity variations																																							
		Lack of readily available utilities on site																																							
		Availability of infrastructure																																							
		Damage to Structure																																							
		Unpredicted technical problems in construction																																							
		Impact of adjacent buildings																																							
3	**Governmental and Political**	Delay in permits and licenses																																							
		Political interference																																							
		Bribery and Corruption																																							
		Custom and import restrictions																																							
		Relocation of projects due to development plans																																							
4	**Legal and Contractual**	Vagueness of purchasing agreement/contract clauses																																							
		Inappropriate risk allocation in purchasing agreement/contracts																																							
		Purchasing agreement/contract errors																																							
		Not meeting milestone deadline clause																																							
		Occurrence of claim and dispute																																							
		Delays in resolving contractual issues																																							

4	**Legal and Contractual**	Delays in resolving disputes																																					
		Breach of contracts																																					
		Communication between project parties (client, consultant and developer)																																					
		Changes in laws, regulations, and policies																																					
		Changes in requirements for permits and their approval																																					
		Inconsistency in government policies, laws, and regulations																																					
		Existing codes and regulations																																					

* If there are risk factors which are not included in the above table, pleace them list down below.

No.	Addtional Risk Factors	Probability of Occurrence					Risk Allocation Criteria																					Impact											
							Forseeable					Assessable					Manageable					Sustainable					Impact on Project Schedule					Impact on Project Cost							
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	I	MI	MO	MA	C	I	MI	MO	MA	C			

APPENDIX E – FUZZY ANALYSIS

E - 1 FUZZY ANALYSIS FOR LIKELIHOOD OF OCCURRENCE OF RISK FACTORS

TABLE - E – 1.1

No.	Response on Impact on Likelihood of Occurrence								Response Frequency					Normalized Values				
	RED 1	RED 3	RED 4	RED 5	RED 6	RED 8	RED 11	RED 13	1	2	3	4	5	1	2	3	4	5
RF 1	5	4	4	4	3	2	4	2	0	2	1	4	1	0	0.5	0.25	1	0.25
RF 2	4	4	4	5	4	4	4	2	0	1	0	6	1	0	0.17	0	1	0.17
RF 3	4	3	2	5	4	3	3	2	0	2	3	2	1	0	0.67	1	0.67	0.33
RF 4	3	2	2	5	4	3	2	2	0	4	2	1	1	0	1	0.5	0.25	0.25
RF 5	3	4	2	4	5	3	4	3	0	1	3	3	1	0	0.33	1	1	0.33
RF 6	4	4	3	1	3	4	4	2	1	1	2	4	0	0.25	0.25	0.5	1	0
RF 7	4	4	4	5	4	4	4		0	0	0	6	1	0	0	0	1	0.17
RF 8	3	3	4	4	4	5	3	1	1	0	3	3	1	0.33	0	1	1	0.33
RF 9	3	3	4	5	3	3	3	2	0	1	5	1	1	0	0.2	1	0.2	0.2
RF 10	2	2	2	4	1	2	2	1	2	5	0	1	0	0.4	1	0	0.2	0
RF 11	2	3	4	5	1	2	3	2	1	3	2	1	1	0.33	1	0.67	0.33	0.33
RF 12	2	3	4	5	3	4	3	2	0	2	3	2	1	0	0.67	1	0.67	0.33
RF 13	2	2	3	4	3	4	2	2	0	4	2	2	0	0	1	0.5	0.5	0
RF 14	1	2	1	4	2	2	2	1	3	4	0	1	0	0.75	1	0	0.25	0
RF 15	1	2	3	5	5	2	2	3	1	3	2	0	2	0.33	1	0.67	0	0.67
RF 16	3	3	2	5	4	2	3	2	0	3	3	1	1	0	1	1	0.33	0.33
RF 17	4	4	3	4	5	2	4	3	0	1	2	4	1	0	0.25	0.5	1	0.25
RF 18	3	3	3	5	3	2	3	3	0	1	6	0	1	0	0.17	1	0	0.17
RF 19	4	3	2	5	3	2	3	4	0	2	3	2	1	0	0.67	1	0.67	0.33
RF 20	4	3	5	5	4	3	3	4	0	0	3	3	2	0	0	1	1	0.67
RF 21	4	3	2	5	3	1	3	3	1	1	4	1	1	0.25	0.25	1	0.25	0.25
RF 22	2	3	1	5	1	2	3	2	2	3	2	0	1	0.67	1	0.67	0	0.33
RF 23	3	2	1	5	3	2	2	2	1	4	2	0	1	0.25	1	0.5	0	0.25
RF 24	2	2	1	5	4	2	2	3	1	4	1	1	1	0.25	1	0.25	0.25	0.25
RF 30	2	2	2	5	3	1	2	3	1	4	2	0	1	0.25	1	0.5	0	0.25
RF 31	2	2	3	5	3	2	2	3	0	4	3	0	1	0	1	0.75	0	0.25
RF 32	2	2	2		3	2	2	2	0	6	1	0	0	0	1	0.17	0	0
RF 33	2	4	4	5	4	4	4	2	0	2	0	5	1	0	0.4	0	1	0.2
RF 34	2	2	2	5	4	5	2	2	0	5	0	1	2	0	1	0	0.2	0.4
RF 35	2	2	2	4	4	4	2	3	0	4	1	3	0	0	1	0.25	0.75	0
RF 36	2	2	2	4	3	4	2	2	0	5	1	2	0	0	1	0.2	0.4	0
RF 37	2	2	2	4	4	4	2	3	0	4	1	3	0	0	1	0.25	0.75	0
RF 38	3	2	4	4	4	5	2	5	0	2	1	3	2	0	0.67	0.33	1	0.67
RF 39	2	3	2	4	3	2	3	3	0	3	4	1	0	0	0.75	1	0.25	0

APPENDIX E – FUZZY ANALYSIS

E - 1 FUZZY ANALYSIS FOR IMPACT OF RISK FACTORS ON PROJECT SCHEDULE

TABLE - E – 1.2

No.	Response on Impact on Project Schedule								Response Frequency					Normalized Values				
	RED 1	RED 3	RED 4	RED 5	RED 6	RED 8	RED 11	RED 13	1	2	3	4	5	1	2	3	4	5
RF 1	4	4	4	4	1	1	4	4	2	0	0	6	0	0.33	0	0	1	0
RF 2	4	3	4	4	1	1	4	4	2	0	1	5	0	0.4	0	0.2	1	0
RF 3	4	3	2	4	1	1	3	4	2	1	2	3	0	0.67	0.33	0.67	1	0
RF 4	3	4	4	3	2	1	2	3	1	2	3	2	0	0.33	0.67	1	0.67	0
RF 5	3	4	4	3	2	1	4	2	1	2	2	3	0	0.33	0.67	0.67	1	0
RF 6	3	4	4	4	1	1	4	3	2	0	2	4	0	0.5	0	0.5	1	0
RF 7	4	4	5	4	2	1	4	4	1	1	0	5	1	0.2	0.2	0	1	0.2
RF 8	2	4	5	3	2	1	4	4	1	2	1	3	1	0.33	0.67	0.33	1	0.33
RF 9	4	3	4	4	1	4	3	4	1	0	2	5	0	0.2	0	0.4	1	0
RF 10	2	4	5	2	1	4	3	3	1	2	2	2	1	0.5	1	1	1	0.5
RF 11	2	3	2	2	1	4	3	4	1	3	2	2	0	0.33	1	0.67	0.67	0
RF 12	4	4	2	4	3	4	3	4	0	1	2	5	0	0	0.2	0.4	1	0
RF 13	4	3	3	4	3	3	2	3	0	1	5	2	0	0	0.2	1	0.4	0
RF 14	4	4	5	2	4	5	2	1	1	2	0	3	2	0.33	0.67	0	1	0.67
RF 15	3	3	4	4	4	4	3	4	0	0	3	5	0	0	0	0.6	1	0
RF 16	4	3	4	3	1	4	4	4	1	0	2	5	0	0.2	0	0.4	1	0
RF 17	3	2	3	3	4	4	4	3	0	1	4	3	0	0	0.25	1	0.75	0
RF 18	2	3	4	3	4	4	4	3	0	1	3	4	0	0	0.25	0.75	1	0
RF 19	2	3	5	4	2	4	3	4	0	2	2	3	1	0	0.67	0.67	1	0.33
RF 20	2	4	4	4	1	3	3	1	2	1	2	3	0	0.67	0.33	0.67	1	0
RF 21	3	4	5	4	1	4	3	4	1	0	2	4	1	0.25	0	0.5	1	0.25
RF 22	2	4	5	3	2	5	4	5	0	2	1	2	3	0	0.67	0.33	0.67	1
RF 23	2	4	2	3	2	4	4	3	0	3	2	3	0	0	1	0.67	1	0
RF 24	2	3	1	3	2	4	4	4	1	2	2	3	0	0.33	0.67	0.67	1	0
RF 30	3	3	5	5	2	4	3	2	0	2	3	1	2	0	0.67	1	0.33	0.67
RF 31	3	3	5	5	2	4	3	3	0	1	4	1	2	0	0.25	1	0.25	0.5
RF 32	3	3	5	5	1	5	3	2	1	1	3	0	3	0.33	0.33	1	0	1
RF 33	3	4	5	5	2	5	3	2	0	2	2	1	3	0	0.67	0.67	0.33	1
RF 34	3	3	5	5	2	4	4	2	0	2	2	2	2	0	1	1	1	1
RF 35	3	4	5	5	3	4	4	3	0	0	3	3	2	0	0	1	1	0.67
RF 36	3	4	5	5	3	5	4	4	0	0	2	3	3	0	0	0.67	1	1
RF 37	3	3	5	5	3	4	4	3	0	0	4	2	2	0	0	1	0.5	0.5
RF 38	3	3	4	5	2	5	5	2	0	2	2	1	3	0	0.67	0.67	0.33	1
RF 39	3	4	5	5	1	5	3	3	1	0	3	1	3	0.33	0	1	0.33	1

APPENDIX E – FUZZY ANALYSIS

E - 1 FUZZY ANALYSIS FOR IMPACT OF RISK FACTORS ON PROJECT COST

TABLE - E – 1.3

No.	Response on Impact on Project Cost								Response Frequency					Normalized Values				
	RED 1	RED 3	RED 4	RED 5	RED 6	RED 8	RED 11	RED 13	1	2	3	4	5	1	2	3	4	5
RF 1	3	4	4	5	3	4	4	4	0	0	2	5	1	0	0	0.4	1	0.2
RF 2	3	4	4	5	3	4	4	4	0	0	2	5	1	0	0	0.4	1	0.2
RF 3	3	4	2	5	3	3	3	4	0	1	4	2	1	0	0.25	1	0.5	0.25
RF 4	3	4	4	4	3	3	3	3	0	0	5	3	0	0	0	1	0.6	0
RF 5	3	4	4	4	3	3	3	3	0	0	5	3	0	0	0	1	0.6	0
RF 6	3	4	4	5	1	4	3	3	1	0	3	3	1	0.33	0	1	1	0.33
RF 7	4	4	4	5	3	4	2	4	0	1	1	5	1	0	0.2	0.2	1	0.2
RF 8	3	4	4	3	2	4	2	4	0	2	2	4	0	0	0.5	0.5	1	0
RF 9	4	3	2	3	1	5	4	4	1	1	2	3	1	0.33	0.33	0.67	1	0.33
RF 10	3	4	5	2	1	5	4	3	1	1	2	2	2	0.5	0.5	1	1	1
RF 11	3	3	2	2	2	3	3	4	0	3	4	1	0	0	0.75	1	0.25	0
RF 12	4	3	2	4	3	3	3	4	0	1	4	3	0	0	0.25	1	0.75	0
RF 13	4	3	3	3	2	4	4	3	0	1	4	3	0	0	0.25	1	0.75	0
RF 14	3	4	3	2	4	4	4	2	0	2	2	4	0	0	0.5	0.5	1	0
RF 15	4	3	4	4	3	4	4	4	0	0	2	6	0	0	0	0.33	1	0
RF 16	3	3	4	4	1	4	3	4	1	0	2	3	0	0.33	0	0.67	1	0
RF 17	3	2	4	3	1	4	3	3	1	1	4	2	0	0.25	0.25	1	0.5	0
RF 18	2	2	4	3	1	4	3	3	1	2	3	2	0	0.33	0.67	1	0.67	0
RF 19	2	3	4	3	2	4	2	4	0	3	2	3	0	0	1	0.67	1	0
RF 20	2	3	3	4	2	4	2	2	0	4	2	2	0	0	1	0.5	0.5	0
RF 21	3	3	4	4	1	4	2	4	1	1	2	4	0	0.25	0.25	0.5	1	0
RF 22	2	4	5	4	3	4	3	5	0	1	2	3	2	0	0.33	0.67	1	0.67
RF 23	2	4	2	4	3	4	3	3	0	2	3	3	0	0	0.67	1	1	0
RF 24	2	3	1	3	3	4	3	4	1	1	4	2	0	0.25	0.25	1	0.5	0
RF 30	3	3	5	4	2	4	2	2	0	3	2	2	1	0	1	0.67	0.67	0.33
RF 31	3	3	5	4	3	4	2	3	0	1	4	2	1	0	0.25	1	0.5	0.25
RF 32	3	3	5	4	1	4	4	2	1	1	2	3	1	0.33	0.33	0.67	1	0.33
RF 33	3	4	5	4	2	4	4	2	0	2	1	4	1	0	0.5	0.25	1	0.25
RF 34	3	3	5	4	2	4	4	2	0	2	2	3	1	0	0.67	0.67	1	0.33
RF 35	3	3	5	4	3	4	4	3	0	0	4	3	1	0	0	1	0.75	0.25
RF 36	3	4	5	4	3	5	4	4	0	0	2	4	2	0	0	0.5	1	0.5
RF 37	3	3	5	3	3	4	4	3	0	0	5	2	1	0	0	1	0.4	0.2
RF 38	3	3	4	3	2	4	3	2	0	2	4	2	0	0	0.5	1	0.5	0
RF 39	3	3	5	3	1	5	3	3	1	0	5	0	2	0.2	0	1	0	0.4

APPENDIX E – FUZZY ANALYSIS

E - 2 ERROR CALCULATION FOR APPROXIMATION INTO TRIANGULAR MEMBERSHIP FUNCTION (LIKELIHOOD OF OCCURRENCE)

TABLE - E – 2.1

No.	Actual Value					Approximate Value					Error					Average Error	Confidence Interval	
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		Min	Max
RF 1	0.00	0.50	0.25	1.00	0.25	0.00	0.33	0.67	1.00	0.00	0.00	0.33	1.67	0.00	1.00	0.60	-0.34	1.14
RF 2	0.00	0.17	0.00	1.00	0.17	0.00	0.33	0.67	1.00	0.00	0.00	1.00	2.00	0.00	1.00	0.80	-0.55	1.09
RF 3	0.00	0.67	1.00	0.67	0.33	0.00	0.50	1.00	0.50	0.00	0.00	0.25	0.00	0.25	1.00	0.30	-0.21	1.28
RF 4	0.00	1.00	0.50	0.25	0.25	0.00	1.00	0.67	0.33	0.00	0.00	0.00	0.33	0.33	1.00	0.33	-0.34	1.14
RF 5	0.00	0.33	1.00	1.00	0.33	0.00	0.33	0.67	1.00	0.00	0.00	0.00	0.33	0.00	1.00	0.27	-0.34	1.41
RF 6	0.25	0.25	0.50	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	0.33	0.33	0.00	0.00	0.33	-0.34	1.14
RF 7	0.00	0.00	0.00	1.00	0.17	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.20	-0.62	1.09
RF 8	0.33	0.00	1.00	1.00	0.33	0.00	0.33	0.67	1.00	0.00	1.00	2.00	0.33	0.00	1.00	0.87	-0.34	1.41
RF 9	0.00	0.20	1.00	0.20	0.20	0.00	0.50	1.00	0.50	0.00	0.00	1.50	0.00	1.50	1.00	0.80	-0.44	1.08
RF 10	0.40	1.00	0.00	0.20	0.00	0.00	1.00	0.67	0.33	0.00	1.00	0.00	2.00	0.67	0.00	0.73	-0.49287	1.13287
RF 11	0.33	1.00	0.67	0.33	0.33	0.00	1.00	0.67	0.33	0.00	1.00	0.00	0.00	0.00	1.00	0.40	-0.05	1.12
RF 12	0.00	0.67	1.00	0.67	0.33	0.00	0.50	1.00	0.50	0.00	0.00	0.25	0.00	0.25	1.00	0.30	-0.21	1.28
RF 13	0.00	1.00	0.50	0.50	0.00	0.00	1.00	0.67	0.33	0.00	0.00	0.00	0.33	0.33	0.00	0.13	-0.42	1.22
RF 14	0.75	1.00	0.00	0.25	0.00	0.00	1.00	0.67	0.33	0.00	1.00	0.00	2.00	0.33	0.00	0.67	-0.49	1.29
RF 15	0.33	1.00	0.67	0.00	0.67	0.00	1.00	0.67	0.33	0.00	1.00	0.00	0.00	2.00	1.00	0.80	-0.21	1.28
RF 16	0.00	1.00	1.00	0.33	0.33	0.00	1.00	0.67	0.33	0.00	0.00	0.00	0.33	0.00	0.33	0.13	-0.34	1.41
RF 17	0.00	0.25	0.50	1.00	0.25	0.00	0.33	0.67	1.00	0.00	0.00	0.33	0.33	0.00	1.00	0.33	-0.34	1.14
RF 18	0.00	0.17	1.00	0.00	0.17	0.00	0.50	1.00	0.50	0.00	0.00	2.00	0.00	2.00	1.00	1.00	-0.55	1.09
RF 19	0.00	0.67	1.00	0.67	0.33	0.00	0.50	1.00	0.50	0.00	0.00	0.25	0.00	0.25	1.00	0.30	-0.21	1.28
RF 20	0.00	0.00	1.00	1.00	0.67	0.00	0.00	0.50	1.00	0.00	0.00	0.00	0.50	0.00	1.00	0.30	-0.46	1.52
RF 21	0.25	0.25	1.00	0.25	0.25	0.00	0.50	1.00	0.50	0.00	1.00	1.00	0.00	1.00	1.00	0.80	-0.26	1.06
RF 22	0.67	1.00	0.67	0.00	0.33	0.00	1.00	0.67	0.33	0.00	1.00	0.00	0.00	2.00	1.00	0.80	-0.21	1.28
RF 23	0.25	1.00	0.50	0.00	0.25	0.00	1.00	0.67	0.33	0.00	1.00	0.00	0.33	2.00	1.00	0.87	-0.34	1.14
RF 24	0.25	1.00	0.25	0.25	0.25	0.00	1.00	0.67	0.33	0.00	1.00	0.00	1.67	0.33	1.00	0.80	-0.26	1.06
RF 30	0.25	1.00	0.50	0.00	0.25	0.00	1.00	0.67	0.33	0.00	1.00	0.00	0.33	2.00	1.00	0.87	-0.34	1.14
RF 31	0.00	1.00	0.75	0.00	0.25	0.00	1.00	0.67	0.33	0.00	0.00	0.00	0.11	2.00	1.00	0.62	-0.49	1.29
RF 32	0.00	1.00	0.17	0.00	0.00	0.00	1.00	0.50	0.00	0.00	0.00	0.00	0.00	2.00	0.00	0.40	-0.62	1.09
RF 33	0.00	0.40	0.00	1.00	0.20	0.00	0.33	0.67	1.00	0.00	0.00	0.17	2.00	0.00	1.00	0.63	-0.49	1.13
RF 34	0.00	1.00	0.00	0.20	0.40	0.00	1.00	0.67	0.33	0.00	0.00	0.00	2.00	0.67	1.00	0.73	-0.49	1.13
RF 35	0.00	1.00	0.25	0.75	0.00	0.00	1.00	0.67	0.33	0.00	0.00	0.00	1.67	0.56	0.00	0.44	-0.49	1.29
RF 36	0.00	1.00	0.20	0.40	0.00	0.00	1.00	0.67	0.33	0.00	0.00	0.00	2.33	0.17	0.00	0.50	-0.49	1.13
RF 37	0.00	1.00	0.25	0.75	0.00	0.00	1.00	0.67	0.33	1.00	0.00	0.00	1.67	0.56	2.00	0.84	-0.49	1.29
RF 38	0.00	0.67	0.33	1.00	0.67	0.00	0.33	0.67	1.00	0.00	0.00	0.50	1.00	0.00	1.00	0.50	-0.21	1.28
RF 39	0.00	0.75	1.00	0.25	0.00	0.00	0.50	1.00	0.50	0.00	0.00	0.33	0.00	1.00	0.00	0.27	-0.49	1.29

APPENDIX E – FUZZY ANALYSIS

E - 2 ERROR CALCULATION FOR APPROXIMATION INTO TRIANGULAR MEMBERSHIP FUNCTION (IMPACT ON SCHEDULE)

TABLE - E – 2.2

No.	Actual Value					Approximate Value					Error					Average Error	Confidence Interval	
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		Min	Max
RF 1	0.33	0.00	0.00	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	2.00	2.00	0.00	0.00	1.00	-0.59	1.12
RF 2	0.40	0.00	0.20	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	2.00	2.33	0.00	0.00	1.07	-0.49	1.13
RF 3	0.67	0.33	0.67	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.20	-0.21	1.28
RF 4	0.33	0.67	1.00	0.67	0.00	0.00	0.50	1.00	0.50	0.00	1.00	0.25	0.00	0.25	0.00	0.30	-0.21	1.28
RF 5	0.33	0.67	0.67	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	0.50	0.00	0.00	0.00	0.30	-0.21	1.28
RF 6	0.50	0.00	0.50	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	2.00	0.33	0.00	0.00	0.67	-0.42	1.22
RF 7	0.20	0.20	0.00	1.00	0.20	0.00	0.33	0.67	1.00	0.00	1.00	0.67	2.00	0.00	1.00	0.93	-0.44	1.08
RF 8	0.33	0.67	0.33	1.00	0.33	0.00	0.33	0.67	1.00	0.00	1.00	0.50	1.00	0.00	1.00	0.70	-0.05	1.12
RF 9	0.20	0.00	0.40	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	2.00	0.67	0.00	0.00	0.73	-0.49	1.13
RF 10	0.50	1.00	1.00	1.00	0.50	0.00	0.50	1.00	0.50	0.00	1.00	0.50	0.00	0.50	1.00	0.60	0.26	1.34
RF 11	0.33	1.00	0.67	0.67	0.00	0.00	1.00	0.67	0.33	0.00	1.00	0.00	0.00	0.50	0.00	0.30	-0.21	1.28
RF 12	0.00	0.20	0.40	1.00	0.00	0.00	0.33	0.67	1.00	0.00	0.00	0.67	0.67	0.00	0.00	0.27	-0.49	1.13
RF 13	0.00	0.20	1.00	0.40	0.00	0.00	0.50	1.00	0.50	0.00	0.00	1.50	0.00	0.25	0.00	0.35	-0.49	1.13
RF 14	0.33	0.67	0.00	1.00	0.67	0.00	0.33	0.67	1.00	0.00	1.00	1.00	2.00	0.00	1.00	0.67	-0.21	1.28
RF 15	0.00	0.00	0.60	1.00	0.00	0.00	0.00	0.50	1.00	0.00	0.00	0.00	0.17	0.00	0.00	0.03	-0.58	1.22
RF 16	0.20	0.00	0.40	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	2.00	0.67	0.00	0.00	0.73	-0.49	1.13
RF 17	0.00	0.25	1.00	0.75	0.00	0.00	0.50	1.00	0.50	0.00	0.00	1.00	0.00	0.33	0.00	0.27	-0.49	1.29
RF 18	0.00	0.25	0.75	1.00	0.00	0.00	0.33	0.67	1.00	0.00	0.00	0.33	0.11	0.00	0.00	0.09	-0.49	1.29
RF 19	0.00	0.67	0.67	1.00	0.33	0.00	0.33	0.67	1.00	0.00	0.00	0.50	0.00	0.00	1.00	0.30	-0.21	1.28
RF 20	0.67	0.33	0.67	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	0.00	0.00	0.00	0.00	0.20	-0.21	1.28
RF 21	0.25	0.00	0.50	1.00	0.25	0.00	0.33	0.67	1.00	0.00	1.00	2.00	0.33	0.00	1.00	0.87	-0.34	1.14
RF 22	0.00	0.67	0.33	0.67	1.00	0.00	0.25	0.50	0.75	1.00	0.00	0.63	0.50	0.13	0.00	0.25	-0.21	1.28
RF 23	0.00	1.00	0.67	1.00	0.00	0.00	0.33	0.67	1.00	0.00	0.00	0.67	0.00	0.00	0.00	0.13	-0.46	1.52
RF 24	0.33	0.67	0.67	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	0.50	0.00	0.00	0.00	0.30	-0.21	1.28
RF 30	0.00	0.67	1.00	0.33	0.67	0.00	0.50	1.00	0.50	0.00	0.00	0.25	0.00	0.50	1.00	0.35	-0.21	1.28
RF 31	0.00	0.25	1.00	0.25	0.50	0.00	0.50	1.00	0.50	0.00	0.00	1.00	0.00	1.00	1.00	0.60	-0.34	1.14
RF 32	0.33	0.33	1.00	0.00	1.00	0.00	0.50	1.00	0.50	0.00	1.00	0.50	0.00	2.00	1.00	0.90	-0.34	1.41
RF 33	0.00	0.67	0.67	0.33	1.00	0.00	0.25	0.50	0.75	1.00	0.00	0.63	0.25	1.25	0.00	0.43	-0.21	1.28
RF 34	0.00	1.00	1.00	1.00	1.00	0.00	0.50	1.00	0.50	0.00	0.00	0.50	0.00	0.50	1.00	0.40	-0.08	1.68
RF 35	0.00	0.00	1.00	1.00	0.67	0.00	0.00	1.00	0.50	0.00	0.00	0.00	0.00	0.50	1.00	0.30	-0.46	1.52
RF 36	0.00	0.00	0.67	1.00	1.00	0.00	0.00	0.50	1.00	0.00	0.00	0.00	0.25	0.00	1.00	0.25	-0.46	1.52
RF 37	0.00	0.00	1.00	0.50	0.50	0.00	0.00	1.00	0.50	0.00	0.00	0.00	0.00	0.00	1.00	0.20	-0.42	1.22
RF 38	0.00	0.67	0.67	0.33	1.00	0.00	0.25	0.50	0.75	1.00	0.00	0.63	0.25	1.25	1.00	0.63	-0.21	1.28
RF 39	0.33	0.00	1.00	0.33	1.00	0.00	0.50	1.00	0.50	0.00	1.00	2.00	0.00	0.50	1.00	0.90	-0.34	1.41

APPENDIX E – FUZZY ANALYSIS

E - 2 ERROR CALCULATION FOR APPROXIMATION INTO TRIANGULAR MEMBERSHIP FUNCTION (IMPACT ON COST)

TABLE - E – 2.3

No.	Actual Value					Approximate Value					Error					Average Error	Confidence Interval	
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5		Min	Max
RF 1	0.00	0.00	0.40	1.00	0.20	0.00	0.00	0.50	1.00	0.00	0.00	0.00	0.25	0.00	1.00	0.25	-0.49	1.13
RF 2	0.00	0.00	0.40	1.00	0.20	0.00	0.00	0.50	1.00	0.00	0.00	0.00	0.25	0.00	1.00	0.25	-0.49	1.13
RF 3	0.00	0.25	1.00	0.50	0.25	0.00	0.50	1.00	0.50	0.00	0.00	1.00	0.00	0.00	1.00	0.40	-0.34	1.14
RF 4	0.00	0.00	1.00	0.60	0.00	0.00	0.00	1.00	0.50	0.00	0.00	0.00	0.00	0.17	0.00	0.03	-0.58	1.22
RF 5	0.00	0.00	1.00	0.60	0.00	0.00	0.00	1.00	0.50	0.00	0.00	0.00	0.00	0.17	0.00	0.03	-0.58	1.22
RF 6	0.33	0.00	1.00	1.00	0.33	0.00	0.33	0.67	1.00	0.00	1.00	2.00	0.33	0.00	1.00	0.87	-0.34	1.41
RF 7	0.00	0.20	0.20	1.00	0.20	0.00	0.33	0.67	1.00	0.00	0.00	0.67	2.33	0.00	1.00	0.80	-0.44	1.08
RF 8	0.00	0.50	0.50	1.00	0.00	0.00	0.33	0.67	1.00	0.00	0.00	0.33	0.33	0.00	0.00	0.13	-0.42	1.22
RF 9	0.33	0.33	0.67	1.00	0.33	0.00	0.33	0.67	1.00	0.00	1.00	0.00	0.00	0.00	1.00	0.40	-0.05	1.12
RF 10	0.50	0.50	1.00	1.00	1.00	0.00	0.50	1.00	0.50	0.00	1.00	0.00	0.00	0.50	1.00	0.50	0.26	1.34
RF 11	0.00	0.75	1.00	0.25	0.00	0.00	0.50	1.00	0.50	0.00	0.00	0.33	0.00	1.00	0.00	0.27	-0.49	1.29
RF 12	0.00	0.25	1.00	0.75	0.00	0.00	0.50	1.00	0.50	0.00	0.00	1.00	0.00	0.33	0.00	0.27	-0.49	1.29
RF 13	0.00	0.25	1.00	0.75	0.00	0.00	0.50	1.00	0.50	0.00	0.00	1.00	0.00	0.33	0.00	0.27	-0.49	1.29
RF 14	0.00	0.50	0.50	1.00	0.00	0.00	0.33	0.67	1.00	0.00	0.00	0.33	0.33	0.00	0.00	0.13	-0.42	1.22
RF 15	0.00	0.00	0.33	1.00	0.00	0.00	0.00	0.50	1.00	0.00	0.00	0.00	0.50	0.00	0.00	0.10	-0.59	1.12
RF 16	0.33	0.00	0.67	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	2.00	0.00	0.00	0.00	0.60	-0.45	1.25
RF 17	0.25	0.25	1.00	0.50	0.00	0.00	0.50	1.00	0.50	0.00	1.00	1.00	0.00	0.00	0.00	0.40	-0.34	1.14
RF 18	0.33	0.67	1.00	0.67	0.00	0.00	0.50	1.00	0.50	0.00	1.00	0.25	0.00	0.25	0.00	0.30	-0.21	1.28
RF 19	0.00	1.00	0.67	1.00	0.00	0.00	0.33	0.67	1.00	0.00	0.00	0.67	0.00	0.00	0.00	0.13	-0.46	1.52
RF 20	0.00	1.00	0.50	0.50	0.00	0.00	1.00	0.67	0.33	0.00	0.00	0.00	0.33	0.33	0.00	0.13	-0.42	1.22
RF 21	0.25	0.25	0.50	1.00	0.00	0.00	0.33	0.67	1.00	0.00	1.00	0.33	0.33	0.00	0.00	0.33	-0.34	1.14
RF 22	0.00	0.33	0.67	1.00	0.67	0.00	0.33	0.67	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.20	-0.21	1.28
RF 23	0.00	0.67	1.00	1.00	0.00	0.00	0.50	1.00	0.50	0.00	0.00	0.25	0.00	0.50	0.00	0.15	-0.46	1.52
RF 24	0.25	0.25	1.00	0.50	0.00	0.00	0.50	1.00	0.50	0.00	1.00	1.00	0.00	0.00	0.00	0.40	-0.34	1.14
RF 30	0.00	1.00	0.67	0.67	0.33	0.00	1.00	0.67	0.33	0.00	0.00	0.00	0.00	0.50	1.00	0.30	-0.21	1.28
RF 31	0.00	0.25	1.00	0.50	0.25	0.00	0.50	1.00	0.50	0.00	0.00	1.00	0.00	0.00	1.00	0.40	-0.34	1.14
RF 32	0.33	0.33	0.67	1.00	0.33	0.00	0.33	0.67	1.00	0.00	1.00	0.00	0.00	0.00	1.00	0.40	-0.05	1.12
RF 33	0.00	0.50	0.25	1.00	0.25	0.00	0.33	0.67	1.00	0.00	0.00	0.33	1.67	0.00	1.00	0.60	-0.34	1.14
RF 34	0.00	0.67	0.67	1.00	0.33	0.00	0.33	0.67	1.00	0.00	0.00	0.50	0.00	0.00	1.00	0.30	-0.21	1.28
RF 35	0.00	0.00	1.00	0.75	0.25	0.00	0.00	1.00	0.50	0.00	0.00	0.00	0.00	0.33	1.00	0.27	-0.49	1.29
RF 36	0.00	0.00	0.50	1.00	0.50	0.00	0.00	0.50	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.20	-0.42	1.22
RF 37	0.00	0.00	1.00	0.40	0.20	0.00	0.00	1.00	0.50	0.00	0.00	0.00	0.00	0.25	1.00	0.25	-0.49	1.13
RF 38	0.00	0.50	1.00	0.50	0.00	0.00	0.50	1.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.42	1.22
RF 39	0.20	0.00	1.00	0.00	0.40	0.00	0.50	1.00	0.50	0.00	1.00	2.00	0.00	2.00	1.00	1.20	-0.49	1.13

APPENDIX F – WHETHER THE RISK FACTORS ARE FORSEEABLE, ASSESSEABLE AND MANAGEABLE

TABLE - F 1 – FORSEEABILITY OF RISK FACTORS

No.	RED 3	RED 4	RED 5	RED 5.1	RED 6	RED 8	RED 11	RED 13	Frequency					Max	Weight	Result
									1 VU	2 U	3 M	4 L	5 VL			
RF 1	4	4	1	2	4	4	3	4	1	1	1	5	0	5	0.625	L
RF 2	3	4	5	4	4	4	3	4	0	0	2	5	1	5	0.625	L
RF 3	3	2	5	3	4	3	3	1	1	1	4	1	1	4	0.5	M
RF 4	2	2	1	2	4	2	2	1	2	5	0	1	0	5	0.625	U
RF 5	3	2	1	2	4	2	3	2	1	4	2	1	0	4	0.5	U
RF 6	3	3	1	4	3	5	3	1	2	0	4	1	1	4	0.5	M
RF 7	3	4	1	5	4	5	4	1	2	0	1	3	2	3	0.375	L
RF 8	2	3	2	3	4	4	3	1	1	2	3	2	0	3	0.375	M
RF 9	2	4	2	2	3	1	3	2	1	4	2	1	0	4	0.5	U
RF 10	1	2	2	2	4	1	1	3	3	3	1	1	0	3		
RF 11	3	2	2	3	3	4	4	2	0	3	3	2	0	3		
RF 12	3	2	2	4	5	4	4	2	0	3	1	3	1	3		
RF 13	2	2	1	4	3	3	3	3	1	2	4	1	0	4	0.5	M
RF 14	2	2	1	1	2	5	2	1	3	4	0	0	1	4	0.5	U
RF 15	2	2	2	1	4	4	2	3	1	4	1	2	0	4	0.5	U
RF 16	1	2	2	3	4	5	1	2	2	3	1	1	1	3	0.375	U
RF 17	3	3	1	3	5	2	4	3	1	1	4	1	1	4	0.5	M
RF 18	2	3	2	3	4	2	3	3	0	3	4	1	0	4	0.5	M
RF 19	3	3	2	4	5	4	4	4	0	1	2	4	1	4	0.5	L
RF 20	3	3	2	4	4	4	3	4	0	1	3	4	0	4	0.5	L
RF 21	4	4	1	4	4	4	4	3	1	0	1	6	0	6	0.75	L
RF 22	3	3	2	2	5	3	4	3	0	2	4	1	1	4	0.5	M
RF 23	3	4	2	3	4	3	4	2	0	2	3	3	0	3		
RF 24	2	2	1	2	4	2	3	3	1	4	2	1	0	4	0.5	U
RF 30	1	3	1	3	4	1	1	2	4	1	2	1	0	4	0.5	VU
RF 31	2	3	1	2	4	2	2	3	1	4	2	1	0	4	0.5	U
RF 32	1	3	1	3	5	1	1	2	4	1	2	0	1	4	0.5	VU
RF 33	2	3	2	3	4	2	2	2	0	5	2	1	0	5	0.625	U
RF 34	3	3	2	2	4	4	2	2	0	4	2	2	0	4	0.5	U
RF 35	2	2	2	2	4	4	2	3	0	5	1	2	0	5	0.625	U
RF 36	2	2	2	2	4	3	2	2	0	6	1	1	0	6	0.75	U
RF 37	3	3	3	3	4	2	3	3	0	1	6	1	0	6	0.75	M
RF 38	4	3	4	2	5	5	4	5	0	1	1	3	3	3		
RF 39	3	4	4	3	3	3	3	3	0	0	6	2	0	6	0.75	M

TABLE - F 2 – WHETHER THE RISK FACTORS ARE ASSESSEABLE

No.	RED 3	RED 4	RED 5	RED 5.1	RED 6	RED 8	RED 11	RED 13	Frequency					Max	Weight	Result
									1 VU	2 U	3 M	4 L	5 VL			
RF 1	4	3	4	2	4	1	4	3	1	1	2	4	0	4	0.5	L
RF 2	3	4	4	4	5	1	3	3	1	0	3	3	1	3		
RF 3	4	4	4	2	5	1	4	2	1	2	0	4	1	4	0.5	L
RF 4	2	4	5	2	5	1	2	2	1	4	0	1	2	4	0.5	U
RF 5	3	4	3	2	5	1	3	3	1	1	4	1	1	4	0.5	M
RF 6	3	4	5	3	5	1	3	2	1	1	3	1	2	3	0.375	M
RF 7	4	4	4	4	5	2	4	1	1	1	0	5	1	5	0.625	L
RF 8	3	4	4	2	5	3	3	1	1	1	3	2	1	3	0.375	M
RF 9	3	4	4	1	5	1	3	2	2	1	2	2	1	2		
RF 10	1	4	4	2	4	1	1	3	3	1	1	3	0	3		
RF 11	4	4	5	2	5	4	4	2	0	2	0	4	2	4	0.5	L
RF 12	3	4	5	4	5	4	3	2	0	1	2	3	2	3	0.375	L
RF 13	3	3	5	4	2	3	3	1	1	1	4	1	1	4	0.5	M
RF 14	2	3	5	1	2	1	2	1	3	3	1	0	1	3		
RF 15	2	3	5	1	5	2	2	3	1	3	2	0	2	3	0.375	U
RF 16	1	3	5	4	4	4	1	2	2	1	1	3	1	3	0.375	L
RF 17	4	3	5	4	4	2	4	3	0	1	2	4	1	4	0.5	L
RF 18	4	3	5	4	4	1	4	3	1	0	2	4	1	4	0.5	L
RF 19	4	3	5	4	5	2	4	4	0	1	1	4	2	4	0.5	L
RF 20	3	3	5	4	4	4	3	4	0	0	3	4	1	4	0.5	L
RF 21	4	3	4	4	4	5	4	3	0	0	2	5	1	5	0.625	L
RF 22	3	3	4	3	5	3	3	2	0	1	5	1	1	5	0.625	M
RF 23	4	3	4	1	4	4	4	2	1	1	1	5	0	5	0.625	L
RF 24	2	3	4	2	4	5	2	3	0	3	2	2	1	3	0.375	U
RF 30	1	3	4	4	4	1	1	2	3	1	1	3	0	3	0.375	M
RF 31	2	3	4	4	4	2	2	2	0	4	1	3	0	4	0.5	U
RF 32	1	3	3	3	4	2	1	2	2	2	3	1	0	3	0.375	M
RF 33	2	3	3	3	5	4	2	2	0	3	3	1	1	3		
RF 34	3	2	2	2	4	4	2	2	0	5	1	2	0	5	0.625	U
RF 35	2	3	2	2	4	2	2	3	0	5	2	1	0	5	0.625	U
RF 36	2	3	2	2	5	2	2	2	0	6	1	0	1	6	0.75	U
RF 37	3	3	2	2	5	4	3	3	0	2	4	1	1	4	0.5	M
RF 38	4	3	3	3	4	4	4	5	0	0	3	4	1	4	0.5	L
RF 39	3	2	3	3	3	1	3	3	1	1	6	0	0	6	0.75	M

TABLE - F 3 – MANAGEABLITY OF THE RISK FACTORS

No.	RED 3	RED 4	RED 5	RED 5.1	RED 6	RED 8	RED 11	RED 13	Frequency					Max	Weight	Result
									1 VU	2 U	3 M	4 L	5 VL			
RF 1	4	3	5	2	5	2	3	4	0	2	2	2	2	2	0.25	
RF 2	4	4	1	4	5	3	3	4	1	0	2	4	1	4	0.5	L
RF 3	4	3	1	2	5	3	3	2	1	2	3	1	1	3	0.375	M
RF 4	2	3	2	2	5	4	2	2	0	5	1	1	1	5	0.625	U
RF 5	3	3	1	3	5	4	3	3	1	0	5	1	1	5	0.625	M
RF 6	3	3	3	3	3	4	3	2	0	1	6	1	0	6	0.75	M
RF 7	4	3	1	4	5	3	4	1	2	0	2	3	1	3	0.375	L
RF 8	3	3	3	2	5	3	3	1	1	1	5	0	1	5	0.625	M
RF 9	3	3	1	1	5	1	3	2	3	1	3	0	1	3	0.375	
RF 10	1	3	1	2	3	1	1	2	4	2	2	0	0	4	0.5	VU
RF 11	4	3	1	2	5	4	4	2	1	2	1	3	1	3	0.375	L
RF 12	4	3	4	4	5	4	4	2	0	1	1	5	1	5	0.625	L
RF 13	3	3	1	4	3	4	3	3	1	0	5	2	0	5	0.625	M
RF 14	2	2	1	1	2	1	2	1	4	4	0	0	0	4		
RF 15	2	2	5	1	5	3	2	3	1	3	2	0	2	3	0.375	U
RF 16	1	4	5	4	5	4	1	2	2	1	0	3	2	3	0.375	L
RF 17	4	3	4	4	5	4	4	3	0	0	2	5	1	5	0.625	L
RF 18	3	4	4	4	5	5	3	3	0	0	3	3	2	3		
RF 19	4	4	4	3	5	5	4	4	0	0	1	5	2	5	0.625	L
RF 20	3	3	4	3	5	3	3	5	0	0	5	1	2	5	0.625	M
RF 21	4	3	4	3	5	3	4	3	0	0	4	3	1	4	0.5	M
RF 22	4	3	3	1	5	3	4	3	1	0	4	2	1	4	0.5	M
RF 23	4	3	2	2	5	3	4	3	0	2	3	2	1	3	0.375	M
RF 24	3	4	2	1	5	3	3	3	1	1	4	1	1	4	0.5	M
RF 30	1	3	1	3	5	2	1	2	3	2	2	0	1	3	0.375	VU
RF 31	2	2	1	3	5	4	2	3	1	3	2	1	1	3	0.375	U
RF 32	1	3	1	1	5	4	1	2	4	1	1	1	1	4	0.5	VU
RF 33	2	2	1	3	5	3	2	2	1	4	2	0	1	4	0.5	U
RF 34	2	3	1	2	5	5	2	2	1	4	1	0	2	4	0.5	U
RF 35	2	3	1	2	5	5	2	3	1	3	2	0	2	3	0.375	U
RF 36	2	3	1	2	5	4	2	2	1	4	1	1	1	4	0.5	U
RF 37	3	3	1	3	5	1	3	3	2	0	5	0	1	5	0.625	M
RF 38	4	3	1	3	5	1	4	5	2	0	2	2	2	2		
RF 39	3	4	1	3	3	1	3	3	2	0	5	1	0	5	0.625	M

APPENDIX G – ARTICLES FROM THE CIVIL CODE OF ETHIOPIA USED IN THE RESEARCH

Art. 1763 - Power of the Court

The court may not vary a contract or alter its terms on the ground of equity except in such cases as are expressly provided by law.

Art. 1764 - Modification of the balance of a contract.

(1) A contract shall remain in force notwithstanding that the conditions of its performance have changed and the obligations a88umed by a party have become more onerous than he foresaw.

(2) The effect of such changes may be regulated by the parties, and not by the court, in the original contract or in a new agreement.

Art. 1792 – Force majeure

(1) Force majeure results from an occurrence which the debtor could normally not foresee and which prevents him absolutely from performing his obligations.

(2) Force majeure shall not exist where the occurrence could normally have been foreseen by the debtor or where it renders more onerous the performance by the debtor of his obligations.

Art. 1793 – Cases of Force majeure

The following occurrences may, according to the circumstances, constitute cases of force majeure:

(a) The unforeseeable act of third party for whom the debtor is not responsible; or

(b) An official prohibition preventing the performance of the contract; or

(c) A natural catastrophe such as earth quake, lightning or floods; or

(d) International or civil war; or

(e) The death or a serious accident or unexpected serious illness of the debtor.

Art. 1794 – Absence of Force majeure

Unless otherwise expressly agreed, the following occurrences shall not be deemed to be cases of force majeure:

(a) A strike or lock-out taking place in the undertaking of a party or affecting the branch of business in which he carries out his activities; or

(b) An increase or reduction in the price of raw materials necessary for the performance of the contract; or

(c) The enactment of new legislations whereby the obligations of the debtor become more onerous.

Article 2876 - Work and labor relating to Immovable and Sale

A contract whereby one of the parties undertake to deliver to the other party a house, a flat or another building which does not yet exist, is a contract of work and labor relating to immovable and not a contract of sale.

Article 2877 - Form of Contract

A contract of sale of an immovable shall be of no effect unless it is made in writing.

Article 3020 – Making and proof of contract (For Contract of work and labor relating to Immovable)

(1) The contract shall be complete where the parties have agreed on the work to be done and on the price.

(2) There shall be evidence of the contract where the contractor has undertaken work to the knowledge of the client or received an advance from the client.