FACTORS AFFECTING THE RISK RATINGS ASSIGNED BY DECISION-MAKERS UNDER UNCERTAIN SITUATIONS: THE CASE OF INTERNATIONAL CONSTRUCTION

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ABSTRACT

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Assessing risk in international construction projects is an essential part of the risk management process. Due to the lack of available data and knowledge about the project risks, objective/quantitative risk assessment is facing with some challenges and subjective/qualitative risk assessment is still a prevailing technique in the construction industry. The Probability-Impact (P-I) risk matrix/table is one of the frequently used techniques among the subjective/qualitative risk assessment methods, which usually utilizes a 1 to 5 Likert scale. However, although it is very widely used, lack of knowledge still exists about the factors that may affect the risk ratings that decision-makers assign to risks during qualitative risk assessment process.

Therefore, this research examines the effects of two important factors such as ‘‘decision-makers’ attitudes toward risk’’ and their assumption about ‘‘risk controllability’’ on the risk ratings using 1-5 scaling. The research was conducted via a questionnaire survey where the 74 professionals and 7 academics from the construction industry participated in this survey. Two hypotheses are proposed and then tested for their validity, confirming that risk attitude and assumptions about risk controllability are the two critical factors that can affect the risk ratings while decision-makers assign ratings during the risk assessment process. The aim of this study is to help professionals who carry risk assessment exercises to measure risk in international construction projects. Also, to help decision-makers who are looking for the causes of variance in the risk ratings being assigned by different individuals. This research is a reminder for the industry professionals to think about the efficient usage of the Probability-Impact risk ratings and become aware of the factors that affect these ratings before their application.

Keywords: Risk Assessment and Management, Decision-Making Under Risk and Uncertainty, Risk Attitude, Controllability.

ÖZ

KARAR VERİCİLER TARAFINDAN BELİRSİZ KOŞULLAR ALTINDA ATANAN RİSK DERECELENDİRMELERİNİ ETKİLEYEN FAKTÖRLER: ULUSLARARASI İNŞAAT ÖRNEĞİ

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Uluslararası inşaat projelerinde risklerin değerlendirilmesi, risk yönetim sürecinin önemli bir parçasıdır. Proje riskleriyle ilgili mevcut verinin ve bilgi birikiminin eksik olması sebebiyle; nesnel/nicel risk değerlendirmesi bazı zorluklara neden olmakta ve buna bağlı olarak öznel/nitel risk değerlendirmesi inşaat endüstrisinde halen geçerliliğini korumaktadır. Olasılık-Etki (O-E) risk matrisi/tablosu, genellikle 1-5 Likert ölçeğinin kullanıldığı öznel/nitel risk değerlendirme yöntemlerinden en sık kullanılanlarından birini oluşturmaktadır. Ancak bu yöntem yaygın olarak kullanılmasına rağmen, karar vericilerin öznel risk değerlendirme sürecinde risklere atadıkları derecelendirmelerine dair bilgi eksikliği halen mevcuttur.

Bu çalışmada, "karar vericilerin riske bakış açısı" ve "riskin kontrol edilebilirliği" hakkındaki varsayımları olmak üzere, iki önemli faktörün etkileri 1-5 Likert ölçeği kullanarak incelenmiştir. Araştırma, inşaat endüstrisinden 74 profesyonelin ve 7 akademisyenin katıldığı bir anket çalışmasıyla yürütülmüştür. Bu kapsamda, iki hipotez ileri sürülmüş ve karar vericilerin risk değerlendirme sürecinde risk faktörlerini atarken, riske bakış açısı ve kontrol edilebilirliği hakkındaki varsayımlarının en kritik iki faktör olduğunu onaylayacak biçimde hipotezlerin geçerliliği test edilmiştir. Bu çalışmanın amacı, uluslararası inşaat projelerinin risk değerlendirme uygulamalarında risk ölçümü yapan profesyonellere yardımcı olmaktır. Çalışmanın bir diğer amacı ise, farklı karar vericiler tarafından atanmış risk derecelendirmelerinin değişkenliğinin sebebini araştıran karar vericilere yol göstermektir. Bu çalışmada, inşaat endüstrisi profesyonellerinin, O-E risk matrislerinin eksikliklerine dikkatleri çekilerek, bu matrislerdeki risk atamalarını etkileyebilecek risk faktörleri konusunda uyarılmaları amaçlanmıştır.

Anahtar Kelimeler: Risk Değerlendirmesi ve Yönetimi, Risk ve Belirsizlik Durumunda Karar Verme, Risk Bakış Açısı, Kontrol Edilebilirlik.

To My Beloved Family…

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LIST OF ABBREVIATIONS

AHP	Analytical Hierarchy Process
CBR	Case Based Reasoning
CE	Certainty Equivalent
COV	Coefficient Of Variation
CPT	Cumulative Prospect Theory
DSS	Decision Support System
E-FCMs	Extended Fuzzy Cognitive Maps
EMV	Expected Monetary Value
EU	Expected Utility
EUT	Expected Utility Theory
FAMs	Fuzzy Associated Memories
FMEA	Failure Mode and Effect Analysis
FST	Fuzzy Set Theory
HRBS	Hierarchical Risk Breakdown Structure
JRAP	Judgmental Risk Analysis Process
MDMSM	Multicriteria Decision-Making Support Method
METU	Middle East Technical University
PATR	Permanent Attitude Toward Risk
P-I	Probability – Impact
PMBOK	Project Management Body Of Knowledge
PMI	Project Management Institute
PPP	Public Private Partnership
PRR	Project Risk Ratings
PT	Prospect Theory
RBDM	Risk Based Decision-Making
RM	Risk Management
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences

TATR	Temporary Attitude Toward Risk
UT	Utility Theory

CHAPTER 1

INTRODUCTION

1.1. Brief Introduction

The importance of risk assessment is now completely recognized in the construction industry where an efficient risk assessment can prevent cost overruns and delays in a project. Therefore, a project will successfully meet its objectives as a result of a good risk assessment. The qualitative risk assessment is still proved to be prevailing in comparison to quantitative risk assessment and is mostly used by practitioners rather than the quantitative risk assessment (Shen, 1997; Akintoye and MacLeod, 1997; Raz and Michael, 2001; Patterson and Neailey, 2002; Wood and Ellis, 2003; Lyons and Skitmore, 2004; and Taroun, 2014). In the qualitative risk assessment, decision-makers are usually applying their intuition, professional judgment, and personal experience (Lyons and Skitmore, 2004; Akintoye and MacLeod, 1997; Wood and Ellis, 2003; and Dikmen et al., 2004) due to two reasons: first, lack of knowledge about the situation where a specific technique could be utilized, and second, limitations of the existing resources such as risk experts, time, money, and technology that practitioners face (Forbes et al., 2008).

However, there are still problems and complications with the utilization of the qualitative risk assessment to be addressed, especially with the widely used risk tool often called as a Probability-Impact (P-I) risk model or matrix when decision-makers assign the risk ratings using 1 to 5 scaling method. Cox (2008) mentioned that despite the weaknesses and techno-mathematical problems that exist in the risk matrix, it is still a widespread technique because of its effective approach and simplicity in the risk management framework. Cox (2008) further suggests the urgency for investigations to be conducted in order to consider the utilization of risk matrices under different situations to see where they can be helpful and where harmful. Thus, due to the lack of research and the unknown fact behind the factors that can affect the risk ratings for which decision-makers use their subjective judgment, it is essential to investigate the issue to find out and reveal the factors that may significantly affect the decisions about the risk ratings. Some researchers have explained the factors that might affect the risk ratings (such as Dikmen and Birgonul, 2006; Dikmen et al., 2007a; Aven et al., 2007; and Keizer et al., 2002). These researchers have used the terminology such as 'controllability', 'manageability', or 'influence' for the factors that can affect the risk ratings. Risk attitude is another factor that may affect the risk ratings according to some researchers such as Dikmen et al., 2008; Akintoye and MacLeod, 1997; Cox, 2008; and Ball and Watt, 2013. Nevertheless, there is no reported study that explains the importance of these two factors together on the risk ratings to the best of our knowledge.

This thesis investigates a particular matter of the risk ratings and the factors that may affect these ratings while decision-makers assign to risk factors during risk assessment. Two important factors such as decision-makers' ''attitudes toward risk'' and theirs assumptions about ''controllability'' are taken into account as the two significant factors that can have influence on the risk ratings using 1 to 5 scales. In the same way, these two factors can reflect decision-makers' personal experience, intuition, and subjective judgment, which are considered the main elements in the qualitative risk assessment. The findings and results of this research are based on a questionnaire survey where a total of 81 individuals participated in. 74 of the participants were professionals and 7 academics from the construction engineering and management business.

1.2. Risk

The concept 'risk' in the construction business is one of the major and common phenomenon that is used almost everywhere for describing hazards and dangers affecting project, and which may in turn have adverse impact on the project objectives such as time, cost, quality, safety, or overall scope. In its broadest sense, risk is generally understood to be an outcome of its impact and probability of occurrence (Howell et al., 2010). From the organizational point of view, it is conceptually accepted that risk emerges when an organization wants to seek opportunities in the face of uncertainty as well as restricted by cost and capability (Bannerman, 2008). Thus, minimizing the effects of risk is considered to be a challenging task in the construction project management due to the unique and complex nature of projects. The PMBOK Guide (2013) has also considered the project risk management to be one of the ten knowledge areas as a separate field of specialty in the project management practice. Regarded by researchers, the importance of risk is now well recognized in the construction industry as Smith (1999) insists that successful and accomplished projects are those in which risks are sufficiently managed and assessed in the beginning stages of projects. In consequence, if managed well, risk will not affect the project objectives as adversely as expected.

1.3. Risk Assessment

Assessing risk is considered to be one of the notable steps in the risk management framework because the risk response strategy and the estimation of contingencies in a project will be based on the risk assessment results. Risk assessment is a continuous process from feasibility study to the closeout of a project or it may be extended even to the post-project evaluation. Due to the unique features of the construction projects, it is always difficult to assess risks, especially in the case of using objective data where there might be the limitations of time, budget, and expertise. Therefore, most of the risk assessment techniques rely on the qualitative risk assessment where subjective data is produced by decision-makers' judgment, intuition, and personal experience for the sake of ease, saving time and cost as well. There still exist some complications with the risk ratings method for the qualitative risk assessment due to the fact that the decisions made in risky and uncertain situations may change from one individual to another.

The principal objective of risk assessment is to obtain the risk intensity, which is derived from the probability of occurrence multiplied by its impact or severity ($R = P \times I$) where R is the degree of risk, P is the probability of occurrence of a risk event, I is the degree of risk severity or impact (Zhi, 1995; Ward, 1999; Cox, 2008; KarimiAzari et al., 2011; Bannerman, 2008; and Zeng et al., 2007). Likewise, Marques and Berg (2011) pointed out the necessity that each risk's impact level and probability of occurrence need to be calculated. Due to the lack of objective data required for the probability and impact of a risk factor, subjective data using 1 to 5 ratings method representing linguistic terms such as very low, low, medium, high, and very high is usually used while conducting qualitative risk assessment. Tah and Carr (2001) describe that the technical characteristic of every risk is delineated and assessed during risk assessment where the values of risks are stated applying linguistic variables such as low, medium, and high with supplementary adverbs consisting 'somewhat' and 'very'.

What important to know is that which factors and how these factors affect a decision-maker's risk rating criterion in the risk assessment process under risk and uncertainty. This research will investigate the significant factors, which will affect the risk ratings assigned by decision makers (using 1-5 scaling method) while risk assessment process is being undertaken.

1.4. Why It is Hard to Assess Risk

Assessing risk in construction projects is a practice where it has some complications for risk assessors while dealing with it. Risk assessment can be described as a difficult process as construction projects are unique as well as risks and uncertainties have different/diverse characteristics in these projects. Also, another ambiguity of this process can be the subjectivity involved due to different decision-makers in the process since their experience, personal judgment, and attitudes toward risk are totally different from each other and they will behave differently while making decisions. Thus, it seems necessary to link risk assessment with intuitive judgment and experience especially at the time of conducting qualitative risk assessment. Therefore, Dikmen et al. (2004) acknowledge the experience and personal judgment as the key tools for assessing risks qualitatively. Moreover, Akintoye and MacLeod (1997) argued about experience and intuition can be the key tools for risk assessment based on the investigation they conducted on the UK construction industry's actual practice of Risk Management (RM). Similarly, Shen (1997), Wood and Ellis (2003), and Lyons and Skitmore (2004) claimed that subjective judgment, intuition, and experience are the key elements that construction practitioners mostly rely on. The third reason that makes risk assessment difficult is uncertainty, which is a major obstacle for risk assessment as Ben-Haim (2012) notices uncertainty as a main challenge for the risk analysis. He believes that uncertainty can be attributed to a lack of information, a possibility for surprise, or a deficiency of understanding when talking about its severe shapes. Hence, uncertainty is the principal problem of the risk analysis where the risk assessors face with difficulties and lack of required information. The fact that there are many methods being used for risk assessment can be another issue that can make this process harder as individuals may not be familiar with the different methods to be used for a specific project case. Therefore, the unavailability of a consensus regarding implementation of a specific method makes risk assessment a challenging and difficult procedure. As a result, the risk assessment process faces challenges each time during its treatment because of the diversities existed in the construction projects, the requirements for a specific tool utilization for different projects, and the decision-makers themselves with different experience and judgmental behaviors and attitudes.

1.5. Research Hypotheses and Objectives

The aim of this thesis is to investigate the two significant factors that may have substantial effects on the decision-making process during qualitative risk assessment in the construction projects. Especially at the time while decision-makers are assigning the risk ratings using their subjective judgment to rate the probability and impact of a risk factor using 1 to 5 scaling method that is known as a simple and widely utilized method when assessing risks qualitatively (from authors such as Dikmen et al., 2012; Baccarini and Archer, 2001; Cox, 2008; Patterson and Neailey, 2002; and Hanna et al., 2013).

Risk attitude is one of the crucial factors affecting decision-making during risky and uncertain circumstances accepted. Also, controllability is the other critical factor having effect on the decision-making process under risk and uncertainty, which is mentioned rarely and in the form of different words such as manageability, influence, or controllability by various authors such as Dikmen and Birgonul, 2006; Dikmen et al., 2007a; Aven et al., 2007; and Keizer et al., 2002. So far, the effects of risk attitude and controllability together on the risk ratings are not studied yet. Therefore, the aim of this research is to investigate the effects of these two factors together on the risk ratings using 1-5 scaling method. The below two hypotheses are proposed in this research that will be validated through statistical analysis.

Research Hypotheses:

Hypothesis I:

Null Hypothesis: While assigning the risk ratings (using 1-5 scale), decision-makers may assign different ratings regardless of their attitudes toward risk.

Alternative Hypothesis: While assigning the risk ratings (using 1-5 scale), decision-makers may assign different ratings depending on their attitudes toward risk.

Hypothesis II:

Null Hypothesis: While assigning the risk ratings (using 1-5 scale), decision-makers may assign different ratings regardless of their assumptions about controllability.

Alternative Hypothesis: While assigning the risk ratings (using 1-5 scale), decision-makers may assign different ratings depending on their assumptions about controllability.

Based on the proposed hypotheses, this research aims to explore that:

- To study how the risk ratings vary with respect to risk attitude of the decision-makers during risk assessment process.

- To question the validity of the hypothesis that controllability also affects a decision maker's decisions about risk rating in addition to his/her risk attitude.

1.6. Organization of the Thesis

This thesis consists of five chapters. Chapter 1 provides a brief introduction to the problem, the background of the problem, the hypotheses, and objectives of the research.

Chapter 2 presents a review of the literature about the researches and studies that have been conducted in the past concerning risk, uncertainty, decision-making under risk and uncertainty with a particular emphasis on the definitions, classifications, and sources of risk and uncertainty. Further, risk analysis techniques that have been discussed in the literature are presented briefly with more focus on the qualitative risk assessment using subjective judgment, intuition, and personal experience. Also, the qualitative risk assessment techniques that are used in the literature after the year 2000 are summarized and presented in a table. Finally, factors that may affect the risk ratings are discussed, which are attitudes of decision-makers toward risk and their assumptions about risk controllability.

Chapter 3 describes the details on the research methodology. It explains the design and development of the questionnaire, the distribution and collection of the questionnaire, the data entry and analysis process using SPSS statistics software and excel spreadsheet, and steps taken for the data analysis in order to achieve the research objectives and validate the hypotheses proposed by this study.

Chapter 4 discusses the results obtained from the data analysis and the findings of the research. Some cases from the results are presented to prove risk attitude and controllability as parameters affecting the risk ratings. Then the research hypotheses are tested and validated at the end of this chapter.

Finally, Chapter 5 is wrapping up this thesis, it explains and summarizes the achievements of the research, the validity of the research hypotheses, the shortcomings of the research. Some recommendations are also provided for further researches that how to use this thesis as a reference for the further studies in this subject.

CHAPTER 2

LITERATURE SURVEY

2.1. A Brief Introduction to Risk and Uncertainty

Risk and uncertainty are two concepts that are common and widely used in the context of risk management in the construction industry. The word ‘risk’ derives from the Latin *risicare*, ‘to dare’, clearly conveying the message that risk is a choice rather than a fate (Smith, 2003). Likewise, MacCrimmon and Wehrung (1986) described risk as ‘‘exposure to the chance of loss in a choice situation’’. The above two definitions provide a general idea of what risk is. However, we need to define risk in the context of construction and project management business, where Baloi and Price (2003) define risk in the construction projects as ‘‘the likelihood of a detrimental event occurring to the project’’. They also defend their idea and explicate that as the time, cost, quality, and scope are the main targets of a construction project, then risk in the project will be failure to fulfill these targets. Loosemore et al. (2006) have defined risk as a potential future event that has an uncertain likelihood and consequence and if occurs, could affect the ability of a company for achieving its objectives or interests. Barber (2005) mentioned that risk is generally stated with respect to uncertainty. He has then defined risk as ‘‘a threat to project success where the final impact upon project success is not certain’’. On the contrary to above definitions, some authors describe risk as having both good and bad sides. Al-Bahar and Crandall (1990) declare that there is no regular usage of the word risk in the literature where many of the definitions on risk have emphasized on its negativity such as damages and losses rather than its positivity, which is gain or profit. Still, risk is understood and realized in different ways for different people, as they perceive it depending on the different fields or areas they work in (Moore, 1983; and Slovic, 2000). Furthermore, some other authors define risk as the probability of an unsure event occurrence that will has either positive or negative effects on the project objectives (PMBOK, 2013; Jaafari, 2001; del Cano and de la Cruz, 2002; and Webb, 2003), which satisfies a full and complete definition of the risk.

Comparing risk with uncertainty, it is believed that the source or root of risk is uncertainty, which means that it is uncertainty that produces risk. Therefore, del Cano and de la Cruz (2002) have emphasized on the origin of risk to be the uncertainty integrated to any project. Being the consequence of uncertainty, Al-Bahar and Crandall (1990) have defined risk in a project as ‘‘the exposure to the chance of occurrences of events adversely or favorably affecting project objectives as a consequence of uncertainty’’.

Definition of uncertainty has a little difference from that of risk because they are not completely similar but are linked to each other very closely and are being used in the literature together even interchangeably in some cases. Anderson et al. (1981) defines uncertainty as being in a situation where one has no understanding about the several states of the nature occurrence. ‘‘Uncertainty applies when there is no prior knowledge of replicability and future occurrences defy categorization’’ (Pender, 2001). In one of the recent researches done by Gosling et al. (2013), they define uncertainty as a situation that ranges from just shortage of certainty to a full shortage of having information about a consequence. Correspondingly, Howell et al. (2010) accept the use of the term ‘uncertainty’ as a ‘‘lack of certainty’’ in its widest form and state that uncertainty does not surround only probabilistic or undefined consequences, but also ambiguity and lack of clarity over situational parameters. Perminova et al. (2008) define uncertainty as ‘‘a context for risks as events having a negative impact on the project’s outcomes, or opportunities, as events that have beneficial impact on project performance’’. Hence, it seems that uncertainty is a slightly different, but a word that is always being used together with risk as Al-Bahar and Crandall (1990) define risk to be the consequence of uncertainty, which is clearly understandable that risk exists when the consequence of an event is uncertain that is occurring or will occur. In the same way, Jaafari (2001) explains uncertainty as an event occurrence having 0% probability. Still, it varies between 0% and 100%, as 100% counts for certain events, and going downward to 0%, uncertainty will be increasing. However, this explanation provide no clear understanding of the matter as a person will argue that why should an event be uncertain if its probability of occurrence is 0%. To support this argument, Loosemore et al. (2006) believe that if the probability of an event occurrence is 0%, then it means that the event will certainly not happen and it is not counted as risk. Also, the probability of 100% means the event is certain to happen. For this reason, when we obtain knowledge about the occurrence of those events or outcomes with a known probability, they change from uncertain situations to risky situations, which will have a specific probability of occurrence. Hillson (2004) links risk and uncertainty and asserts that ‘‘risk is measurable uncertainty’’; and ‘‘uncertainty is unmeasurable risk’’. Lefley (1997) emphasized that even though risk is a result of uncertainty, these two words are not synonymous theoretically. Finally, it is clearly noticeable that in an uncertain case, we do not have any knowledge about either consequence or probability of an event occurrence, but in a risk case, we have the idea about an event that will probably occur and about its probable outcome as well.

Looking to the uncertainty situation that confronts difficulties, it seems that there is need for changing an uncertain situation into a condition where we can at least know about the occurrence of an event that is likely taking place or will take place. Taking this step will eliminate uncertainty and reach to a stage where we can call it risk. Accordingly, Flanagan and Norman (1993) suggested that it is possible to convert an uncertain situation to a risky situation if we assign subjective probability to it. They also argued that subjective probability in this scenario is preferable to the objective one, as decision makers with the same knowledge and experience may have different intuitions about an event, which will be reflected in the subjective probability. This is because, personal attitude and behavior differences among decision makers will play an important role, and these differences will be easily identified by subjective probability in the early analysis process. Then, we would have changed uncertain situation with an optimal solution to a risky situation. The same argument is presented in other words by Öztaş and Ökmen (2005), they express that the uncertainty that is quantitatively represented at some point is not called uncertainty furthermore as it will be counted as risk. Even now, this is a very difficult task for decision makers to assign probability to an uncertain occurrence of an event using their subjective judgment. Decision-making under risk and uncertainty will be explained later in this chapter.

2.1.1. Classification and Sources of Risk

The uniqueness, diversity, and complexity in the construction projects produce different kind of problems and difficulties. The higher the level of complexity and diversity in a project, the higher the risk and uncertainty is. Flanagan and Norman (1993) classified sources of risks in four categories such as: project or individual, market or industry, company, and environment risks. Zhi (1995) identified two possible sources of risks in the overseas construction projects such as environmental impacts, which were called external risks, and uncertainties existing within the project itself, which were called internal risks. In another study, which was carried out be Ng and Loosemore (2007), they classified risks in PPP projects into two major groups: project and general risks. Project risks emerge from the events directly associated with microenvironment in each project. Nevertheless, general risks are not directly associated with project strategies, but may have considerable impact on its consequence. El-Adaway and Kandil (2010) cited the categorization of risks into five sources for the purpose of insurance in construction for example: site, economic, political, design, and environmental risks. Marques and Berg (2011) proposed another kind of classification where the risks are separated into contextual, production, and commercial risks in infrastructure projects. The production process risks are usually tolerated by the private sector and the contextual and commercial risks are usually borne by public sector but sometimes supported by both. They advocated this risk classification to be compatible in practice with intuitions. Tah and Carr (2000) represented a hierarchical risk breakdown structure within a construction project where the risks were named as internal and external risks. In this study, they mentioned that internal risks are controllable, but external risks are uncontrollable comparatively such as acts of God, exchange rate fluctuations, inflation, and legislative changes. With the introduction of a new model, which was called International Construction Risk Assessment Model (ICRAM-1) by Hastak and Shaked (2000), a methodology is proposed for international projects where the risks are sorted out into three levels such as macro or country, market, and project level risks. In another study, Dikmen and Birgonul (2006) proposed another hierarchical risk breakdown structure to facilitate identification of risk sources in the international construction projects. They divided the risk sources into project and country level in the big picture, and then prepared a complete hierarchy of all the possible risks in international projects.

2.1.2. Classification and Sources of Uncertainty

This is generally understood that when there is uncertainty, there always exits risk, which means that risk is associated with uncertainty. Richards and Rowe (1999) state that there are four types of uncertainty, the first one is temporal uncertainty, which is uncertainty in the past and future states; second one is metrical uncertainty, which is uncertainty in measurement; the third one is translational uncertainty, which is uncertainty in explaining uncertain results; and the fourth one is structural uncertainty, which is uncertainty due to complexity. All four types may occur in any situation, but relying on the situation one or more controls. They also have arranged a hierarchical form for the heterogeneous sources of uncertainty as their initial method based on individual's ability to validate the model and data practically. The hierarchy of data sources has been prepared in eight steps such as: standard distribution, empirical distribution, validated model, unvalidated model, alternate models, expert value judgment, best guess estimate, and test case. However, Baloi and Price (2003) pointed out the main types of uncertainty in different terms but a little similar to what Richards and Rowe (1999) did. They listed the main types of uncertainty as variability, ambiguity, vagueness, ignorance, error, and imprecision. They then concluded that as there is diversity in terms for different types of uncertainty, it is very difficult to model the process because the information concerning each specific uncertainty is limited. Therefore, uncertainty has various types and sources (Krause and Clark, 1993).

2.2. Risk Analysis Techniques

Risk analysis is the process to assess each possible risk in terms of probability of occurrence and its impact on the project objectives. Risks in a project can be analyzed using either quantitative or qualitative techniques. The main quantitative risk analysis techniques (Simon et al. 1997; de la Cruz 1998; del Caño and de la Cruz 1998; and PMI 2000) currently used as cited by del Caño and de la Cruz (2002) are summarized in the following list;

- Sensitivity analysis, to discover the criticality of various project parameters.
- Expected value tables, to compare expected values for different risk responses.
- Triple estimates and probabilistic sums applied to cost estimating (for example).
- Monte Carlo, Latin hypercube simulation, to obtain the cumulative likelihood distributions of the project's objectives (net present value, cost, time) using probabilistic estimation of the input parameters.
- Decision trees to aid decision making when there are choices with uncertain outcomes.
- Probabilistic influence diagrams combining influence diagrams with probability and Monte Carlo theory to simulate aspects of project risk.
- Multicriteria decision-making support methods (MDMSMs) for making choices among alternatives with conflicting demands. Analytic hierarchy process (AHP), for example, is a type of MDMSM that can be used for multicriteria selection among different risk responses, mixing qualitative and quantitative criteria.
- Process simulation, using a variety of techniques to simulate specific project processes.
- System dynamics, combining influence diagrams with a more complex mathematical framework to dynamically simulate specific aspects of project parameters with feedback loops and the ability to simulate the selection among different alternative actions.
- Fuzzy logic, with potential applications to scheduling, cost control, and multicriteria selection among several alternatives.

And the main qualitative risk analysis techniques (Simon et al. 1997; de la Cruz 1998; del Caño and de la Cruz 1998; and PMI 2000) currently used as cited by del Caño and de la Cruz (2002) are summarized as the followings;

- Checklists.
- Assumptions analysis.
- Data precision ranking, to examine the extent to which a risk is understood, the data available about it, and the reliability of the data in order to evaluate the degree to which the data about risks are useful.
- Probability and impact description, to describe those parameters in qualitative terms (very high, high, moderate, and so on).
- Probability-impact risk rating tables, which assign risk ratings (very low, low, moderate, and so on) to risks based on combining probability and impact qualitative scales.
- Cause-and-effect diagrams, also called Ishikawa or fishbone diagrams, to illustrate the interrelations between risks and their causes, including the domino effect.
- Flowcharts and influence diagrams, as pure graphs reflecting the interrelations between activities, risks, and responses.
- Event and fault trees, which are typically used in risk analysis of engineering systems (nuclear power and petrochemical plants, and so on) and which can also be used in project management.

In addition to the techniques mentioned above, other support techniques for risk analysis exist as well, such as Delphi, brainstorming, and interviewing technique (del Caño and de la Cruz, 2002).

The Delphi technique or method is an interactive and organized technique that is based on the subjective judgment of a panel of experts (Hallowell and Gambatese, 2010). The participants are identified based on the pre-established rules, but with an anonymous participation. The experts are then asked to participate in two or more rounds of structured questionnaires. When one round is completed, an anonymous summary of the experts' input is provided by the facilitator from the previous questionnaire as a part of the succeeding questionnaire. In each succeeding session, other expert or experts review another expert's opinions so that to minimize the variability of the responses (Hallowell and Gambatese, 2010). Lastly, the consensus of the panel with majority is counted as a final result. This is also important to remind that the bias and any influence of a particular expert can be reduced in the Delphi technique. Therefore, this technique is considered to be one of the effective techniques to be used for qualitative risk assessment. Gunhan and Arditi (2005) developed an international expansion decision model for construction companies based on AHP, which was improved by Delphi survey. A relative comparison between pairs of factors was asked from the experts to make in two rounds. Gunhan and Arditi (2005) then emphasized that the reason for conduction the Delphi survey was to ensure and acquire possible consistency ratio.

In a latest study carried out by Goh et al. (2013), they indicated the most common techniques and tools that are being used in risk management are: probability impact matrices, subjective judgment, brainstorming, decision tree analysis, checklists, Monte Carlo simulation, and sensitivity analysis. They also outlined the risk management (RM) techniques and tools that were discussed by previous researchers in the construction and engineering industry. The summarized table of risk management tools prepared by Goh et al. (2013) is presented as in the below Table 2.1.

Table 2.1: Summary of RM Tools and Techniques Discussed in Previous Studies in Literature (Goh et al., 2013)

Techniques	Perry and Hayes (1985)	Akintoye and MacLeod (1997)	Ward (1999)	Raz and Michael (2001)	Tah and Carr (2001)	Tummala et al. (2001)	Wood and Ellis (2003)	Lyon and Skitmore (2004)	Dikmen et al. (2008)	Forbes et al. (2008)
Intuition/subjective judgement/ experience		✓					✓	✓	✓	✓
Decision analysis	✓	✓						✓		✓
Monte Carlo simulation	✓	✓		✓			✓	✓		✓
Risk premium		✓						✓		
Subjective probability analysis	✓	✓		✓	✓	✓		✓		✓
Brainstorming				✓			✓	✓		✓
Checklists		✓		✓			✓	✓		✓
Historical data use						✓		✓		
Probability impact grids/matrix			✓				✓			✓
Sensitivity analysis	✓						✓	✓		✓
Workshop							✓			
FMEA						✓				✓
Hazard totem pole diagram						✓				
Hierarchical risk breakdown structure					✓				✓	✓
Use case diagram					✓				✓	
Risk register			✓	✓	✓		✓			
Case-based reasoning/approach								✓		✓
Utility theory	✓									✓

The quantitative risk analysis techniques have some difficulties associated with their nature, as the application of these techniques require some data input before applying them in the risk assessment process. Dikmen et al. (2007a) assert that it is usually hard to use statistical data in terms of probabilistic approach to assess risks due to the unique features of construction projects that always have data scarcity. Likewise, Baloi and Price (2003) confirm the heavy dependence of risk management on subjective judgment and experience. Still, some researchers divide the risk analysis into two steps as qualitative and quantitative analysis where the PMBOK Guide (2013) emphasizes on both qualitative and quantitative risk analysis techniques to be performed in the context of project risk management processes so that to be counted as complete analysis. However, the guide suggests that it will be sometimes difficult to perform quantitative analysis because of the lack of data and time limitations. Iyer and Sagheer (2010) classify risk analysis into two: qualitative analysis to identify and assess risks; and quantitative analysis to evaluate risks. As per Ebrahimnejad et al. (2007), risk assessment can be carried out qualitatively, quantitatively or semi quantitatively.

Among the tools and techniques mentioned above, the probability-impact risk rating technique using subjective judgment will be the topic of this research as further discussions will be focused on the subjective judgment and risk ratings criteria applied by decision makers during uncertain situations. Which will comprehensively investigate the way that how different risk ratings are assigned by different decision-makers using their subjective judgment, intuition, and experience in the situations concerning uncertainty, as well as to know the important factors that will affect their decision-making during risk rating assignments.

2.3. Qualitative Risk Assessment Using Subjective Judgment

While conducting risk assessment, the risk intensity is derived from probability of occurrence of a risk event multiplied by its severity or impact (Zhi, 1995; Ward, 1999; Cox, 2008; KarimiAzari et al., 2011; Bannerman, 2008; Williams, 1993; and Zeng et al., 2007). Since the qualitative risk assessment represents a linguistic terms, we need the two factors (probability and impact) to be introduced in a numerical term in order that a risk level can be calculated. Zhi (1995) defined a numerical term between 0 and 1 that could be used for both the probability of occurrence of a risky event and the impact of risk on the project objectives. However, Tah and Carr (2001) used a Fuzzy Associative Memories (FAMs) applying subjectivity for calculation of the risk magnitude (Risk Likelihood x Risk Severity) using linguistic terms such as very low, low, medium, high, and very high representing a 1 to 5 scaling. The risk Probability-Impact (P-I) matrices that represent 1-5 risk rating system or linguistic terms such as very low, low, medium, high, and very high are adopted and discussed by some researchers in the construction industry and risk analysis field for instance (Cox, 2008; El-Sayegh, 2008; Abdelgawad and Fayek, 2010; Baccarini and Archer, 2001; Chapman, 2001; and Hanna et al., 2013), which uses subjective judgment of the experts. Similarly, but with a little difference, Ward (1999) proposed the qualitative scoring grid for probability-impact using just 1-3 rating system for example: low, medium, and high.

Some other qualitative risk assessment tools are also used rather than the 1-5 risk rating or P-I risk rating matrix in the construction industry. Where Öztaş and Ökmen

(2005) proposed Judgmental Risk Analysis Process (JRAP) for schedule risks in the construction projects, which they called it an effective methodology for changing the high uncertain situations judgmentally to risk when there is no historical or previous data about a project. Tah and Carr (2000) assessed the risk probability-impact and risk interdependencies generated by Fuzzy Set Theory (FST). Hastak and Shaked (2000) utilized the Analytical Hierarchy Process (AHP) for international construction project risk assessment with adoption of the probability-impact risk method. The risks were subjectively assessed using a predetermined scale of 0-100, where 0 meant no risk and 100 meant maximum risk. Similarly, Fuzzy and AHP techniques incorporated with other supports are widely utilized for qualitative risk assessment by various authors such as Baloi and Price, 2003; Choi et al. 2004; Shang et al., 2005; Thomas et al., 2006; Dikmen and Birgonul, 2006; Dikmen et al., 2007a; Zeng et al., 2007; Zhang and Zou, 2007; Han et al., 2008; Abdelgawad and Fayek, 2010; and Nieto-Morote and Ruz-Vila, 2011. In the existing literature, there are some other qualitative risk assessment methods, which rely on the intuition, experience, and subjective judgment of the experts. Some of these techniques are briefly summarized in Table 2.2.

In one of the recent studies carried out by Taroun (2014), which is almost a complete literature review on construction risk modeling and assessment, he argues that the Probability-Impact (P-I) risk model is a popular method by which risk is usually assessed through assessment of probability of occurrence and its impact. However, with this amount of rich literature, a little and insufficient attention has been paid and there is still lack of knowledge available behind the fact that how decision-makers are assigning the risk ratings and which factors have influence on the ratings.

Most of the times, subjective data and judgment are used for risk analysis in construction projects due to lack of the available data and limitations on the practical usage of formal risk analysis. Risk analysis and management depend centrally on experience, judgment, and intuition in the construction (Akintoye and MacLeod, 1997; Raz and Michael, 2001; Taroun, 2014; Lyons and Skitmore, 2004; Shen, 1997; Patterson and Neailey, 2002; and Wood and Ellis, 2003). Among these researchers, Akintoye and MacLeod (1997) in the UK, Shen (1997) in China, Wood and Ellis (2003) in the UK, Raz and Michael (2001) in Israel, and Lyons and Skitmore (2004) in the Queensland found that complex tools were not being used extensively for the risk assessment process as most of the risk assessment tools were based on expert judgment, intuition, and experience of the practitioners. Likewise, Dikmen et al. (2004) explored that in the qualitative risk assessment, experience, and personal judgment are the main tools. The following Table 2.2 summarizes the tools and techniques used in the literature for qualitative risk assessment from year 2000 up to now.

Table 2.2: List of Tools and Methods Used for the Qualitative Risk Assessment Based on the Subjective Judgment in the Literature Afterwards Year 2000

Tool & Method Name	Author(s)	Publication Year	Brief Explanation
AHP	Hastak and Shaked	2000	In the ICRAM-1 model, the hierarchy of risk indicators is systematically evaluated through matrix calculations for preference order determination of a decision maker from the various existing criteria.
FST	Tah and Carr	2000	HRBS model is used. For risk assessment, the likelihood, severity and timing values are determined using qualitative measures such as low, medium and high.
PI Grid	Chapman	2001	Probability-Impact matrix scoring using subjective judgment is involved in this method.
PRR	Baccarini and Archer	2001	Project Risk Rating, where the likelihood and consequence of risks that affect the project cost, quality, and time are rated qualitatively using a matrix.
FST & DSS	Baloi and Price	2003	A fuzzy decision framework is developed to analyze the global risk factors that affect cost performance in construction projects.
P-I Matrix, Subjective Judgment	Wood and Ellis	2003	Subjective judgment in RM practice based on experience.

Table 2.2: (continued)

Tool & Method Name	Author(s)	Publication Year	Brief Explanation
Judgment, Intuition, and Experience	Lyons and Skitmore	2004	Survey results of individuals' perceived risk tolerances involved in senior management in the Queensland engineering construction industry, which shows frequent use of qualitative risk assessment.
P-I & Questionnaire	Fang et al.	2004	In this method, a questionnaire is used to collect the data from respondents who are qualitatively assigning the risk ratings based on risk occurrence probability and influence.
FST, Subjective Judgment with use of a Software	Choi et al.	2004	A risk analysis software system for underground construction projects. The risk analysis software can assess the level of risks based on either experts' subjective judgments or probabilistic parameter estimates depending on the availability of risk-related data.
JRAP	Öztaş and Ökmen	2005	A judgmental risk analysis process for project duration with combination of Monte Carlo simulation for converting uncertainty to risk judgmentally.
FST	Shang et al.	2005	A web-based risk assessment system with the use of fuzzy logic, which enables remote project team members to assess the risks at the conceptual design stage.
Influence Networks	Poh and Tah	2006	An integrated duration-cost influence network is developed to systematically represent the interdependencies among the duration and cost parameters of a construction task.
FST & Fault Tree	Thomas et al.	2006	A risk probability-impact assessment framework based on fuzzy-fault tree and the Delphi method is proposed based on professional judgment.

Table 2.2: (continued)

Tool & Method Name	Author(s)	Publication Year	Brief Explanation
Risk Ratings & Questionnaire	Andi	2006	A four point rating scale is used to specify the level of risk occurrence and impact in Indonesian construction projects based on owner-contractor's perspective with the help of a questionnaire survey.
AHP	Dikmen and Birgonul	2006	AHP as a MCDM technique is used for risk and opportunity assessment in the international projects as well their rankings.
FST & Influence Diagramming	Dikmen et al.	2007a	This is an influence diagramming method combined with fuzzy risk assessment approach to estimate cost overrun using risk ratings.
FST & AHP	Zeng et al.	2007	This model can handle the expert judgment; also, risks can be evaluated directly using linguistic terms.
CBR & UT	Dikmen et al.	2007b	A case-based reasoning model is used for risk, competition, and opportunity rating estimation. The ratings are then converted to profit mark-up and risk values using linear utility function.
Fuzzy AHP	Zhang and Zou	2007	In this model, the weight coefficients of risk groups and risk factors are obtained with the help of AHP techniques and fuzzy evaluation matrix based on expert judgment.
Cognitive Argument & Questionnaire	Zou et al.	2007	A matrix is used to calculate the significance of influences of risks on project cost, quality, time, safety, and environmental sustainability with the help of questionnaire to collect data from the respondents.

Table 2.2: (continued)

Tool & Method Name	Author(s)	Publication Year	Brief Explanation
P-I Matrix & Questionnaire	El-Sayegh	2008	Based on the survey results, the relative importance index (RII) is calculated based on probability-impact rating for each risk in this method.
AHP & Questionnaire	Zayed et al.	2008	A risk index (R) model is proposed in order to assess the effect of sources of risk and uncertainty on a construction project. The weight of risks is calculated with the use of AHP. Also, questionnaires are used to collect the data from experts who have used subjective judgment for the weights of risks.
AHP	Han et al.	2008	This is a web-based decision support system for basic decision-making process in the international construction projects where uncertainty exists. The AHP technique is used in this method.
P-I and use of MS Access as a Database	Dikmen et al.	2008	This is a post-project risk assessment tool where the risk assessment step is done using probability-impact risk rating with expert judgment.
Fuzzy FMEA & Fuzzy AHP	Abdelgawad and Fayek	2010	This method is applied in a case study using probability, impact, detection/control, and the level of criticality of risk event with the help of linguistic term usage.
E-FCMs	Lazzerini and Mkrtchyan	2011	Extended fuzzy cognitive maps are proposed to analyze the relationships between risks and the risk factors, and adopting a pessimistic approach to assess the overall risk of a project.
FST & AHP	Nieto-Morote and Ruz-Vila	2011	Fuzzy linguistic terms are used by subjective judgment, and pair-wise comparative judgment using AHP technique.

Table 2.2: (continued)

Tool & Method Name	Author(s)	Publication Year	Brief Explanation
Risk Rating	Hanna et al.	2013	In this method, the relative impact (RI), likelihood of risk realization (LORR), risk rating, and the input of recommendations and notification of a 1-5 scale is involved with the application of subjective judgment.

2.4. Decision Making under Risk and Uncertainty

The main problem of the decision science and risk management is the framing of decisions that are under risky conditions (He and Huang, 2008). According to Baloi and Price (2003), problems that involve decision-making are divided into deterministic, stochastic/risk and uncertain categories. The data known with certainty is called deterministic problems, while the data known with a probability distribution but not with certainty is called stochastic or commonly called risky data, and the third kind is the data, which is not known and is called uncertain. They have concluded that most of the problems involved in risk management fall into the last two categories. Hence, the process of decision-making in risk management will facilitate to reduce the amount of uncertainties involved in a project applying optimal solutions. As per He and Huang (2008), Expected Utility Theory (EUT) was recognized as a normative theory, as well as descriptive theory for the decisions under the situation of risk before the raising of some renowned experimental researches and paradoxes that competed with and challenged its legitimacy (Kahneman and Tversky, 1979; and Allais, 1953). Suhonen (2007) demonstrates that in the traditional decision theories, the notions of risk and uncertainty are separated, as in case of decision-making under risk, the probabilities of outcomes are known. Conversely, in case of decision-making under uncertainty, the probabilities of outcomes are not known. Still, most of the decisions are made between the middle field of known and unknown probabilities. As a result, we do not make partition between the decisions under risk and uncertainty.

The collection of information is the first step when making a decision. Then it should be analyzed and interpreted in terms of assigning numbers or values to the possible outcomes, where this interpretation will be influenced by some factors such as judgment, intuition, experience, knowledge, preference, cognition and attitude. The preference and attitude can be analyzed throughout utility function of individuals making decisions (Pennings and Smidts, 2000; Au and Chan, 2005; and Fellner and Maciejovsky, 2007). Discussing the decision-maker's cognition, Sanderson (2012) proposed three conceptions of decision-maker cognition under risk and uncertainty for governance in megaprojects such as optimizing, optimizing within limits, and satisficing as explained in the following Table 2.3. Sanderson (2012) also suggested that these assumptions may not be a comprehensive cure to project risk and uncertainty, but can be considered as a way of conscious decisions about organizing in projects.

Table 2.3: Assumptions About Decision-Maker Cognition (Sanderson, 2012)

Cognition Category 1: optimizing	All decision-makers have unlimited time, information and cognitive capacity, and make choices that maximize their best interests
Cognition Category 2: optimizing within limits	All decision-makers operate within constraints of limited time, information and cognitive capacity, but still maximize their best interests within those limits
Cognition Category 3: satisficing	All decision-makers operate within constraints of limited time, information and cognitive capacity, and make choices that satisfy their aspiration levels

Many organizations have adapted some rules and principles for decision-making that are already prepared and emplaced within the organization's policy framework and are applied to the routine business. However, the risks that create concerns in a project are always unique, which need a special treatment not a typical one. Therefore, the existing policies and regulations may not work sufficiently to solve these risky problems as it only depends on the decision makers themselves that how to decide and take action based on their knowledge, personal feelings, behaviors, and attitudes toward those risks that they face. In different aspects of construction, individuals make decisions on a daily basis about the source and consequence of a risk that may be hard to understand and handled. That is why Flanagan and Norman (1993) stated that ‘‘decision-making is a game of imperfect information involving the future, change and human action and reaction’’. Decision-making is being affected when there is uncertainty in the information (Sachs and Tiong, 2009).

Wu et al. (2004) address two general questions on the study of decision-making under risk: 1. ‘‘How should individuals behave when faced with a risky choice’’? 2. ‘‘How do individuals behave when faced with a risky choice’’? Thus, this is understood that decision theory is generally divided into normative and descriptive parts as the 1st question above represents normative and the 2nd one represents descriptive decision theory. Johnson and Busemeyer (2010) provide a very good explanation on the descriptive and normative theories of decision making under risk and uncertainty. They say that ‘‘normative theories focus on how to make the best decisions by deriving algebraic representations of preference fro idealized behavioral axioms’’ while ‘‘descriptive theories adopt this algebraic representation, but incorporate known limitations of human behavior’’. A very important thing for a decision maker is to identify and select the best choice for obtaining the optimal objective that the organization expects. When making the choices under risky and uncertain situations using subjectivity, the risk attitudes of decision-makers play a vital role in this process. Hence, it creates the impression to study individual’s risk attitude, who is in the position of making decisions under risk in an organization or a project level as the whole organization or project will be affected by decisions he makes. Also, individuals in the position of making decision under risk feel responsible if something goes wrong in the project, or failure to achieve the project objectives because of their decisions. Tversky and Kahneman (1986) insist that the chances of survival in a competitive environment will be increased by optimal decisions, and minority of rational individuals may sometimes put the rationality in place in the market. Still, all the decisions being made under risk depend on individuals' risk attitudes and the way they behave. Risk attitude is discussed in details in the section 2.6 of this chapter.

2.5. Factors that May Affect 1-5 Scale Risk Ratings

One of the most widely used techniques for qualitative risk assessment is the P-I risk rating model or matrix (Goh et al., 2013; and Taroun, 2014), which is developed with decision-makers' subjective judgment where they assign the risk ratings to the probability of a risk event occurrence and its impact. Various researchers in the construction industry have been used the P-I risk rating method using 1-5 scaling or Likert scale for assessing risks such as (Dikmen et al., 2012; El-Sayegh, 2008; Abdelgawad and Fayek, 2010; Baccarini and Archer, 2001; Chapman, 2001; Goh et al., 2013; and Hanna et al., 2013). Due to the heavy reliance of this technique on the subjective judgment of individuals, it is important to know that how these individuals behave and make decisions for assessing and rating the risks. Also, what factors may affect their risk rating is the critical part to understand exactly.

There are still some shortcomings with the utilization of risk matrices to be addressed, as Cox (2008) claims about the logical and mathematical drawbacks of the risk matrices, which are considered as the bases of information for risk management decision making. In his study under the title of ''*What's wrong with risk matrices?*'', Cox (2008) identifies some rational and mathematical limitations of the risk matrices performance such as suboptimal resource allocation, errors, ambiguous inputs and outputs, and poor resolution. He agrees with the widespread and uncomplicated utilization of risk matrices in the risk management decisions, but strongly recommends a research to be conducted for its better understanding in order to provide some specific indications that in which situations these risk matrices can help and in which situations cannot. Following Cox's research, Ball and Watt (2013) examined the utility and reliability of the risk matrices in the context of public leisure activities and travel where they found that: ''(1) Different risk assessors may assign vastly different ratings to the same hazard. (2) Even following lengthy reflection and learning scatter remains high. (3) The underlying drivers of disparate rating relate to fundamentally different worldviews, beliefs, and a panoply of psychosocial factors that are seldom explicitly acknowledged''. Actually in this study, which was a two-stage survey, international postgraduate and undergraduate students those studying either occupational health and safety or risk management had participated. A risk matrix used in this study was a product of (1-5) scaling method where the (1-5) scores were assigned to the individual likelihood and consequence ratings, then the respondents were asked to assign the risk ratings accordingly. At the first stage of the survey, 50 students participated, and then in the second stage of the survey, 21 students representing a subset of the first 50 students participated. The important findings of Ball and Watt's (2013) research were that they prepared a table of factors affecting the risk ratings. The risk attitude and lack of specific knowledge were the two factors out of the 15 that can have effect on the risk ratings and which can be connected to this thesis. For detailed information about this study, please refer to Ball and Watt (2013).

Focusing on risk attitude, some other researchers have also stated the effect of risk attitude on the risk ratings, where Akintoye and MacLeod (1997) asserted that individual attitude, belief, feeling, and judgment have influence on risk perception in general. Dikmen et al. (2008) admitted the role of risk attitude as one of the important factors on the risk ratings and quantification, which will be taken into account by a company. Therefore, prior knowledge and experience will be then directly connected to attitudes and judgments of decision-makers. Similarly, Cox (2008) explains the importance of risk attitude and subjective judgment on the risk ratings.

The illusion of controllability is another important factor that is rarely mentioned in the literature, which in this thesis is considered as a very important factor to have significant influence on the risk ratings. Dikmen and Birgonul (2006) described 'controllability' as a latent factor, which is not being used in the formulas of the risk quantification. However, decision-makers may assign a lower risk rating during evaluation of probability of occurrence and impact in case a company can reasonably control a risk. Later, Dikmen et al. (2007a) pointed out the same issue and stated that in general, decision-makers count an implied factor while assigning the risk ratings called 'controllability', which is not considered in the formulas for risk quantification, but its effect is generally taken into account under impact and probability ratings. They believe that if a firm is able to reasonably control a risk factor, then a lower risk rating might be assigned, which means that the experience of a company will have a considerable influence that can mitigate the level of risk in the projects. Aven et al. (2007) also raised some issues related to the risk ‘manageability’ concept but different from that of Dikmen et al. (2007a), where they expressed that some risks are more manageable than others, which means that the possibility of effects reduction for some risks may be larger in comparison to the other risks. They also argued that a higher risk with a higher manageability would provide a considerable opportunity than the risk with a medium level and low manageability, but no specific methodology was provided to show the importance of manageability in the risk assessment process while assigning the risk ratings. The same dilemma was discussed by Keizer et al. (2002), but in different words. They described the project risk character not to be determined by its likelihood and effect only, but by a firm’s ability to influence the risk factors as well.

To conclude, some researchers have addressed some limitations of the P-I risk rating models, but these models are still prevailing and widespread because of their simplicity and attractiveness. Risk attitude is a factor that will have effect on the risk ratings based on the literature. Controllability is another factor that may have some effects on the risk ratings, but there is lack of research existed in this subject to prove it explicitly. Therefore, this thesis will study the effects of risk attitude and assumptions about the illusion of risk controllability while decision-makers assign the risk ratings (using 1-5 scale) during qualitative risk assessment.

2.6. Attitudes toward Risk

One of the particular and important parts of the decision-making process under risk and uncertainty is to deal with individuals’ risk attitudes. In the same way, while risk assessment is being performed, studying the risk attitude of individuals that make decisions is essential as well. For this reason, it is clearly understandable that risk attitude plays a significant role in terms of decision-making while risk and uncertainty exist. According to Flanagan and Norman (1993), risk attitude is one of the important components of the risk management framework, which needs to be assessed as shown in the below Figure 2.1. They also insist that making decisions about risk will be affected by the attitude of the individual or organization that makes decisions. It is risk attitude that explains an individual's choice selection and behavior in decision-making. Fellner and Maciejovsky (2007) also insist on the assessment of an individual's risk attitude as they argue that in theory and practice, risk attitude plays a central role in both financial and managerial decision making.

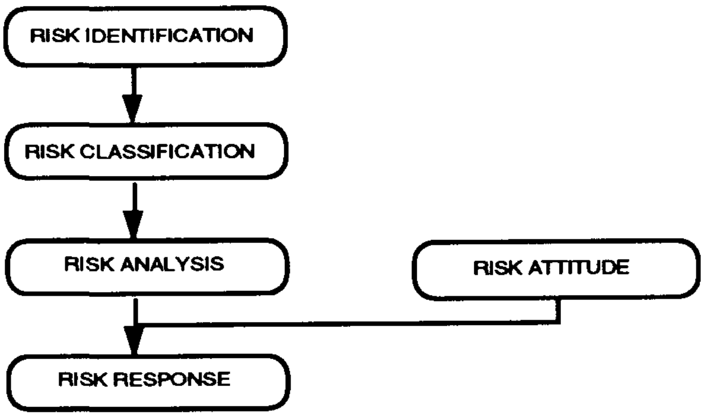

Figure 2.1: The Risk Management Framework (Flanagan and Norman, 1993)

There are some techniques in the literature used for the purpose of risk attitude assessment. Many of these techniques are based on gamble and lottery choices, as they are being used in the fields of both psychology and economy for decision-making in the situations under risk and uncertainty. A common approach for risk attitude measurement is the Expected Utility Theory (EUT), which was developed by von Neumann and Morgenstern (1944) under the title of ''*Theory of Games and Economic Behavior*''. Later, another alternative approach to EUT was proposed and developed by Kahneman and Tversky (1979), which explained the failure of EUT in some cases with evidences; the theory was named as Prospect Theory (PT). These two theories will be explained in more details later in this chapter.

In general, there exist three types of risk attitude as per EUT shown by the curvature of utility function named as;

1. Risk seeking/lover: is a person whose utility value is greater than the expected monetary value, which means that he will prefer to take risk rather than to accept a certain amount of money.
2. Risk neutral: is a person who is indifferent between his utility value and the expected monetary value, which means that he will be indifferent between the risky choice and the expected monetary value.
3. Risk averse: is a person whose utility value is smaller than the expected monetary value, which means that he will prefer to take a smaller certain amount of money rather than to take risk.

There exist two types of risk attitude as per PT (Kahneman and Tversky, 1979):

1. Risk seeking
2. Risk averse

However, Murray-Webster and Hillson (2008) added one more type of risk attitude, which is called risk tolerant such as:

1. Risk averse
2. Risk seeking
3. Risk tolerant
4. Risk neutral

2.6.1. Definition: Risk Attitude

As the perception of risk can be affected by individual's attitude towards that specific risk in the time of making decision, defining risk attitude is essential for individuals in order to know and understand what it is. Hillson and Murray-Webster (2007) define risk attitude as ''a chosen state of mind with regard to those uncertainties that could have a positive or negative effect on objectives''. They also insist that attitude only exist in relation to a datum point, which shows that attitude of same individuals changes with the change of circumstances in which they make a decision. Also, it depends on the decision maker's attitude whether to take risk or not. The ISO Guide 73:2009 in their risk management vocabulary defines an organization's risk attitude as ‘‘organization’s approach to assess and eventually pursue, retain, take or turn away from risk. The definitions of risk attitude types proposed by Murray-Webster and Hillson (2008) are given in the following Table 2.4.

Table 2.4: Definition of Basic Risk Attitudes (Murray-Webster and Hillson, 2008)

Term	Definition
Risk Averse	‘‘Uncomfortable with uncertainty, desire to avoid or reduce threats and exploit opportunities to remove uncertainty. Would be unhappy with an uncertain outcome".
Risk Seeking	‘‘Comfortable with uncertainty, no desire to avoid or reduce threats or to exploit opportunities to remove uncertainty. Would be happy with an uncertain outcome".
Risk Tolerant	‘‘Tolerant of uncertainty, no strong desire to respond to threats or opportunities in any way. Could tolerate an uncertain outcome if necessary".
Risk Neutral	‘‘Uncomfortable with uncertainty in the long term so prepared to take whatever short-term actions are necessary to deliver a certain long-term outcome".

2.6.2. Measuring and Assessing Risk Attitudes

Risk attitude can be measured and assessed by expected utility function or via psychometric approaches such as questionnaires and scales (Pennings and Smidts, 2000; and Fellner and Maciejovsky, 2007). In the expected utility framework, choices over lotteries are used to represent the attitudes toward risk, shown by a probability distribution, and the utility curvature function will imitate these attitudes. On the other hand, psychological approaches ask the people directly about their willingness and agreement about some questions on risky situations, which directly measures risk attitudes (Fellner and Maciejovsky, 2007). Another approach that challenges the expected utility theory and measures risk attitude of individuals is prospect theory proposed by Kahneman and Tversky (1979). Some researchers have used the technique of lottery choices for the risk attitude assessment in the field of both psychology and economy such as Wärneryd, 1996; Kahneman and Tversky, 1979; Fellner and Maciejovsky, 2007; Pennings and Smidts, 2000; Dohmen et al, 2011; Donkers et al., 2001; Kachelmeier and Shehata, 1992; Cardenas and Carpenter, 2013; and Ye and Wang, 2013. On the other hand, some others have used the method of gamble choices to measure attitudes toward risk in various fields such as Eckel and Grossman, 2008; Binswanger, 1980; and Balaz and Williams, 2011.

Besides, a number of researches have been performed to assess and measure risk attitudes in the construction industry. Raftery et al. (2001) investigated professionals' risk attitudes vigorousness toward monetary risks via interviews before and after a business cycle variation where they found that decisions will vary in response to three stimuli such as framing of decisions, the amount of money involved, and economical condition background. Au and Chan (2005) studied the risk attitudes of contract parties (contractors and employers) to see that how contractors request for payments, and how employers are willing to make payments for the time delay risk due to weather in a construction project. Han et al. (2005) focused on findings about the risk attitudes and bid decision behavior of contractors in the selection of international construction projects in the situations of losses and profits using the Certainty Equivalent (CE), which is used for utility function assessment. Wang and Yuan (2011) identified the important factors that affect risk attitudes of contractors in the Chinese construction industry so that to improve the Risk Based Decision-Making (RBDM). From the 26 factors that were identified, three of them were determined to be of great importance such as: engineering experience, consequences of decision-making, and completeness of project information. Kim and Reinschmidt (2011a) studied that how risk attitude of an individual affects the competition, and the contractor's competitive success in the construction market. They also insisted that risk-taking behavior is affected by organizational risk attitude. For this reason, they developed an evolutionary simulation model to investigate that how risk attitudes will have effect on the success of contractors and the market. In another research that has been carried out by Kim and Reinschmidt (2011b), they discovered that the diversified market of construction business might have risk attitudes that are different from each other as determined by the risk-taking behavior involved in competition. Their main job in this study was to investigate among those multiple contractors that have organizational risk attitudes associated with the diversification they have, on a simulated competition basis. Bossuyt et al. (2012) explored risk attitudes through utility theory in risk-based design in order to address the important risks via numerically based approach rather than the gut felling usage to explain risk-based decisions.

2.6.3. Expected Utility Theory (EUT)

Expected utility theory is one of the most used methods in the literature that is capable of measuring and assessing risk attitudes. This is important to firstly understand what utility means? ‘‘Utility means the satisfaction the decision-maker receives from given quantities of money’’ (Flanagan and Norman, 1993). The EUT was developed by von Neumann and Morgenstern (1944), where the theory was basically for the choice preference of an individual decision maker under uncertain and risky situations in order to maximize his/her utility over all possible outcomes based on the rational behavior. It is the utility function that describes the three basic attitudes toward risk such as risk averse, risk seeking, and risk neutral through its curvature, where the concavity means the individual is risk averse, convexity means the individual is risk seeking, and finally the straight linear function represents a risk neutral attitude toward risk as shown in Figure 2.2. Given a choice between two options, where one involving a certain outcome of utility (x), and the other option involving a gamble or lottery with the equivalent expected utility (x), a risk seeking person will prefer the gamble, a risk averse person will prefer the certain outcome, and a risk neutral person will be indifferent between the two options (Levy, 1992). Swalm (1966) and Hammond (1967) state that a decision maker’s attitude towards risk can be completely summarized by utility function, which is a model, adapted by many researchers. Keeney and Raiffa (1976) explained expected utility (EU) as a model where the u(x) function describes the risk attitude of an individual in the state of making decisions, which means that the function is determined by risk preference of an individual. Thus, the utility of a person can be easily understood via lottery choices or direct scaling (Pennings and Smidts, 2000). Utility theory states that people try to maximize their utility or satisfaction instead of maximizing the Expected Monetary Value (EMV) in the situations where risk and uncertainty exist. The general formula for the expected utility function is:

$$\mathbf{EU} = \sum_{i=1}^{n} \mathbf{p}_i \, \mathbf{U} \, (\boldsymbol{x}_i) = \mathrm{p}_1 \, \mathbf{U} \, (\boldsymbol{x}_1) + \mathrm{p}_2 \, \mathbf{U} \, (\boldsymbol{x}_2) + \ldots + \mathrm{p}_n \, \mathbf{U} \, (\boldsymbol{x}_n)$$

U = Utility, **p** = probability, ***x*** = value or wealth's outcome

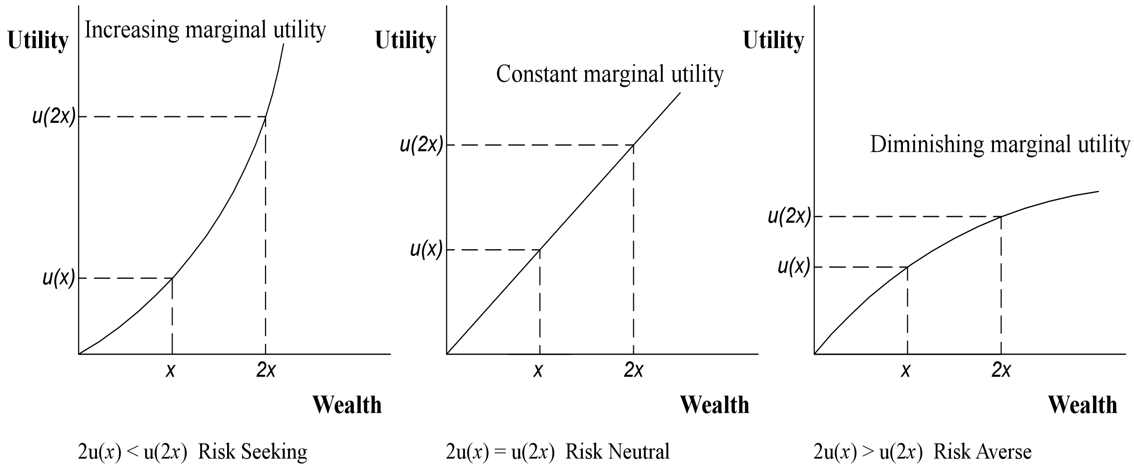

Figure 2.2: The Expected Utility Function with its three Different Shapes

The EMV does not catch risk attitude of individuals. If we look to the EMV formula, it does not describe anything about utility or preferences of an individual, as it just calculates the summation of possible outcomes associated with its probabilities. However, EMV is a common criterion used for decision-making situations where the EMV of each strategy is clarified by multiplying the value of each outcome by its probability of occurrence, and then adding all the calculated figures.

$$\mathbf{EMV} = \sum_{n=1}^{N} \mathbf{Value}_n \ \mathrm{x} \ \mathbf{Probability}_n \qquad \mathbf{Probability} = \mathrm{P}, \quad \mathbf{Value} = \mathrm{V}$$

Following example on expected utility concept is borrowed from the book of Flanagan and Norman (1993), titled ''Risk Management and Construction'', which is a good example for the implementation of utility concept in the construction business.

Example: Two companies, one large and the other one small are going to bid for two contracts K and L. The firms cannot undertake both contracts, which means that they have to choose just one of the available contracts to bid for. Also, it is supposed that each contract can have three possible outcomes with their probabilities and payoffs as shown in the following Table 2.4.

Table 2.5: Probabilities and Payoffs of Contracts K and L
(Flanagan and Norman, 1993)

Contract K		**Contract L**	
Probability	**Outcome**	**Probability**	**Outcome**
0.2	£100,000,0	0.2	£200,000
0.5	£500,000	0.7	£150,000
0.3	-£10,000	0.1	-£0

The proper calculations according to the EMV are as follows:

EMV(L) = £200,000 * 0.2 + £150,000 * 0.7 + £0 * 0.1 = £145,000

EMV(K) = £100,000,0 * 0.2 + £500,000 * 0.5 - £10,000 * 0.3 = £447,000

The expected utility values of the companies are already on hands and are given in the following Table 2.6.

Table 2.6: The Utility Values of Each Company Under the Different Outcomes (Flanagan and Norman, 1993)

Outcome	Utility value for the large company	Utility value for the small company
£100,000,0	1.0	1.0
£500,000	0.8	0.9
£200,000	0.5	0.85
£150,000	0.3	0.8
-£0	0.0	0.0
-£10,000	0.0	0.0

Expected utility values of the small firm for contract **L**: 0.2 * 0.85 + 0.7 * 0.8 + 0.1 * 0 = **0.73**

For contract **K**: 0.2 * 1.0 + 0.5 * 0.9 + 0.3 * 0 = **0.65**

And the expected utility values of the large firm for contract **L**: 0.2 * 0.5 + 0.7 * 0.3 + 0.1 * 0 = **0.31**

For contract **K**: 0.2 * 1.0 + 0.5 * 0.8 + 0.3 * 0 = **0.6**

Considering the above calculations, the small company will go for choosing contract **L**, and the large company will choose contract **K**. The above problem proved that instead of maximizing EMV, people maximize their utility.

As per Flanagan and Norman (1993), ‘‘to be of use in decision-making, utility values must be assigned to all possible outcomes because the decision-maker’s choice will change according to the risk involved’’. Kutsch and Hall (2005) explain EUT as a dominant normative and descriptive model for decision making under uncertainty. Therefore, the fundamental objective of decision-making studies using utility theory is to maximize the outcomes facing with risk situations (Yang and Qiu, 2005).

However, there are some limitations of EUT and this theory is criticized in its some aspects by some researchers, as Markowitz (1952) focused on some issues against expected utility. He asserted that during the decision making process, total wealth will not be the only factor but change in wealth may also be a factor. He further examined that temporary changes may take place in the utility function; thus, a discrimination should be made between present wealth and the wealth called conventional. Another criticism to utility theory is introduced by Allais (1953), where he concentrated to prove that the preferences are non-linear. Allais (1953) acknowledged that an amount's increase having probability from 0.99 to 1.00 has more impact on individuals than an amount's increase having probability from 0.10 to 0.11, which clearly contradicts the expected utility theory, as increase of 0.01 U(x) is an equal increase with no difference between the two above probabilities and choices by an individual in terms of EUT. Later, a very well argument developed by Kahneman and Tversky (1979) that violated EUT in some cases based on the experimental study results. Although, the EUT is recognized for its problem in describing the Allais paradox and a set of real-life behavior of individuals, it is still heavily reliable for researchers (Ye and Wang, 2013).

2.6.4. Prospect Theory (PT)

Prospect Theory (PT) is an alternative theory to EUT, which challenges this theory with its experimental arguments that were explored and formulated by Kahneman and Tversky (1979). The EUT is explaining an individual's rational behavior, where the PT theory explains its limitations of rationality in some cases where individuals face with different options of prospects in terms of loss and gain. To clarify, the main point that PT explains is that people are risk averse in the domain of gains, and risk seeking in the domain of losses. This behavior is shown by an 'S' shaped value function which is concave for gains, and convex for losses, where it is steeper for losses than for gains as shown in the following Figure 2.3. For this reason, some researchers use prospect theory method instead of expected utility theory method in order to measure attitudes of decision-makers toward risk as far as this theory is a behavioral decision theory. In a typical experiment by Kahneman and Tversky (1979), a certain outcome of $3000 was preferred by about 80% of the respondents to an 80% chance of winning $4000 and about 20% chance of winning nothing. By comparison, when the respondents were asked the same scenario in the form of negative prospects, 80% chance of losing $4000 and 20% chance of losing nothing was preferred by about 92% respondents to a certain loss of $3000 (Levy, 1992). Framing and valuation are the two phases in the choice process that are treated differently in the prospect theory, where in the framing phase, the decision maker builds a description of the performances, outcomes, contingencies that are related to the decision, and in the valuation phase, the decision maker assesses the value of each prospect and make his choice accordingly (Tversky and Kahneman, 1992).

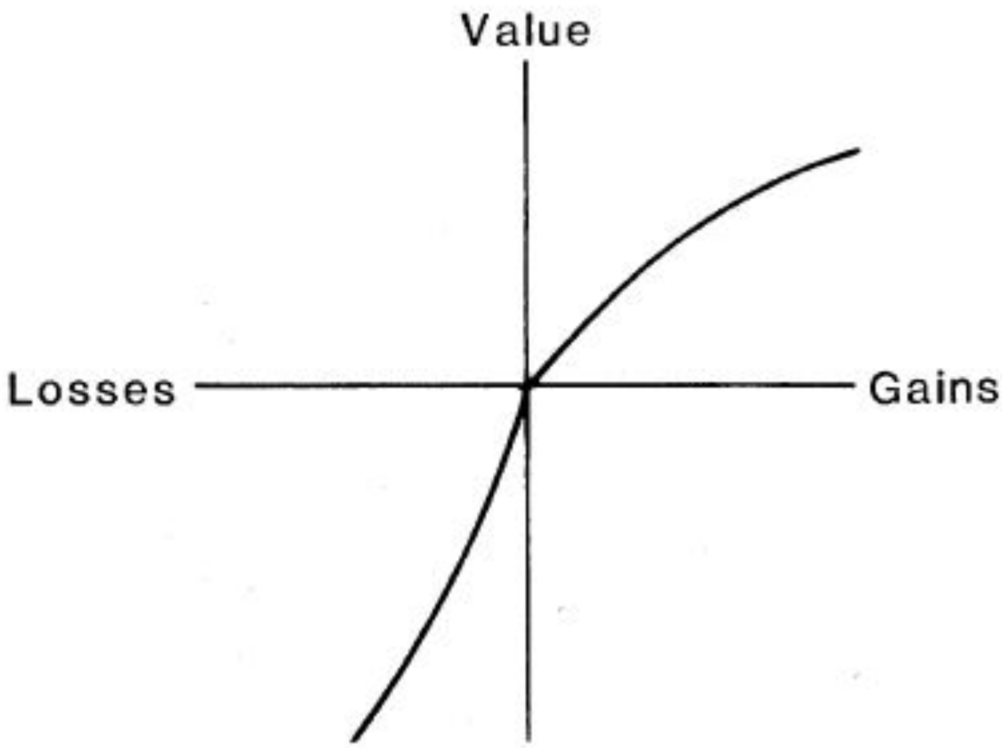

Figure 2.3: A Typical Value Function (Kahneman and Tversky, 1979)

The value of a prospect 'V(x, p)' is described in the following formula as per PT;

$$\mathbf{V}(\boldsymbol{x}, \boldsymbol{p}) = w(p_1)v(x_1) + w(p_2)v(x_2) + \ldots + w(p_n)v(x_n)$$

According to Han et al. (2005), some authors have supported the prospect theory value and made some justifications such as: (1) People are usually risk averse while dealing with a little chance a extreme losses, risk seeking while dealing with a chance of gains having very low probability; (2) decision-makers combine losses and isolate gains so that they can maximize their utility; (3) the increment of gains goes more slower than the decrement of losses, which shows a loss aversion attitude. Hartono and Yap (2011) examined a contractor's risky bid mark-up decision in construction competitive bidding that was grounded in prospect theory. They claimed that the framing effect is a particular assertion of prospect theory that is closely connected to bid mark-up study, where framing in this theory reflects the way a special risky problem is perceived by decision makers. Then this special framing of a decision-maker will lead to a methodical model of decisions where a known risky attitude such as risk seeking/averse is displayed. The framing effect assumes that decision makers tend to be risk seeking when a risky choice problem is structured as a loss in the domain of a negative prospect, and to be risk averse in case if the same choice problem is structured as a gain in the domain of a positive prospect (Kahneman and Tversky, 1979). Another good example on the effect of variations in framing has been illustrated by Tversky and Kahneman (1981) under the title of ‘‘The framing of decisions and the psychology of choices’’. Thus, the interested reader can refer to mentioned paper. For both psychologists and economists, an attractive part of the PT is that it predicts when and why people will make decisions that have a complete divergence from the normative or rational decisions.

Later in 1992, Tversky and Kahneman introduced a new version of PT, which was called Cumulative Prospect Theory (CPT). In the CPT, cumulative decision weights are employed rather than the separable decision weights, where the theory can be applied to risky and uncertain prospects with any number of outcomes, as well as, allows different weighting functions for losses and gains. Afterwards, Fennema and Wakker (1997) pointed out the difference between the PT and CPT. They discussed the violation of stochastic dominance by PT, where CPT satisfies stochastic dominance. ‘‘Stochastic dominance requires that a shift of probability mass from bad outcomes to better outcomes leads to an improved prospect’’ (Fennema and Wakker, 1997). They also stated that in addition to avoidance of some theoretical problems, CPT provides different empirical predictions as well.

In a recent research conducted by Levy and Wiener (2013), they introduced the concept of Temporary Attitude Toward Risk (TATR) and Permanent Attitude Toward Risk (PATR) so that they can settle the conflict between the EUT and PT and to be used as a bridge between the gaps existed in between these two theories. They revealed that the permanent attitude toward risk (PATR) is reflected by decision-making that is based on the total wealth. By comparison, temporary attitude toward risk (TATR) is reflected by decision-making based on changes in the wealth.

To conclude, both EUT and PT have their own places of usages where some researchers prefer to use EUT for determining the attitudes of people toward risk, and some on the other hand, prefer to use PT. Thus, analysis of decision-making under risk and uncertainty can be performed through the methods described by these two theories.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. Objective

The objective of this thesis is to study the variance in the risk ratings that decision-makers assign to risks during risk assessment, with respect to their attitudes toward risk as well as illusion of controllability. Therefore, a questionnaire survey was conducted where 81 individuals participated in this survey. The survey data was then analyzed in order to acquire the research objectives and to test the hypotheses that were proposed in this study.

3.2. Development of the Questionnaire

A questionnaire was designed to facilitate the collection of data so that to prove the hypotheses of the research and obtain the main objectives of the thesis via this survey data. Therefore, a questionnaire with close-ended questions was administered to ensure acquiring correct, complete and meaningful data and responses. A considerable amount of work has been done on the questionnaire design, and after making some corrections that were pointed out in the two times pilot questionnaire that distributed to the research supervisor and co-supervisor, a final version of the questionnaire was organized consisted of three parts with the aim that:

1. To study how the risk ratings vary with respect to risk attitude of decision-makers during the risk assessment process.

2. To question the validity of the hypothesis that controllability also affects a decision maker's decisions about risk rating in addition to his/her attitude.

The three sections of the questionnaire were as follows.

Part 1. General information about the respondents
Part 2. Assigning the risk ratings for the risk controllability level and the four risk scenario cases
Part 3. Measuring risk attitude

In Part 1 of the questionnaire, general information about the respondents were asked, which were composed of four questions such as respondents' current position/title in a firm/company where they work, organization type, experience in the construction industry, and finally their experience in the risk management field. In Part 2 of the questionnaire, there was a question about respondents' controllability level on a risk factor followed by four risk rating scenarios, where a risk checklist containing nineteen (19) risk factors was utilized for all four risk scenarios and the risk controllability level section. The risk checklist was borrowed from the research paper of Dikmen et al. (2007a) in which they had identified and modeled the risks using influence diagrams. As mentioned, Dikmen et al. (2007a) have been used influence diagramming method together with fuzzy risk assessment approach for the cost overrun risk ratings in the international construction projects in order to determine a project's overall risk level at an early phase. The proposed methodology has also been applied to a foreign company's project in Turkey being as an international project for the company. In this methodology, two separate influence diagrams are presented named such as country and project risks where seven (7) risk factors are identified having influence on the country risk, and twelve (12) risk factors having influence on the project risk. All these nineteen (19) risk factors affect cost overrun in the international construction projects. Anyhow, in this research, all these risks in our questionnaire are presented as having impact on the cost, schedule, quality, and overall scope of a project, which are listed in the Table 3.1. The risk factors 1 to 7 in the list are country relevant risks, and the remaining risk factors (8 to 19) are project relevant risks.

Table 3.1: Risk Checklist for the Risk Controllability Level and the Four Risk Scenarios

No.	Risk Description	Risk Ratings (1-5)
1	Poor international relations	
2	Instability of political condition	
3	Poor attitude towards foreign companies	
4	Poor macroeconomic conditions	
5	Immaturity of legal system	
6	Societal conflict	
7	Cultural/Religious differences	
8	Vagueness of construction techniques/methods	
9	Complexity (technical and managerial)	
10	Unavailability of resources	
11	Poor planning	
12	Vagueness of scope	
13	Design errors	
14	Unavailability of funds	
15	Delay in payments	
16	Attitude of client	
17	Inexperience of client	
18	Unavailability of subcontractors	
19	Poor performance of subcontractors	

The aim for the controllability risk ratings in Part 2 was to find out that how a decision-maker assumes the controllability level for a risk factor. Also, to see that how this controllability affects the risk ratings with respect to magnitude of risk in the different risk scenarios, or how the assumptions about controllability change according to the magnitude or level of risk during risk assessment process in international construction projects. The respondents were then asked to assign the risk ratings for the four different risk scenarios after they assign ratings to the controllability section. The four risk scenarios were designed based on the project and country risk level, where the first scenario was formed as a case of a project with high complexity (high risk) in a high risky country, the second scenario was formed as a case of a project with low complexity (low risk) in a high risky country, the third scenario was formed as a case of a project with high complexity (high risk) in a low risky country, and the fourth scenario was formed as a case of a project with low complexity (low risk) in a low risky country. This is also important to mention that all four risk scenarios were arranged to represent an international project case. All the four risk scenario cases are presented in Table 3.2.

Table 3.2: Arrangement of Four Risk Scenarios

Risk Scenarios	Project Risk Level (Complexity)	Country Risk Level
1st Risk Scenario	High	High
2nd Risk Scenario	Low	High
3rd Risk Scenario	High	Low
4th Risk Scenario	Low	Low

In addition to above risk scenarios design, respondents were asked to evaluate the risk level of a project in each scenario depending on their own perception toward that specific case marking them as low, medium, or high level of risk.

Table 3.3a: Legend for Risk Ratings

Legend for Risk Ratings	
Very low impact	1
Low impact	2
Medium impact	3
High impact	4
Very high impact	5

Table 3.3b: Legend for Controllability Ratings

Legend for Controllability Ratings	
Fully uncontrollable	1
Partially controllable	2
Fully controllable	3

The controllability ratings were considered to range between 1 and 3 rating scale, and the four risk scenario ratings were considered to range between 1 and 5 ratings scale. The legends for the risk ratings and controllability ratings were explained to the respondents as shown in the above Tables 3.3a and 3.3b in order to help them for selecting their choices from the existing legends and assign the risk ratings accordingly using their subjective judgment. After all the risk ratings are assigned in Part 2 of the questionnaire, the Mean, Standard Deviation (SD), and

Coefficient Of Variation (COV) of each risk in each risk scenario will be calculated. The risk factors with highest or lowest Mean ratings, SD, and COV in each risk scenario will be considered for some further analyses and comparisons. These comparisons will then help us to discuss some important points about respondents' attitudes toward risk and their assumptions about risk controllability. Some cases and evidence will be acquired to show the importance of risk attitude and controllability as a two important factors that may affect the risk ratings. Some statistical correlations will be then tested among the risk attitude, controllability, and the four risk scenarios, which will be used for the validation of research hypotheses.

As the pre-defined risk checklist was adopted from Dikmen et al. (2007a), which was used for the purpose of cost overrun in the international construction projects, this list is used here for the purpose of having impact on the cost, time, quality, and overall scope a project. Therefore, a brief explanation is provided below to each risk factor so that no confusion remains about these factors as being the causes of affecting the objectives of a project.

1. **Poor international relations:** When a country has weak relations with other countries in term of trade and alliance, it may have some effects on the projects that are being implemented in that country. Because there might be some financial problems regarding money transfers, and having problems in custom for importing project materials to country, which will have impact on the cost overrun and delay of a project.
2. **Instability of political conditions:** If the political situation is not stable in a country like the presence of riots and strikers, fighting, and no strong legal system, it will have a direct effect on the project objectives.
3. **Poor attitude towards foreign companies:** When the foreign companies are required to comply with the rules such as strict requirements for paying tax, obtaining work permit, import and export of goods and materials, special residency permit, and requirement for local partners in a country, it may affect the quality and overall scope of the project.
4. **Poor macroeconomic conditions:** The economic condition in a country is the most important factor for the financial aspects to a company. If the foreign exchange rates are unstable, or if there is a high level of inflation, it

may result cost overruns, and which may affect the overall objective of the project.

5. **Immaturity of legal system:** Existence of no independent judiciary, high level of changes in law, weakness in the legal system, these all will have impacts on the project objectives such as time, cost, quality, and scope.
6. **Societal conflict:** Occurrence of civil war, protests and demonstrations, gender inequality, and racial inequality are the factors that may affect the project.
7. **Cultural/Religious differences:** When the people of a country are sensitive to difference in the cultures and religions, it will be very difficult for a company to implement the project eliminating this kind of risk. Because different type of expertise with different cultures and religions might be required in order to do the job. Thus, it will be a risk factor that may affect the objectives of the project.
8. **Vagueness of construction techniques/methods:** The definitions of methods to be applied in an unclear way may also result in poor quality, delay, and cost overrun in a project.
9. **Complexity (technical and managerial):** The difficulties that arise from technical and managerial point of views in a project are counted to have impact on the project objectives. Technical complexity can be that how to take the steps in sequence to construct the footings for a special plant with a unique production. The managerial complexity in this case means that how to plan it and assign a team that has experience in this type of complex construction.
10. **Unavailability of resources:** If there is the shortage of project resources such as machinery, manpower, material, and money, the project will face difficulties that may result in cost overrun and delay because the import of these resources from outside of the country will take more time and require extra costs.
11. **Poor planning:** Planning the project activities in way that might take more or less time that what is planned is an example of the poor planning.
12. **Vagueness of scope:** When the scope of the project is not clear and well defined will also result in delay and cost overrun.

13. **Design errors:** Mistakes in dimensions and quantities may result to redo some works, which will have impact on quality, cost, and schedule of a project.
14. **Unavailability of funds:** Difficulty in getting loans from banks may be a serious impact on the cost overruns and delays.
15. **Delay in payments:** The duration in which client is providing the payments for the job done may get longer than what is aimed by the contractor. Therefore, contractor may face some difficulties for the further job implementation until he receives the payment. This payment delay may cause to affect project objectives.
16. **Attitude of client:** The way that how the client behave is also important for a contractor. The change in behavior of the client may have impact on the project.
17. **Inexperience of client:** When the client does not have experience, it will be difficult to work with him because some difficulties might arise that may affect the project objectives.
18. **Unavailability of subcontractor:** The unavailability of skilled and experience subcontractors have impact on the quality, schedule, and cost of a project.
19. **Poor performance of subcontractors:** When subcontractors are performing low quality job because of their poor skills, the overall project objectives will be affected.

In the last part of the questionnaire, which is Part 3, a risk attitude measurement scenario is put in place so that to capture respondents' attitudes toward risk whether they have risk averse, risk neutral, or risk seeking attitudes. In this section of the questionnaire, a very simple example of a coin flipping game is offered to respondents in order that everyone can understand it easily, and to provide correct answers based on the attitudes they have toward risk. In this game, a coin will be flipped, if the coin comes heads, the participant will get $100, and if the coin comes tails, the participant will get $0 means nothing. The important point here is to mention that this coin flipping game is just for once and it is not a continuous game, the game will be stopped after one flip. What respondents are asked is to choose the minimum certain amount of money they would accept to leave the game for. The following options of money are presented to the respondents in the following Table 3.4 for selecting their choices. The Expected Monetary Value (EMV) for this game is \$50, as EMV = 100 x 0.50 + 0 x 0.50 = 50. Therefore, it is aimed that if a respondent selects \$50, he or she will has a risk neutral attitude, if selects less than \$50, a risk averse attitude, and if selects more than \$50, will has risk seeking attitude.

Table 3.4: Table for the Certain Amount of Money Selection

<\$10	
\$10	
\$20	
\$30	
\$40	
\$50	
\$60	
\$70	
\$80	
\$90	
>\$90	

After determining the risk attitude of a respondent, the significant Mean, SD, and COV of respondents in each risk scenario will be compared with risk attitudes of the related respondent to see the effects of risk attitude on the risk ratings that they have already assigned.

To avoid confusions, the risk rating scenarios in Part 2 of the questionnaire are organized having just one column for the ratings instead of two columns, which is used as a conventional method for the P-I ratings. The reason for providing just one column for both probability and impact ratings is not to quantify and evaluate the risks but to study the variance and causes of the risk ratings that change with respect to two factors namely risk attitude and the assumptions about the illusion of controllability of decision-makers. Therefore, the respondents are asked to assign their risk ratings considering both probability of occurrence of a risk event and its impact on the project objectives so that to examine how controllability and risk attitude affect their ratings. This is very important to state that the questionnaire was prepared and designed in a very simple and attractive way in order that every respondent can understand and answer each question. A complete format of the questionnaire can be found in Appendix A.

3.3. Questionnaire Distribution and Collection

The questionnaire was sent in the electronic form in E-mail to a total of 202 intended respondents. The target respondents of this questionnaire were the professionals working in the construction industry and the academics as well. One E-mail was sent to 190 practitioners where most of them working in the Turkish construction industry involved in international construction projects, and some other professionals working in International Companies and Organizations inside and outside of Turkey. Another E-mail was sent to 12 graduate students of the Middle East Technical University (METU) who were involved in the construction management studies. The questionnaires were sent out in mid March 2014 and the respondents were given a one-month time to return their responses. In return and with a two follow-up E-mails, a total of 81 useable responses were received making a total of 40.1 % response rate of the survey which is an acceptable response rate in E-mailing questionnaire survey as per the assertion of Moser and Kalton (1972).

3.4. Data Entry Process

The Statistical Package for Social Sciences (SPSS) Desktop Version 22.0 software was used for the questionnaire data analysis. All the collected data were entered into SPSS in a specific way so that the software can read and analyze the data. After all the value labels were assigned to each variable, the coded data were then entered into the SPSS Data editor table.

3.5. Methodology for the Data Analysis

The data analysis process is divided into three steps so that to manage the data and use it for the required results in a better way. The data analysis was the product of two SPSS data files and an Excel file, where the data entry to the first data file was carried out directly from the questionnaire, and the data entry to the second data file was carried out via an Excel file. The analysis methods performed in each step will be explained in details in the following steps.

1. 1st Step of Data Analysis

After entering the questionnaire data into SPSS, the first step for the data analysis was to acquire some basic statistics about respondents such as respondents' organization type, experience in the construction industry, experience in the risk management field, and their attitudes toward risk. The statistics about risk levels that respondents had chosen for the four risk scenarios were also obtained in the first step of the data analysis.

2. 2nd Step of Data Analysis

In the second step of the data analysis, risk factors in each risk scenario and in controllability section were ranked with respect to their Mean ratings so that to see their rankings in different risk scenarios, compare them with each other, and observe that how the assumptions of decision-makers about risk controllability affect these ratings or these rankings. Studying the effects of decision-makers' risk attitudes on the risk ratings will be another task in this step as well. Some cases with evidence will be presented for supporting the thesis hypotheses. Therefore, all the nineteen (19) risk factors from the risk controllability and four risk scenario sections were aimed for rankings with respect to their Mean ratings as shown in the Appendix C with another summarized table shown in Table 4.1. This is also important to mention that the data analysis in the first and second steps was performed from the first data file.

3. 3rd Step of Data Analysis

The third step of the data analysis was taken for the purpose of correlation test among the six variables such as controllability level of risk, first risk scenario, second risk scenario, third risk scenario, fourth risk scenario, and the risk attitude. Taking into account that all these variables are categorical (ordinal and nominal), a Spearman's Rank Correlation Coefficient or Spearman's rho test was performed to discover the strength of link between the pairs of variables. This is to remind that before performing Spearman's rho test, the relationships were checked through scatter plot diagrams confirming the relationships for further correlation testing. Spearman's rho test is considered as an appropriate analysis for the non-parametric tests and for the strength of association between a pair of random variables as per Schmid and Schmidt (2007). The numerical value for Spearman's rho ranges from +1.0 to -1.0, and in general, correlation coefficient or $r > 0$ represents a positive relationship and $r < 0$ represents a negative relationship between pairs of variables. For Spearman's rho test, the level of significance or alpha was set to 5%, which means that the null hypothesis will be rejected at the p-value smaller than or equal to 0.05 ($p \leq 0.05$). The following statistical formula represents Spearman's rho or Spearman's Rank Correlation Coefficient.

$$r_s = 1 - \frac{6\sum d_i^2}{n(n^2 - 1)}$$

In above formula, r represents Spearman's rho, 6 is a constant number, d represents the ranks, and n represents the number of data pairs.

The results of data analysis are discussed in the next chapter.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1. Results of the 1st Step Data Analysis

In the first step of the data analysis, the following statistical results were obtained about respondents' organization type, experience in the construction industry, experience in the risk management field, level of risk in the different risk scenarios, controllability level of risk, and their attitudes toward risk. All the statistical results are presented in the following Figures 4.1, 4.2, 4.3, 4.4, and 4.5.

Statistics

Organization Type

N	Valid	81
	Missing	0

Organization Type

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Client	7	8.6	8.6	8.6
	Contractor	51	63.0	63.0	71.6
	Consultant	12	14.8	14.8	86.4
	Other	4	4.9	4.9	91.4
	Academic	7	8.6	8.6	100.0
	Total	81	100.0	100.0	

Figure 4.1: Statistics about Respondents' Organization Type

Organization Type: The results in the above Figure 4.1 show that 63% of the respondents are Contractors and 15% of them are Consultants, which make a major part of the respondents. Hence, we can understand that the major part of the results is based on contractors' perspectives about the risk ratings.

The following Figure 4.2 presents statistics about respondents' experience in the construction industry and in the risk management field.

Statistics

		Experience in Construction Industry	Experience in Risk Management Field
N	Valid	81	81
	Missing	0	0

Frequency Table

Experience in Construction Industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 5 years	17	21.0	21.0	21.0
	5 to 10 years	28	34.6	34.6	55.6
	11 to 15 years	13	16.0	16.0	71.6
	More than 15 years	23	28.4	28.4	100.0
	Total	81	100.0	100.0	

Experience in Risk Management Field

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low/Limited	31	38.3	38.3	38.3
	Medium	38	46.9	46.9	85.2
	High	12	14.8	14.8	100.0
	Total	81	100.0	100.0	

Figure 4.2: A Statistical Illustration about Respondents' Experience in Both Construction and Risk Management Fields

Experience in the Construction Industry: Respondents' experience in the construction industry is another factor that can affect the quality and validity of the questionnaire data. The statistics about the received data in the above Figure 4.2

show that 34.6% have 5 to 10 years of experience, 28.4% more than 15 years, and 16% of the respondents have 11 to 15 years of experience in the construction industry respectively. Adding these three figures up, it makes a 79% of the whole respondents, which give us the impression that there is no problem with the quality of the responses as the respondents have reasonable experience. The remaining 21% of the respondents have experience of less than 5 years from which, half of them are the graduate students. It can be concluded that experience of respondents in the construction sector is medium-high as far as almost 35% of the respondents have 5-10 years, and almost 45% have more than 10 years of experience respectively.

Experience in the Risk Management Field: Respondents were asked to specify their level of experience in the risk management field in terms such as low/limited, medium, or high. Thus, the obtained results in the above Figure 4.2 are based on these three levels of experience in the risk management field. In the results, it can be noticed that 47% have a medium level of experience, 38% Low/limited, and 15% high level of experience in the risk management field respectively. If we add the figures up for the medium and high experience levels, it will give us 62%, which can be considered as a sensible figure for the data validity. We can finally say that experience in risk management is low-medium as far as 38% of the respondents have low/limited, and about 47% have medium level experience in the risk management field respectively.

The results acquired for the risk levels that respondents have specified for the different risk scenarios are for the purpose of observing the percentage of overall level of the risk in a risk scenario as shown in the following Figure 4.3

Frequencies

Statistics

		First Scenario Risk Level	Second Scenario Risk Level	Third Scenario Risk Level	Fourth Scenario Risk Level
N	Valid	81	81	81	81
	Missing	0	0	0	0

Frequency Table

First Scenario Risk Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Medium Level Risk	8	9.9	9.9	9.9
	High Level Risk	73	90.1	90.1	100.0
	Total	81	100.0	100.0	

Second Scenario Risk Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low Level Risk	3	3.7	3.7	3.7
	Medium Level Risk	49	60.5	60.5	64.2
	High Level Risk	29	35.8	35.8	100.0
	Total	81	100.0	100.0	

Third Scenario Risk Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low Level Risk	20	24.7	24.7	24.7
	Medium Level Risk	57	70.4	70.4	95.1
	High Level Risk	4	4.9	4.9	100.0
	Total	81	100.0	100.0	

Fourth Scenario Risk Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low Level Risk	77	95.1	95.1	95.1
	Medium Level Risk	4	4.9	4.9	100.0
	Total	81	100.0	100.0	

Figure 4.3: Statistics about Respondents' Level of Risk in Different Risk Scenarios

Level of Risk in Different Risk Scenarios: Respondents have chosen the level of risk in different risk scenarios based on their own perceptions or based on the attitudes they have toward risk. Three different options for choosing the risk level were offered to the respondents such as low, medium, and high level of risk in each scenario. The results in the first risk scenario in the above Figure 4.3 indicate that 90% of the respondents have chosen this scenario as high level risk, and 10% of them have chosen it as medium level risk. This scenario was designed as a circumstance of high risky project in a high risky country. However, 10% of the respondents have marked it as a medium level risk, which can be inferred that their attitudes may have affected their decisions about the risk level. The second scenario was designed as a circumstance of low risky project in a high risky country. In this scenario, 60.5% of the respondents have marked it as medium level risk, 35.8% high level risk, and 3.7% have marked it as low level risk. Here we can notice a considerable difference where most of the respondents have marked it as medium level, but some of them have marked it as high level, which conveys the message that the magnitude of risk is related with the decision-makers' attitudes toward risk. It also indicates that the decision-makers are more sensitive to the risk level of a country rather than the risk level of the project itself. The third scenario was designed as a situation of high risky project in a low risky country. Again, we can notice some differences as 70.4% of the respondents have chosen it as medium level risk, 24.7% have chosen it as low level risk, and just 4.9% have chosen it as high level risk. The fourth scenario was designed as a low risky project in a low risky country situation. Therefore, it was easy for the respondents to mark their choice, where 95% of them have chosen it as a low level and risk and just 5% have chosen it as medium level of risk.

It was also important to obtain the statistics about risk controllability assumptions that respondents have. The reason for acquiring this data was to compare the difference in risk ratings for different risk scenarios with the controllability level of the respondents. This data will also help us for the hypothesis test.

Controllability Level of Risk

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fully Uncontrollable	1	1.2	1.2	1.2
	1.26	1	1.2	1.2	2.5
	1.47	1	1.2	1.2	3.7
	1.53	1	1.2	1.2	4.9
	1.63	3	3.7	3.7	8.6
	1.68	2	2.5	2.5	11.1
	1.74	7	8.6	8.6	19.8
	1.79	7	8.6	8.6	28.4
	1.84	5	6.2	6.2	34.6
	1.89	4	4.9	4.9	39.5
	1.95	9	11.1	11.1	50.6
	Partially Controllable	12	14.8	14.8	65.4
	2.05	5	6.2	6.2	71.6
	2.11	6	7.4	7.4	79.0
	2.16	4	4.9	4.9	84.0
	2.21	2	2.5	2.5	86.4
	2.26	5	6.2	6.2	92.6
	2.32	3	3.7	3.7	96.3
	2.37	1	1.2	1.2	97.5
	2.42	1	1.2	1.2	98.8
	2.84	1	1.2	1.2	100.0
	Total	81	100.0	100.0	

Figure 4.4: Statistics about Respondents' Level of Risk Controllability for Risk Factors

Controllability Level of Risk: In this question, the respondents were asked to assign ratings of 1 to 3 that represented assumptions about controllability level of a respondent for a risk factor as the rating of 1 represented fully uncontrollable, 2 represented partially controllable, and 3 represented fully controllable assumption about a risk factor. The results in the above Figure 4.4 show that 51% of the respondents have showed the assumptions about risk controllability that ranges from Fully Uncontrollable to Partially Controllable means between 1 and 2. 49% of the respondents on the other hand, have indicated their assumptions about risk controllability that ranges from Partially Controllable to Fully Controllable means between 2 and 3. This big difference about the risk controllability assumptions have a direct effect on the risk scenarios and on the risk ratings in the scenarios, which will be explained later in details in the section 4.2.2.

Finally, the statistics about respondents' risk attitudes were acquired in the 1st step of the data analysis, where the percentages for different type of risk attitudes such as risk averse, risk neutral, and risk seeking were obtained as shown in the following Figure 4.5. These statistics will help us to observe that there is enough number of respondents in each category of risk attitude so that we can validate the research hypothesis stating that the risk attitude measurement scenario in the questionnaire was designed fair enough to catch different risk attitudes of the respondents.

Frequencies

Statistics

Risk Attitude Measurement

N	Valid	81
	Missing	0

Risk Attitude Measurement

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Risk Averse	25	30.9	30.9	30.9
	Risk Neutral	19	23.5	23.5	54.3
	Risk Seeking	37	45.7	45.7	100.0
	Total	81	100.0	100.0	

Figure 4.5: Statistics about Respondents' Attitudes toward Risk

Risk Attitude Measurement: The attitudes toward risk of the respondents were measured via a scenario and the acquired results are shown in the above Figure 4.5. As there exist three kinds of risk attitudes such as risk averse, risk neutral, and risk seeking/lover attitude generally, our results are also based on these three types of risk attitudes. Looking to the results, we can notice that we have the respondents with all risk attitude types as 30.9% of the respondents are risk averse, 23.4% risk neutral, and 45.7% are risk seeking individuals. Having reasonable numbers of respondents in each category of the risk attitude, the data can be counted logical for its validity.

The effects of these different types of risk attitudes on the risk ratings in different risk scenarios will be explained in details in the section 4.2.1.

4.2. Results of the 2nd Step Data Analysis

In the second step of the data analysis, all the nineteen (19) risk factors were ranked with respect to their Mean ratings in each risk scenario as shown in below Table 4.1. In addition to Mean ratings, the SD and COV for each risk factor is calculated as well in order to help the results in some cases where required. This table is a summary of the original results that were obtained from SPSS as shown in Appendix C. The results show that in all four risk scenarios, the risk factors #14 and #15 (Unavailability of funds and Delay in payments) from the original risk checklist of the questionnaire have taken the top two positions in terms of their Mean rankings in each scenario with an exception in the third risk scenario where the risk factor #15 has 3rd position, but with a very small difference of 0.04 with the risk factors ranked in the 2nd position. Still, being at the top positions, the Mean ratings of these risk factors changes from one risk scenario to another one, e.g. the mean ratings for the top two risk factors (Unavailability of funds and Delay in payments) in the first risk scenario are 4.19 and 3.96, in the second risk scenario 3.86 and 3.80, in the third risk scenario 3.57 and 3.47, and in the fourth risk scenario, 3.17 and 3.02 respectively.

The risk factors #2 and #5 (Instability of political condition and Immaturity of legal system) from the original risk checklist of the questionnaire have taken the highest positions in the first and second risk scenarios after risk #14 and #15. The risk factor #11 (Poor planning) is another factor that has taken 2nd position in the third risk scenario and 3rd position in the fourth risk scenario with respect to its Mean rating in the rankings. The rest of the risk factors have different rankings in terms of their Mean ratings in the different risk scenarios as indicated in the following Table 4.1. Which means that the rankings change with respect to risk scenarios except for those few factors as explained above.

This is clearly understandable that the risk attitudes and illusion of risk controllability of respondents change with respect to risk magnitude in different risk scenarios. Therefore, the risk ratings also change as decision-makers' take their attitudes toward risk and assumptions about risk controllability into account in the ratings. Consequently, we can say that these two factors (risk attitude and illusion of controllability) are the causes of variance in the risk ratings.

Table 4.1: Risk Factors Ranking in Different Risk Scenarios with Respect to Mean Ratings

Risk Factors Rankings with Respect to Mean Ratings in Different Risk Scenarios											
1st Risk Scenario (High-High)						2nd Risk Scenario (Low-High)					
Ranking with Respect to Mean Ratings	Ranking in the Risk Checklist	Risk Factors	Mean Ratings	SD	COV	Ranking with Respect to Mean Ratings	Ranking in the Risk Checklist	Risk Factors	Mean Ratings	SD	COV
1	14	Unavailability of funds	4,19	1,03	0,25	1	14	Unavailability of funds	3,86	1,06	0,27
2	15	Delay in payments	3,96	1,03	0,26	2	15	Delay in payments	3,80	1,07	0,28
2	2	Instability of political condition	3,96	1,02	0,26	3	2	Instability of political condition	3,67	1,17	0,32
3	5	Immaturity of legal system	3,94	1,07	0,27	4	5	Immaturity of legal system	3,65	1,13	0,31
4	11	Poor planning	3,81	1,03	0,27	5	16	Attitude of client	3,30	1,05	0,32
5	10	Unavailability of resources	3,72	1,00	0,27	6	4	Poor macroeconomic conditions	3,27	1,17	0,36
6	19	Poor performance of subcontractors	3,68	0,97	0,26	7	10	Unavailability of resources	3,23	1,02	0,32
7	13	Design errors	3,64	1,00	0,27	8	19	Poor performance of subcontractors	3,19	0,98	0,31
8	12	Vagueness of scope	3,62	1,06	0,29	9	6	Societal conflict	3,06	1,21	0,40
9	4	Poor macroeconomic conditions	3,52	1,01	0,29	10	18	Unavailability of subcontractors	3,04	0,99	0,33
10	18	Unavailability of subcontractors	3,47	0,96	0,28	11	11	Poor planning	3,02	1,12	0,37
11	16	Attitude of client	3,44	1,06	0,31	12	1	Poor international relations	2,99	1,09	0,36
12	8	Vagueness of construction techniques/methods	3,40	1,09	0,32	12	3	Poor attitude towards foreign companies	2,99	1,07	0,36
13	9	Complexity (technical and managerial)	3,38	0,97	0,29	13	12	Vagueness of scope	2,98	1,05	0,35
14	1	Poor international relations	3,31	0,99	0,30	14	13	Design errors	2,77	0,97	0,35
15	3	Poor attitude towards foreign companies	3,20	1,03	0,32	15	17	Inexperience of client	2,73	1,14	0,42
16	17	Inexperience of client	3,12	1,17	0,38	16	8	Vagueness of construction techniques/methods	2,54	1,04	0,41
17	6	Societal conflict	3,10	1,20	0,39	17	7	Cultural/Religious differences	2,37	0,97	0,41
18	7	Cultural/Religious differences	2,30	0,90	0,39	18	9	Complexity (technical and managerial)	2,32	0,93	0,40
Mean Ratings for the 1st Risk Scenario			**3,51**			**Mean Ratings for the 2nd Risk Scenario**			**3,09**		

Table 4.1: (continued)

Risk Factors Rankings with Respect to Mean Ratings in Different Risk Scenarios											
3rd Risk Scenario (High-Low)						4th Risk Scenario (Low-Low)					
Ranking with Respect to Mean Ratings	Ranking in the Risk Checklist	Risk Factors	Mean Ratings	SD	COV	Ranking with Respect to Mean Ratings	Ranking in the Risk Checklist	Risk Factors	Mean Ratings	SD	COV
1	14	Unavailability of funds	3,57	1,23	0,34	1	14	Unavailability of funds	3,17	1,23	0,39
2	11	Poor planning	3,51	1,15	0,33	2	15	Delay in payments	3,02	1,28	0,42
2	13	Design errors	3,51	1,07	0,30	3	11	Poor planning	2,64	1,13	0,43
3	15	Delay in payments	3,47	1,18	0,34	4	10	Unavailability of resources	2,63	1,02	0,39
4	12	Vagueness of scope	3,37	1,13	0,34	5	12	Vagueness of scope	2,62	1,36	0,52
5	9	Complexity (technical and managerial)	3,33	1,03	0,31	6	19	Poor performance of subcontractors	2,53	1,05	0,42
6	10	Unavailability of resources	3,27	1,01	0,31	7	16	Attitude of client	2,49	1,09	0,44
7	19	Poor performance of subcontractors	3,22	1,07	0,33	8	13	Design errors	2,48	1,01	0,41
8	8	Vagueness of construction techniques/methods	3,11	1,05	0,34	9	5	Immaturity of legal system	2,46	1,15	0,47
9	18	Unavailability of subcontractors	3,09	1,04	0,34	10	18	Unavailability of subcontractors	2,37	1,00	0,42
10	16	Attitude of client	2,95	1,09	0,37	11	4	Poor macroeconomic conditions	2,27	1,03	0,45
11	5	Immaturity of legal system	2,75	1,19	0,43	12	2	Instability of political condition	2,22	1,11	0,50
12	17	Inexperience of client	2,62	1,00	0,38	13	6	Societal conflict	2,21	1,05	0,48
13	2	Instability of political condition	2,56	1,14	0,45	14	8	Vagueness of construction techniques/methods	2,19	0,90	0,41
14	4	Poor macroeconomic conditions	2,53	1,03	0,41	15	9	Complexity (technical and managerial)	2,15	0,92	0,43
15	6	Societal conflict	2,36	1,05	0,44	16	17	Inexperience of client	2,11	0,91	0,43
16	3	Poor attitude towards foreign companies	2,35	0,99	0,42	17	3	Poor attitude towards foreign companies	2,04	0,98	0,48
17	1	Poor international relations	2,28	1,00	0,44	18	1	Poor international relations	1,84	0,87	0,47
18	7	Cultural/Religious differences	1,86	0,90	0,48	19	7	Cultural/Religious differences	1,72	0,76	0,44
Mean Ratings for the 3rd Risk Scenario			2,93			Mean Ratings for the 4th Risk Scenario			2,38		

4.2.1. Risk Attitude As a Parameter for Risk Ratings

This section will present some cases and facts about the effects of risk attitudes on the risk ratings with some examples that were obtained from the survey data analysis. As we had 25, 19, and 37 respondents for the risk averse, risk neutral, and risk seeking attitudes respectively, it could be inferred that there exist reasonable number of respondents with the different attitudes toward risk. Therefore, we were interested in some special cases in order that we could compare the risk ratings with regard to different types of risk attitudes in the same risk scenarios whether we could set the risk attitude as a parameter for the risk ratings or not.

Case 1: The highest and lowest Mean ratings for each type of risk attitude in the same risk scenario were identified in this case. The purpose of finding this kind of cases was to differentiate the risk attitudes based on the ratings. Also, to observe the impact of different risk attitudes on the ratings whether these ratings change with respect to risk attitudes or not. Thus, these cases are identified in the data analysis and are summarized in the following Figure 4.6.

Cases	1st Risk Scenario	2nd Risk Scenario	3rd Risk Scenario	4th Risk Scenario	Attitude Towards Risk
Highest Mean Ratings	4.58	4.47	4.00	4.05	Risk Averse
Lowest Mean Ratings	2.84	2.74	2.32	1.85	Risk Averse
Highest Mean Ratings	4.16	3.68	3.84	3.42	Risk Neutral
Lowest Mean Ratings	2.58	2.26	2.11	1.42	Risk Neutral
Highest Mean Ratings	4.37	4.05	4.00	4.00	Risk Seeking
Lowest Mean Ratings	1.53	1.37	1.26	1.00	Risk Seeking

Figure 4.6: Cases for the Highest and Lowest Mean Ratings with Respect to Risk Attitude

No significant difference can be noticed between the highest mean ratings of respondents with the risk averse and risk seeking attitudes in the above figure. However, a clear difference exists between risk averse and risk seeking attitudes in the lowest mean ratings. The lowest Mean ratings of the respondents with risk neutral attitudes are situated in between lowest Mean ratings of risk averse and risk seeking respondents (greater than risk seeking, and smaller than risk averse Mean ratings). An example is also provided regarding above case comparing the risk ratings of a risk averse, risk neutral, and a risk seeking respondent in a same risk scenario.

Example: A risk averse respondent has assigned ratings of 5 for the risk factors #2, 5, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18 and 19 with a Mean rating of 4.47 in the second risk scenario. A risk neutral respondent has assigned ratings to the same risk factors such as 4, 5, 3, 3 , 4, 4, 3, 3, 4, 4, 3, 4, and 3 respectively with a Mean rating of 3.68. A risk seeking respondent on the other hand, has assigned quite different ratings to the same risk factors in the same risk scenario, which is the 2nd risk scenario. This respondent has assigned ratings of 5, 5, 5, 3, 3, 3, 3, 3, 5, 3, 3, 5, and 5 to the same risk factors respectively with a Mean rating of 4.05. The following Figure 4.7 is a summary of the above example to clarify the difference in the risk ratings.

Respondents	**Scenario**	**R.F. #2**	**R.F. #5**	**R.F. #8**	**R.F. #10**	**R.F. #11**	**R.F. #12**	**R.F. #13**	**R.F. #14**	**R.F. #15**	**R.F. #16**	**R.F. #17**	**R.F. #18**	**R.F. #19**
Risk Averse Respondent	2nd	5	5	5	5	5	5	5	5	5	5	5	5	5
Risk Neutral Respondent	2nd	4	5	3	3	4	4	3	3	4	4	3	4	3
Risk Seeking Respondent	2nd	5	5	5	3	3	3	3	3	5	3	3	5	5

Figure 4.7: Difference Between Respondents' Ratings with Different Risk Attitudes

Case 2: The aim of results in this case are to support the research hypothesis about risk attitude being as a factor that may affect the risk ratings that decision-makers assign to risks during risk assessment. Hence, the Mean risk ratings of all respondents from the three risk attitude categories in each risk scenario were acquired. The results helped us to observe the difference in the overall Mean ratings for each risk scenario in the different categories of risk attitudes. Interpreting the results as shown the below Figure 4.8, the survey could differentiate among all risk attitudes. And it can be clearly noticed that the risk ratings vary with respect to risk attitudes of decision-makers, which is in support of the research hypothesis about the risk attitude being as a factor affecting the risk ratings.

Cases	1st Risk Scenario	2nd Risk Scenario	3rd Risk Scenario	4th Risk Scenario	Attitude Towards Risk
Mean Ratings for the Entire Risk Averse Respondents	3.90	3.49	3.13	2.72	Risk Averse
Mean Ratings for the Entire Risk Neutral Respondents	3.35	3.01	2.98	2.40	Risk Neutral
Mean Ratings for the Entire Risk Seeking Respondents	3.37	2.86	2.71	2.13	Risk Seeking

Figure 4.8: Comparison of the Entire Mean Ratings in Each Risk Scenario with Respect to Risk Attitude

Case 3: The results from the 1st risk scenario are compared with the results in the 4th risk scenario in this case as shown in Table 4.2. 1st scenario was assumed as a case of high risky project in a high risky country, the 4th scenario was assumed as a case of low risky project in a low risky country. Studying results in this case will also help to support the research hypothesis about the effects of respondents' risk attitudes on the risk rankings under risky situations. If we see the Mean ratings of all risk factors in the 1st risk scenario, they are 3.51, and the Mean ratings of all risk factors in the 4th risk scenario are 2.38. In addition to the difference that exists between the Mean ratings of these two scenarios, the rankings of the risk factors also differs with respect to Mean ratings except for the risk factors #14, 15, and 7. The cause of the rating distance that exists between the 1st and the 4th risk scenario is due to the change in the risk scenarios because decision-makers are assigning the ratings based on the risk level of the project. However, the rankings that are changing in these scenarios are related to the respondents' risk attitude. The difference between ratings can be explained by other factors such as ''lack of information'' or ''level of experience'', but the difference in rankings may be due to the ''illusion of controllability'' and ''risk attitude'' because the illusion of controllability changes according to nature of the risk criteria, and risk attitude changes according to risk scenarios. Therefore, the factors that cause the difference in rankings and difference in ratings should be realized, as they are separate factors from each other.

Table 4.2: Comparison of the Mean Ratings between 1st and 4th Risk Scenarios

Comparison of 1st Risk Scenario with the 4th Risk Scenario							
1st Risk Scenario (High Risky Project-High Risky Country)				4th Risk Scenario (Low Risky Project-Low Risky Project)			
Ranking with Respect to Mean Ratings	Ranking in the Risk Checklist	Risk Factors	Mean Ratings	Ranking with Respect to Mean Ratings	Ranking in the Risk Checklist	Risk Factors	Mean Ratings
1	14	Unavailability of funds	4,19	1	14	Unavailability of funds	3,17
2	15	Delay in payments	3,96	2	15	Delay in payments	3,02
2	2	Instability of political condition	3,96	3	11	Poor planning	2,64
3	5	Immaturity of legal system	3,94	4	10	Unavailability of resources	2,63
4	11	Poor planning	3,81	5	12	Vagueness of scope	2,62
5	10	Unavailability of resources	3,72	6	19	Poor performance of subcontractors	2,53
6	19	Poor performance of subcontractors	3,68	7	16	Attitude of client	2,49
7	13	Design errors	3,64	8	13	Design errors	2,48
8	12	Vagueness of scope	3,62	9	5	Immaturity of legal system	2,46
9	4	Poor macroeconomic conditions	3,52	10	18	Unavailability of subcontractors	2,37
10	18	Unavailability of subcontractors	3,47	11	4	Poor macroeconomic conditions	2,27
11	16	Attitude of client	3,44	12	2	Instability of political condition	2,22
12	8	Vagueness of construction techniques/methods	3,40	13	6	Societal conflict	2,21
13	9	Complexity (technical and managerial)	3,38	14	8	Vagueness of construction techniques/methods	2,19
14	1	Poor international relations	3,31	15	9	Complexity (technical and managerial)	2,15
15	3	Poor attitude towards foreign companies	3,20	16	17	Inexperience of client	2,11
16	17	Inexperience of client	3,12	17	3	Poor attitude towards foreign companies	2,04
17	6	Societal conflict	3,10	18	1	Poor international relations	1,84
18	7	Cultural/Religious differences	2,30	19	7	Cultural/Religious differences	1,72
Mean Ratings for the 1st Risk Scenario			3,51	Mean Ratings for the 4th Risk Scenario			2,38

4.2.2. Controllability As a Parameter for Risk Ratings

The cases in this section are related with the effects of assumptions about controllability on the risk ratings in different risk scenarios.

Case 1: Two cases, one for the second highest and second one for the second lowest Mean ratings of the risk controllability level were identified to prove the research hypothesis stating that controllability is a hidden factor that may affect the risk ratings, which are being assigned by decision-makers during risk assessment process. The reason for not considering the highest and lowest Mean ratings was that the ratings in these cases were not logical as the respondent with the highest Mean ratings had assigned ratings of 3 to all risk factors except for three factors, and the respondent with the lowest Mean ratings had assigned ratings of 1 to all risk factors. Therefore, an example representing second highest and second lowest Mean ratings is presented here from the results that were acquired during the survey data analysis.

Example: The results in below Table 4.3 show that two respondents have assigned quite different ratings to the same risk factors depending on their assumptions about risk controllability. The Mean ratings that these two respondents have assigned to the risk factors in each risk scenario is the important part to be explained as indicated in Figure 4.9. The respondent with a higher level of controllability has assigned lower risk ratings, and the respondent with a lower controllability has assigned higher risk ratings. Thus, it is evident that assumptions about risk controllability affect the risk ratings, which supports the truth about the research hypothesis about controllability assumptions.

Table 4.3: Cases of Highest and Lowest Mean Ratings for Controllability

Risk Factors	Respondent A's Ratings	Respondent B's Ratings
1	3	2
2	1	1
3	2	2
4	1	1
5	1	1
6	2	1
7	2	1
8	3	2
9	3	1
10	3	1
11	3	2
12	3	1
13	3	1
14	3	1
15	3	1
16	3	1
17	3	1
18	3	1
19	3	2
Mean Ratings	**2,53**	**1,26**

Cases	Controllability	1st Risk Scenario	2nd Risk Scenario	3rd Risk Scenario	4th Risk Scenario
Highest Mean Ratings for Controllability	2.53	3.63	2.79	2.42	1.84
Lowest Mean Ratings for Controllability	1.26	4.32	3.90	3.53	2.79

Figure 4.9: Comparison of the Highest and Lowest Controllability Cases

The above Figure 4.9 describes that a respondent with Mean ratings of 2.53 for risk controllability (which is between Partially and Fully Controllable state), has assigned Mean ratings of 3.63, 2.97, 2.42, and 1.84 to 1st, 2nd, 3rd, and 4th risk scenarios respectively. On the contrary, another respondent with Mean ratings of 1.26 for risk controllability (which is between Partially and Fully Uncontrollable state), has assigned Mean ratings of 4.32, 3.90, 3.53, and 2.79 to 1st, 2nd, 3rd, and 4th risk scenarios respectively. The difference between Mean ratings in each risk scenario is visible and indicates that these ratings are affected by the assumptions about risks controllability.

Case 2: In this case, the Mean ratings of all respondents about risk controllability assumptions are ranked. The rankings in the following Table 4.4 explain that the project risks are more controllable than the country risks. Risk factors #1, 2, 3, 4, 5, and 6 in the below tale are country risk factors, which are located below the assumptions of a partially controllable level, as their Mean ratings are below 2 (Partially Controllable). Witnessing this case about the risks controllability assumptions, it can be concluded that decision-makers take the country risks more seriously than the project risks in the case of international projects.

Table 4.4: Risk Factors Ranking with Respect to Mean Ratings for Risk Controllability Assumptions

Risk Factors Rankings with Respect to Mean Ratings of Controllability					
Controllability Level of Risk					
Rankings with Respect to Mean Ratings	**Ranking in the Risk Checklist**	**Risk Factors**	**Mean Ratings**	**SD**	**COV**
1	11	Poor planning	2,49	0.71	0,29
2	9	Complexity (technical and managerial)	2,46	0.69	0,28
3	13	Design errors	2,33	0.61	0,26
4	19	Poor performance of subcontractors	2,30	0.60	0,26
5	8	Vagueness of construction techniques/methods	2,26	0.67	0,30
6	16	Attitude of client	2,14	0.63	0,29
7	12	Vagueness of scope	2,09	0.62	0,30
7	18	Unavailability of subcontractors	2,09	0.62	0,30
8	10	Unavailability of resources	2,04	0.64	0,31
9	7	Cultural/Religious differences	2,00	0.65	0,33
9	17	Inexperience of client	2,00	0.73	0,37
10	3	Poor attitude towards foreign companies	1,95	0.50	0,26
11	15	Delay in payments	1,88	0.60	0,32
12	1	Poor international relations	1,86	0.67	0,36
13	14	Unavailability of funds	1,72	0.68	0,40
14	6	Societal conflict	1,69	0.68	0,40
15	4	Poor macroeconomic conditions	1,46	0.57	0,39
16	5	Immaturity of legal system	1,44	0.63	0,44
17	2	Instability of political condition	1,35	0.57	0,42
Mean Rating for the Controllability Level of Risk			**1,98**		

Case 3: Another important case was observed while comparing the Mean ratings of four risk scenarios with the risk controllability ratings. As it was discussed in the section 4.2 that risk factors #14 and 15 (Unavailability of funds and Delay in payments) in all four risk scenarios were at the top positions in terms of their Mean ratings, these two risk factors in the controllability rating part are located in the category of those risks that are below the level of Partially Controllable risk (which means that these factor are between Partially and Fully Uncontrollable state) as shown in the above Table 4.4. Therefore, it can be proved that with a lower level of controllability, the respondents have assigned highest ratings to risks or vice-versa. As a result, we can say that the assumptions about risk controllability can affect decision-makers’ risk rating criteria.

4.3. Results of the 3rd Step Data Analysis

Correlations between each pair of variables are tested in the results obtained from the 3rd step data analysis. Thus, a Spearman's Rank Correlation Coefficient or Spearman's rho test was performed between the pairs of variables with the results that will be explained in this section. According to Cohen and Cohen (1983), the significance of a positive/direct or negative/inverse relationship between two variables is:

Small/Weak: when the correlation coefficient (r) is between 0.1 and 0.3
Moderate/Medium: when r is between 0.3 and 0.5
Strong: when r is between 0.5 and 1

Before going to results that were obtained from Spearman's rho test for correlations, a table that explains statistical characteristics about the Mean, SD, and Variance of risk controllability and all risk scenarios in each category of risk attitude was prepared in order to discuss the two hypotheses of the research. This Table 4.5 is a complete summary of the questionnaire data with statistics about variables in different categories of risk attitudes.

Noticing the Mean ratings for risk controllability in each category of risk attitude, the controllability level increases going towards risk seeking attitude from 1.79 to 2.1. On the other hand, the Mean ratings in each risk scenario decrease going from risk averse toward risk seeking with exception of the 1st risk scenario Mean ratings for risk neutral attitude that are 3.35 (smaller than 3.37 in the same risk scenario for risk seeking attitude). What it means is that with a higher controllability, decision-makers assign lower risk ratings or vice-versa. Decision-makers with different risk attitudes may assign different risk ratings depending on the attitude they have toward risk.

Table 4.5: Summarized Table for the Questionnaire Data with Some Statistics

Risk Attitude		Assumptions about Risk Controllability	1st Scenario Risk Ratings	2nd Scenario Risk Ratings	3rd Scenario Risk Ratings	4th Scenario Risk Ratings
Risk Averse	Mean	1.79	3.90	3.49	3.13	2.72
	SD	0.25	0.40	0.45	0.40	0.57
	Variance	0.06	0.16	0.20	0.16	0.33
Risk Neutral	Mean	1.97	3.35	3.01	2.98	2.40
	SD	0.20	0.47	0.49	0.49	0.61
	Variance	0.04	0.22	0.24	0.24	0.37
Risk Seeking	Mean	2.1	3.37	2.86	2.71	2.13
	SD	0.33	0.64	0.66	0.79	0.73
	Variance	0.11	0.41	0.43	0.63	0.54
Total	Mean	1.97	3.52	3.10	2.91	2.37
	SD	0.31	0.59	0.62	0.65	0.70
	Variance	0.10	0.34	0.38	0.42	0.50

The results from Spearman's correlation test show that there is a moderate or medium positive relationship between risk attitude and risk controllability, as the correlation coefficient (r) between these two variables is 0.461 ($r = +0.461$), which falls into a moderate relationship category even close to strong relationship or 0.5. The significance level at p is smaller than 0.05 ($p < 0.05$). To remind, SPSS shows the values smaller than 0.05 as 0.000, but in reality there will be a number after three or four zeros, like in this case the actual p value is 0.000015, clearly showing a smaller value than 0.05. Thus, we can claim that the relationship is significant at the level of even smaller than 0.01, and the chance or probability that these two variables are not correlated is less than 1% as shown the following Figure 4.10.

			Assumptions About Risk Controllability Level	Risk Attitude
Spearman's rho	Assumptions About Risk Controllability Level	Correlation Coefficient	1.000	0.461**
		Sig. (2-tailed)	.	0.000
		N	81	81
	Risk Attitude	Correlation Coefficient	0.461**	1.000
		Sig. (2-tailed)	0.000	.
		N	81	81

**. Correlation is significant at the 0.01 level (2-tailed)

Figure 4.10: Correlation Between Controllability and Risk Attitude

4.3.1. Hypotheses Testing

In order to test the hypotheses that were proposed in this research, it was important to find the correlations among the variables whether to accept the hypotheses or reject them.

Hypothesis I:

Null Hypothesis: While assigning the risk ratings (using 1-5 scale), decision-makers may assign different ratings regardless of their attitudes toward risk.

Alternative Hypothesis: While assigning the risk ratings (suing 1-5 scale), decision-makers may assign different ratings depending on their attitudes toward risk.

The results from the Spearman's rho or Spearman's correlation coefficient test between risk attitude and each risk scenario in the following Figure 4.11 explains that respondents' risk attitude has a moderate negative or inverse relationship with the first, second, and fourth risk scenarios. Relationship between two variables is moderate when the correlation coefficient (r) is greater than 0.3, which is accepted by Cohen and Cohen (1983). Risk Attitude's relationship with the third risk scenario is in the category of weak negative relationship, which is smaller than -0.3. Negative or inverse relationship explains that increase in one variable will cause decrease in another variable or vice-versa. Here the decrease in risk attitude means risk averse attitude, and increase means going from risk averse towards risk seeking attitude.

			Risk Attitude	1st Risk Scenario	2nd Risk Scenario	3rd Risk Scenario	4th Risk Scenario
Spearman's rho	Risk Attitude	Correlation Coefficient	1.000	-0.372**	-0.422**	-0.262*	-0.380**
		Sig. (2-tailed)	.	0.001	0.000	0.018	0.000
		N	81	81	81	81	81
	1st Risk Scenario	Correlation Coefficient	-0.372**	1.000	0.711**	0.604**	0.454**
		Sig. (2-tailed)	0.001	.	0.000	0.000	0.000
		N	81	81	81	81	81
	2nd Risk Scenario	Correlation Coefficient	-0.422**	0.711**	1.000	0.707**	0.663**
		Sig. (2-tailed)	0.000	0.000	.	0.000	0.000
		N	81	81	81	81	81
	3rd Risk Scenario	Correlation Coefficient	-0.262*	0.604**	0.707**	1.000	0.799**
		Sig. (2-tailed)	0.018	0.000	0.000	.	0.000
		N	81	81	81	81	81
	4th Risk Scenario	Correlation Coefficient	-0.380**	0.454**	0.663**	0.799**	1.000
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	.
		N	81	81	81	81	81

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

Figure 4.11: Correlation of Risk Attitude with Four Risk Scenarios

H_0 (Null Hypothesis): $r = 0$ between risk attitude and risk ratings, which means that the risk ratings do not have any correlation with the risk attitude. The level of significance or alpha was set at 5% (alpha = 0.05).

H_A (Alternative Hypothesis): $r > 0$ or $r < 0$, which means that there will be positive or negative correlation between risk attitude and risk ratings. The level of significance or alpha was set at 5% of confidence (alpha = 0.05).

Testing Results: The results show that there exists a moderate negative or inverse correlation between risk attitude and each risk rating scenario except for the third risk scenario where the correlation is weak negative relationship. And since the p-value in all correlations is smaller than alpha (alpha = 0.05), we can easily reject the null hypothesis and accept the alternative hypothesis.

Hypothesis II:

Null Hypothesis: While assigning the risk ratings (using 1-5 scale), decision-makers may assign different ratings regardless of their assumptions about controllability.

Alternative Hypothesis: While assigning the risk ratings (suing 1-5 scale), decision-makers may assign different ratings depending on their assumptions about controllability.

The correlations of controllability between each risk ratings scenario are in the category of moderate negative or inverse relationship. We cannot see any weak relationship here like we had in the case of risk attitude's relationship with the risk scenarios. The following matrix in Figure 4.12 indicates all the correlations where the correlation coefficient is greater than 0.3 in each case. The p-value in each correlation is smaller than 0.05 ($p < 0.05$).

			Assumptions About Risk Controllability Level	1st Risk Scenari	2nd Risk Scenario	3rd Risk Scenario	4th Risk Scenario
Spearman's rho	Assumptions About Risk Controllability Level	Correlation Coefficient	1.000	-0.445**	-0.452**	-0.423**	-0.447**
		Sig. (2-tailed)	.	0.001	0.000	0.000	0.000
		N	81	81	81	81	81
	1st Risk Scenario	Correlation Coefficient	-0.445**	1.000	0.711**	0.604**	0.454**
		Sig. (2-tailed)	0.000	.	0.000	0.000	0.000
		N	81	81	81	81	81
	2nd Risk Scenario	Correlation Coefficient	-0.452**	0.711**	1.000	0.707**	0.663**
		Sig. (2-tailed)	0.000	0.000	.	0.000	0.000
		N	81	81	81	81	81
	3rd Risk Scenario	Correlation Coefficient	-0.423**	0.604**	0.707**	1.000	0.799**
		Sig. (2-tailed)	0.018	0.000	0.000	.	0.000
		N	81	81	81	81	81
	4th Risk Scenario	Correlation Coefficient	-0.447**	0.454**	0.663**	0.799**	1.000
		Sig. (2-tailed)	0.000	0.000	0.000	0.000	.
		N	81	81	81	81	81

**. Correlation is significant at the 0.01 level (2-tailed)

Figure 4.12: Correlation of Controllability with Four Risk Scenarios

H_0 (Null Hypothesis): $r = 0$ between controllability and risk ratings, which means that the risk ratings do not have any correlation with the assumptions about controllability. The level of significance or alpha was set at 5% (alpha = 0.05).

H_A (Alternative Hypothesis) $r > 0$ or $r < 0$, which means that there will be positive or negative correlation between controllability and risk ratings. The level of significance or alpha was set at 5% of confidence (alpha = 0.05).

Testing Results: The results here also show that there exists a moderate negative or inverse correlation between assumptions about risk controllability and each risk scenario. Since the p-value in all correlations is smaller than alpha (alpha = 0.05), which was proposed by null hypothesis, we can clearly reject the null hypothesis and accept the alternative hypothesis.

4.4. Summary of the Study

Qualitative risk assessment in construction projects is still a dominant and prevalent technique rather than the quantitative risk assessment due to its simplicity, no requirement for much data; it is cost and time efficient as well. The P-I risk matrix/table is the most used technique among the other qualitative risk assessment techniques where subjective judgment and intuition of decision-maker is applied in this technique. Risk assessors usually use a qualitative risk rating scale that ranges from 1 to 5 in P-I risk matrix, which determines the probability of a risk occurring event and the impact of this risk event on the project objectives. The fact behind the different ratings that decision-makers assign to a risk factor during risk assessment process is not revealed explicitly. The findings of this thesis have introduced two important factors that may affect the risk ratings during risk assessment, which are ‘‘attitudes of decision-makers toward risk’’ and ‘‘their assumptions about illusion of controllability’’. However, some researchers have discussed the effects of risk attitude and controllability in some extents but separately from each other, e.g. Akintoye and MacLeod (1997) emphasize on the issue that people’s risk attitude can affect the risk perception, which gives a signal that the risk ratings can be altered by decision-makers with respect to their personal attitudes toward risk. Dikmen et al. (2008), Cox (2008), and Ball and Watt (2013) also confirm the importance of risk attitude that can play a significant role in the process of risk ratings. All the above-mentioned researchers have only explained the effects of individuals’ risk attitudes on risk ratings, but controllability is not discussed in these researches at all. Some other researchers on the other hand have claimed about the effects of controllability on the risk ratings. For example: Dikmen and Birgonul (2006), and Dikmen et al. (2007a) describe the word ‘‘controllability’’ as a covert or implied factor, which is not being used in the calculations for the risk quantification, but it affects the risk ratings that decision-makers assign to risk factors. Likewise, but with a little difference, Keizer et al. (2002) acknowledge the word ‘‘influence’’ as a factor for risks in addition to probability and impact. In another research paper that has been written by Aven et al. (2007), they introduce the notion about the risk ‘‘manageability’’, where they believe that the risk ratings may change depending on how manageable a risk is. In consequence, different individuals with respect to their manageability criteria for that specific risk might assign different ratings. If we consider all these words such as controllability, influence, and manageability, it can be noticed that they are somewhat similar words and represent a common perception about controllability that can be considered as a factor in the risk ratings. Still, these papers do not discuss anything about risk attitudes. Reviewing the literature, it can be realized that some researchers have recognized the effects of risk attitude and controllability on the risk ratings during the risk assessment process. Still, these two factors (risk attitude and controllability) are not mentioned in the literature together in the studies concerning causes of change in the risk ratings during risk assessment. Also, there is no specific research or study to explain the effects of both risk attitude and illusion of controllability on the risk ratings yet, to the best of our knowledge.

This research investigated the effects of ‘‘risk attitude’’ and ‘‘illusion of controllability’’ on the risk ratings using P-I matrices in international construction projects. The study is a reminder for those researchers who is willing to pursue the shortcomings and drawbacks of the P-I risk matrices. More significant factors that may affect the variance in the risk ratings may be founded in addition to the two factors studied in this research.

4.5. Summary of Major Findings

The main achievements of this study are the validation of the research hypotheses confirming that risk attitude and controllability are the two latent but important factors that affect the risk ratings while decision-makers are assigning to risk factors using 1 to 5 scales. The results of this research proved that the risks ratings would vary with reference to decision-makers’ risk attitude and their assumptions about risk controllability.

The findings of this research may help the decision-makers and risk assessors who are involved in the risk assessment exercises to measure risk in international construction projects. The results in this study show that ‘‘risk attitude’’ and ‘‘illusion of controllability’’ are the two significant factors that affect the risk ratings, and the cause of variance in the risk ratings from one individual to another is these two factors. Different decision-makers may assign quite different risk ratings to the same risk factors, which implies that these decision-makers consider some latent factors (may be risk attitude or illusion of controllability) into consideration that causes these differences. Therefore, it is important for decision-makers to think and find a way while designing risk checklists or any other method for risk ratings when the subjective judgment of decision-makers is involved, e.g. while designing risk checklists, make sure that everybody assumes the same level of controllability so that their ratings are compatible, or before asking the decision-makers to assign the risk ratings, measuring their attitudes toward risk can help to categorize individuals of the same risk attitude in one group so that the ratings are compatible. Delphi technique is another solution that can be helpful to be used for measuring risks in a consistent way by different decision-makers. The Delphi technique or method is an interactive and organized technique that is based on the subjective judgment of a panel of experts (Hallowell and Gambatese, 2010). The participants are identified based on the pre-established rules, but with an anonymous participation. The experts are then asked to participate in two or more rounds of structured questionnaires. When one round is completed, an anonymous summary of the experts' input is provided by the facilitator from the previous questionnaire as a part of the succeeding questionnaire. In each succeeding session, other expert or experts review another expert's opinions so that to minimize the variability of the responses. Thus, a final consensus from experts' opinions is obtained counted as a reliable answer. This is also important to remind that the bias and any influence of a particular expert can be reduced in the Delphi technique. As a result, Delphi method can reduce the variance in the risk ratings when different decision-makers with difference risk attitudes and different illusions of controllability are involved in risk measuring for international construction projects.

The major findings of this research are listed as follow.

- Risk attitude is an important factor that can affect the risk ratings when decision-makers assign these ratings to risk factors during the risk assessment process.
- Illusion of controllability is another important factor that can affect the risk ratings the same as risk attitude.

- Risk attitude has a negative moderate correlation with the risk ratings, which means that a risk averse person may assign higher ratings to risks, whereas a risk seeking person may assign lower ratings to risks in contrast to a risk averse person.
- Controllability has also a negative moderate correlation with the risk ratings that decision-makers assign to risk factors. The higher the controllability, the lower the risk ratings are or vice-versa.
- Decision-makers always consider a latent but important factor into account while assigning the risk ratings during risk assessment, which is controllability.
- Decision-makers are more sensitive to country risk rather than the project risk itself.
- Comparing country and project risks, country risks are less controllable than project risks for decision-makers while using their subjective judgment.
- Although being prevalent and dominant, the P-I risk ratings still have some drawbacks, as there are some hidden factors that can affect the ratings and these ratings change from one individual to another.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This research investigated the effects of both ‘‘risk attitude’’ and ‘‘ illusion of controllability’’ on the risk ratings using 1 to 5 scaling method as a case of international construction projects. Therefore, a questionnaire survey was conducted for this purpose in order to see that how decision-makers assign different ratings to risks with respect to their attitudes toward risk and the assumptions about risk controllability. Also to see that how risk ratings change with respect to risk attitude and assumptions about risk controllability. The risk rating part of the questionnaire was divided into four risk scenarios, where each scenario was designed based on the situations that were concerned with the risk level of both country and project. The design of four different risk scenarios helped the research to observe the changes in decision-makers’ risk ratings assignment with respect to their risk attitude and risk controllability assumptions for that specific case. The questionnaire also consisted a risk controllability assumption and risk attitude measurement part for which the research objectives were established. Two hypotheses for the aim of this research were then tested and validated, claiming that while assigning the risk ratings using 1 to 5 scale, decision-makers may assign different ratings to risks depending on their risk attitude, and the assumptions of controllability is also an important factor that can affect a decision-maker’s risk ratings in addition to his/her attitude towards risk.

For the data analysis, SPSS Statistical software was utilized where the data analysis consisted of two SPSS data files and in addition to these two data files, an excel spread sheet was also used to help the process of the data analysis. Hence, the data analysis results from the questionnaire survey showed that risk attitude and controllability are the two significant factors that can change a decision-makers risk rating criteria depending on what their attitudes toward risks, and how they assume the controllability measures for risks during the risk assessment process. The correlation between risk attitude and each risk scenario was a moderate negative correlation, which meant that with a more risk seeking attitude, decision-makers will assign lower risk ratings or with a more risk averse attitude, decision-makers will assign higher risk ratings while assessing risk. The same condition was true for the illusion of controllability factor, where the correlation between controllability and each risk scenario was moderately negative, and the more controllable the risk factors were, the lower the risk ratings were or vice-versa. Finally the correlation between risk attitude and the illusion of controllability was tested as well, which was a moderate positive relationship. As a result, the research hypotheses were tested and validated through some cases with evidence from the survey results and via correlations test among these variables. This is essential to point out that the correlation test chosen for all the variables was Spearman’s Rank Correlation Coefficient or Spearman’s rho test that was an appropriate test for ordinal and nominal data having non-parametric characteristics.

To conclude, the P-I risk matrices are widely used and easy to utilize, but they have some serious shortcomings where some factors affect the ratings that decision-makers assign to risks. Thus, risk attitude and illusion of controllability are the two critical factors that may affect the risk ratings according to this research. Further studies are required to conduct comprehensive research designing specific and detailed cases and scenarios for the risky situations so that to get more precise results with new finding about the topic.

5.1. Limitations of the Research

As almost each research has some shortcomings, this research also has a few drawbacks, which will be discussed here. First, the mailing questionnaires have some limitations, as the respondents may not understand the questions clearly that what is required exactly. There will be no extra explanations to the questions rather than what is stipulated in the questionnaire. Thus, some respondents who have doubt about the questions may not answer the questionnaire or ignore it. Also, some people may not willing to respond at all to this kind of questionnaire, which will result in a lower response rate, or some may provide wrong answers based on their own understandings. The questionnaire for this research was affected by this limitation too, where the response rate for the mailing questionnaire of this research was about 40.1%. The other limitation of this study can be the design of the risk scenarios in the questionnaire, where the conditions of risk for a project were put a little vague as there were no further terms about project, e.g. the type of the contract, the delivery method of the project (is it Design-Did-Build, Design-Build, Engineer-Procure-Construct, or Build-Operate-Transfer project), the size and value of the project and who the client organization is (government or private sector). Because a decision-maker's attitude towards risk and assumption about risk controllability may change with respect to different project terms and situations as explained above. Third, some confusion about the risk ratings part also existed as the typical risk-rating matrix has two components for the probability and impact separately. However, this questionnaire had just one section for the risk ratings, as the aim of this research was just to investigate the variance in the risk ratings not any further risk assessment that is concerned with the ratings of both probability and impact. Still, some respondents may have assigned different ratings based on probability or impact. Lastly, the scenario for the risk attitude measurement had a limitation as well. The scenario was designed in a very simple way, which involved very little amount of money that may has not caught the actual risk attitudes that respondents had.

5.2. Recommendations for Future Researches

This study can be a good reference for those who are willing to pursue a comprehensive research about the effects and factors that can affect the risk ratings while decision-makers assign to risks using 1 to 5 scaling method in international construction projects. Further researches can focus on more specific risk cases and scenarios for international construction projects conducting a questionnaire survey with a greater sample size than what was performed by this research. In addition to mailing survey, brainstorming session, group interviews, and Delphi method surveys may help further researches to find stronger relationships among the risk ratings, risk attitude, and assumptions about risk controllability. Much detailed cases for risk attitude measurement and illusion of risk controllability may also help further researches. This should be always kept in mind that P-I risk rating tables are not as simple as thought, because there are significant hidden factors that cause big differences in the ratings from one decision-maker to another, questioning the reliability of the risk assessment process. Therefore, before applying the P-I risk rating method, it will be useful to think carefully about its effects and shortcomings, eliminating those shortcomings, reducing the effects, and then utilizing the method.

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APPENDIX A

SAMPLE QUESTIONNAIRE

The objectives of the Research Study

The aims of the research are;

1. To study how the risk ratings vary with respect to risk attitude of decision-makers during the risk assessment process.
2. To question the validity of the hypothesis that controllability also affects a decision maker's decisions about risk rating in addition to his/her risk attitude.

Contents of the Questionnaire

The questionnaire has got 3 sections as follows;

Part 1. General information about the respondents
Part 2. A risk rating exercise for 4 cases
Part 3. Measuring risk attitude

Part 1. General Information about the Respondents

1. Please write your current position/title in the company: **[ ]**

2. Your organization type (check a box where appropriate):

☐ **Client**

☐ **Contractor**

☐ **Consultant**

☐ **Other (**Please specify**)**

3. Your experience in the construction industry (check a box where appropriate):

☐ **Less than 5 years**

☐ **5 – 10 years**

☐ **11– 15 years**

☐ **More than 15 years**

4. Your experience in the risk management field (check a box where appropriate):

☐ **Low/Limited**

☐ **Medium**

☐ **High**

Part 2. Risk Ratings

There are four (4) scenarios. For each scenario, the risk checklist is given below. Please assign the risk ratings considering the probability of occurrence and its impact on the project success from 1 to 5. Before the scenarios' start, there is a question asking to rate your controllability level for the risks from 1 to 3.

Legend for Risk Ratings	
Very low impact	1
Low impact	2
Medium impact	3
High impact	4
Very high impact	5

Legend for Controllability Ratings	
Fully uncontrollable	1
Partially controllable	2
Fully controllable	3

Q1. Please assign your controllability ratings to each risk from 1 to 3 using the given legend.

No.	Risk Description	Level of Risk Controllability 1-3
1	Poor international relations	
2	Instability of political condition	
3	Poor attitude towards foreign companies	
4	Poor macroeconomic conditions	
5	Immaturity of legal system	
6	Societal conflict	
7	Cultural/Religious differences	
8	Vagueness of construction techniques/methods	
9	Complexity (technical and managerial)	
10	Unavailability of resources	
11	Poor planning	
12	Vagueness of scope	

13	Design errors	
14	Unavailability of funds	
15	Delay in payments	
16	Attitude of client	
17	Inexperience of client	
18	Unavailability of subcontractors	
19	Poor performance of subcontractors	

1st Scenario: There is an international project, which is technically complex. It is going to be carried out in a high risk country:

a. Please evaluate the risk level of this project based on your perception.

Level of Risk

☐ **Low**

☐ **Medium**

☐ **High**

b. Please assign the ratings to each risk from 1 to 5 using the given legends.

Note: The listed risks may have adverse effects on project cost, schedule, scope, quality or all of them at the same time.

No.	Risk Description	Risk Ratings (1-5)
1	Poor international relations	
2	Instability of political condition	
3	Poor attitude towards foreign companies	
4	Poor macroeconomic conditions	
5	Immaturity of legal system	
6	Societal conflict	
7	Cultural/Religious differences	
8	Vagueness of construction techniques/methods	
9	Complexity (technical and managerial)	
10	Unavailability of resources	
11	Poor planning	
12	Vagueness of scope	
13	Design errors	

14	Unavailability of funds	
15	Delay in payments	
16	Attitude of client	
17	Inexperience of client	
18	Unavailability of subcontractors	
19	Poor performance of subcontractors	

2nd Scenario: There is an international project, which has low complexity. It is going to be carried out in a high risk country:

a. Please evaluate the risk level of this project based on your perception.

Level of Risk

☐ **Low**

☐ **Medium**

☐ **High**

b. Please assign the ratings to each risk from 1 to 5 using the given legends.

Note: The listed risks may have adverse effects on project cost, schedule, scope, quality or all of them at the same time.

No.	Risk Description	Risk Ratings (1-5)
1	Poor international relations	
2	Instability of political condition	
3	Poor attitude towards foreign companies	
4	Poor macroeconomic conditions	
5	Immaturity of legal system	
6	Societal conflict	
7	Cultural/Religious differences	
8	Vagueness of construction techniques/methods	
9	Complexity (technical and managerial)	
10	Unavailability of resources	
11	Poor planning	
12	Vagueness of scope	
13	Design errors	
14	Unavailability of funds	
15	Delay in payments	

16	Attitude of client	
17	Inexperience of client	
18	Unavailability of subcontractors	
19	Poor performance of subcontractors	

3rd Scenario: There is an international project, which is technically complex. It is going to be carried out in a low risk country:

a. Please evaluate the risk level of this project based on your perception.

Level of Risk

☐ **Low**

☐ **Medium**

☐ **High**

b. Please assign the ratings to each risk from 1 to 5 using the given legends.

Note: The listed risks may have adverse effects on project cost, schedule, scope, quality or all of them at the same time.

No.	Risk Description	Risk Ratings (1-5)
1	Poor international relations	
2	Instability of political condition	
3	Poor attitude towards foreign companies	
4	Poor macroeconomic conditions	
5	Immaturity of legal system	
6	Societal conflict	
7	Cultural/Religious differences	
8	Vagueness of construction techniques/methods	
9	Complexity (technical and managerial)	
10	Unavailability of resources	
11	Poor planning	
12	Vagueness of scope	
13	Design errors	
14	Unavailability of funds	
15	Delay in payments	
16	Attitude of client	
17	Inexperience of client	

18	Unavailability of subcontractors	
19	Poor performance of subcontractors	

4th Scenario: There is an international project, which has low complexity. It is going to be carried out in a low risk country:

a. Please evaluate the risk level of this project based on your perception.

Level of Risk

☐ **Low**

☐ **Medium**

☐ **High**

b. Please assign the ratings to each risk from 1 to 5 using the given legends.

Note: The listed risks may have adverse effects on project cost, schedule, scope, quality or all of them at the same time.

No.	Risk Description	Risk Ratings (1-5)
1	Poor international relations	
2	Instability of political condition	
3	Poor attitude towards foreign companies	
4	Poor macroeconomic conditions	
5	Immaturity of legal system	
6	Societal conflict	
7	Cultural/Religious differences	
8	Vagueness of construction techniques/methods	
9	Complexity (technical and managerial)	
10	Unavailability of resources	
11	Poor planning	
12	Vagueness of scope	
13	Design errors	
14	Unavailability of funds	
15	Delay in payments	
16	Attitude of client	
17	Inexperience of client	
18	Unavailability of subcontractors	
19	Poor performance of subcontractors	

Part 3. Measuring Risk Attitude

A coin flipping game is offered to you. If the coin comes heads, you will get $100, and if the coin comes tails, you will get $0. What is the minimum certain amount of money you would accept to leave the game?

Note: The important point here is to mention that this coin flipping game is just for once and it is not a continuous game, the game will be stopped after one flip.

< $10	
$10	
$20	
$30	
$40	
$50	
$60	
$70	
$80	
$90	
> $90	

APPENDIX B

CALCULATIONS OF THE MEAN, SD, AND COV FOR THE RISK CONTROLLABILITY LEVEL AND FOUR RISK SCENARIOS

Table B.1: Summarized Table for the Mean, SD, COV, Risk Level, and Risk Attitudes of the Respondents

Respondents No.	Level of Risk Controllability			1st Scenario (High-High)				2nd Scenario (Low-High)				3rd Scenario (Low-High)				4th Scenario (Low-High)				Attitude Towards Risk
	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	
1	2,26	0,65	0,29	Medium	3,68	1,00	0,27	Low	2,74	0,65	0,24	Low	2,95	1,35	0,46	Low	2,37	0,83	0,35	Risk Averse
2	1,84	0,69	0,37	High	3,47	1,22	0,35	High	3,26	1,37	0,42	Medium	3,53	1,17	0,33	Low	3,32	1,34	0,40	Risk Seeking
3	1,89	0,81	0,43	Medium	3,47	1,12	0,32	Medium	3,68	0,82	0,22	Low	3,32	1,63	0,49	Low	3,16	1,68	0,53	Risk Neutral
4	1,89	0,81	0,43	High	4,32	0,75	0,17	High	3,00	1,33	0,44	Low	2,00	0,67	0,33	Low	1,21	0,42	0,35	Risk Seeking
5	2,05	0,71	0,34	Medium	3,42	0,77	0,22	Medium	3,11	1,05	0,34	Low	3,37	0,76	0,23	Low	2,53	0,61	0,24	Risk Seeking
6	2,32	0,67	0,29	High	3,74	1,05	0,28	Medium	2,74	0,87	0,32	High	3,37	1,38	0,41	Low	2,47	0,96	0,39	Risk Averse
7	2,00	0,58	0,29	High	2,58	0,96	0,37	High	2,32	0,95	0,41	Medium	2,26	0,81	0,36	Low	1,79	0,42	0,23	Risk Neutral
8	1,74	0,45	0,26	High	3,68	0,89	0,24	High	3,16	1,12	0,35	Medium	3,84	0,83	0,22	Low	3,42	0,90	0,26	Risk Neutral
9	1,74	0,73	0,42	High	3,42	0,90	0,26	High	3,11	1,05	0,34	Medium	2,84	0,60	0,21	Low	2,58	0,61	0,24	Risk Averse
10	2,05	0,62	0,30	High	3,58	0,90	0,25	High	3,37	1,01	0,30	Medium	2,63	1,07	0,40	Low	2,11	0,66	0,31	Risk Neutral
11	1,95	0,71	0,36	High	3,79	0,85	0,23	Medium	2,42	1,07	0,44	Medium	3,05	1,22	0,40	Low	2,05	1,08	0,53	Risk Seeking
12	2,16	0,76	0,35	High	3,79	1,03	0,27	High	3,95	0,97	0,25	Medium	3,47	1,12	0,32	Low	2,95	1,13	0,38	Risk Averse
13	1,79	0,79	0,44	High	3,89	0,94	0,24	High	2,84	1,21	0,43	Medium	2,79	1,27	0,46	Low	2,00	1,05	0,53	Risk Averse
14	1,00	0,00	0,00	High	3,58	1,07	0,30	High	4,05	1,22	0,30	Medium	3,21	1,58	0,49	Low	2,00	0,00	0,00	Risk Seeking
15	2,00	0,67	0,33	High	3,74	0,99	0,27	Medium	3,37	0,83	0,25	Medium	3,68	0,75	0,20	Low	2,89	0,99	0,34	Risk Seeking
16	2,11	0,74	0,35	High	3,68	0,48	0,13	Medium	3,26	0,45	0,14	Medium	3,16	0,90	0,28	Low	2,74	0,56	0,21	Risk Neutral
17	1,53	0,51	0,34	High	4,26	0,73	0,17	Medium	3,84	0,96	0,25	Medium	4,00	0,82	0,20	Low	3,63	1,01	0,28	Risk Seeking
18	2,00	0,67	0,33	High	4,37	0,60	0,14	High	3,89	0,74	0,19	Low	3,79	0,85	0,23	Low	2,16	0,37	0,17	Risk Seeking
19	1,74	0,73	0,42	High	2,84	1,17	0,41	Medium	2,79	1,18	0,42	Medium	2,63	1,34	0,51	Low	2,16	1,12	0,52	Risk Averse
20	1,79	0,63	0,35	High	3,95	0,91	0,23	Medium	3,68	1,11	0,30	Medium	3,68	0,89	0,24	Low	3,42	0,96	0,28	Risk Seeking

Table B.1: (continued)

Respondents No.	Level of Risk Controllability			1st Scenario (High-High)				2nd Scenario (Low-High)				3rd Scenario (Low-High)				4th Scenario (Low-High)				Attitude Towards Risk
	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	
21	1,68	0,67	0,40	High	3,58	1,39	0,39	Low	2,21	1,27	0,58	High	3,21	1,69	0,53	Low	2,42	1,12	0,46	Risk Seeking
22	2,11	0,66	0,31	High	3,89	0,81	0,21	Medium	3,11	1,10	0,35	Medium	2,37	0,83	0,35	Low	1,26	0,65	0,52	Risk Seeking
23	1,89	0,88	0,46	High	3,53	1,47	0,42	Medium	2,68	1,25	0,47	Medium	2,79	1,13	0,41	Low	2,42	1,07	0,44	Risk Seeking
24	2,16	0,76	0,35	High	3,68	1,25	0,34	High	3,16	0,90	0,28	Medium	2,89	1,45	0,50	Low	2,53	1,07	0,42	Risk Averse
25	2,26	0,65	0,29	High	3,05	1,03	0,34	Medium	3,05	1,03	0,34	Medium	3,05	1,03	0,34	Low	3,05	1,03	0,34	Risk Neutral
26	2,84	0,37	0,13	High	4,11	0,66	0,16	High	3,79	0,42	0,11	Medium	3,16	0,60	0,19	Low	2,89	0,32	0,11	Risk Seeking
27	2,21	0,42	0,19	High	4,00	0,82	0,20	High	4,00	0,82	0,20	Medium	4,00	0,82	0,20	Low	4,00	0,82	0,20	Risk Seeking
28	1,74	0,65	0,38	High	3,42	1,07	0,31	Medium	2,95	0,85	0,29	Medium	2,37	1,12	0,47	Low	1,79	0,79	0,44	Risk Seeking
29	2,32	0,67	0,29	High	2,37	1,67	0,71	Medium	3,74	1,66	0,44	Low	3,95	1,13	0,29	Low	2,32	0,89	0,38	Risk Seeking
30	1,95	0,85	0,44	High	3,21	0,92	0,29	Medium	2,26	1,15	0,51	Medium	2,11	1,05	0,50	Low	1,53	0,51	0,34	Risk Neutral
31	2,00	0,75	0,37	High	3,58	0,69	0,19	High	3,21	0,92	0,29	Medium	2,74	1,10	0,40	Low	2,11	0,88	0,42	Risk Averse
32	2,26	0,81	0,36	High	3,63	1,16	0,32	Medium	2,84	1,21	0,43	Medium	2,89	1,24	0,43	Low	2,42	0,96	0,40	Risk Seeking
33	2,05	0,62	0,30	High	1,53	0,61	0,40	High	1,37	0,50	0,36	Low	2,05	0,40	0,20	Low	2,05	0,40	0,20	Risk Seeking
34	1,95	0,52	0,27	Medium	3,58	0,61	0,17	Medium	3,37	0,50	0,15	Low	2,37	0,50	0,21	Low	2,16	0,37	0,17	Risk Averse
35	2,00	0,75	0,37	High	3,11	1,33	0,43	Medium	2,11	1,10	0,52	Medium	2,37	1,16	0,49	Low	1,63	0,68	0,42	Risk Seeking
36	1,47	0,51	0,35	High	2,63	0,83	0,32	Medium	2,26	0,87	0,39	Medium	2,47	0,51	0,21	Low	1,68	0,48	0,28	Risk Neutral
37	2,11	0,66	0,31	High	3,00	1,00	0,33	Medium	2,68	1,11	0,41	Medium	2,53	1,12	0,44	Low	2,11	1,10	0,52	Risk Neutral
38	1,74	0,56	0,32	High	4,05	0,78	0,19	Medium	2,74	0,93	0,34	Medium	3,68	0,82	0,22	Low	2,05	0,52	0,26	Risk Seeking
39	2,00	0,58	0,29	High	3,74	1,15	0,31	Medium	3,37	1,07	0,32	Medium	3,63	1,61	0,44	Low	3,26	0,87	0,27	Risk Seeking
40	1,79	0,42	0,23	High	3,84	0,90	0,23	Medium	3,42	1,07	0,31	Medium	3,21	0,98	0,30	Low	2,95	0,91	0,31	Risk Neutral

Table B.1: (continued)

Respondents No.	Level of Risk Controllability			1st Scenario (High-High)				2nd Scenario (Low-High)				3rd Scenario (Low-High)				4th Scenario (Low-High)				Attitude Towards Risk
	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	
41	1,63	0,50	0,30	High	3,79	0,79	0,21	Medium	3,26	0,81	0,25	Low	3,05	0,91	0,30	Low	2,79	0,92	0,33	Risk Averse
42	2,05	0,78	0,38	High	3,68	0,67	0,18	High	3,68	0,67	0,18	Medium	3,42	0,69	0,20	Low	2,42	0,69	0,29	Risk Neutral
43	1,84	0,69	0,37	High	4,16	0,76	0,18	Medium	3,53	0,90	0,26	Medium	3,53	0,90	0,26	Low	3,00	1,11	0,37	Risk Neutral
44	1,84	0,50	0,27	High	3,79	0,63	0,17	Medium	3,53	0,70	0,20	Medium	3,79	0,63	0,17	Low	2,79	0,63	0,23	Risk Neutral
45	1,89	0,66	0,35	High	4,16	0,96	0,23	High	3,58	1,12	0,31	Medium	3,21	1,03	0,32	Low	2,95	1,13	0,38	Risk Averse
46	2,11	0,66	0,31	High	2,89	0,94	0,32	High	2,63	1,21	0,46	Low	2,53	0,96	0,38	Low	2,26	1,19	0,53	Risk Seeking
47	2,21	0,79	0,36	High	3,47	1,26	0,36	Medium	2,63	1,30	0,49	Medium	2,74	1,19	0,44	Low	1,68	0,95	0,56	Risk Seeking
48	1,79	0,71	0,40	High	3,58	0,96	0,27	Medium	3,16	0,96	0,30	Medium	3,32	1,00	0,30	Low	2,95	0,91	0,31	Risk Neutral
49	2,00	0,82	0,41	Medium	2,53	1,12	0,44	Low	2,32	1,11	0,48	Medium	2,47	1,12	0,45	Low	2,26	1,28	0,57	Risk Seeking
50	1,95	0,71	0,36	Medium	3,05	1,31	0,43	Medium	3,11	1,10	0,35	Low	2,95	1,22	0,42	Low	2,32	1,06	0,46	Risk Neutral
51	2,00	0,75	0,37	High	3,95	0,91	0,23	Medium	2,84	0,96	0,34	Medium	3,05	1,03	0,34	Low	1,42	0,51	0,36	Risk Neutral
52	1,95	0,78	0,40	High	4,47	0,77	0,17	Medium	3,47	0,90	0,26	Medium	3,32	1,06	0,32	Low	2,21	0,71	0,32	Risk Averse
53	1,42	0,51	0,36	High	4,32	0,67	0,16	Medium	3,89	0,81	0,21	Medium	3,42	1,12	0,33	Low	3,47	1,26	0,36	Risk Averse
54	2,53	0,77	0,31	High	3,63	0,60	0,16	Medium	2,79	0,42	0,15	Medium	2,42	0,90	0,37	Low	1,84	0,60	0,33	Risk Seeking
55	2,26	0,73	0,32	High	2,79	1,13	0,41	Medium	2,26	1,10	0,48	Medium	2,79	0,98	0,35	Low	2,00	1,00	0,50	Risk Neutral
56	2,37	0,76	0,32	High	3,16	0,83	0,26	High	3,16	0,96	0,30	Low	1,63	0,50	0,30	Low	1,53	0,51	0,34	Risk Seeking
57	1,53	0,51	0,34	High	4,11	0,74	0,18	Medium	3,84	0,37	0,10	Low	2,32	1,25	0,54	Low	2,21	1,23	0,56	Risk Averse
58	2,47	0,51	0,21	High	3,21	0,63	0,20	Medium	2,42	0,61	0,25	Low	1,79	0,42	0,23	Low	1,63	0,50	0,30	Risk Seeking
59	1,84	0,76	0,42	High	3,95	0,85	0,21	High	3,53	1,17	0,33	Medium	2,79	0,71	0,26	Low	1,95	0,23	0,12	Risk Averse
60	1,63	0,50	0,30	Medium	4,47	0,90	0,20	Medium	4,47	0,90	0,20	Low	3,11	1,49	0,48	Low	3,16	1,30	0,41	Risk Averse

Table B.1: (continued)

Respondents No.	Level of Risk Controllability			1st Scenario (High-High)				2nd Scenario (Low-High)				3rd Scenario (Low-High)				4th Scenario (Low-High)				Attitude Towards Risk
	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	Risk Level	Mean	SD	COV	
61	2,26	0,73	0,32	Medium	2,58	1,12	0,43	Medium	2,42	0,96	0,40	Medium	1,42	0,51	0,36	Low	1,47	0,51	0,35	Risk Seeking
62	1,74	0,81	0,46	High	4,11	0,66	0,16	High	4,05	0,78	0,19	Medium	4,00	0,67	0,17	Low	4,05	0,78	0,19	Risk Averse
63	1,68	0,58	0,35	High	3,68	1,00	0,27	Medium	3,42	1,07	0,31	Medium	3,21	1,36	0,42	Low	3,53	0,77	0,22	Risk Averse
64	1,79	0,71	0,40	High	4,58	0,69	0,15	High	4,00	0,94	0,24	High	3,47	1,35	0,39	Medium	3,00	1,25	0,42	Risk Averse
65	1,74	0,65	0,38	High	4,11	0,94	0,23	High	3,63	1,01	0,28	Medium	3,74	1,15	0,31	Low	3,26	1,05	0,32	Risk Averse
66	1,79	0,63	0,35	High	4,26	0,73	0,17	Medium	3,83	0,76	0,20	Medium	3,26	0,56	0,17	Low	1,85	0,51	0,27	Risk Averse
67	2,32	0,75	0,32	High	2,74	1,28	0,47	Medium	2,68	1,29	0,48	Medium	2,63	0,90	0,34	Low	1,74	0,65	0,38	Risk Neutral
68	1,74	0,45	0,26	High	3,74	0,93	0,25	High	3,58	1,12	0,31	Medium	3,32	1,11	0,33	Low	3,32	1,11	0,33	Risk Averse
69	2,42	0,51	0,21	High	2,00	0,82	0,41	Medium	1,74	0,81	0,46	Low	1,26	0,65	0,52	Low	1,00	0,00	0,00	Risk Seeking
70	2,16	0,76	0,35	High	3,53	1,12	0,32	High	3,05	1,27	0,42	Medium	2,74	1,05	0,38	Medium	2,32	1,00	0,43	Risk Seeking
71	2,32	0,48	0,21	High	3,42	1,30	0,38	Medium	1,74	0,81	0,46	Low	1,26	0,65	0,52	Low	1,00	0,00	0,00	Risk Seeking
72	2,47	0,51	0,21	High	2,58	1,39	0,54	High	2,58	0,90	0,35	Medium	2,42	0,96	0,40	Medium	2,05	1,03	0,50	Risk Seeking
73	1,45	0,51	0,35	High	3,47	1,39	0,40	High	3,37	1,42	0,42	Medium	3,05	0,97	0,32	Low	2,89	0,94	0,32	Risk Averse
74	1,26	0,45	0,36	High	4,32	0,67	0,16	High	3,90	0,94	0,24	Medium	3,53	0,51	0,15	Low	2,79	0,63	0,23	Risk Averse
75	2,00	0,58	0,29	High	3,21	0,98	0,30	Medium	2,84	0,96	0,34	Medium	2,63	0,60	0,23	Low	2,37	0,68	0,29	Risk Neutral
76	2,26	0,65	0,29	High	3,53	0,77	0,22	Medium	2,68	0,67	0,25	Medium	2,68	0,67	0,25	Low	1,42	0,51	0,36	Risk Seeking
77	2,42	0,69	0,29	High	3,32	1,20	0,36	Medium	2,58	0,61	0,24	Medium	2,05	0,78	0,38	Low	1,58	0,51	0,32	Risk Seeking
78	2,16	0,60	0,28	High	2,95	1,08	0,37	Medium	2,58	0,96	0,37	Low	2,21	0,71	0,32	Low	1,97	0,67	0,34	Risk Seeking
79	2,00	0,67	0,33	High	3,21	0,63	0,20	Medium	2,95	0,85	0,29	Low	2,05	0,71	0,34	Low	1,58	0,51	0,32	Risk Seeking
80	2,58	0,51	0,20	High	2,68	0,75	0,28	Medium	2,21	1,27	0,58	Low	1,95	0,71	0,36	Low	1,32	0,48	0,36	Risk Seeking
81	1,68	0,75	0,44	High	3,63	0,83	0,23	High	3,53	0,84	0,24	High	3,47	1,17	0,34	Medium	3,16	1,38	0,44	Risk Averse

APPENDIX C

RISK FACTORS RANKINGS WITH RESPECT TO THEIR MEAN RATINGS IN THE DIFFERENT RISK SCENARIOS

The risk factors from the questionnaire data are analyzed and ranked with respect to their mean ratings in each risk scenario. A report is produced by the SPSS software and presented here for more information.

Report

	First Scenario Risk Rating #1	Second Scenario Risk Rating #1	Third Scenario Risk Rating #1	Fourth Scenario Risk Rating #1
Mean	3.31	2.99	2.28	1.84
N	81	81	81	81
Std. Deviation	.996	1.090	1.003	.873

Report

	First Scenario Risk Rating #2	Second Scenario Risk Rating #2	Third Scenario Risk Rating #2	Fourth Scenario Risk Rating #2
Mean	3.96	3.67	2.56	2.22
N	81	81	81	81
Std. Deviation	1.018	1.173	1.140	1.107

Report

	First Scenario Risk Rating #3	Second Scenario Risk Rating #3	Third Scenario Risk Rating #3	Fourth Scenario Risk Rating #3
Mean	3.20	2.99	2.35	2.04
N	81	81	81	81
Std. Deviation	1.030	1.066	.989	.980

Report

	First Scenario Risk Rating #4	Second Scenario Risk Rating #4	Third Scenario Risk Rating #4	Fourth Scenario Risk Rating #4
Mean	3.52	3.27	2.53	2.27
N	81	81	81	81
Std. Deviation	1.014	1.173	1.026	1.025

Report

	First Scenario Risk Rating #5	Second Scenario Risk Rating #5	Third Scenario Risk Rating #5	Fourth Scenario Risk Rating #5
Mean	3.94	3.65	2.75	2.46
N	81	81	81	81
Std. Deviation	1.065	1.131	1.189	1.152

Report

	First Scenario Risk Rating #6	Second Scenario Risk Rating #6	Third Scenario Risk Rating #6	Fourth Scenario Risk Rating #6
Mean	3.10	3.06	2.36	2.21
N	81	81	81	81
Std. Deviation	1.210	1.208	1.052	1.045

Report

	First Scenario Risk Rating #7	Second Scenario Risk Rating #7	Third Scenario Risk Rating #7	Fourth Scenario Risk Rating #7
Mean	2.30	2.37	1.86	1.72
N	81	81	81	81
Std. Deviation	.914	.968	.802	.762

Report

	First Scenario Risk Rating #8	Second Scenario Risk Rating #8	Third Scenario Risk Rating #8	Fourth Scenario Risk Rating #8
Mean	3.40	2.54	3.11	2.19
N	81	81	81	81
Std. Deviation	1.092	1.037	1.049	.896

Report

	First Scenario Risk Rating #9	Second Scenario Risk Rating #9	Third Scenario Risk Rating #9	Fourth Scenario Risk Rating #9
Mean	3.38	2.32	3.33	2.15
N	81	81	81	81
Std. Deviation	.969	.933	1.025	.923

Report

	First Scenario Risk Rating #10	Second Scenario Risk Rating #10	Third Scenario Risk Rating #10	Fourth Scenario Risk Rating #10
Mean	3.72	3.23	3.27	2.63
N	81	81	81	81
Std. Deviation	1.003	1.016	1.013	1.018

Report

	First Scenario Risk Rating #11	Second Scenario Risk Rating #11	Third Scenario Risk Rating #11	Fourth Scenario Risk Rating #11
Mean	3.81	3.02	3.51	2.64
N	81	81	81	81
Std. Deviation	1.026	1.118	1.152	1.133

Report

	First Scenario Risk Rating #12	Second Scenario Risk Rating #12	Third Scenario Risk Rating #12	Fourth Scenario Risk Rating #12
Mean	3.62	2.98	3.37	2.62
N	81	81	81	81
Std. Deviation	1.056	1.049	1.134	1.135

Report

	First Scenario Risk Rating #13	Second Scenario Risk Rating #13	Third Scenario Risk Rating #13	Fourth Scenario Risk Rating #13
Mean	3.64	2.77	3.51	2.48
N	81	81	81	81
Std. Deviation	1.004	.965	1.074	1.014

Report

	First Scenario Risk Rating #14	Second Scenario Risk Rating #14	Third Scenario Risk Rating #14	Fourth Scenario Risk Rating #14
Mean	4.19	3.86	3.57	3.17
N	81	81	81	81
Std. Deviation	1.026	1.058	1.234	1.233

Report

	First Scenario Risk Rating #15	Second Scenario Risk Rating #15	Third Scenario Risk Rating #15	Fourth Scenario Risk Rating #15
Mean	3.96	3.80	3.47	3.02
N	81	81	81	81
Std. Deviation	1.030	1.066	1.184	1.275

Report

	First Scenario Risk Rating #16	Second Scenario Risk Rating #16	Third Scenario Risk Rating #16	Fourth Scenario Risk Rating #16
Mean	3.44	3.30	2.95	2.49
N	81	81	81	81
Std. Deviation	1.061	1.054	1.094	1.085

Report

	First Scenario Risk Rating #17	Second Scenario Risk Rating #17	Third Scenario Risk Rating #17	Fourth Scenario Risk Rating #17
Mean	3.12	2.73	2.62	2.11
N	81	81	81	81
Std. Deviation	1.166	1.140	.995	.908

Report

	First Scenario Risk Rating #18	Second Scenario Risk Rating #18	Third Scenario Risk Rating #18	Fourth Scenario Risk Rating #18
Mean	3.47	3.04	3.09	2.37
N	81	81	81	81
Std. Deviation	.963	.993	1.039	.993

Report

	First Scenario Risk Rating #19	Second Scenario Risk Rating #19	Third Scenario Risk Rating #19	Fourth Scenario Risk Rating #19
Mean	3.68	3.19	3.22	2.53
N	81	81	81	81
Std. Deviation	.972	.976	1.072	1.050