Fuzzy Set-based Risk Management for Construction Projects

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ABSTRACT

Fuzzy Set-based Risk Management for Construction Projects

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Efficient and comprehensive risk management is critical for successful delivery of engineering, procurement, and construction management (EPCM) projects. Complexity of construction projects is on the rise, which makes it necessary to model uncertainties and to manage risk items related to this class of projects. For decades, researchers and construction practitioners worked together to introduce methods for risk identification and assessment. Considerably less effort was directed towards the development of methods for mitigation, monitoring, and control. The respective individual limitations of these methods prevent the development of comprehensive model which satisfies the needs of practitioners. In this research a comprehensive risk management model "CRMM" is developed to address the limitations of existing methods and to fill the gap between research and practice. The developed model implements a micro system approach to introduce a novel risk identification methodology that provides a systematic procedure to identify risk associated with construction projects. The identification procedure implements root cause analysis and brainstorming technique to identify risk items, consequences, and root causes. The developed CRMM also introduces new method for determination of risk ownership utilizing fuzzy set theory and "One Risk – One Owner" concept. The ownership determination method allocates risk to the owner with highest ability, effectiveness, and capacity to deal with that risk. It also introduces a new qualitative and quantitative evaluation process that utilizes fuzzy set theory and fuzzy probability theory, as well as a new risk mapping procedure which allows for the determination of risk level associated with any project component (e.g.,

category). The quantitative assessment methodology allows for the use of linguistic and numeric fuzzy evaluations. Fuzzy Linguistic-Numeric Conversion Scheme (FLNCS) is introduced to convert the linguistic evaluations into numeric. The quantitative assessment methodology also introduces the pre-mitigation contingency that represents the contingency fund required for a risk in case no mitigation strategy is implemented. In this respect a novel risk mitigation framework is developed to generate and evaluate possible mitigation strategies for each risk being considered. It also provides a selection procedure which allows users to select the most effective mitigation strategy; making use of fuzzy set theory. The mitigation methodology introduces the post-mitigation contingency that quantifies the contingency required for the selected mitigation strategy. Performance of selected mitigation strategy is monitored using a newly developed risk monitoring method that compares the actually depleted contingency to the post mitigation contingency. The developed monitoring method provides an early warning that alerts users of detected possible failure of selected mitigation strategy. It also determines the correct time for initiation of control process based on a set of qualitative factors. Once risk control process is initiated, the developed control method identifies, evaluates, and selects the most effective control action(s) to support the selected mitigation strategy. In cases where the selected control action fails, the developed control method notifies the user to revise the risk management plan. These notifications allows user to avoid potential failures of similar risk items which are expected to occur in the future. The developed CRMM was coded using VB.Net under Microsoft® windows and .NET framework environment to facilitate its application. A set of case studies are collected from literature and analysed to validate the developed methods within CRMM and to illustrate their essential features. Also, a numerical example elucidates the complete computational processes of the developed comprehensive model.

"To my beloved wife Dr. Lola EL-Sahmarany"

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Glossary

CRMM	=	Comprehensive Risk Management Model
R	=	Risk value (Severity)
P	=	Probability of occurrence
C	=	Consequence (Impact)
μ	=	Fuzzy membership function
$\tilde{A}$	=	Fuzzy number A
MRBS	=	Micro Risk Breakdown Structure
PREMC	=	Pre-Mitigation Contingency
PEF	=	Planned Efficiency Factor
AEF	=	Actual Efficiency Factor
POSTMC	=	Post Mitigation Contingency
ACTMC	=	Actual Mitigation Contingency
CA	=	Control Action
PCF	=	Post Control Factor
EPCM	=	Engineering Procurement Construction Management
RRM	=	Risk Responsibility Matrix
WBS	=	Work Breakdown Structure
OBS	=	Organization Breakdown Structure
UIDN	=	Unique Identification Number
PRCER	=	Preventive Root Cause and Effect Remedial
RCA	=	Root Cause Analysis
CL	=	Consequence List
PA	=	Preventive Action
RA	=	Remedial Action
ROS	=	Risk Ownership Score

AbI	=	Ability Index
CaI	=	Capacity Index
EfI	=	Effectiveness Index
RAM	=	Risk Assignment Matrix
FLNCS	=	Fuzzy Linguistic Numeric Conversion Scheme
UB	=	Upper Boundary
LB	=	Lower Boundary
W	=	Weight
EMV	=	Expected Monetary Value
MEF	=	Mitigation Efficiency Factor
MSC	=	Mitigation Strategy Cost
MEFP	=	Mitigation Efficiency on Probability
MEFC	=	Mitigation Efficiency on Consequence
RAC	=	Remedial Action Cost
PAC	=	Preventive Action Cost
MS	=	Mitigation Strategy
ACTMC (t)	=	Periodic Actual Mitigation Contingency at period t
AC	=	Actual Cost
RA	=	Risk Acceptance tolerance
RR	=	Risk Residual
CEF	=	Cost Efficiency Factor
CAC	=	Control Action Cost
PRC	=	Post control Risk Cost
RMPI	=	Risk Management Performance Index

CHAPTER 1: INTRODUCTION

1.1 General

The challenges inherent to construction projects are continuously increasing, along with the number of stakeholders involved, the level of complexity, and the volume of work. These increases affect the number and magnitude of the associated risks, particularly for engineering, procurement, construction, and management (EPCM) projects. The use of an effective procedure in construction projects contributes to reduction of cost overruns and schedule delays (Serpella, Ferrada, Howard, & Rubio, 2014), and also minimizes the number of non-identified and unplanned risk events that may be harmful to one or more project objectives (Rounds & Segner, 2011; Loosemore, Raftery, Reilly, & Higgon, 2006). Traditional procedure includes five processes: identification (Ebrahimnejad, Mousavi, & Seyrafianpour, 2010), assessment (Hassanein & Afifi, 2007; Abdelgawad & Fayek, 2012), mitigation (Abdelgawad & Fayek, 2010), monitoring (Jun-yan, Feng, & Yan, 2011), and control (Lingard, et al., 2015). Apart from a few studies (Marcelino Sádaba, Pérez-Ezcurdia, Echeverría-Lazcano, & Benito-Amurrio, 2014; Yoon, Tamer, & Hastak, 2014; Zhao, Hwang, & Low, 2013; Fang & Marle, 2012; Banaitiene & Banaitis, 2012; Abdelgawad & Fayek, 2010), comprehensive procedure has received less attention than individual processes. This situation has led to a lack of comprehensive and effective procedures, which has compelled construction practitioners to develop their own procedures using a combination of commercially available tools. However, the majority of construction practitioners are not yet satisfied and have demonstrated their interest in the revision or replacement of their current procedure by 2015 (Deloitte, 2012).

In the construction industry, ineffective risk management is the most common cause of project failure (Beckers, et al., 2013). A study conducted by Project Management Solutions (PMSolutions, 2011) among 134 organizations comprising a total of 20,821 construction projects was completed in 2011. The results showed that 37% of construction projects were at risk, for an average of $74million/year/firm. Out of these 37% projects at risk, 25% could be recovered and 12% failed which translates into an average of $24 M / firm lost every year due to risk management failure. However, these amounts are about to increase according to a recent study conducted among practitioners in the construction industry by Strategic Risk (2014). Their results indicate that 61% and 17% of participants have declared that overall risk has increased and decreased, respectfully, over the last 10 years. It also showed that 71% and 5% of participants have concluded that overall risk is likely to increase and decrease, respectively, in the upcoming 10 years.

1.2 Research Motivation and Problem Statement

The literature reveals that most of the published work is focused on the development of risk assessment methodologies using deterministic, probabilistic, or fuzzy set modelling, or a combination thereof. Considerably less work, however, has been devoted to the development of risk identification, mitigation, monitoring, and control, which has contributed to the lack of a comprehensive methodology. Identification techniques (Borghesi & Gaudenzi, 2013; Tworek, 2010) are used to identify the risk associated with construction projects. However, these techniques on their own cannot identify all risk items associated with construction projects (Borghesi & Gaudenzi, 2013; Tworek, 2010). Also, a common practice for risk identification in the construction industry is to use a pre-generated list of risk items at the project level (Rezakhani, 2012). Little effort has been directed toward risk ownership determination, which represents a critical part of the risk identification process (Hanna, Thomas, & Swanson, 2013; Peckiene, Komarovska, & Ustinovicius, 2013).

In terms of risk assessment, the current methods do not consider uncertainty and imprecision-associated probability of occurrence of each risk item. Current assessment methods either provide qualitative or quantitative perspectives, without providing a systematic correlation procedure to allow users to shift from qualitative to quantitative assessments. Also, a majority of risk assessment methods are simulation-based methods and rely on availability of historical data. Mitigation methods have received less attention than identification and assessment. These methods are based on the intuitive selection of mitigation strategies (Abdul-Rahman, Loo, & Wang, 2012; Agrawal, 2012; Chan J. H., Chan, Chan, & Lam, 2012), or on the use of a general mitigation strategy such as avoidance, transfer, reduction, and retention (Abdelgawad & Fayek, 2010; Hallowell & Gambatese, 2009). However, the use of general mitigation strategies has been proven ineffective according to a study conducted by Burns (2012). The results of that study showed that more that 33% (40%) of the participants experienced no reduction when risk transfer (retention) mitigation strategy was applied, while 3.7% (4%) were faced with an increase in the total cost of the risk being considered. Risk monitoring researchers have recommended the use of existing monitoring techniques originally developed for other industries (e.g. Financial). These techniques are reactive rather than proactive and they do not consider the efficiency of a selected mitigation strategy. Also, they do not provide any information about the most suitable time for risk control process initiation (Zi-mei & Ke-fan, 2013).

According to a recent study conducted by Deloitte (2012), among 192 professionals from corporate management and financial organizations in the USA, 90% of the participants are yet to be satisfied with their current and mitigation procedures. Also, more than 50% of the Deloitte study participants declared their intention to change their current procedures by the end of 2015. The control process received the least attention from researchers. The majority of studies have recommended the use of intuitive judgement and on-site decision making to control the occurred risk items (Ehsan, Alam, Mirza, & Ishaque, 2010; Dey, Kinch, & Ogunlana, 2007; Curtis & Turley, 2007). The limitations and shortcomings of the current methods for in the construction industry represent the key motivations for this research.

1.3 Aim and Objectives

The aim of this research is to develop a comprehensive model for construction projects, focusing on identification, assessment, mitigation, monitoring, and control processes. A set of objectives have been generated to realize the ultimate aim of this research:

1. Development of a systematic risk identification method based on a micro-approach which allows the identification of known and unknown risk items. The identification method provides a systematic procedure for selecting risk owners using a set of criteria. It also introduces risk responsibility matrix, using the "one risk, one owner" approach, which highlights the responsibility of team members to each risk item.
2. Development of a new risk assessment methodology using fuzzy set theory and fuzzy probability theory. The developed method provides qualitative and quantitative assessment of each risk item, while considering vagueness and imprecision associated with expert judgement. It also introduces pre-mitigation contingency, which represents the upper contingency baseline for the risk monitoring process.
3. Development of a new methodology for mitigation which identifies, evaluates, prioritizes and selects the most effective mitigation strategy for each risk item using

fuzzy set and fuzzy probability theories. This method introduces the post-mitigation contingency which represents the lower contingency baseline for the risk monitoring process.

4. Development of a new methodology for systemized risk monitoring which makes use of the contingency baselines to evaluate the efficiency of a selected mitigation strategy. It also highlights the most suitable time for initiating the control process, which allows proactive rather than reactive actions.
5. Development of a new risk control methodology, using fuzzy theory, which identifies, evaluates, prioritizes and selects the most effective control action to support the selected strategy. The output of control processes allows users to dynamically update the mitigation strategies of similar risks and to avoid the unnecessary depletion of project resources.

The advancement of the risk management theory represents the main academic objectives of this research. This advancement includes new procedures, methods, and algorithms which systemize the application of each risk management process from identification to control. Also, it models the dynamic interactions among these processes.

1.4 Research Philosophy

The research philosophy behind the developments made in this thesis rests on (1) integration as a means for benefiting from the advantages and useful features of available methodologies in the literature; (2) the dynamic integration among the different processes to build a comprehensive and effective model; and (3) understanding of the processes, with a focus on improving current practice via the development of innovative and practical methods for each process. Based on this philosophy and in an effort to understand the process of in the construction industry, the following questions were deemed critical:

- What are the inputs of each process?
- What are the outputs of each process?
- What is the function of each process?
- How does this function add value to the process? and
- What is the most suitable model that maps the relation between each process and its respective predecessor or successor?

As to the automation of the process for construction projects, the following questions were deemed important:

- What is the purpose of each process? and
- How can this process be simplified?

The philosophy and its related questions listed above were helpful in guiding the research work presented in this thesis.

1.5 Research Methodology

The methodology followed to achieve the objectives of this research is presented in Figure 1.1. The methodology is summarized in five stages: analysis, development, implementation, validation, and conclusion. The analysis stage began with a problem statement and definition of the research objectives. It then focuses on performing a comprehensive review of the following processes:

- Identification
- Assessment
- Mitigation

- Monitoring
- Control

From the analysis stage, gaps and limitations in the current literature are identified. To respond to the limitations and gaps identified in the analysis stage, a model was developed to provide a comprehensive and effective procedure in the development stage. Data collection was conducted in the implementation stage, and the challenges associated with the practical integration of the process into the developed model were also addressed at this stage. In addition, prototype software was developed to validate the developed model using case studies collected from the literature. The findings of this research, including its limitations and observations, are presented in the conclusion.

1.6 Thesis Organization

Chapter 2 presents a review of the literature focusing on existing methods, the use of fuzzy set theory, applications in the construction industry, and related policies and procedures presently used in the field. The proposed model encompasses methods for; identification, assessment, mitigation, monitoring, and control are presented in Chapter 3. Chapter 4 presents different case studies and scenarios which illustrate the application of the proposed methods for each process and highlights their essential features. Chapter 5 presents a standalone automated tool, coded using VB.net, which facilitates and eases the application of the proposed methodologies using a graphical user interface (GUI) in a windows environment. The results of case studies and a numerical example are analysed and discussed in Chapter 6. Chapter 7 summarizes this research, highlights the main contributions, draws conclusions, and provides recommendations for future work.

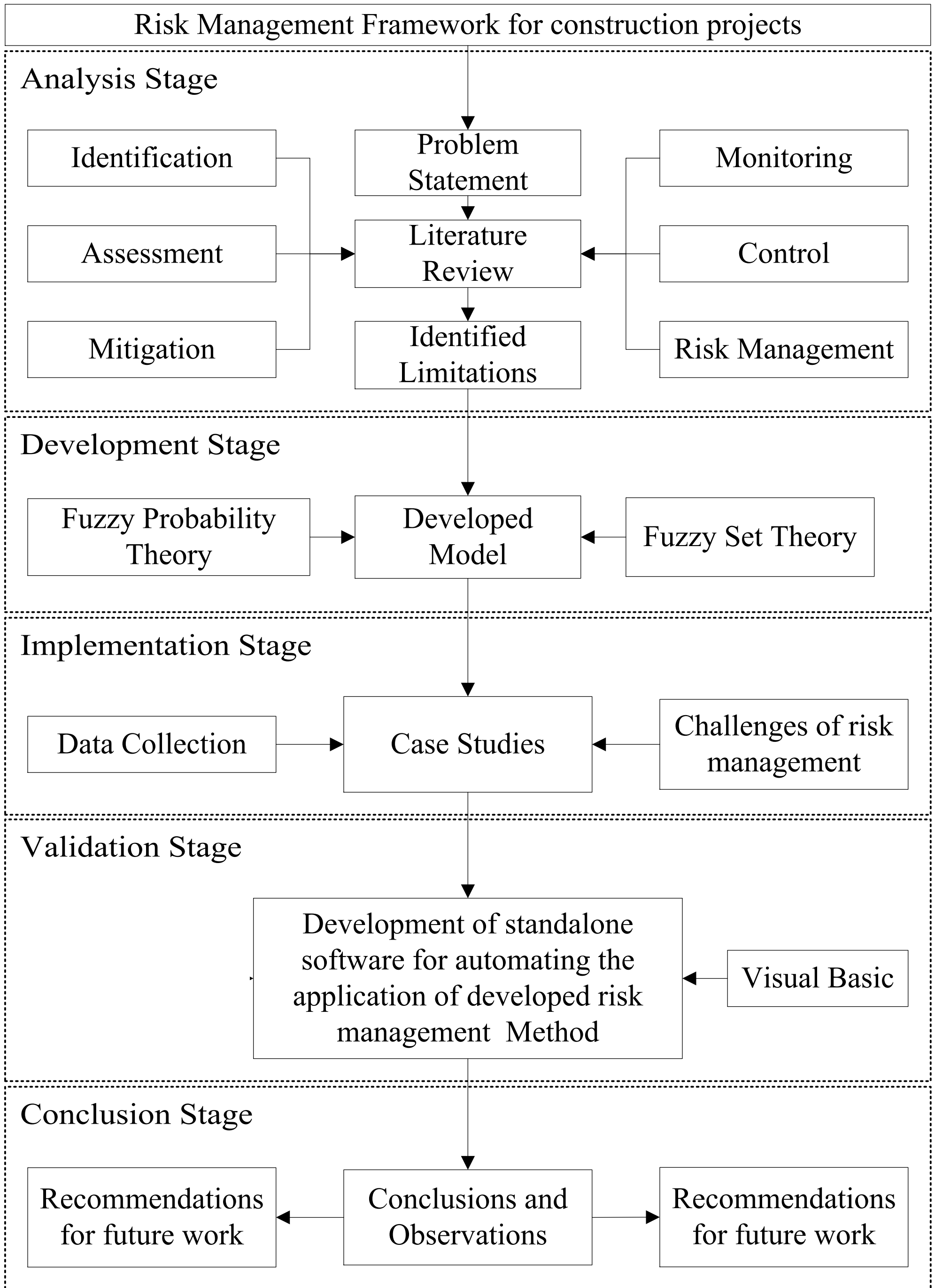


Figure 1.1 Research Methodology

CHAPTER 2: LITERATURE REVIEW

2.1 General

The literature provides a wide range of risk definitions; however, that of Project Management Institute (PMI®) is selected as risk definition in the context of this thesis. PMI® defines risk as "*an uncertain event or condition that, if it occurs, has a positive or negative effect on one or more project objectives such as scope, schedule, cost, and quality*" (PMI, A Guide to the Project Management Body of Knowledge, 2013). An event is considered as uncertain only if $0<P<1$ and an uncertain event is considered as a risk only if $C\neq0$. In the context of this thesis, risk with negative or positive consequences is referred to as threat or opportunity, respectively. Consequently, the probability-impact (P-I) model dominates the literature (Zhou & Zhang, 2010). The P-I model calculates the risk value as a multiplication of the probability of occurrence (P) and of the consequence (C), as presented in Eq. 2.1

$$R = P \times C \tag{2.1}$$

Over the decades, researchers have proposed extensions to the P-I risk model, such as predictability (Williams, 1999), exposure (Jannadi & Almishari, 2003), Discrimination (Nieto-Morote & Ruz-Vila, 2011; Cervone, 2006), manageability (Dikmen, Birgonul, & Han, 2007), controllability (Cagno, Caron, & Mancini, 2007), factor index (Zeng, An, & Smith, 2007), vulnerability (Vidal & Marle, 2012; Zhang J. , 2007), and significance (Han, Kim, Kim, & Jang, 2008). However, it has been found that the P–I risk model still prevails, while improvement efforts have increased recently (Taroun, 2014). Therefore, the P-I risk model was selected for modelling the risk associated with construction projects in this thesis.

Risk management plan (RMP) represents the overall planning to deal with the identification, evaluation, mitigation, monitoring, and control of risk items associated with construction projects (Kwan & Leung, 2011). Several methods for the identification, assessment, mitigation, monitoring, and control of risks are available in the literature (Kaplan & Mikes, 2012; Kwan & Leung, 2011; Lee, Park, & Shin, 2009). This chapter focuses on the existing methods, highlighting their respective advantages and limitations.

2.2 Related Work

In the construction industry, risk management is considered as a continuous process which includes the identification, assessment, mitigation, monitoring, and control of the risks associated with projects. The nature, volume increase, and complexity of construction projects contribute to the need for an effective model, one that requires a managerial intervention approach and not a simple analytical approach (Thamhain, 2013). Project in the construction industry should not only consider project risks but also business risks (Schaufelberger, 2009). Contractors and owners have used mainly to maximize the profit margin and to minimize the cost of risk consequences (Zhao, Hwang, & Low, 2013). However, overemphasis on profit and cost can lead to the failure of, starting with inappropriate risk allocation and ending with the inability to deliver a project's objectives (Zhao, Hwang, & Low, 2013). Inappropriate risk allocation practice assigns the risk contractually to one of the project stakeholders without considering that stakeholder's capacity, ability, and efficiency to manage the associated risk (Hanna, Thomas, & Swanson, 2013).

Raydugin (2010) and Chapman & Ward (2003) clustered the risk associated with construction projects into two major categories: 1) Known risks, and 2) Unknown risks. Known risks (known-unknowns) are those which are included in a plan, and unknown risks (by definition) fail to be included. Kaplan and Mikes (2012) clustered construction risks into three major categories: 1) preventable risks (i.e. project risks, internal risks), 2) strategy risks (i.e. business risks, competition risks), and 3) external risks (i.e. political risks, natural risks). Regardless of the clustering scheme, the common practice is to use a pre-defined list with a limited number of risks associated with construction projects (Thamhain, 2013; Kaplan & Mikes, 2012; Raydugin, 2010; Tang, Qiang, Duffield, Young, & Lu, 2007; Chapman & Ward, 2003).

Risk Management procedures in the construction industry have recently received considerable attention from researchers (Marcelino Sádaba, Pérez-Ezcurdia, Echeverría-Lazcano, & Benito-Amurrio, 2014; Yoon, Tamer, & Hastak, 2014; Zhao, Hwang, & Low, 2013; Fang & Marle, A simulation-based risk model for decision support for project risk management, 2012; Banaitiene & Banaitis, 2012; Abdelgawad & Fayek, 2010), although a significant gap remains between the existing theory and practice of (Carvalho & Rabechini Junior, 2015; Taroun, 2014; Kelmeti, 2006; Baloi & Price, 2003). This review focused on the methods introduced for construction industry.

Marcelino-Sádaba et al. (2014) introduced a new methodology for small construction firms. Their method identifies two types of risks; operational and strategic. These risks are analysed and evaluated using a newly introduced risk priority index (RPI). Their method assumes that a project manager has selected a suitable response plan for each risk based on its respective RPI value. The monitoring process includes a list of general criteria to detect the failure of a risk response plan. The control process is initiated based on a set of general information which is received periodically. However, their method did not consider the interdependencies between the mitigation, monitoring and control processes.

Yoon et al. (2014) introduced a post-completion framework. Their method focuses on the impact of each risk on the profitability of construction projects. It identifies the risk items based on the difference between the cost of each activity at completion and its original contract cost. The assessment of each risk is based on the criticality of its respective impact on profit (PI). Their method recommended the use of general mitigation strategies: avoidance, transfer, education, and retention. However, it did not provide any monitoring and processes procedure, nor an evaluation procedure for the selected mitigation strategy.

Zhao et al. (2013) introduced a fuzzy based model to deal with enterprise for construction firms using a set of criteria wherein each criterion has a set of best practices identified through a survey conducted among professionals. Their method tends to rank the criteria and calculate the enterprise maturity index (ERMMI) based on the identified set of criteria (Zhao, Hwang, & Low, 2012). The ERMMI, a value between 0 and 1, was calculated using the fuzzy number for each best practice assigned by experts and the criteria's weights (Zhao, Hwang, & Low, 2013). However, this method can only be applied to evaluate the capacity of an organization to manage risk, rather than to managing the risk associated with projects.

Fang and Marle (2012) introduced a simulation based model for decision support in project. Their method takes into consideration the interactions, assumed to be independent, between different risks. It uses the cause and effect calculation to transform the risk structure matrix (RSM) into a risk numeric matrix (RNM). They claim that a combination of the evaluation (classic) and simulation methods could increase the reliability of their proposed method if historical data is available (Fang & Marle, 2012). However, it is not realistic to assume that historical data are always being available.

Dey (2012) introduced a new methodology for utilizing a multiple criteria decision-making (MCDM) technique and decision tree analysis (DTA). He suggested the identification of risks using a cause and effect diagram, and evaluates them using the analytic hierarchy process (AHP). The possible mitigation responses are then identified using the risk mapping generated by the qualitative assessment of risks. Decision tree analysis is used to select the best mitigation response. However, Dey's method does not provide any procedure to evaluate the effect of using a mitigation strategy. Also, no monitoring criteria or control procedure are provided; assuming that the mitigation strategy has always a good performance.

Abdelgawad and Fayek (2010) introduced a framework using fuzzy failure mode-effect analysis (FMEA) and the fuzzy analytical hierarchy process (AHP). Their method identifies the risks associated with construction projects at the work package level. It also recommends the assessment of probability (P), consequence (C), and detection (D) using linguistic evaluations. The results of their assessment process provide a qualitative value referred to as the risk criticality number (RCN). Based on the RCN value of each risk item, a general corrective action is recommended. However, each corrective action was based on one of the general mitigation strategies (e.g. avoid) with no systematic procedure for the evaluation of the corrective action being considered. Also, the method did not provide any monitoring criteria, or control procedure.

The development of a comprehensive procedure, which combines all of the processes, has received less attention from researchers. Therefore, it is necessary to review the literature of the methods developed for the identification, assessment, mitigation, monitoring, and control of risks associated with construction projects.

2.3 Risk Identification

Risk identification is the process that generates the register of risks associated with these projects. It is considered as critical process, because unidentified risks may be dangerous for one or more project objectives and may generate harmful consequences even before it can be addressed (Rounds & Segner, 2011; ISO, 2009). Also, Loosemore et al. (2006) assert that a single unidentified risk may totally cripple a project or business. Reliable risk identification process should first be performed to ensure effective risk assessment (Salah & Moselhi, 2013; Tworek, 2012; ISO, 2009).

Researchers introduced several methods for risk identification such as: checklists, documentation review (Deniz & Kaymak, 2007), brainstorming (Chapman R. J., 2001), surveys (Bajaj, Oluwoye, & Lenard, 1997), interviews (Chapman R. J., 2001), Strength Weakness Opportunity Threat (SWOT) analysis (Sweeting, 2011), nominal group technique (Delbecq & VandeVen, 1971), and Delphi technique (Chapman R. J., 1998). Results of a study about effectiveness of these techniques show that 68% of contractors use brainstorming technique to identify risks associated with construction projects (Tworek, 2010). Diagramming and analysis techniques are also used in identifying risks associated with construction projects such as; Organizational charts, Flow charts, Vulnerability analysis, Event chain diagrams, and decision trees. Borghesi and Gaudenzi (2013) conduct a comprehensive study of diagramming and analysis techniques in respect to type of project or business. They found that these techniques, on their own, cannot identify all risks associated with the project or business. Consequently, they recommended the combination of several techniques which may increase the likelihood of identification process success without providing a systematic procedure for identification. Fuzzy Set-based risk identification methods have been also introduced which integrate fuzzy set theory (Zadeh, 1965) with the Analytic Network Process (ANP) (Liu & Tsai, 2012), root cause analysis (Abdelgawad & Fayek, 2010), multi-criteria group decision making (Tavakkoli-Moghaddam, Mousavi, & Hashemi, 2011), and what is referred to as macro-approach (Borghesi & Gaudenzi, 2013). Moreover, other researchers investigated the methods used in risk identification of a specific field such as; safety and security (Raspotnig & Opdahl, 2013).

Raspotnig and Apdahl (2013) investigated the techniques used in identification of security and safety risks using an assessment framework which is based on twelve criteria: 1) time of use, 2) stakeholders, 3) type of system, 4) application area, 5) layered view, 6) input, 7) process, 8) output, 9) interoperability, 10) scalability, 11) creativity, and 12) communication. Results of the investigation highlighted the strengths and weaknesses of each technique with recommendations to improve by research. It also indicated that the techniques which are currently used for identification of security risks are considered more mature than the ones used for identification of safety risks.

Liu and Tsai (2012) introduced an identification method for major hazards. Their method utilized quality function deployment (QDF), root cause analysis, and fuzzy analytic network process (ANP). Their method is applicable to differentiate among hazards based on their respective criticality. However, this method focused on the ranking rather than identification of hazards and causes.

Tavakkoli-Moghaddam et al. (2011) introduced a new comprehensive approach for identifying and prioritizing risks of engineering, procurement and construction (EPC) projects. His method utilized multiple criteria group decision making (MCGDM) in a fuzzy environment based on the fuzzy entropy (Dhar, Chutia, & Mahanta, 2012) and VIKOR (Opricovic, 2011) techniques. However, their method provided a ranking system and selection procedure rather than identification.

Abdelgawad and Fayek (2010) utilized the root cause analysis for identification of risk associated with construction projects. They recommended the identification of risk events and root causes at work package level, rather than macro approach (Borghesi & Gaudenzi, 2013), as presented in the work breakdown structure (WBS). Their method was considered helpful, by two construction practitioners, in identification of risk events which require higher attention. However, their method did not provide a systematic procedure for risk identification prior to application of root cause analysis.

Hall (2008) claimed that risk identification process could be broken into four stages: 1) Identification of the unfavourable events, 2) Analysis of the hazards associated with each event, 3) Analysis of related contingencies, and 4) Identification of the types of effect stemming from each event. Their method is similar to SWOT analysis but it was focused on threats rather than opportunities.

An important part of risk identification process is the determination of risk ownership (Hanna, Thomas, & Swanson, 2013). The common practice for risk owner determination is to shift the risk being considered to one of project stakeholders (e.g. Contractor) with minimum effort and less cost. This allocation practice is referred to by Hanna et al. (2013) as inappropriate risk allocation method. Also, Peckiene et al (2013) described the contractual risk assignment as inequitable and unreasonable process. Hanna and Swanson (2006) suggested the selection of risk owner, among several project parties, based on his capacity and ability to evaluate, mitigate, monitor, and control this risk. Otherwise, the failure rate of project would be increased (Hanna, Thomas, & Swanson, 2013).

However, majority of risk identification researchers agreed that the scope of risk identification is to generate a risk register which include valuable and appropriate information about each risk such as: risk Number (ID), description, probability of occurrence, impact, risk owner, and planned response. However, risk register has no standardized document in terms of number and type of included information. Therefore, the common practice of risk register is that each company generates a customized risk register based on its needs (Morton, 2010).

2.4 Risk Assessment

The risk assessment process received higher attention from researchers as compared to other processes. Several methods for risk assessment have been developed which can be clustered into three categories: 1) qualitative assessment (Taroun, 2014; Lazzerini & Mkrtchyan, 2011), 2) quantitative assessment (Abdelgawad, Fayek, & Martinez, 2010), and 3) hybrid techniques called also semi-qualitative and semi-quantitative techniques (Marhavilas, Koulouriotis, & Gemeni, 2011a). The qualitative assessment evaluates, prioritizes the identified risk items and highlights the critical risk items based on their respective risk values. The quantitative risk assessment evaluates the consequences (in dollars values), and probability of occurrence of critical items in risk register. Then, the quantitative risk value can be calculated using Eq. 2.1. Researchers utilized different approaches to develop their methodologies for risk assessment such as: deterministic-based, simulation-based, and fuzzy set based. However, the main focus of this review is on the fuzzy set based methods.

Tmošaitienė et al. (2013) introduced a project ranking method based on a combination between technique of preference by similarity of ideal solution (TOPSIS) and fuzzy set theory (FST). The proposed method ranked the projects based on set of risks. Their method calculated the similarity to negative ideal solution "C" of each project. Then, it ranked all the projects based on their respective similarities where, a project with higher similarity is considered more critical than another with lower similarity. However, this method could be applied in qualitative assessment at the organization level rather than work package level.

Nieto-Morote and Ruz-Vila (2011) introduced a fuzzy approach for risk assessment of construction project. Their method calculated the overall risk factor as multiplication of risk probability of occurrence and risk impacts divided by risk discrimination. The risk discrimination, which was proposed by Cervone (2006), represents the relation between risks by gauging the impact of risk to the overall perspective of project rather than the independent perspective. However, their assessment method is complicated and its application requires an expert.

Fuzzy set theory has been also used by Dikmen et al. (2007). They introduced a framework using decision matrix based on fuzzy linguistic value and aggregation rules. Their method calculated the rating of risks associated with construction projects at the project level rather than at the work package level.

Lazzerini and Mkrtchyan (2011) introduced a method using fuzzy set theory for tackling the subjectivity and complexity of risk assessment using the Extended Fuzzy Cognitive Maps (E-FCMs). The use of E-FCM allows the mapping of fuzzy rules among risks and risk factors.

However, their method incorporated high level of subjectivity in the process of relationship elimination.

Kangari and Riggs (1989) utilized the linguistic capability of fuzzy set theory to assess the risk associated with construction project. Their method evaluated the total risk level of the project based on the severity of loss “S” and the Euclidean distance “d”. The distance is calculated between the “S” and the predefined fuzzy sets (i.e. Low, Medium, and High). The fuzzy set which has the smallest distance to “S” represents the overall risk level of the project.

The output of qualitative risk assessment usually is a mapping system which highlights the criticality of each risk item based on its respective qualitative risk value. However, risk mapping may differ from an organization to another; it also may differ from a risk type to another. Table 1 shows an example of risk mapping based on scale from 1 to 25 where, 1 denotes the ultimate very low and 25 represents the ultimate very high.

Table 2- 1

Risk				
Very Low	**Low**	**Moderate**	**High**	**Very High**
Score<3	3< Score<9	9< Score<16	16< Score<22	Score >22

Several methods have been introduced in literature for quantitative risk assessment. However, similar to the qualitative assessment, this review is focused only on the fuzzy set theory based methods. Polat and Bingol (2013) introduced, using fuzzy logic and multiple regression analysis (MRA), a method to predict the contingency required to manage the risk associated with international construction projects. Their method integrated the Mamdani's inference by employing linguistic logical rules which are constructed using the expert judgment. However, their method achieved a reliable contingency estimation, as compared to MRA, at the project level rather than at the work package level.

Zhao et al. (2013) introduced a quantitative assessment model to quantify the risk using an enterprise risk model. Their model utilized fuzzy theory to tackle the problems relating to the imprecision and ambiguity of expert judgment. Their model calculated the fuzzy representation of each risk based on its respective weight and evaluations of experts. However, this method provided an evaluation system for maturity of organization risk without consideration of type of risk or level of risk.

Researchers use hybridization of fuzzy system with other approaches to overcome the limitations of these approaches and to model the imprecision and ambiguity associated with project risks. However, this hybridization transfer the limitations of these approached to the fuzzy system. Liu and Tsai (2012) introduced a hybrid method between fuzzy set theory (FST) and the failure modes and effect analysis (FMEA) used to assess the risk value of hazard causes based on the fuzzy inference approach. However, their method was applicable only when limited number of risks is involved. It also utilized fuzzy number with triangular membership function only with recommendation to incorporate other membership function shapes.

Abdelgawad and Fayek (2012) introduced a framework for construction projects risk using failure mode and effect analysis (FMEA), fault tree analysis (FTA), and Fuzzy Logic. This method was used to calculate the overall probability (OP) and expected risk magnitude (ERM). Output of their method was a percentage of risk allowance at project level based on selected mitigation strategies. However, it did not provide a mitigation strategy selection procedure and it did not consider the cost and the efficiency of each strategy. .

Abdelgawad et al. (2010) for quantitative risk assessment of horizontal drilling project. The method uses the fault tree to calculate the top event fuzzy probability based on the basic event which may cause the occurrence of this risk. The proposed method calculated the fuzzy probability of the top event using the α-cut method and the mean of maximum method. However, their method did not considers the uncertainty associated with the determination of relation (i.e. “OR” and “AND” gates) between top risk event and its respective factors.

Sadeghi et al. (2010) introduces a new hybrid method which combines the fuzzy set theory and Monte Carlo simulation. The Fuzzy Monte Carlo Simulation (FMCS) method uses a combination between probabilistic input and three types of fuzzy input: 1) Constant, 2) uniform, and 3) triangular. The method has ability to capture the fuzzy as well as probabilistic uncertainty using the generated fuzzy cumulative distribution function. However, their method is similar to hybrid-based methods and considers only the Inf and Sup values of α-cuts in formulating the decision making process.

Shaheen et al. (2007) introduces a quantification method for estimating the cost range of construction project using fuzzy set theory. However, their method includes a lengthy procedure for data collection using several rounds of Delphi method. Similarly, Salah and Moselhi (2015) provide a quantitative method that provides a simpler procedure for range cost estimating and provides a systematic calculation for contingency associated with the project. However, both methods did not consider the fuzzy membership calculations and assumed the membership function of cost range estimating has a trapezoidal shape which is not always reflect the reality.

In addition, fuzzy set theory has been used to quantify the risk associated with a specific type of: projects (Li & Zou, 2012; Tong-yin, Wei, & Ying-hua, 2011; Xu, Yeung, Chan, Wang, & Ke, 2010; Ebrahimnejad, Mousavi, & Seyrafianpour, 2010), contracts (Chan J. H., Chan, Chan, & Lam, 2011; Bi & Tan, 2010), or specific risk categories Ling & Low, 2007) (Aminbakhsh, Gunduz, & Sonmez, 2013; Arikan, Dağdeviren, & Kurt, 2013; Liu & Tsai, 2012; Badri, Gbodossou, & Nadeau, 2012; Rolstadås, Hetland, Jergeas, & Westney, 2011; Kong, Lu, Kang, Lo, & Xie, 2011; Ling & Low, 2007). However, these methods quantified the risk at macro level and they are applicable only when limited number of risks is involved.

2.5 Risk Mitigation

Risk mitigation process has major influences on success of the risk management plan and has an important impact on cost overrun and schedule delays of projects (Hanna, Swanson, & Aoun, 2014). Despite that, considerably less work has been directed toward risk mitigation (Lyons & Skitmore, 2004). Majority of the risk mitigation work available in literature focused on the use of general mitigation strategies such as: avoidance, transfer, retention, and reduction (Zhang & Fan, 2014; Fang, Marle, Xie, & Zio, 2013; Fang, Marle, Xie, & Zio, 2013; PMI, A Guide to the Project Management Body of Knowledge, 2013; Abdelgawad & Fayek, 2012; Abdelgawad, Fayek, & Martinez, 2010; Baker, Ponniah, & Smith, 1999; Raftery, 1994). However, a recent survey conducted by Burns (2012) highlights the ineffectiveness of general mitigation strategies. The results of this investigation showed that 3.7% suffer from an increase in cost and 33.3 % of the participants received no reduction when risk transfer has been used as shown in Figure 2.1. It also showed that 4.6% suffered from an increase of risk cost, 34% were not sure, and 7% received no reduction when retention has been used as shown in Figure 2.1 (Burns, 2012).

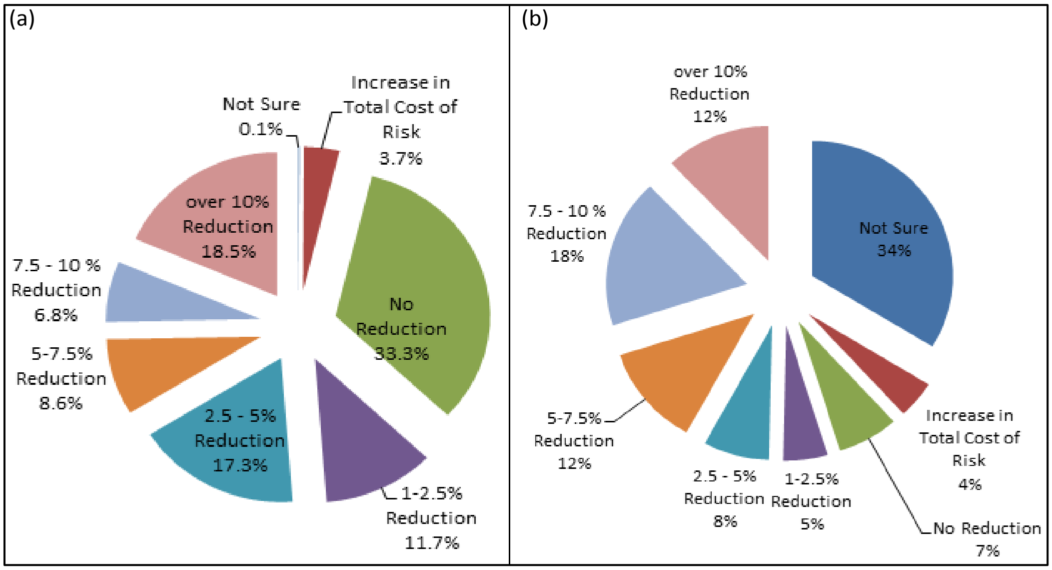


Figure 2.1 Use of General Mitigation Strategies: a) Transfer, b) Retention (Burns, 2012)

Fan et al. (2015) introduced selection procedure for risk response using case-based reasoning (CBR). Their method selected the risk response(s) based on similar case from historical data. However, their method is predicated on availability of historical data and its application required human interventions especially for identification of inapplicable strategies. Also, their selection procedure is lengthy and it is only applicable when limited number of risks is involved.

Other researches focused on evaluation of limited number of risk mitigation strategies (Morris, 2014; Agrawal, 2012; Abdul-Rahman, Loo, & Wang, 2012; Chan J. H., Chan, Chan, & Lam, 2012; Fang & Marle, 2012; Hallowell & Gambatese, 2009). Morris (2014) provided a review of practical mitigation actions such as "buying an insurance policy" however this review did not provide any systematic and structured procedure for selection of risk mitigation strategy.

Agrawal (2012) investigated a list of risk associated with renewable energy projects and recommended a mitigation strategy for each risk item. However, the recommendations failed to indicate the contribution of recommended strategies in decreasing the risk value. Similarly, Abdul-Rahman et al. (2012) focused in his study on the mitigation of risks associated with construction project in Gulf area using a questionnaire. The questionnaire was successfully completed by 143 respondents (41 Architect, 35 Engineer, and 67 Contractor). The method uses the risk significance index to rank the risk factors. Then, a list of risk response measures has been identified based on three categories: engineering, construction common. Their method presented a comprehensive description of the identified risk factors and recommended a response measure for each risk. However, their method is considered as subjective because it did not provide any systematic selection procedure. Also, it did not indicate the effect of each mitigation strategy on its respective risk factors.

Chan et al. (2012) utilized the questionnaire method to rate the effectiveness of 18 risk mitigation strategies. The respondents were requested to evaluate the 18 strategies based on scale of 5: least effective, fairly effective, effective, very effective, and most effective. Their method first rated the proposed mitigation strategies individually and then it consolidated these strategies into seven groups to overcome the interdependency effects. The results showed that the highly rated strategies are; 1) right selection of project team, 2) mutual trust between contract parties, 3) clearly defined scope of works, 4) involvement of contractor in development process at early stage, and 5) proactive participation by the main contractor throughout the GMP process.

Fang and Marle (2012), based on a simulated risk frequency, compare the risk frequency with a classic mitigation action (i.e. without interactions among risks) and new mitigation action (i.e. with interactions among risks). The new mitigation actions show a decrease of the risk frequency by 60% at the local mitigation level. Then, different types of strategies (i.e. action 1, 2, and 3) have been compared to “no-action” strategy. The results show that action 3 has higher effect on all risks except the risk 3 as shown in Figure 2.2. However, their method assumed that same strategy (e.g. action) can be applied to mitigate all risks associated with the project. Also, it did not provide any systematic evaluation for each mitigation strategy and how it decreases the value of each risk item.

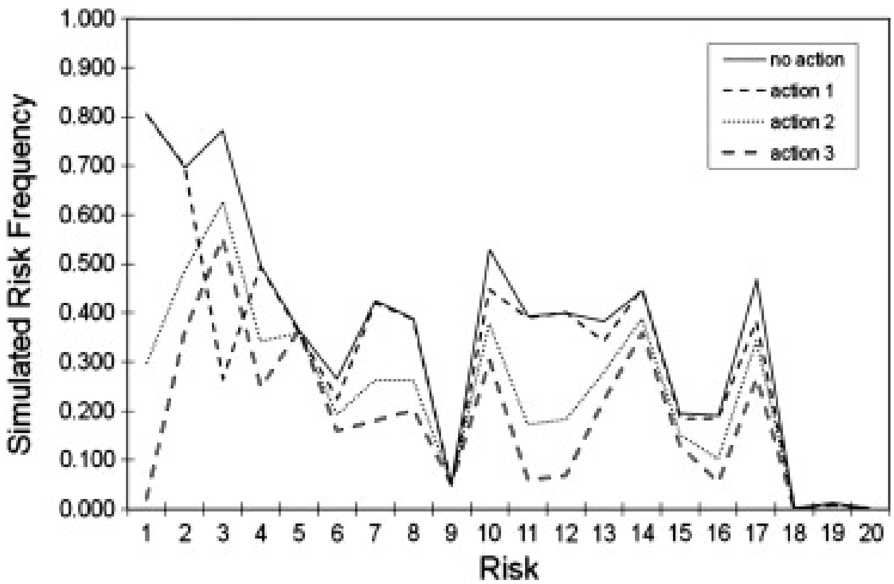


Figure 2.2 Comparison of Risk Mitigation Actions (Fang & Marle, 2012)

Hallowell and Gambatese (2009) focused on mitigation strategies of safety risks associated with construction projects. Their method was based on Delphi technique using a questionnaire. It quantified the ability of each strategy to mitigate the individual risk. Then, it calculated the total capacity of each strategy as the sum of its respective capacities on all risk items. However, their method dealt with a limited number of risks with a limited number of strategies.

The literature review of risk mitigation practice showed intuitive judgment in selecting the mitigation strategies and responses. The lack of reliable methodologies and documented standards leads practitioners to generate a list of strategies and responses. These strategies are used to mitigate limited number of identified risks associated with construction projects.

2.6 Risk Monitoring

Risk monitoring process represents a major challenge for practitioners, especially under ever increasing complexity of construction projects (Wilson, 2015). Risk monitoring is important to ensure that the exposure to a specific risk is not being exceeded (Hopkin, 2014). The aim of monitoring process is to establish an indicator system over which project managers could evaluate the risk mitigation plan. Unfortunately, risk monitoring process received considerably less effort from researchers even though the majority agreed that risk monitoring is a mandatory process. The lack of risk monitoring methodologies in literature enforced practitioners to use basic project management tools (e.g. Earned Value) for risk monitoring (Pritchard, 2015; Kerzner, 2013).

The results of a survey conducted by Deloitte and Forbes (2012) revealed that less than 25% of construction industry practitioners use continuous risk monitoring. It also showed that 90% of surveyed executives consider, as priority, the restructure of their procedure by end of 2015. Also, half of the survey's respondents confirm their plans to invest in development of a continuous risk monitoring system. In addition, Zi-mei and Ke-fan (2013) declared that no attempt was made to identify the precise timing for the initiation of risk control process.

Fang and Marle (2012) concluded that the risk monitoring process has a continuous evolvement of risk network since there are always newly identified risks which should be evaluated. Consequently, the risks should be re-evaluated based on the interactions of previously mitigated risks and newly identified risks. Their method recommended the update of risk network and risk response plan based on newly identified risks. However, it did not provide a systematic procedure for monitoring the performance of selected mitigation strategy.

Likewise, Liu et al. (2011) proposed a method for risk monitoring based on risk matrix method. Their method recommended the use of risk monitoring instruments based on the ranking of risk level using a scale from 1 to 5. The risk matrix method has been used to evaluate the risk level of the risks associated with deep excavation projects. They claimed that their method allows for identification of abnormal and dangerous situations. However, their method provided a reactive monitoring system which is based on field observations and reports. It also provided general recommendations for risk monitoring rather than a systematic procedure with a clear set of evaluation criteria.

Ning and Mao (2011) introduced a new method for risk monitoring. Their method was able to maps the interaction between four categories of risks: managerial, technical, environmental, and economical. These interactions allow users to compare between the targeted and actual risk value of each category. For example, if actual is higher than targeted risk value then, a mitigation strategy is applied to reduce this score. This procedure is repeated until the actual risk value is at least equal to targeted risk value. However, their method did not provide any systematic procedure for selection of mitigation strategy. Also, it assumed that the targeted risk value can be always reached. Also, the performance of mitigation strategy is not considered as one of the monitoring criteria.

Ehsan et al. (2010) suggested that the risks associated with construction projects should be monitored based on predictive indicators. These indicators should provide an early warning once the project reaches a risky point. They also suggested the preparation of a contingency plan prior to the occurrence of risk event. The amount of contingency for each risk is calculated based on the risk consequences. However, their method did not provide a calculation procedure for the contingency fund. Also, it recommended the use of predictive indicators rather than a systematic monitoring procedure based on actual data.

The literature review of risk monitoring showed intuitive judgment in selection of the monitoring procedure. The performance of selected mitigation strategy is not accounted as one of the monitoring criteria. It also highlighted that the precise timing for initiation of control process is not considered as part of the monitoring system.

2.7 Risk Control

Risk control represents a dynamic process throughout the life-cycle of construction project. Researchers recommended the use of a general mitigation strategy (e.g. Transfer) for risk control tool without providing any systematic procedure for selection or evaluation (Lingard, et al., 2015; Borghesi & Gaudenzi, 2013; Baker, Ponniah, & Smith, 1999). Other researchers (Ehsan, Alam, Mirza, & Ishaque, 2010; Curtis & Turley, 2007; Dey, Kinch, & Ogunlana, 2007) consider the risk control as continuous and dynamic process which incorporates subjective and intuitive selection of control actions based on the results of monitoring process (Lingard, et al., 2015). The different meanings of risk control process, in literature, justified the volume of research effort oriented toward it.

Pritchard (2015) recommended the use of risk review as risk control method. He claimed that the risk review allows the examination of risk status, and mitigation strategy performance. It also highlights the need for supplemental mitigation strategy (e.g. action). However, his method did not provide any systematic procedure or criteria for mitigation strategy evaluation.

Mahendra et al. (2013) considered the risk control process as a part of the monitoring process. If the strategy has positive effect on the risk being considered then, no control action is required. Otherwise, it is recommended to register the results of the selected mitigation strategy for future risk management plan. However, their method is considered as reactive because it affects the risk management plan of future projects. Also, it did not provide any systematic procedure for risk control. Similarly, Dey et al. (2007) suggested the control of occurred risk dynamically through faster decisions form a small decision group. This group include representatives from both developer and owner sides and it has to work closely with risk monitoring group. However, the type and quality of shared information between monitoring and decision groups are not clear. Also, the method did not provide a systematic evaluation or selection procedure for such decision.

The literature review of risk control showed intuitive judgment in selection of the control procedure. It also illustrated the different meanings of risk control process from a practitioner to another. It also highlighted the lack of a systematic risk control procedure which considers the results of monitoring process and performance of selected mitigation strategy. Also, the literature highlighted the lack of systematic decision support which indicate the precise time for initiation or termination of control process based on set of criteria.

2.8 Summary

2.8.1 Gap and Limitations

The literature cited above on risk management depicts the following gaps and limitations:

1. Identification techniques cannot identify risks associated with projects in a comprehensive manner.
2. Inadequate procedures for risk allocation and related risk ownership determination.
3. No systematic interaction between qualitative and quantitative assessment.
4. Mitigation procedure suffers from the lack of reliable methodologies for evaluation and selecting the most appropriate mitigation strategies.
5. Lack of specialized risk monitoring methodology.
6. Inability to determine precise time for imitating risk control process.
7. No systematic control procedures to overcome subjective judgement.
8. No consideration of interactions among the risk management processes need for comprehensive and robust risk management..
9. Application of risk management at macro level rather than micro level; which makes it difficult to identify the root causes behind unacceptable performance.

2.8.2 Modelling Techniques

Probabilistic modelling methods deal with randomness of variables similar to probability theory. The application of simulation-based methods (i.e. Monte-Carlo Simulation) needs historical data. The construction projects represents planned, rather than random, human actions which incorporate imprecision and vagueness. In addition, the historical data are not always available which prevent the application of simulation-based method. Therefore the fuzzy set theory (Zadeh, 1965) is integrated in this research. The selection of fuzzy set theory is based on its definition as a theory that allows the modelling of imprecision and vagueness associated with variables (Zadeh, 1965). Also unlike probability theory, the application of fuzzy set theory does not require historical data. In this research, the algebraic sum and product introduced by Zadeh (1965) are used to add and multiply the fuzzy numbers.

2.8.3 Opportunities vs. Threat

The literature on risk management generally deals with threats. However opportunities may assist in decreasing the effect of threats. This research focuses on management of threats however the opportunities can be considered as negative threats as described later in Chapter 3. For example, the difference between the costs of threats and opportunities represents the cost of risk associated with the project. It should be noted that the opportunities, unlike threats, are favourable to occur and their benefits have to be maximized.

CHAPTER 3: COMPREHENSIVE RISK MANAGEMENT MODEL

3.1 General

The aim of this chapter is to provide a comprehensive description of the developed model for risk management. This chapter presents the methods and algorithms used to perform each process in risk management. The developed model provides a comprehensive and systematic risk management procedure for construction projects. Figure 3.1 depicts this chapter's main sections. The methodology represents integration, in one computational platform, of five newly developed methods for identification, assessment, mitigation, monitoring, and control of risks associated with construction projects. Included also is brief over view of fuzzy set theory and macro versus micro modelling prior to the description of the developments made in this chapter.

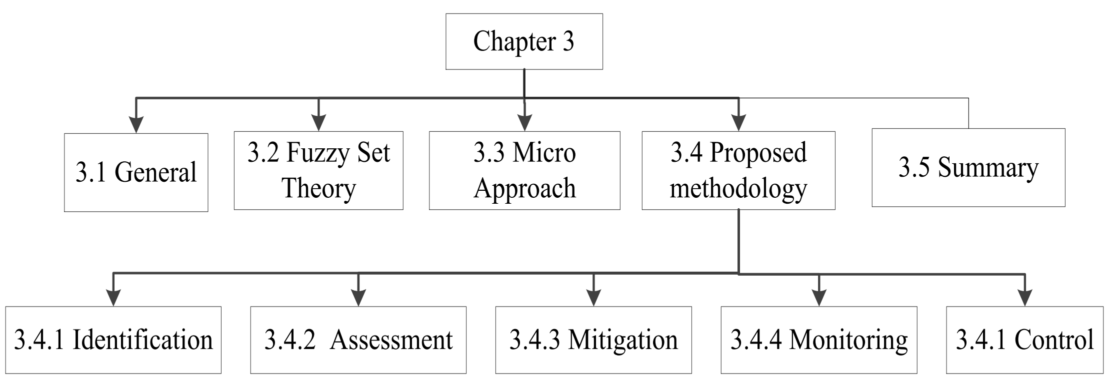


Figure 3.1 Chapter 3 Overview

3.2 Fuzzy Set Theory

Fuzzy set (Zadeh, 1965) and fuzzy probability (Zadeh, 2008) theories are found more suitable to model uncertainty associated with risk mitigation input. Unlike probabilistic and statistical techniques, these theories can be used regardless of the availability of historical data (Liu B. , 2015). Also, fuzzy theory facilitates the use of linguistic evaluation, or natural language terms, which is difficult to express with probability theory (Pinto, Nunes, & Ribeiro, 2011). In addition, probability theory is based on the assumption of randomness, whereas construction projects deal with consciously planned human actions that are generally not random (Faber & Stewart, 2003; Nilsen & Aven, 2003). Therefore, fuzzy set theory was selected to model the uncertainty associated with input of the developed model (Salah & Moselhi, 2015).

3.2.1 Fuzzy Numbers

Fuzzy numbers are usually represented using a quadruple of real numbers [a, b, c, d] where the interval [b, c] represents the core and interval [a, d] represents the support as shown in Figure 3.2. Fuzzy numbers are characterized by their membership function μ(x) which can be expressed as shown in Eq. 3.1.

$$\mu(x) = \begin{cases} 0, & -\infty < x \leq a \\ f(x), & a < x \leq b \\ g(x), & b < x \leq c \\ h(x), & c < x \leq d \\ 0, & d < x \leq +\infty \end{cases} \quad 3.1$$

Four basic types for fuzzy numbers can be used to model the uncertainty associated with an input. The crisp fuzzy number is represented by a singleton (e.g., [a]) and its membership function equals to 0 except for x=a. Uniform fuzzy number is represented using the core only (e.g., [a=b, c=d]), which means right and left boundaries are equals to 0 respectively. Triangular fuzzy number is represented by a triplet (e.g., [a, b=c, d]) which represents its left and right boundaries. Trapezoidal when the fuzzy number is represented by quadruple (e.g., [a, b, c, d]) and its membership function is presented in Eq. 3.1. The membership function of a trapezoidal fuzzy number is shown in Figure 3.2.

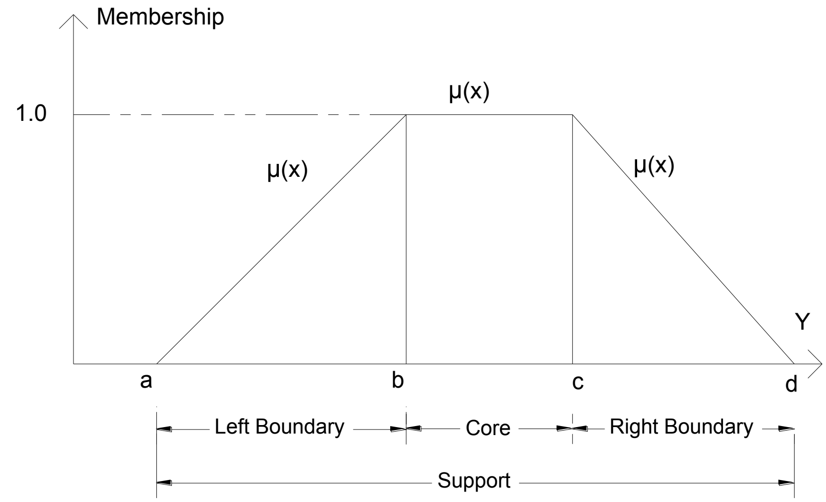


Figure 3.2 Trapezoidal Fuzzy Membership Function

3.2.2 Fuzzy Operations

Literature provides several fuzzy operation definitions that include: addition, subtraction, multiplication, and division (Nieto-Morote & Ruz-Vila, 2011). However, in this thesis two types of fuzzy addition have been used: addition of dependent fuzzy numbers, and addition of independent fuzzy numbers (Eq. 3.2a). The addition of dependent fuzzy numbers represents the combination of several evaluations, using expert (j) judgement, for the same fuzzy number "A" (e.g., A_j) as shown in Eq. 3.2b which represents the algebraic sum introduced by Zadeh, (1965). Where, (Λ) and (V) operators are utilized to minimize and maximize respectively expert evaluations for the four items of the quadruple that represents the fuzzy number A. In the other hand, the addition of independent fuzzy numbers represents the addition of different fuzzy numbers (e.g., A + B), for example, the cost of each risk consequence is added on top of other consequences. The addition of independent numbers adds the quadruple elements as shown in Eq. 3.3. As for Fuzzy multiplication or algebraic product (Zadeh, 1965), only the multiplication of independent fuzzy numbers is used as shown in Eq. 3.4.

Addition of dependent fuzzy numbers:

$$\widetilde{A}=\widetilde{A}_1+\widetilde{A}_2+\ldots+\widetilde{A}_n=\left[\bigwedge_{i=1}^{i=n} a_{i1}\,,\bigwedge_{i=1}^{i=n}(a_{i2},a_{i3})\,,\bigvee_{i=1}^{i=n}(a_{i2},a_{i3})\,,\bigvee_{i=1}^{i=n} a_{i4}\right] \quad 3.2a$$

Equation (3.2a) provides a quadruple representation of the algebraic sum operation introduced by Zadeh (1965). Equation 3.2b shows that the membership of the sum f_{A+B} of two fuzzy numbers equals to 1 when f_A or f_B is equal to 1. However, it equals 0 only when f_A and f_B are equal to 0 thus Equation 3.2a is generated.

$$f_{A+B} = f_A + f_B - f_{AxB} \quad 3.2b$$

Addition of independent fuzzy numbers:

$$\widetilde{A}+\widetilde{B} = [a_1 + b_1, a_2 + b_2, a_3 + b_3, a_4 + b_4] \quad 3.3$$

Multiplication of two independent fuzzy numbers:

$$\widetilde{A}\times\widetilde{B}=[a_1\times b_1, a_2\times b_2, a_3\times b_3, a_4\times b_4] \quad 3.4$$

Defuzzification methods are commonly used to transform fuzzy number into a real number (Nieto-Morote & Ruz-Vila, 2011). Several defuzzification methods exist in the literature such as: centre of area (COA), center of sum (COS), center of maximum (COM), and mean of maximum (MOM). However, the centre of area method presented in Eq. 3.5 is employed for defuzzification of fuzzy numbers because, unlike the other defuzzification methods, it incorporates all areas of membership functions. Also, it considers that all such areas to be of equal importance.

$$A=\frac{\int_{-\infty}^{+\infty} x\times\mu_{\widetilde{A}}(x)dx}{\int_{-\infty}^{+\infty} \mu_{\widetilde{A}}(x)dx} \quad 3.5$$

3.3 Macro vs. Micro

Micro and macro are different but equally important (Taylor, 2014). The macro is based on similarity and treats a large population of risk items together as shown in Figure 3.3. In the other hand, the micro represents the practice that treats each risk items individually (Taylor, 2014). Complexity of construction projects and uniqueness of the construction processes generate unique set of risks. Managing those risks requires a plan for responses, at the individual level, to decrease their consequences. As compared to macro, micro has several benefits. Therefore, it was integrated in the proposed model. These benefits include but are not limited to:

1. Number of risks associated with micro level is limited.
2. Identification rate of risks and their respective consequences is increased.

3. Alteration between micro to macro levels is possible.
4. Critical risk items, within a group or category, are identifiable.
5. Potentials for minimizing the consequences of critical risks are recognizable.

Figure 3.3 Example of Risk Management at Macro Level

It should be noted that the number of risks at micro level is way higher than that at the macro level. However, dealing with risks at the micro level indicates the potential failure before the risk becomes bigger and uncontrollable. The Figure 3.3 shows an example of macro risk level which deals with risk associated at category level where internal risks represents those with direct relation to the project activity (e.g. safety) external risks those which affect the project without direct relation to the project activities (e.g. labour strike).

3.4 Methodology

The developed model follows traditional practices, however; it provides a comprehensive procedure that deals with risk items, associated with construction projects, continuously from identification up to control processes. The developed model is based on fuzzy set theory (Zadeh, 1965), fuzzy probability theory (Zadeh, 2008) and micro approach (Taylor, 2014). Figure 3.4 presents the outline of developed model, which encompasses five methods for identification, assessment, mitigation, monitoring, and control respectively. The developed model inherits its dynamic feature from the continuous interactions among its five processes as shown in Figure 3.4. Each process interchanges with other processes, as required, newly collected data to update the risk management plan. The developed model makes use of the micro approach to decrease the number of risks associated with the level being considered and to increase the rate of identification of these risks as shown in Figure 3.5.

The identification method introduces the micro-risk breakdown structure (MRBS) which employs the micro approach to elevate the identification rates of known and unknown risks considerably. In this research, known risks represent those which are already encountered, managed and documented in previous projects. Unknown risks represent those which are not previously encountered or managed. The developed risk identification introduces a systematic methodology for risk ownership determination using a set of identified criteria and fuzzy theory (Zadeh, 1965). It also provides a new risk register document that provides a comprehensive set of information about each risk. The assessment method evaluates the risk qualitatively and quantitatively using fuzzy set theory (Zadeh, 1965) and fuzzy probability theory (Zadeh, 2008), which are referred to as fuzzy theory.

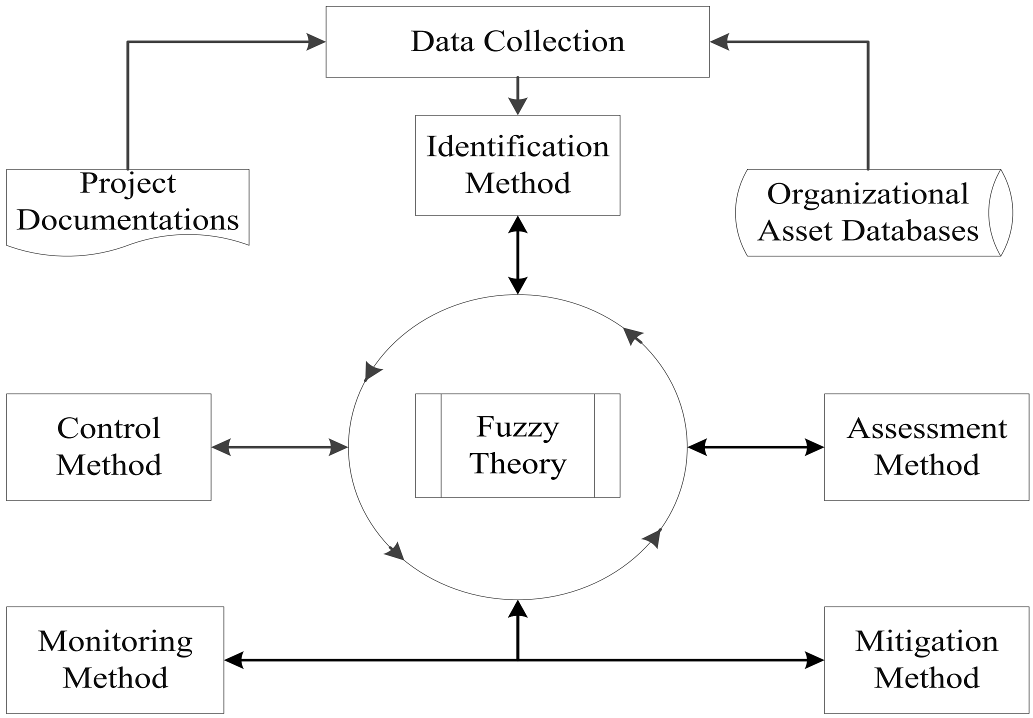


Figure 3.4 Overview of Developed Model

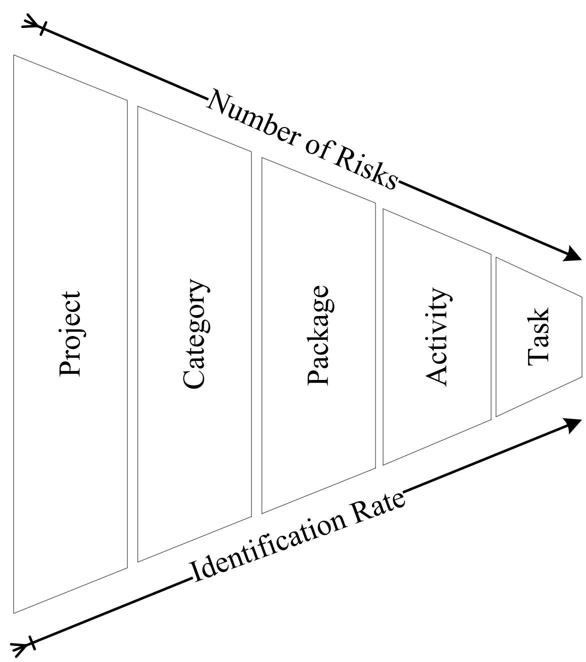


Figure 3.5 Characteristics of Micro Approach

The developed model provides a new risk mapping technique that utilized the qualitative risk value and fuzzy calculation. The quantitative risk assessment calculates the newly introduced pre-mitigation contingency (PREMC), which represents the quantitative risk value prior to consideration of mitigation strategy. The mitigation method evaluates the possible mitigation strategies for each risk and selects the most suitable mitigation strategy based on newly introduced planned efficiency factor (PEF). It also introduces the post mitigation contingency (POSTMC), which represents the quantitative risk value after implementation of selected mitigation strategy. The monitoring method represents a continuous process that aims to identify the possible failures of selected mitigation strategy based on the analysis of planned efficiency factor (PEF) vs. actual efficiency factor (AEF). It also identifies and highlights, based on the results of the analysis, the precise timing for initiation of the control process. The control method evaluates and selects the most suitable control action (CA) based on the monitoring results. It also introduces the post control cost factor (PCF) which indicates the effectiveness of selected control action. It also provides a decision-making support that allows users to update their risk management plan based on newly collected data from occurred risks and/or failed mitigation strategy.

3.4.1 Identification

The developed risk identification method makes use of a micro approach to identify, at the task level, the known and majority of unknown risks associated with construction projects. It addresses the inappropriate risk allocation by introducing a systematic procedure for determination of risk ownership using fuzzy theory. It introduces the risk responsibility matrix using “one risk, one owner” approach to determine and allocate the risk responsibilities among project team members. The procedure of develop method includes six phases: data collection, generation of micro risk breakdown structure (MRBS), identification process, determination of risk ownership, generation of risk responsibility matrix (RRM), and generation of risk register. These phases are described below.

The developed risk identification method collects data, using data gathering tools, from project documentations and organizational asset databases such as: past experience database, and learned lessons database as shown in Figure 3.6. Successful data collection, which includes data pertinent to work breakdown structure (WBS) and organization breakdown structure (OBS), eases the generation of micro risk breakdown structure (MRBS) and risk responsibility matrix (RRM).

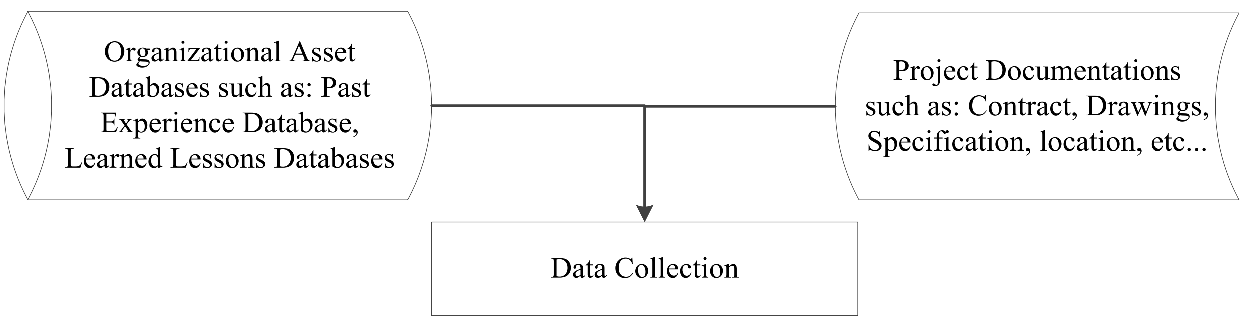


Figure 3.6 Data Collection

After data collection, a micro risk breakdown structure (MRBS), which breakdowns the project up to task level, is generated as shown in Figure 3.7. Generated MRBS identifies the known risk items and increases the identification rate of unknown risk items considerably by focusing only on risks associated with the individual task. Similar to project WBS, the MRBS helps users to assign a unique identification number (UIDN) for each risk item (m) using numbers of: associated task (k), activity(j), package(i), category(l), and project (p) as shown in Figure 3.7.

The number of levels in MRBS differs from one project to another, therefore, the UIDN referred to risk item associated with a certain project differs from the UIDN refers to the same risk in another projects. However, a standardized UIDN, which represents the same risk in all the projects, can be reached if an organization uses a fixed number for levels.

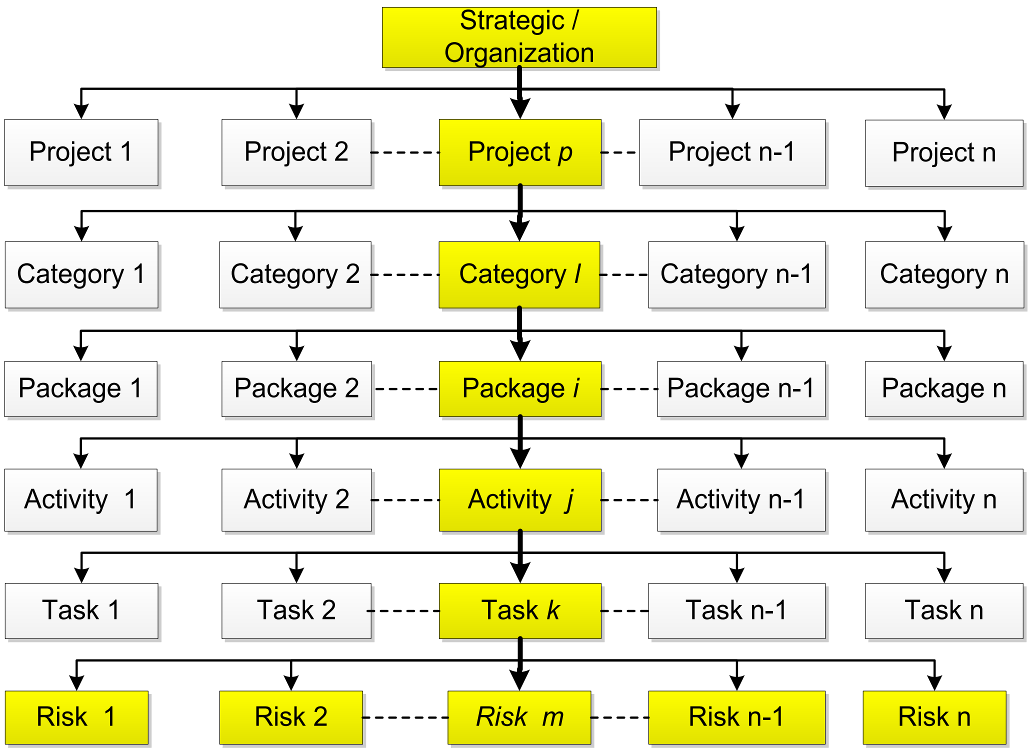


Figure 3.7 Micro Risk Breakdown Structure

Experts identify, using a combination of identification tools, the known risk items associated with each task as shown in Figure 3.8. However, unknown risk items are identified using root cause analysis along with brainstorming and cause effect diagram as shown in Figure 3.8. The use of micro level (i.e., task level) may elevate the rate of identification for known and unknown risks and their respective consequences considerably.

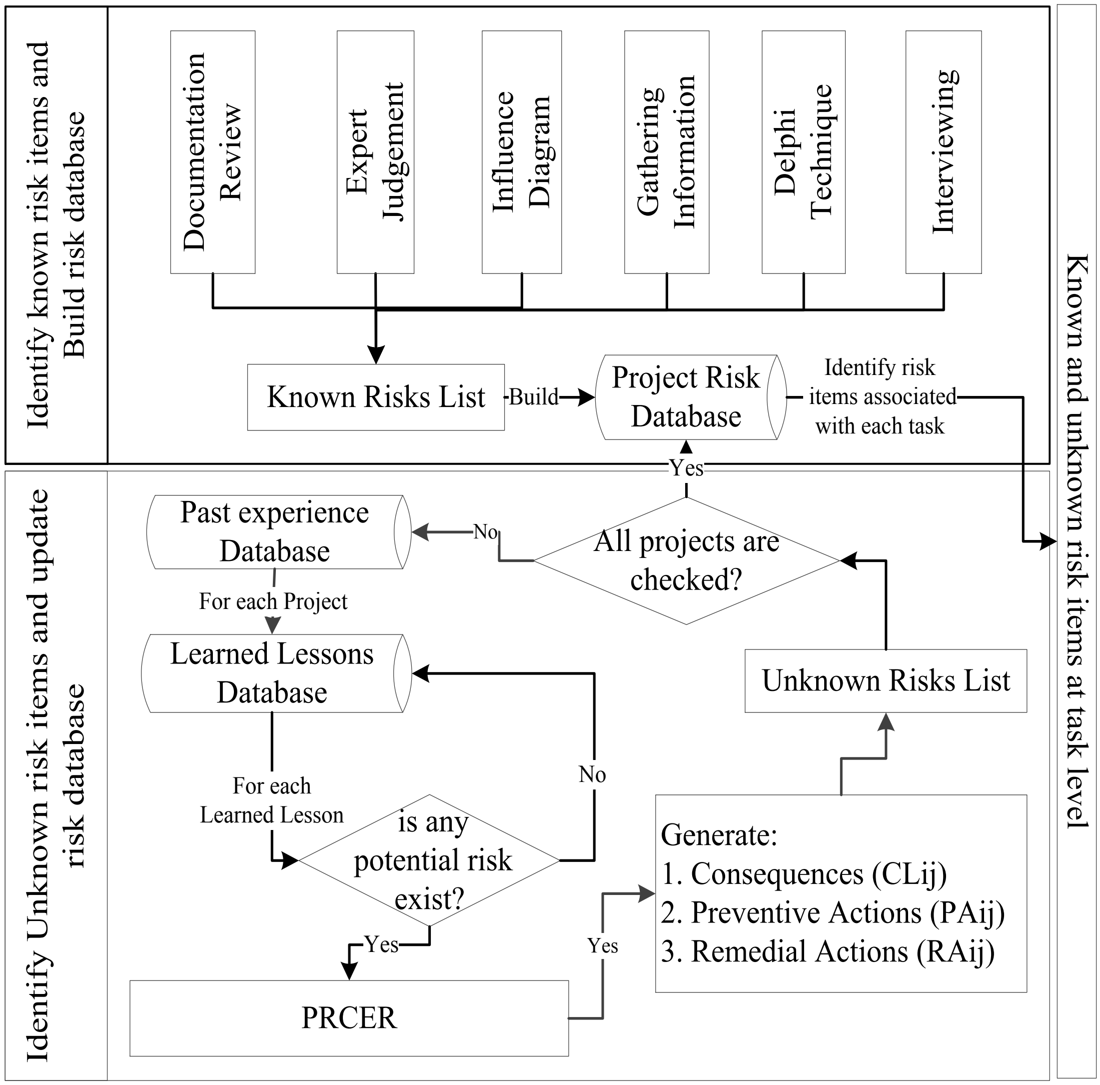


Figure 3.8 Identification Process

Past experience database and documented learned lessons database represent the main sources for identification of problems, non-conforming procedure or difficulties confronted in similar projects. The developed identification method utilizes a newly introduced an algorithm referred to as Preventive Root Cause and Effect Remedial (PRCER), which combines three types of techniques: root cause analysis, cause effect diagram and brainstorming. The root cause analysis (RCA) identifies the root causes, and brainstorming technique identifies their respective preventive actions. The cause effect diagram identifies the consequences of a risk, and brainstorming technique identifies lists of remedial actions. The PRCER algorithm, shown in Figure 3.9, is similar to Bow-Tie method that presented for health and safety risk analysis. However, unlike bow tie method, PRCER has two-way identification process for cause ⇔ risk and consequence ⇔ risk. The two ways identification process allows the identification of cause (consequence) if the risk item has been identified first and vice-versa.

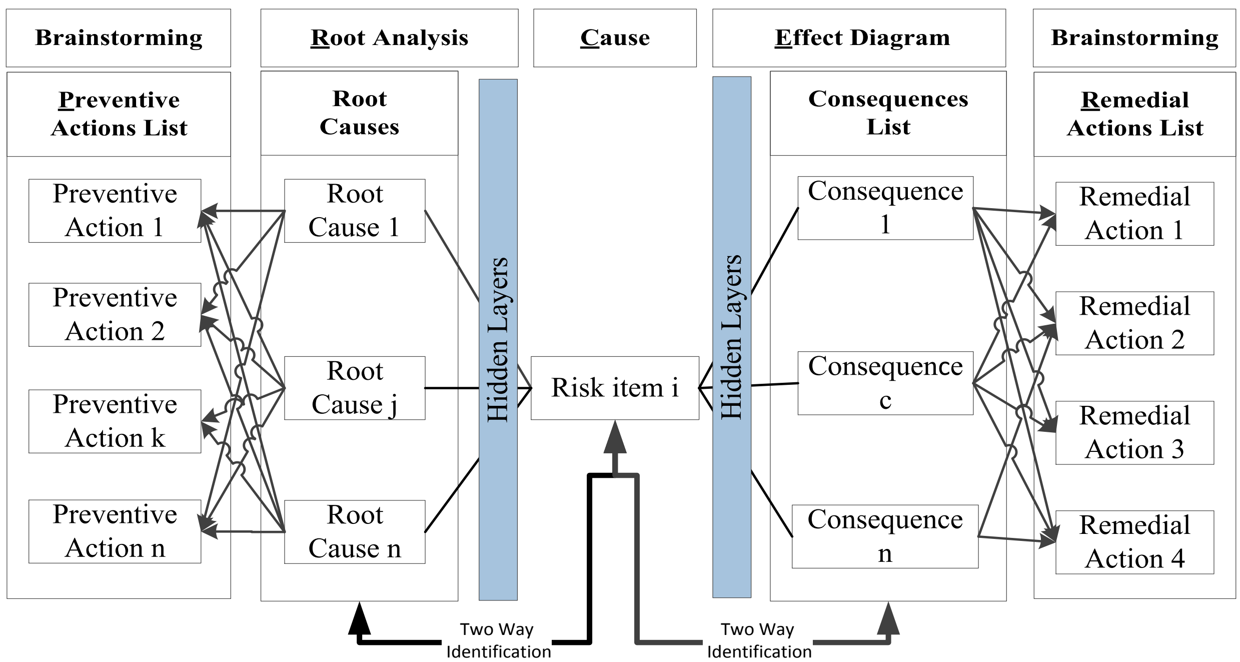


Figure 3.9 PRCER Procedure

The output of PRCER represents three lists for each risk item: consequences, preventive actions, and remedial actions. Risk consequences list includes all the consequences implied by the occurrence of the risk being considered. Each expert (j) independently is requested to provide a list of consequences (CLij) for each identified risk item (i). A consolidation process, represented in Eq. 3.6, is used to generate for each risk item an ultimate consequences list (CLi) which combines all consequence lists provided by experts.

$$CL_i = \bigcup_{j=1}^{j=m} CL_{ij} \qquad 3.6$$

Where, CL_{ij} represents the list of risks consequences provided by expert "j" for risk item "i", and m represents number of experts.

Preventive and remedial lists include all actions that have been proven effective based on the expert judgment in preventing or remediating the risk being considered respectively. Each expert generates a list of possible preventive (PAij) and remedial (RAij) actions for the risk being considered. Then, consolidated lists for preventive (PAi) and remedial (RAi) actions are generated using Eqs. 3.7, and 3.8 respectively.

$$PA_i = \bigcup_{j=1}^{j=m} PA_{ij} \qquad 3.7$$

$$RA_i = \bigcup_{j=1}^{j=m} RA_{ij} \qquad 3.8$$

Where, PA_{ij} and RA_{ij} represent respectively the lists of preventive and remedial actions provided by expert "j" for risk item "i".

The developed identification method introduces a new systematic procedure for selection of risk owner. This procedure is based on "one risk, one owner" approach that tends to allocate each risk to one owner only. Risk owner is characterized by his capacity, effectiveness and ability to manage the risk being considered (Department of Education Training and Employment, 2012; Risk Management Capabilities, 2011; ISO, 2009). Capacity, effectiveness, and ability are defined respectively as maximum effort that can be handled, degree of successfulness in producing desired results, and possession of means and skills to do things. The ownership is granted to a risk owner based on the newly introduced risk ownership score (ROS). The ROS evaluates the ability (Ab), capacity (Ca), and effectiveness (Ef) of each risk owner to effectively manage the risk being considered. A fuzzy index is developed to measure the degree of satisfying of each ownership criterion: capacity (CaI), efficiency (EfI) and ability (AbI). The degree of satisfaction for each criterion is evaluated as fuzzy percentage where $\tilde{0}$ and $\tilde{1}$ denote, respectively, extremely does not satisfy and totally satisfy. The three fuzzy indices are combined into a fuzzy ROS using Eq. 3.9. Fuzzy Membership function of ROS is calculated also using Eq. 3.10. The fuzzy addition is selected in order to incorporate the extreme case when all indices are equal to 0. The fuzzy ROS is defuzzified using the centre of area method as shown in Eq. 3.11.

$$\widetilde{ROS} = \widetilde{AbI} + \widetilde{CaI} + \widetilde{EfI} \qquad 3.9$$

$$1-\mu_{\widetilde{ROS}} = (1-\mu_{\widetilde{EFI}}) \times (1-\mu_{\widetilde{AbI}}) \times (1-\mu_{\widetilde{CaI}}) \qquad 3.10$$

Where,

$\tilde{A}$, $\tilde{C}$, and $\tilde{E}$ represent risk ownership, ability, capacity, and efficiency indices.

$\mu_{\tilde{A}}$, $\mu_{\tilde{C}}$, and $\mu_{\tilde{E}}$ represent the membership functions of risk ownership, ability, capacity, and efficiency indices.

$$ROS = \frac{\int_{-\infty}^{+\infty} x \times \mu_{\widetilde{ROS}}(x)dx}{\int_{-\infty}^{+\infty} \mu_{\widetilde{ROS}}(x)dx} \qquad 3.11$$

The risk responsibility matrix (RRM) represents a combination of introduced MRBS and the responsibility assignment matrix (RAM) which is currently used to assign responsibilities at the activity level (PMI, 2013). The RRM interprets the relation between responsible team members, whether to support (S) or to approve (A), and risk owner (O). One of project team members is selected as the risk owner using the risk ownership score. Since the risk item represents an exposure to all parties and not to the entity represented by the risk owner, support members are assigned to the risk owner in managing occurred risk. Also, approval members are assigned to approve, as required, the deviations from risk management plan. Table 3.1 illustrates an example of the risk responsibility matrix. The developed risk ownership determination procedure represents a replacement of the inappropriate risk allocation practice reported in literature (Hanna, Thomas, & Swanson, 2013; Peckiene, Komarovska, & Ustinovicius, 2013; Zhao, Hwang, & Low, 2013).

Table 3.1 Example of Risk Responsibility Matrix

Risk UIDN	Team Members (TM)				Project Manager	High Mgmt.	Client Mgmt.
	TM1	TM2	TM3	TM4			
6.4.3.2.5.1	O		S		A		
6.4.3.2.5.2		O		S	A	A	
6.4.3.2.5.3	S		S	O			A
6.4.3.2.5.4		S	O			A	
6.4.3.2.5.5	S	O		S	A		A
…………………………							
O: Own			S: Support			A: Approve	

Identification of risk items, their respective consequences, selection of risk owner, and generation of risk responsibility matrix allow users to generate a risk register that includes risk details such as: UIDN, name, description, owner, support members, approval members, risk consequences, preventive actions, and remedial actions as shown in Table 3.2. However, this risk register is usually extended in progressing with assessment, mitigation, monitoring, and control processes.

Table 3.2 Proposed Risk Register at Identification Level

UIDN	Name	Description	Owner	Support Members	Approval Members	Consequences
6.4.3.2.5.1	Error in Design of Concrete Column Formwork	affects the column shape, number or spacing of form ties	Design Engineer	Engineering Manager	Project Manager	▪ Redesign ▪ Rework ▪ Wasted material

3.4.2 Assessment

Risk register items are evaluated, qualitatively and quantitatively, using fuzzy theory (Zadeh, 2008; Zadeh, 1965). Experts involved in assessment process evaluate consequence/impact (C) and the probability of occurrence (P) using a linguistic or numeric fuzzy numbers. The developed risk assessment method incorporates, as shown in Figure 3.10, six phases: fuzzification, linguistic conversion, qualitative assessment, risk mapping, quantitative assessment, and pre-mitigation contingency estimating. These phases are described subsequently.

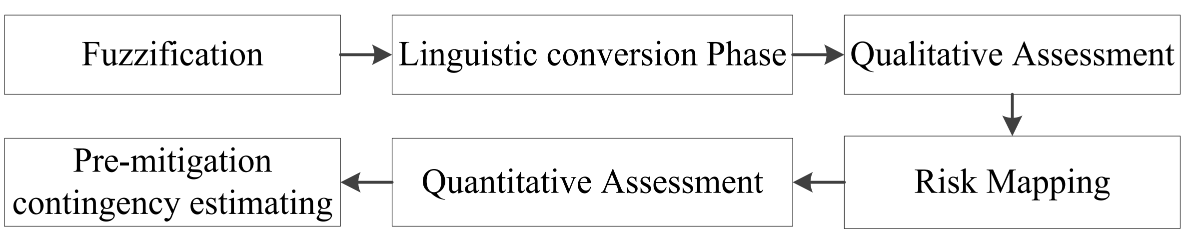


Figure 3.10 Overview of Developed Risk Assessment Method

In the first phase, each expert "j" evaluates numerically (or linguistically) the fuzzy consequence and fuzzy probability for each risk item "i" as shown in Figure 3.11. The numerical fuzzy evaluations can be represented using a quadruple of real numbers ranging from 0 to 10; where 0 denotes very low and 10 denotes very high. If such numeric evaluation is impossible, experts can evaluate risk components using linguistic evaluations.

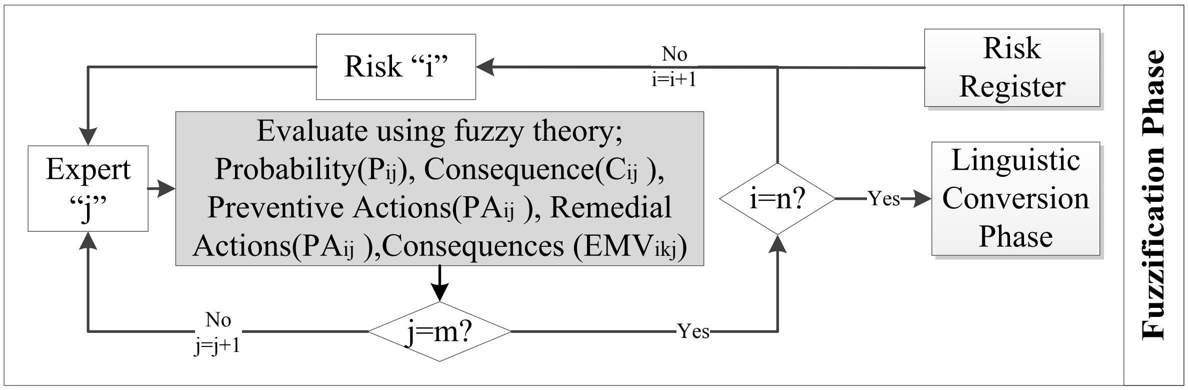


Figure 3.11 Fuzzification Phase

The linguistic evaluations are converted into numeric using fuzzy linguistic numeric conversion scheme (FLNCS) prior to proceeding to qualitative assessment of risk being considered. Generation of FLNCS utilizes expert judgement to evaluate the interrelation between linguistic term (e.g. Very Low) and their respective numeric fuzzy evaluation. The generation process includes four steps as follows:

1. <u>Define Lower and Upper Boundaries of each fuzzy attribute</u>

Each fuzzy attribute (i.e., Low) is represented by its lower boundary (LB) and upper boundary (UB). To facilitate the evaluation of each fuzzy attribute, each expert is requested to evaluate the lower and upper boundary as shown in Table 3.3; this excludes the lower boundary of the first attribute and the upper boundary of the last attribute, which are equal to 0 and 10 respectively. Appendix "A" presents a numeric example to illustrate the generation of FLNCS. Lower and upper boundaries are calculated using Eq. 3.12 and Eq. 3.13 respectively as follows:

$$LB_i = \bigwedge_{j=1}^{j=m} LB_{ij} \tag{3.12}$$

$$UB_i = \bigwedge_{j=1}^{j=m} UB_{ij} \tag{3.13}$$

Where,

LB_{ij} and UB_{ij} represent, respectively, the lower and upper boundaries of fuzzy attribute "i" evaluated by expert "j".

2. <u>Generate Uniform Fuzzy number of each fuzzy attribute</u>

Uniform fuzzy number, which represents each fuzzy attribute, is generated using lower and upper boundaries. The uniform fuzzy number (F) of attribute (i) can be expressed using Eq. 3.14 as follows:

$$F_i = [LB_i, UB_i] \tag{3.14}$$

Table 3.3 shows an example for generation of FLNCS using five attributes from very low to very high. The number of attributes is recommended to be minimum three and maximum seven as recommended by several researchers.

Table 3.3 Generation of Fuzzy Attributes

Fuzzy System								
Experts	Very Low (i=1) F_1	Low (i=2) F_2		Medium (i=3) F_3		High (i=4) F_4		Very High (i=5) F_5
	Lower than	Between		Between		Between		Higher than
E_1	UB_{11}	LB_{21}	UB_{21}	LB_{31}	UB_{31}	LB_{41}	UB_{41}	LB_{51}
E_2	UB_{12}	LB_{22}	UB_{22}	LB_{32}	UB_{32}	LB_{42}	UB_{42}	LB_{52}
E_3	UB_{13}	LB_{23}	UB_{23}	LB_{33}	UB_{33}	LB_{43}	UB_{43}	LB_{53}
E_4	UB_{14}	LB_{24}	UB_{24}	LB_{34}	UB_{34}	LB_{44}	UB_{44}	LB_{54}

<table>
<tr><td colspan="11">Fuzzy System</td></tr>
<tr><td rowspan="2">Experts</td><td colspan="2">Very Low
(i=1)
F_1</td><td colspan="2">Low
(i=2)
F_2</td><td colspan="2">Medium
(i=3)
F_3</td><td colspan="2">High
(i=4)
F_4</td><td colspan="2">Very High
(i=5)
F_5</td></tr>
<tr><td colspan="2">Lower than</td><td colspan="2">Between</td><td colspan="2">Between</td><td colspan="2">Between</td><td colspan="2">Higher than</td></tr>
<tr><td colspan="11">………</td></tr>
<tr><td>E_n</td><td colspan="2">UB_{1n}</td><td>LB_{2n}</td><td>UB_{2n}</td><td>LB_{3n}</td><td>UB_{3n}</td><td>LB_{4n}</td><td>UB_{4n}</td><td colspan="2">LB_{5n}</td></tr>
<tr><td>F_i</td><td>0</td><td>UB_1</td><td>LB_2</td><td>UB_2</td><td>LB_3</td><td>UB_3</td><td>LB_4</td><td>UB_4</td><td>LB_5</td><td>10</td></tr>
</table>

The uniform fuzzy numbers generated in "Step 2" are used to generate preliminary conversion scheme, which highlight the fuzzy area of each attribute. The fuzzy area represents the common area between two consecutive fuzzy attributes as shown in Figure 3.14(a). The left boundary of fuzzy area belongs to the left fuzzy attribute (i.e. μ_L=1, μ_R=0) whereas right boundary belongs to the right fuzzy area (i.e. μ_R=1, μ_L=0). Thus, final FLNCS is generated by linking the boundaries of each fuzzy area to the core of respective fuzzy attribute as shown in Figure 3.14(b).

3. <u>Conversion of linguistic Evaluation</u>

Post generation of FLNCS, the linguistic evaluations of each risk item are converted into numeric as shown in

Figure 3.12. It should be noted that the fuzzy linguistic numeric conversion scheme, shown in Figure 3.14, is generated once for each risk item (or group of risks). That mean $FLNCS_i$ represents an organizational asset and it can be used in the conversion process of the risk item "i" in future projects. After the conversion of all linguistic evaluations, the probability and consequence associated with each risk item are expressed on a scale from 0 to 10, where 0 denotes extremely low and 10 denotes extremely high. In the qualitative assessment phase, fuzzy number calculations (Moselhi & Salah, 2012; Carlsson, Fedrizzi, & Fuller, 2004) are utilized to

add or multiply fuzzy numbers. Fuzzy consequence and probability of occurrence for each risk item are calculated using fuzzy addition as shown in Eqs. 3.15, and 3.17 respectively.

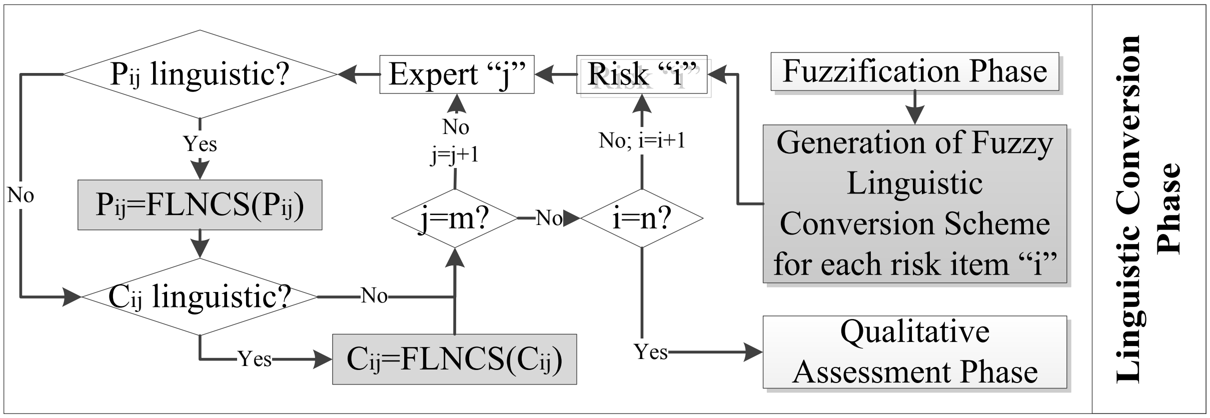


Figure 3.12 Linguistic Conversion Phase

The fuzzy risk value (R) which represents the qualitative severity of each risk item. It is calculated using fuzzy arithmetic multiplication of probability and consequence of each risk item as shown in Eq. 3.19.

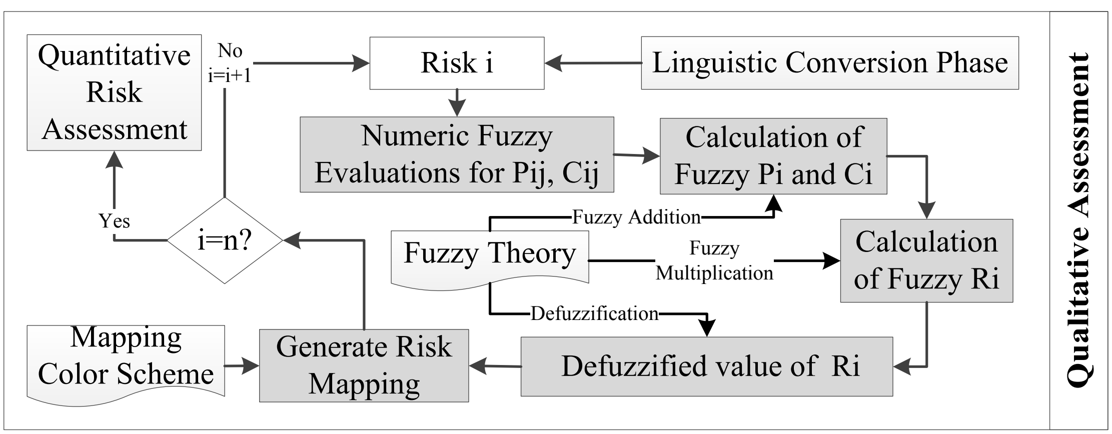


Figure 3.13 Qualitative Assessment Phase

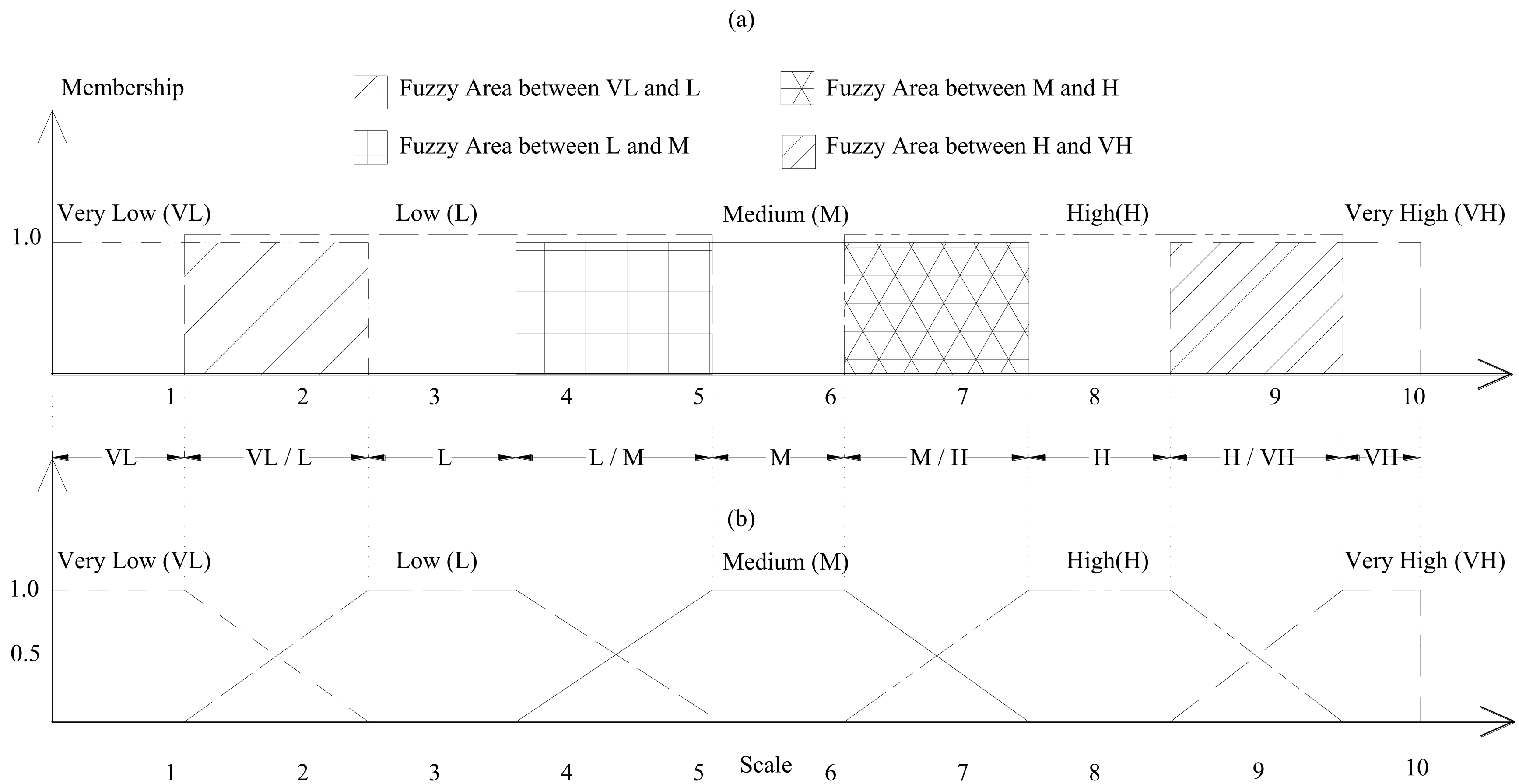


Figure 3.14 Fuzzy Linguistic Numeric Conversion Scheme: Preliminary (a) and Final (b)

For each risk component, fuzzy membership functions are generated using Eq. 3.16 and Eq. 3.18. Similarly, the membership function of risk value is generated using Eq. 3.22 (Zadeh, 1965). The flow diagram of qualitative assessment phase is presented in Figure 3.13.

$$\tilde{C_i} = \left[\bigwedge_{j=1}^{j=m} c_{ij1}, \bigwedge_{j=1}^{j=m} c_{ij2}, \bigvee_{j=1}^{j=m} c_{ij3}, \bigvee_{j=1}^{j=m} c_{ij4} \right] \quad 3.15$$

$$\mu_{\tilde{C}_i}(x) = \begin{cases} 0, & -\infty < x \leq c_{i1} \\ 1 - \prod_{j=1}^{j=m} (1 - \mu_{\widetilde{C_{ij}}}), & c_{i1} < x \leq c_{i2} \\ 1 - \prod_{j=1}^{j=m} (1 - \mu_{\widetilde{C_{ij}}}), & c_{i2} < x \leq c_{i3} \\ 1 - \prod_{j=1}^{j=m} (1 - \mu_{\widetilde{C_{ij}}}), & c_{i3} < x \leq c_{i4} \\ 0, & c_{i4} < x \leq +\infty \end{cases} \quad 3.16$$

Similarly, the risk's probability could be represented as follows:

$$\tilde{P_i} = \left[\bigwedge_{j=1}^{j=m} p_{ij1}, \bigwedge_{j=1}^{j=m} p_{ij2}, \bigvee_{j=1}^{j=m} p_{ij3}, \bigvee_{j=1}^{j=m} p_{ij4} \right] \quad 3.17$$

$$\mu_{\tilde{P}_i}(x) = \begin{cases} 0, & -\infty < x \leq p_{i1} \\ 1 - \prod_{j=1}^{j=m} (1 - \mu_{\widetilde{P_{ij}}}), & p_{i1} < x \leq p_{i2} \\ 1 - \prod_{j=1}^{j=m} (1 - \mu_{\widetilde{P_{ij}}}), & p_{i2} < x \leq p_{i3} \\ 1 - \prod_{j=1}^{j=m} (1 - \mu_{\widetilde{P_{ij}}}), & p_{i3} < x \leq p_{i4} \\ 0, & p_{i4} < x \leq +\infty \end{cases} \quad 3.18$$

The risk value can be calculated using the fuzzy multiplication operation as follows:

$$\tilde{R}_i = \frac{1}{\alpha}[C_{i1} \times P_{i1}, C_{i2} \times P_{i2}, C_{i3} \times P_{i3}, C_{i4} \times P_{i4}] \quad 3.19$$

$$\mu_{\tilde{R}_i}(x) = \begin{cases} \mu_{\tilde{P}_i}(x) \times \mu_{\tilde{C}_i}(y), & p_{i1} < x \leq p_{i2} \; and \; c_{i1} < y \leq c_{i2} \\ \mu_{\tilde{P}_i}(x) \times \mu_{\tilde{C}_i}(y), & p_{i2} < x \leq p_{i3} \; and \; c_{i2} < y \leq c_{i3} \\ \mu_{\tilde{P}_i}(x) \times \mu_{\tilde{C}_i}(y), & p_{i3} < x \leq p_{i4} \; and \; c_{i3} < y \leq c_{i4} \\ 0, & otherwise \end{cases} \quad 3.20$$

$$\alpha = Scale(P) \times Scale(C) \quad 3.21$$

Where,

Scale (P) and Scale (C) (not necessary equal) are used to evaluate the fuzzy probability and fuzzy consequence, respectively (e.g., scale 0-10; 1-5).

The fuzzy risk values calculated are defuzzified using the center of area method (Nieto-Morote & Ruz-Vila, 2011) using Eq. 3.22. The risk value is defuzzified to calculate the qualitative risk value "R_i" of each item and to generate the risk mapping, shown in Figure 3.16, based on the selected mapping scale shown in Table 3.4.

$$R = \frac{\int_{-\infty}^{+\infty} x \times \mu_{\tilde{R}}(x)dx}{\int_{-\infty}^{+\infty} \mu_{\tilde{R}}(x)dx} \quad 3.22$$

In the risk mapping phase a new method is developed to overcome limitations of traditional related procedures. For example, the traditional risk rating matrix is used to illustrate graphically the level of risk associated with a project. The probability of occurrence and impact represents X-axis and Y-axis of the risk matrix as shown in Figure 3.15. However, current risk matrix is useful only if a limited number of risk items are involved. In addition, it does not provide any information about the risk level of any other project components (e.g., activity). The developed risk mapping method overcomes these limitations by introducing a new illustration that provides information about risk level at the various project levels. The developed mapping utilizes the qualitative risk value "R_i" that ranges from 0 to 1. It illustrates graphically the criticality of each project component from risk level up to project level. The introduced risk mapping scheme shown in Table 3.4 and the micro approach presented in Figure 3.7, jointly allow for the generation of risk mapping for the project being considered as shown in Figure 3.16. The developed risk mapping provides decision support that allows managers to identify the high-risk project component without delving into details. However, it should be noted that the mapping scheme, shown in Table 3.4, depends on risk acceptance of an organization, and, therefore, each organization sets a scheme of criticality for each risk item or type.

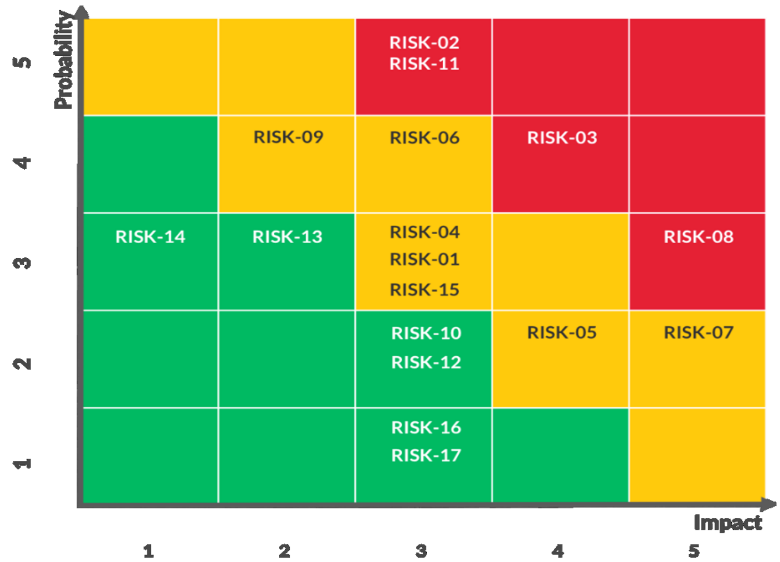


Figure 3.15 Example of a Risk Matrix

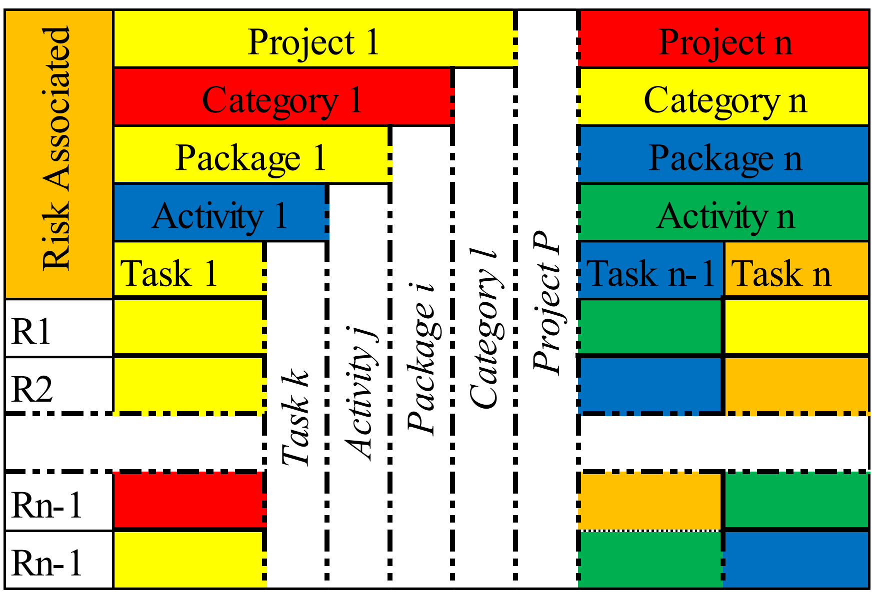


Figure 3.16 Developed Risk Mapping

Table 3.4 Risk Mapping Color Scheme

Qualitative Risk Value (%)	Criticality scheme	Color Scheme
0-5	Very Non-Critical	
5-20	Non-Critical	

Qualitative Risk Value (%)	Criticality scheme	Color Scheme
20-50	Medium	
50-80	Critical	
80-100	Very Critical	

The risk value of each project component is calculated as the weighted average of the risk values of sub-components associated with the component being considered using Eq. 3.23a and Eq. 3.23b as follows:

$$\widetilde{R_j}=\sum_{j=1}^{j=n} Wi\times \widetilde{R_{ij}} \tag{3.23a}$$

Where,

Wi represents the weight of sub-component "i" associated with project component "j".

The weight of each sub-component "i" is calculated as follows:

$$W_i=\frac{R_i}{\sum_{i=1}^{i=n} R_{ij}} \tag{3.23b}$$

Where,

Rij represents the defuzzified risk value of sub-component "i" associated with component "j".

As to quantitative assessment, it should be note that qualitative risk values alone are meaningless in expressing monetary impact; therefore, it is important to evaluate the risk quantitatively. Thethe developed quantitative assessment method introduces the pre-mitigation contingency ($PREMC_i$) that represents the contingency fund allocated for each risk item prior to the selection of mitigation strategy. PREMC integrates the qualitative risk value with expected monetary value (EMV_i) of each risk item. The overview of the quantitative assessment phase is shown in

Figure 3.17.

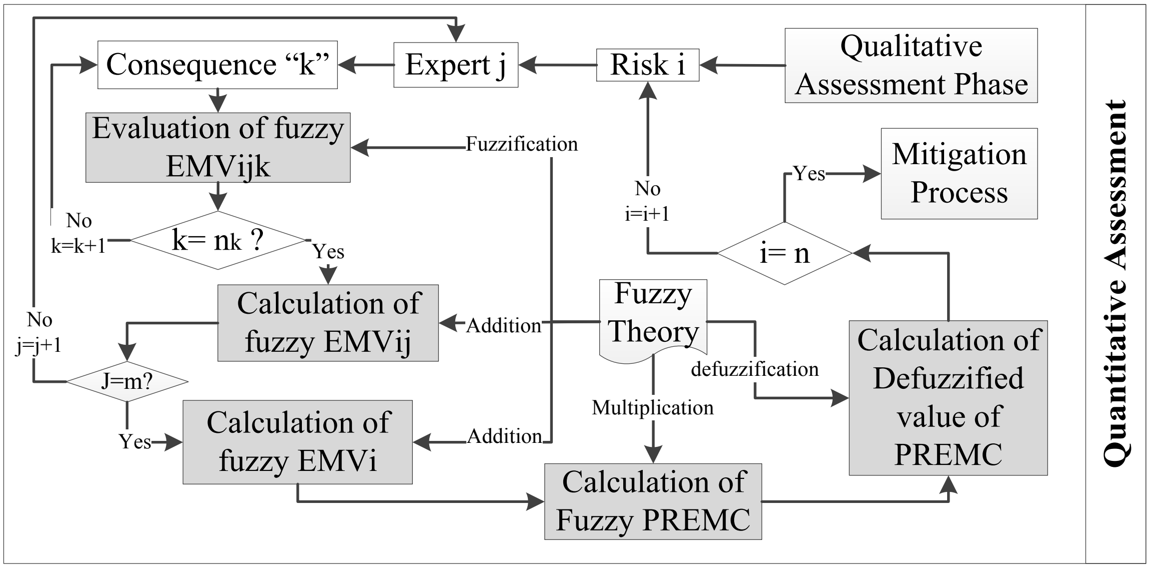


Figure 3.17 Overview of Quantitative Assessment Phase

The risk consequences, identified by experts during the identification phase, are evaluated using fuzzy theory. Each risk item "i" has "n" consequences and each consequence (k) receives "m" expected monetary value evaluations where "m" represented the number of experts. The expected value of each consequence (k) associated with risk (i) evaluated by expert (j) is represented as $\widetilde{EMV}_{ijk}$. Using fuzzy arithmetic addition, $\widetilde{EMV}_{ij}$ and $\widetilde{EMV}_{i}$ are calculated using Eqs. 3.24a, and 3.24b respectively as follows:

$$\widetilde{EMV}_{ij} = \left[\sum_{k=1}^{k=n} \widetilde{EMV}_{ijk1}, \sum_{k=1}^{k=n} \widetilde{EMV}_{ijk2}, \sum_{k=1}^{k=n} \widetilde{EMV}_{ijk3}, \sum_{k=1}^{k=n} \widetilde{EMV}_{ijk4}\right] \quad 3.24a$$

$$\widetilde{EMV}_{i} = \left[\bigwedge_{j=1}^{j=m} \widetilde{EMV}_{ij1}, \bigwedge_{j=1}^{j=m} \widetilde{EMV}_{ij2}, \bigvee_{j=1}^{j=m} \widetilde{EMV}_{ij3}, \bigvee_{j=1}^{j=m} \widetilde{EMV}_{ij4}\right] \quad 3.24b$$

Using fuzzy membership function addition, membership functions of $\widetilde{EMV}_{ij}$, and $\widetilde{EMV}_i$ is generated using Eqs. 3.25, and 3.26 respectively as follows:

$$\mu_{\widetilde{EMV}_{ij}} = \frac{1}{n}\sum_{k=1}^{k=n} \mu_{\widetilde{EMV}_{ijk}} \qquad 3.25$$

$$\mu_{\widetilde{EMV}_i}(x) = \begin{cases} 0, & -\infty < x \leq EMV_{i1} \\ 1 - \prod_{j=1}^{j=m}(1 - \mu_{\widetilde{EMV}_{ij}}), & EMV_{i1} < x \leq EMV_{i2} \\ 1 - \prod_{j=1}^{j=m}(1 - \mu_{\widetilde{EMV}_{ij}}), & EMV_{i2} < x \leq EMV_{i3} \\ 1 - \prod_{j=1}^{j=m}(1 - \mu_{\widetilde{EMV}_{ij}}), & EMV_{i3} < x \leq EMV_{i4} \\ 0, & EMV_{i4} < x \leq +\infty \end{cases} \qquad 3.26$$

Fuzzy pre-mitigation contingency $\widetilde{PREMC}$ of each risk item "i" and its respective membership function are calculated using Eq. 3.27 and Eq. 3.28 respectively. The defuzzified value of PREMC is calculated using Eq. 3.29 as follows:

$$\widetilde{PREMC}_i = \tilde{R}_i \times \widetilde{EMV}_i \qquad 3.27$$

$$\mu_{\widetilde{PREMC}_i} = \begin{cases} \mu_{\tilde{R}_i}(x) \times \mu_{\widetilde{EMV}_i}(y), & \forall\, R_{i1} < x < R_{i2} \text{ and } \forall\, EMV_{i1} < y < EMV_{i2} \\ 1, & \forall\, R_{i2} < x < R_{i3} \text{ and } \forall\, EMV_{i2} < y < EMV_{i3} \\ \mu_{\tilde{R}_i}(x) \times \mu_{\widetilde{EMV}_i}(y), & \forall\, R_{i3} < x < R_{i4} \text{ and } \forall\, EMV_{i3} < y < EMV_{i4} \\ 0, & \forall\, R_{i1} > x > R_{i4} \text{ and } \forall\, EMV_{i1} > y > EMV_{i4} \end{cases} \qquad 3.28$$

$$PREMC_i = \frac{\int_{-\infty}^{+\infty} x \times \mu_{\widetilde{PREMC}_i}(x)dx}{\int_{-\infty}^{+\infty} \mu_{\widetilde{PREMC}_i}(x)dx} \qquad 3.29$$

Total contingencies associated with each project component are calculated using Equations 3.30 - 3.33. The total project contingency is calculated using Eq. 3.34.

At task (k) level:

$$PREMC_k = \sum_{r=1}^{n_{risk}} PREMC_{kr} \qquad 3.30$$

At activity (j) level:

$$PREMC_j = \sum_{k=1}^{n_{task}} PREMC_{jk} \qquad 3.31$$

At package (i) level:

$$PREMC_i = \sum_{j=1}^{n_{activity}} PREMC_{ij} \qquad 3.32$$

At category (l) level:

$$PREMC_l = \sum_{i=1}^{n_{package}} PREMC_{li} \qquad 3.33$$

At project (p) level:

$$PREMC_p = \sum_{l=1}^{n_{category}} PREMC_{pl} \qquad 3.34$$

Where, n_{risk}, n_{task}, $n_{activity,}$ $n_{package,}$ and $n_{category}$ are respectively numbers of risks, tasks, activities, packages, and categories.

Calculation of pre-mitigation contingency highlights the total amount of risk associated with the project. The developed risk assessment method was firstly introduced to manage the risk associated with construction projects. However, its generic nature allows for its application to other types of projects. It also provides decision support to project owners at an early stage of project development, especially when go/no-go decision is required. The cumulative PREMC represents a contingency baseline that assists users in evaluating the performance of contingency depletion in the case where no mitigation strategy is implemented.

3.4.3 Mitigation

The developed risk mitigation method generalizes the post-mitigation assessment procedure developed by Salah and Moselhi (2014). It also provides a new method for identification, assessment, and selection of the most effective mitigation strategy. It also evaluates the post-mitigation contingency (POSTMC), which represents the required contingency fund in case mitigation strategy is implemented. Overview of the mitigation process is presented in Figure 3.18 which illustrates the three main phases as follows:

- Assessment phase in which the cost and efficiency factor of preventive and remedial actions are evaluated using fuzzy set theory (Zadeh, 1965) as shown in Figure 3.8.
- Selection phase in which list of possible mitigation strategy is generated; the cost (MSC) mitigation efficiency factor (MEF), and planned efficiency factor (PEF) of each strategy are calculated. Thus, the strategy with highest planned efficiency is selected as the most effective strategy in mitigating the risk being considered.
- Post-mitigation Phase in which post-mitigation contingency (POSTMC) is calculated using the planned efficiency factor and the pre-mitigation contingency (PREMC).

In the first phase, the assessment process of preventive and remedial actions makes use of fuzzy theory (Zadeh, 1965). The assessment process includes two steps: 1) assessment of efficiency factor, and 2) assessment of cost.

Step 1. Assessment of efficiency factors

Mitigation efficiency factor on probability (MEFP) measures the capability of preventive action measure to prevent the occurrence of a risk. Mitigation efficiency factor on consequence (MEFC) measures the capability of remedial action to reduce the impact of a risk. Each expert evaluates, using linguistic or numeric fuzzy numbers, the mitigation efficiency factor on probability (MEFP) for each PA_i, and 2) mitigation efficiency factor on consequence (MEFC) for each RA_i. Linguistic evaluations of $\widetilde{MEFP}$ and $\widetilde{MEFC}$ are converted into numeric using Eq. 3.35 and Eq. 3.38, respectively. Then, evaluations of all experts are combined to generate fuzzy numbers for $MEFP_{ik}$ and $MEFC_{ik}$ using Eq. 3.36 and Eq. 3.39, respectively. Thus, defuzzified values of MEFP and MEFC are calculated using Eq. 3.37 and Eq. 3.40, respectively.

$$MEFP_{ikj} = \begin{cases} FLNCS_i\left(MEFP_{ikj}\right), \ if \ \ linguistic \\ MEFP_{ikj}, \ if \ \ numeric \end{cases} \forall j \qquad 3.35$$

$$MEFP_{ik} = \left[\overset{j=1}{\underset{n}{\wedge}} MEFP_{ikj1}, \overset{j=1}{\underset{n}{\wedge}} MEFP_{ikj2}, \overset{j=1}{\underset{n}{\vee}} MEFP_{ikj3}, \overset{j=1}{\underset{n}{\vee}} MEFP_{ikj4} \right] \qquad 3.36$$

$$MEFP_{ik} = \frac{\int_{-\infty}^{+\infty} x\mu_{MEFP_{ik}}\left(x\right)dx}{\int_{-\infty}^{+\infty} \mu_{MEFP_{ik}}\left(x\right)dx} \qquad 3.37$$

$$MEFC_{iqj} = \begin{cases} FLNCS_i\left(MEFC_{iqj}\right), \ if \ \ linguistic \\ MEFC_{iqj}, \ if \ \ numeric \end{cases} \forall j \qquad 3.38$$

$$MEFC_{iq} = \left[\overset{j=1}{\underset{n}{\wedge}} MEFC_{iqj1}, \overset{j=1}{\underset{n}{\wedge}} MEFC_{iqj2}, \overset{j=1}{\underset{n}{\vee}} MEFC_{iqj3}, \overset{j=1}{\underset{n}{\vee}} MEFC_{iqj4} \right] \qquad 3.39$$

$$MEFC_{iq} = \frac{\int_{-\infty}^{+\infty} x \mu_{MEFC_{iq}}(x)\,dx}{\int_{-\infty}^{+\infty} \mu_{MEFC_{iq}}(x)\,dx} \qquad 3.40$$

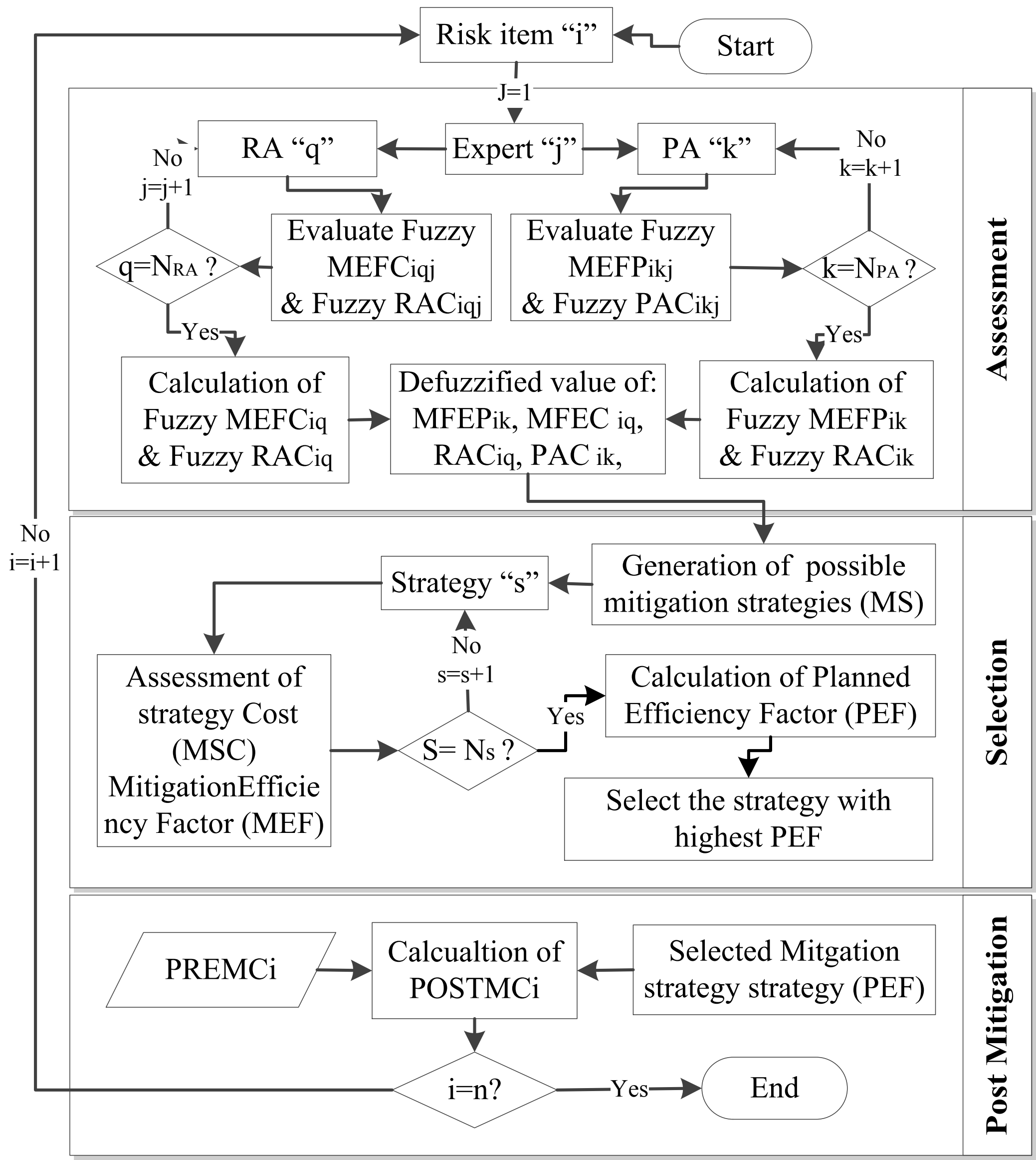


Figure 3.18 Overview of Developed Risk Mitigation Method

Where, k and q represent, respectively, numbers of preventive and remedial actions associated with risk item "i".

Step2. Assessment of Cost

Each expert evaluates, using linguistic or numeric fuzzy numbers, the costs of preventive (PAC) and remedial (RAC) actions. Linguistic evaluations of $\widetilde{PAC}$ and $\widetilde{RAC}$ are converted into numeric using Eq. 3.41 and Eq. 3.44, respectively. The fuzzy representations for the costs of preventive action "k" and remedial action "q" are calculated using fuzzy number calculation as presented in Eq. 3.42 and Eq. 3.45 respectively. The defuzzified values are calculated using Eq. 3.43 and Eq. 3.46 respectively.

$$PAC_{ikj} = \begin{cases} FLNCS_k\left(PAC_{ikj}\right),\ if\ \ linguistic \\ PAC_{ikj},\ if\ \ numeric \end{cases} \forall j \tag{3.41}$$

$$PAC_{ik} = \left[\overset{j=1}{\underset{n}{\wedge}} PAC_{ikj1}, \overset{j=1}{\underset{n}{\wedge}} PAC_{ikj2}, \overset{j=1}{\underset{n}{\vee}} PAC_{ikj3}, \overset{j=1}{\underset{n}{\vee}} PAC_{ikj4}\right] \tag{3.42}$$

$$PAC_{ik} = \frac{\int_{-\infty}^{+\infty} x\mu_{PAC_{ik}}\left(x\right)dx}{\int_{-\infty}^{+\infty} \mu_{PAC_{ik}}\left(x\right)dx} \tag{3.43}$$

$$RAC_{iqj} = \begin{cases} FLNCS_q\left(RAC_{iqj}\right),\ if\ \ linguistic \\ RAC_{iqj},\ if\ \ numeric \end{cases} \forall j \tag{3.44}$$

$$RAC_{iq} = \left[\overset{j=1}{\underset{n}{\wedge}} RAC_{iqj1}, \overset{j=1}{\underset{n}{\wedge}} RAC_{iqj2}, \overset{j=1}{\underset{n}{\vee}} RAC_{iqj3}, \overset{j=1}{\underset{n}{\vee}} RAC_{iqj4}\right] \tag{3.45}$$

$$RAC_{iq} = \frac{\int_{-\infty}^{+\infty} x \mu_{RAC_{iq}}(x)\,dx}{\int_{-\infty}^{+\infty} \mu_{RAC_{iq}}(x)\,dx} \qquad 3.46$$

In the selection phase, the most effective mitigation strategy (MS) is selected among list of possible mitigation strategies generated using combination technique lists. The selection phase includes three main steps: 1) generation of possible mitigation strategies, 2) assessment of possible mitigation strategies, and 3) selection of the most effective mitigation strategy.

Step 1. Generation of possible mitigation strategies

Each strategy can be represented by a combination of remedial and preventive action(s) as shown in Eq. 3.47. The number of possible mitigation strategies (m) is calculated using the combination technique (McCaffrey, 2006) as shown in Eq. 3.48.

$$MS_i = \left[\left(PA_1, \ldots\ldots\ldots, PA_k \right), \left(RA_1, \ldots\ldots\ldots, RA_q \right) \right] \qquad 3.47$$

Where, k and q are respectively number of preventive and remedial actions included in the mitigation strategy.

$$m = \sum_{r=1}^{k+q} \binom{k+q}{r} \qquad 3.48$$

$$C_r^n = \binom{n}{r} = \frac{n!}{r!(n-r)!} \qquad 3.49$$

Where,

k, represents the number of preventive actions.

q, represents the number of remedial actions.

r, represents the number of items in a combination.

Each combination is calculated using Eq. 3.49. For example, If two preventive actions (pa_1, pa_2) and two remedial actions (ra_1, ra_2) are involved in the selection procedure which means k+q = 4 and r = 4 (i.e. all possible combination). Thus, number of possible mitigation strategies is calculated as follows:

$$m = \sum_{r=1}^{4} \binom{4}{r} = \binom{4}{1} + \binom{4}{2} + \binom{4}{3} + \binom{4}{4} = 4 + 6 + 4 + 1 = 15$$

The possible mitigation strategies associated with risk "i", when two preventive actions and two remedial actions are involved, can be listed as follows:

$$MS_{is} = \left\{ \begin{array}{c} (pa_1),(pa_2),(ra_1),(ra_2),(pa_1,pa_2),(pa_1,ra_1),(pa_1,ra_2),(pa_2,ra_1),(pa_2,ra_2), \\ (ra_1,ra_2),(pa_1,pa_2,ra_1),(pa_1,pa_2,ra_2),(pa_1,ra_1,ra_2),(pa_2,ra_1,ra_2), \\ (pa_1,pa_2,ra_1,ra_2) \end{array} \right\}$$

Step 2. Assessment of possible mitigation strategies

Total cost of a mitigation strategy is calculated using cost of its respective remedial and preventive actions using Eq. 3.50. Mitigation efficiency factor (MEF) of strategy "s" is calculated using mitigation efficiency factors of preventive ($MEFP_{ik}$) and remedial ($MEFC_{iq}$) actions respectively using Eq. 3.51

$$\widetilde{MSC}_{is} = \sum_{k=1}^{k=nk} \widetilde{PAC}_k + \sum_{q=1}^{q=nq} \widetilde{RAC}_q \tag{3.50}$$

Where, PAC and RAC represent, respectively, cost of each preventive and remedial action associated with mitigation strategy "s".

$$1 - MEF_{is} = \prod_{k=0}^{k=n_k} [1 - MEFP_{ik}] \times \prod_{q=0}^{q=n_q} [1 - MEFC_{iq}] \tag{3.51}$$

Where, n_k, and n_q, are, respectively, numbers of preventive and remedial actions associated with mitigation strategy "s".

Mitigation efficiency factor (MEF) is important for the evaluation of mitigation strategies; however, it cannot distinguish between different mitigation strategies because it does not consider the mitigation strategy cost (MSC). Therefore, a factor that incorporates mitigation strategy cost (MSC) and pre-mitigation contingency (PREMC) is needed to select the most effective mitigation strategy.

Step 3. Selection of most effective mitigation strategy

Planned efficiency factor (PEF) is a newly introduced measure used to select the most effective mitigation strategy. It integrates mitigation efficiency factor (MEF) with mitigation strategy cost (MSC) and pre-mitigation contingency (PREMC) using Eq. 3.52. The mitigation strategy that has the highest PEF is considered as the most effective mitigation strategy for risk item (i).

$$PEF_{is} = \frac{MEF_{is} \times PREMC_i - MSC_{is}}{PREMC_i} \tag{3.52}$$

The planned efficiency factor (PEF) of selected mitigation strategy "s" is then used to calculate the post-mitigation contingency (POSTMC) of risk item "i" using Eq. 3.53 as follows:

$$POSTMC_{is} = (1 - PEF_{is}) \times PREMC_i \qquad 3.53$$

Post-mitigation contingency of non-mitigated risk item equals to its pre-mitigation contingency. Thus, total post-mitigation contingency of a project (TPC) combines all post-mitigation contingency (POSTMC) of its components using Eqs. 3.54 - 3.58 as follows:

<u>At task (k) level:</u>

$$POSTMC_k = \sum_{r=1}^{n_{risk}} POSTMC_{kr} \qquad 3.54$$

<u>At activity (j) level:</u>

$$POSTMC_j = \sum_{k=1}^{n_{task}} POSTMC_{jk} \qquad 3.55$$

<u>At package (i) level:</u>

$$POSTMC_i = \sum_{j=1}^{n_{activity}} POSTMC_{ij} \qquad 3.56$$

<u>At category (l) level:</u>

$$POSTMC_l = \sum_{i=1}^{n_{package}} POSTMC_{li} \qquad 3.57$$

<u>At project (p) level:</u>

$$POSTMC_p = \sum_{l=1}^{n_{category}} POSTMC_{pl} \qquad 3.58$$

Where, n_{risk}, n_{task}, $n_{activity,}$ $n_{package,}$ and $n_{category}$ are respectively numbers of risks, tasks, activities, packages, and categories.

Estimating post-mitigation contingency of a project and its components, using Equations (3.48) - (3.52), helps users to estimate the contingency required for each project component contingency with a higher level of confidence. It also assists in eliminating the unnecessary allocation of contingency fund that may be incorporated in PREMC. Identification, assessment, selection, and implementation of most effective mitigation strategy averts cost overrun and schedule delay. In addition, the post-mitigation contingency curve represents a baseline for the contingency fund required to mitigate all risk associated with construction projects. It also represents a useful criterion for monitoring the performance of selected mitigation strategy.

3.4.4 Monitoring

Developed risk monitoring method makes use of: pre-mitigation contingency (PREMC) calculated during the assessment process and post-mitigation contingency (POSTMC) calculated during the mitigation phase (Salah & Moselhi, 2014). The developed method consists of three phases: calculation of actual efficiency factor, determination of risk acceptance, and initiation of control action criteria. An overview of risk monitoring is presented in Figure 3.19.

In phase one, the actual efficiency factor is calculated as described subsequently. The actual mitigation contingency is calculated as cumulative mitigation cost over the life cycle of risk item "i" using Eq. 3.59.

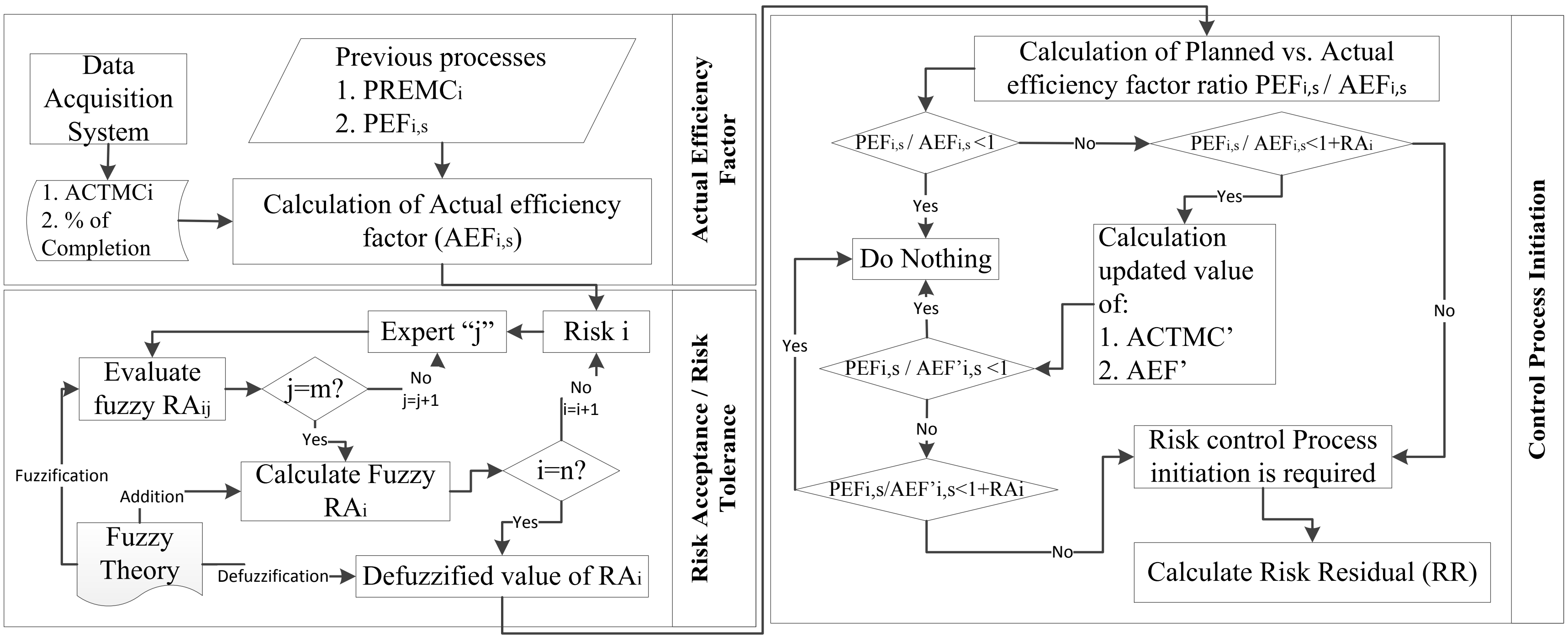


Figure 3.19 Overview of Risk Monitoring Process

$$ACTMC_{i,s}(t)=ACTMC_{i,s}(t\text{-}1)+AC_{i,s}(t) \qquad 3.59$$

Where,

(t) and (t-1) represents respectively the current and previous monitoring period.

$ACTMC_{i,s}(t)$ represents the cumulative actual mitigation contingency up to monitoring period "t".

$AC_{i,s}(t)$ represents the actual cost of risk item "i" using mitigation strategy "s" during the current period t.

The actual mitigation contingency at t=0 equals to mitigation strategy cost (MSC) of selected mitigation strategy "s" (e.g., Buy insurance policy) as expressed in Eq. 3.60.

$$ACTMC_{i,s}(t=0)=MSC_s \qquad 3.60$$

However, expected mitigation contingency that represents the actual mitigation contingency at the end of risk life cycle is estimated using Eq. 3.61 as follows:

$$ACTMC_{i,s}=MSC_s+\frac{ACTMC_{i,s}(t)-MSC_s}{\%\ of\ \ completion_i(t)} \qquad 3.61$$

Where,

MSC_s, represents the initial cost of employed mitigation strategy "s".

% of $completion_i$ (t), represents the percentage of completion of risk item "i" at period "t".

$ACTMC_{i,s}$, represents the actual mitigation contingency expected to be used at the end of life when risk item "i" is retired.

Percentage of completion represents the ratio of the remaining duration over the total duration of each risk item "i". This percentage of completion is expressed as follows:

$$\% \text{ of completion } (t) = \frac{FD_i - CD}{FD_i - SD_i} \quad 3.62$$

Where,

SD, FD, and CS represent respectively start, finish, and current dates.

Actual efficiency factor (AEF) represents the actual efficiency of the mitigation strategy "s" in mitigating risk item "i". AEF is calculated, similar to PEF, using the ratio between actual and pre-mitigation contingencies as presented in Eq. 3.63.

$$AEF_{i,s} = 1 - \frac{ACTMC_{i,s}}{PREMC_i} \quad 3.63$$

Risk acceptance, which represents the capacity to accommodate risk, represents the deviation percentage between actual (AEF) and planned (PEF) efficiency factors. Quantification of risk acceptance should account for the inherent uncertainty associated with its computational process as described below. Fuzzy set theory (Zadeh, 1965) is utilized in modelling such uncertainty. Each expert (j) evaluates, on a scale from 0 to 1, the risk acceptance of risk item "i" using a fuzzy number. The fuzzy risk acceptance RA_i, and its defuzzified value are calculated using Eqs. 3.64, and 3.65 respectively.

$$RA_i = \sum_{j=1}^{j=m} RA_{ij} \quad 3.64$$

Where,

m, represents the number of experts involved in the evaluation process.

$\widetilde{RA}_{ij}$, represents the fuzzy risk acceptance of risk item "i" evaluated by expert "j".

$\widetilde{RA}_i$, represents the fuzzy risk acceptance of risk item "i".

$$RA_i = \frac{\int_{-\infty}^{+\infty} x.\mu_{RA_i}(x).dx}{\int_{-\infty}^{+\infty} \mu_{RA_i}(x).dx} \qquad 3.65$$

Where,

$\mu_{\widetilde{RA}_i}$, represents the membership function of the risk acceptance of risk item "i".

RA_i, represents the defuzzified value of the risk acceptance of risk item "i".

In the risk control initiation phase, planned and actual efficiency factors of selected mitigation strategy "s" and risk acceptance (RA) of risk item "i" are used to flag and trigger initiation of control. If, $\frac{PEF_{i,s}}{AEF_{i,s}} \leq 1$ indicates that the selected mitigation strategy is effective and no further actions are needed. If, $1 < \frac{PEF_{i,s}}{AEF_{i,s}} \leq 1+RA_i$ indicates that the evaluation process of employed mitigation strategy need to be re-visited, and accordingly revised. Thus, pre-control updated actual efficiency factor (AEF') is then calculated using projected cost instead of actual risk cost as follows:

$$AEF'_{i,s} = 1 - \frac{ACTMC'_{i,s}}{PREMC_i} \quad 3.66$$

If $\frac{PEF_{i,s}}{AEF'_{i,s}} \leq 1 + RA_i$, that means mitigation strategy has an acceptable efficiency, and no necessary action is needed. If $\frac{PEF_{i,s}}{AEF'_{i,s}} > 1 + RA_i$, similar to the situation where $\frac{PEF_{i,s}}{AEF_{i,s}} > 1 + RA_i$, indicates the possibility of selected mitigation strategy failure that initiates the control process to ease consequences of the risk item being considered. However, prior to the initiation of the risk control process, the risk residual (RR), which represents the remaining part of risk item "i", is calculated using Eq. 3.67.

$$RR_{i,s} = ACTMC_{i,s} - ACTMC_{i,s}(t) \quad 3.67$$

3.4.5 Control

Failure of any mitigation strategy initiates the risk control process. However, prior to risk control process initiation, the user needs to investigate the reasons behind such failure. If the employed mitigation strategy fails because of managerial decision or inappropriate application then, the elimination of these reasons is required prior to consideration of similar risk items. Otherwise, the control process has to be initiated to ease consequences and minimize contingency of the risk item being considered.

If the risk item being considered is not retired yet, then control action is required to support the employed mitigation strategy "s". Experts identify and evaluate the possible control actions by its control efficiency factor ($CEF_{i,s}$) which represents the capacity of control action to ease the consequences of risk residual (RR_i). Overview of the developed risk control method is presented in Figure 3.20.

Each expert "j" evaluates, using fuzzy set theory, the control efficiency factor (CEF) of action "k" on consequences of risk item "i" mitigated by strategy "s". Fuzzy control efficiency factor and its defuzzified value are calculated respectively using Eq. 3.68 and Eq. 3.69.

$$CEF_{i,s,k} = \sum_{j=1}^{j=m} CEF_{i,s,kj} \tag{3.68}$$

$$CEF_{i,s,k} = \frac{\int_{-\infty}^{+\infty} x.\mu_{CEF_{i,s,k}}(x).dx}{\int_{-\infty}^{+\infty} \mu_{CEF_{i,s,k}}(x).dx} \tag{3.69}$$

Where,

$CEF_{i,s,k\,j}$ represents the control efficiency factor of control action "k" evaluated by expert j.

$CEF_{i,s,k}$ represents the average of control efficiency factors for control action "k".

$RR_{i,s}$ represents the residual of risk item "i" mitigated using strategy "s".

Post control factor (PCF) which integrates the control efficiency factor (CEF) of control action "k" and the risk residual of risk item "i" mitigation with strategy "s" is calculated using Eq. 3.70. Then, the control actions being considered are ranked in a descending order (e.g., high to low) using post control factor.

$$PCF_{i,s,k} = \frac{CEF_{i,s,k} \times RR_{i,s} - CAC_k}{RR_{i,s}} \tag{3.70}$$

Where,

$PCF_{i,s,k}$, represents the post control factor of risk item "i" using control action "k" to support mitigation strategy "s".

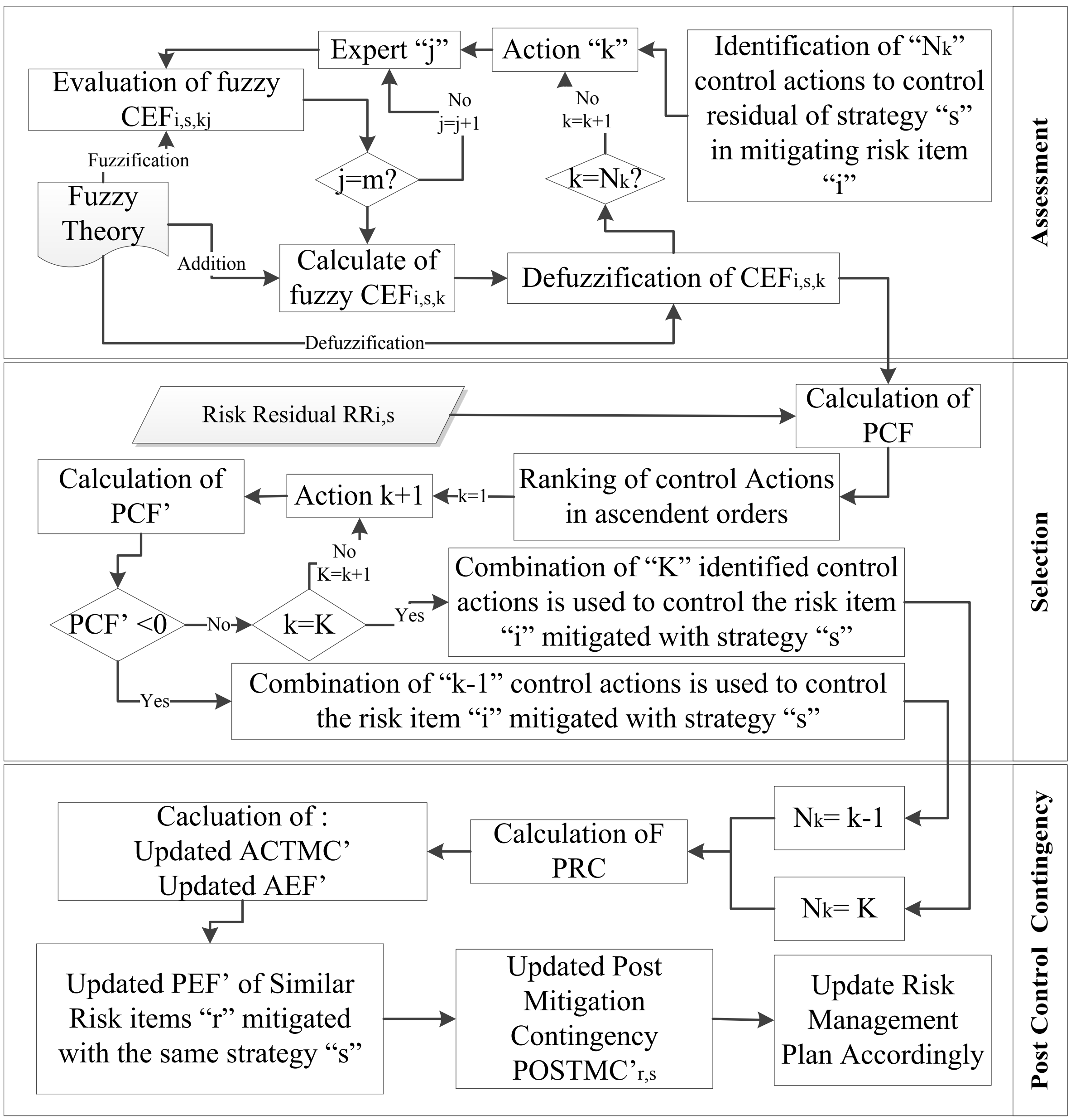


Figure 3.20 Overview of Developed Risk Control Method

CAC_k , represents the cost of control action "k".

Post control factor is used to rank the possible control actions and to select the most effective control action. The control action "k" with highest post control factor is selected to be primary control action to control the risk residual of risk item "i" mitigated with strategy "s". If, $PCF_{i,s,k} \leq 0$, that indicates the use of control action "k" is considered as unnecessary depletion of project resources without considerable outcomes. Otherwise, $PCF_{i,s,k} > 0$, control action "k" can be used to support the employed mitigation strategy "s". Subsequently, projected risk cost (PRC) of selected control action "k" is calculated using Eq. 3.71 as follows:

$$PRC_{i,s,k} = RR_{i,s} \times \left(1 - PCF_{i,s,k}\right) \qquad 3.71$$

However, it is important to evaluate the efficiency of the combination of two control actions or more to check the possibility to ease, beyond selected control action "k", the consequences of risk residual. Post control factor of a combination of two control action "k" (highest PCF) with control action "k+1" (second highest PCF) is calculated using Eq. 3.72 as follows:

$$PCF'_{i,s,k+1} = \frac{CEF_{i,k+1} \times PRC_{i,s,k} - CAC_{k+1}}{PRC_{i,s,k}} \qquad 3.72$$

If, $PCF'_{i,s,k+1} \leq 0$, indicates the inefficiency of control action "k+1" which is considered as unnecessary depletion of project resources. Similarly, projected risk cost for a combination of K control actions is calculated using Eq. 3.73 as follows:

$$PRC_{i,s,K} = RR_{i,s} \times \prod_{k=1}^{k=K} \left(1 - PCF'_{i,s,k}\right) \qquad 3.73$$

Where,

K represents the number of combined control actions.

The post control actual mitigation contingency and the updated actual efficiency factor using combination of "K" control actions are calculated using Eq. 3.74 and Eq. 3.75 respectively.

$$ACTMC'_{i,s,K} = ACTMC_{i,s} + PRC_{i,s,K} \quad 3.74$$

$$AEF'_{i,s,K} = 1 - \frac{ACTMC'_{i,s,K}}{PREMC_i} \quad 3.75$$

In case none of the identified control actions is found effective, that indicates failure of control process of the risk being considered; and consequently the failure of the risk management plan of that risk. In such a case, the risk mitigation process needs to be re-initiated to identify new mitigation strategies that are more effective than the previously identified ones.

Failure of the management plan of risk item "i" denotes potential failure of the mitigation process of similar risk item "r" mitigated with the same strategy "s". Consequently, selection of most effective mitigation strategy needs to be re-evaluated, or replaced if required, prior to consideration of similar risk item "r" as shown in Figure 3.21. Thus, updated value of planned efficiency factor (PEF) of mitigation strategy "s" in mitigating risk item "r" is calculated using Eq. 3.76 as follows:

$$PEF'_{r,s} = \frac{AEF_{i,s}}{PEF_{i,s}} \times PEF_{r,s} \quad 3.76$$

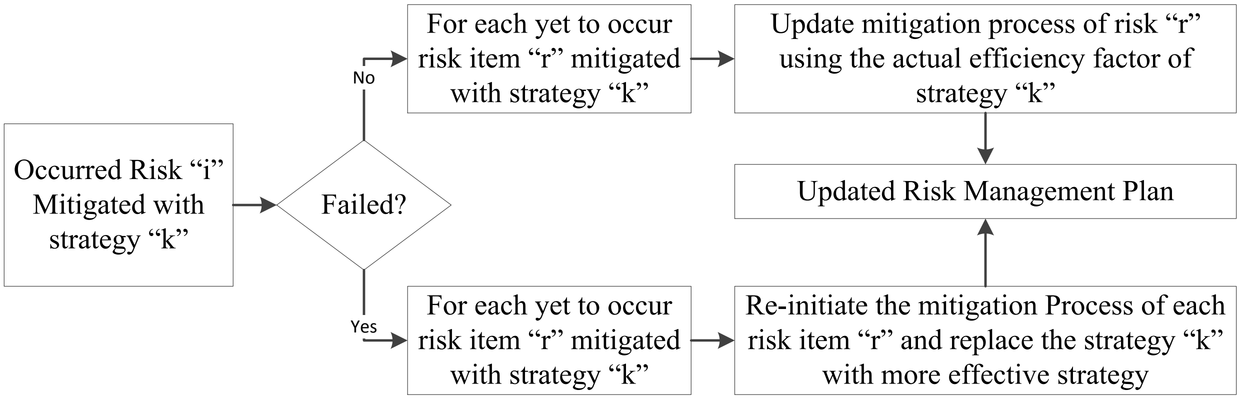


Figure 3.21 Dynamic Update of Risk Management Plan Using Newly Collected Data

Updated values of the planned efficiency factors (PEF) of strategy "s", previously selected to mitigate risk item "r", initiates the re-ranking procedure of identified mitigation strategies. If, strategy "s" remains the most effective strategy then, updated post-mitigation contingency re-evaluated using Eq. 3.77a. Otherwise, strategy "s" should be replaced by strategy "s+1", which has the highest PEF based on the new ranking, and subsequently, post-mitigation contingency of risk item "r" is calculated using Eq. 3.77b.

$$POSTMC'_{r,s}=PREMC_r\times(1-PEF'_{r,s}) \qquad 3.77a$$

$$POSTMC'_{r,s+1}=PREMC_r\times(1-PEF'_{r,s+1}) \qquad 3.77b$$

Updates of post-mitigation contingency for upcoming risk items provide valuable information about expected performance of risk mitigation process. Such information allows users to make "available contingency vs. expected contingency" analysis that indicates the status of the contingency fund. It also allows users to take, if required, proactive decisions that may avoid the over-depletion of contingency and consequently project overruns.

3.4.6 Risk Management Performance Index

Developed model allows risk owners to manage the risk items effectively at the micro level. However, project stakeholders need to evaluate the performance of the risk management plan (RMP) without delving into details. Thus, performance index (RMPI) is introduced to evaluate the RMP performance in a similar manner to earned value management. RMPI compares the pre-mitigation contingency baseline (PREMC), post-mitigation contingency baseline (POSTMC), and the actual mitigation contingency (ACTMC) during the same period "t". The RMPI is calculated using Eq. 3.78 and presented graphically as shown in Figure 3.22.

$$RMPI=\frac{PREMC_p - ACTMC_p}{PREMC_p - POSTMC_p} \qquad 3.78$$

The RPMI provides information about the performance of risk management plan at any time during the project execution. Such information is utilized to support the decision making in implementing a deviation from the risk management plan, if necessary. It can be also utilized to generate soft or hard notification, respectively, when post or pre-mitigation baselines have been exceeded.

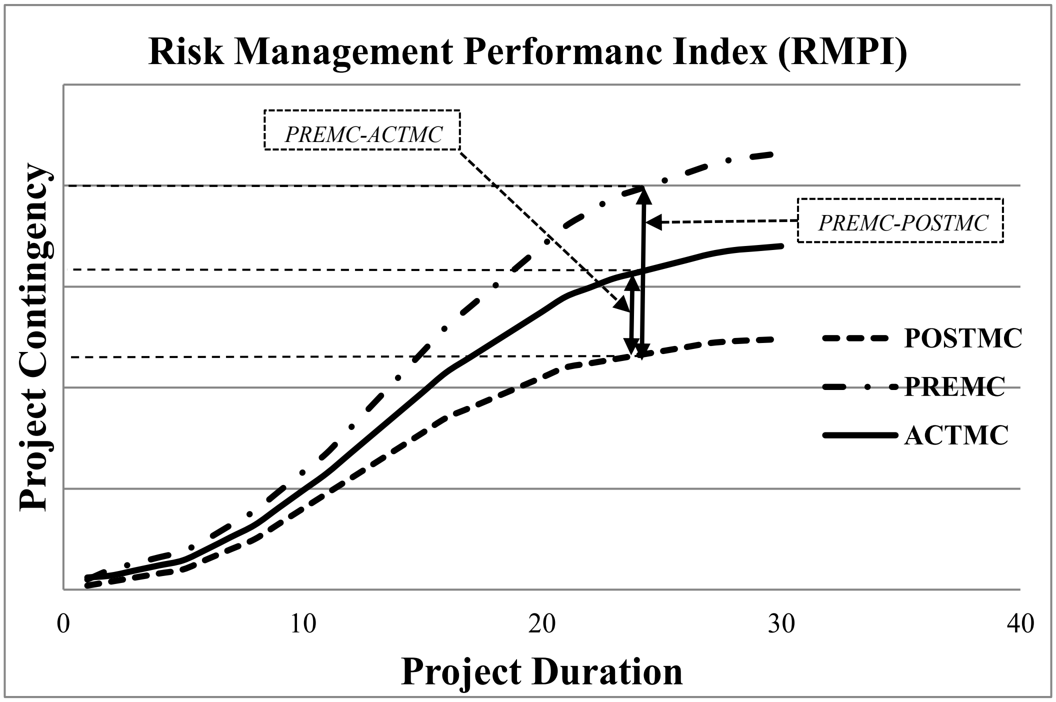


Figure 3.22 Performance Index

3.5 Opportunity Modeling

The developed CRMM manages the threats; however, in the assessment phase opportunities can be integrated indirectly by considering them as negative threats. In the mitigation phase, opportunity should be mitigated with inciting actions instead of preventive actions and exploiting action instead of remedial action. Inciting actions represent the actions which encourage the opportunity to occur for example delay a procurement of material to get benefit from an expected price reduction. Exploiting actions represent those which maximize the benefits of the opportunity being considered for example make partial procurement to benefit from a further decrease in the material prices. For the monitoring and control process similar procedure to threats can be followed for monitoring and control of opportunities. By considering the opportunities (O) and threats (T) the overall pre-mitigation contingency at a task (k) can be calculated using Eq. 3.79 as follows:

$$\mathrm{PREMC_k} = \mathrm{PREMC(T)} - \mathrm{PREMC(O)} \quad 3.79$$

3.6 Summary

This chapter presents the developed CRMM and its frameworks, modules, sub-modules, methods, procedures and algorithms. The developed CRMM is implemented in a systematic framework; utilizing fuzzy theory in an adaptive way, using the algebraic sum and product introduced by Zadeh (1965), to facilitate the modelling of uncertainties associated with the input data of CRMM. The developed CRMM integrates dynamically the five processes described in this chapter using fuzzy set theory at micro level. This integration facilitates interactive input-output exchange among the developed risk management processes.

CHAPTER 4: CASE STUDIES AND A NUMERICAL EXAMPLE

4.1 Overview

The aim of this is to validate the developed model and to illustrate its essential features using a set of case studies and a numerical example. It should be noted that data collection for the first application of the developed model represents a major challenge. However, these data represents an organizational asset that can be used for future projects. The set of case studies are gathered from literature to validate the applicability and reliability of the developed methods for identification, assessment, and mitigation. The numerical example is presented to illustrate the complete application process for the developed model including the developed methods for monitoring and control. Overview of the chapter is provided in Figure 4.1.

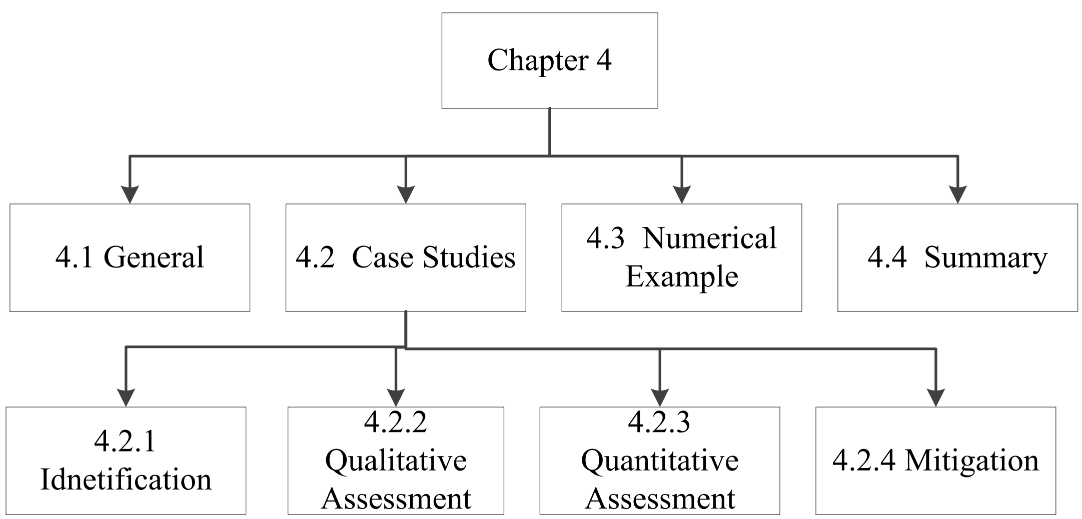


Figure 4.1 Overview of Chapter 4

4.2 Case Studies

The developed model encompasses five methods for risk identification, assessment, mitigation, monitoring and control. The validation process aims to illustrate the features and to investigate the accuracy of developed model as compared to existing methods.

4.2.1 Identification Method

Sydney Opera House (SOH) case study is selected to validate the identification method. The specifications and details of SOH are as follows:

- The owner: State Government of New South Wales
- Architect : Jorn Utzon
- Cost: Initial Estimate was A$ 7 million and actual cost is A$102 million
- The building covers about 1.8 hectares
- The roof is supported on 32 concrete columns up to 2.5 m (8 ft) square
- 1300% over budget
- 10 years Delay

At early stage of the SOH project vital considerations were neglected such as the innovative nature of the project. Australian government was enthusiastic to build the project and, therefore, it pushes Utzon (i.e. the architect) to start the construction based on initial structural sketches. This led to erroneous design that conveys to several re-design iterations.

SOH project at that time was the largest project in Australia with innovative architecture and long with unprecedented structure. The roof shape was introduced for the first time and it was hard to design due to lack of structural analysis software. The project is considered one of the architectural wonders of the world and the roof is made of spherical. Considering these facts at that time would avoid and at least unveiled various risk items associated with the project. Figures Figure 4.2, Figure 4.3 and Figure 4.4 show the root causes, risk items and consequences using the developed identification method.

The application of developed identification method considering the three facts associated with the SOH projects leads to 19 risk items as compared to 12 risk items identified using traditional method as shown in Table 4.1.The rate of identification using the developed method is increased to 94 % as compared to the traditional method 67%.

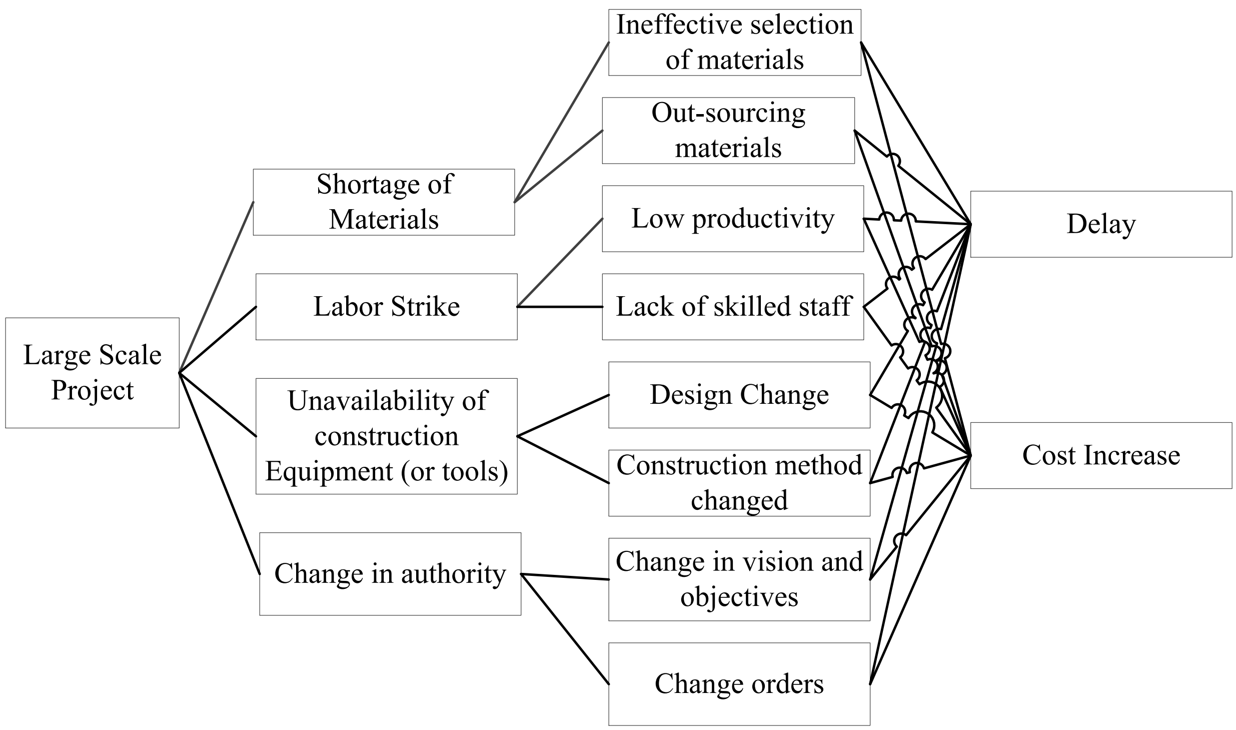


Figure 4.2 Risks Associated with Large Scale Project Criterion

The application of developed method increases by 27% the identification rate of the risks associated with SOH project. It should be noted that the application of the method at early stage with considerations of all project circumstances and along with the cooperation of all project parties, may help to identify more risks and subsequently avoid more problems. It should be noted that the SOH case study demonstrates the use of the developed identification method. However, it does not test the capabilities of the developed in various stages of project execution.

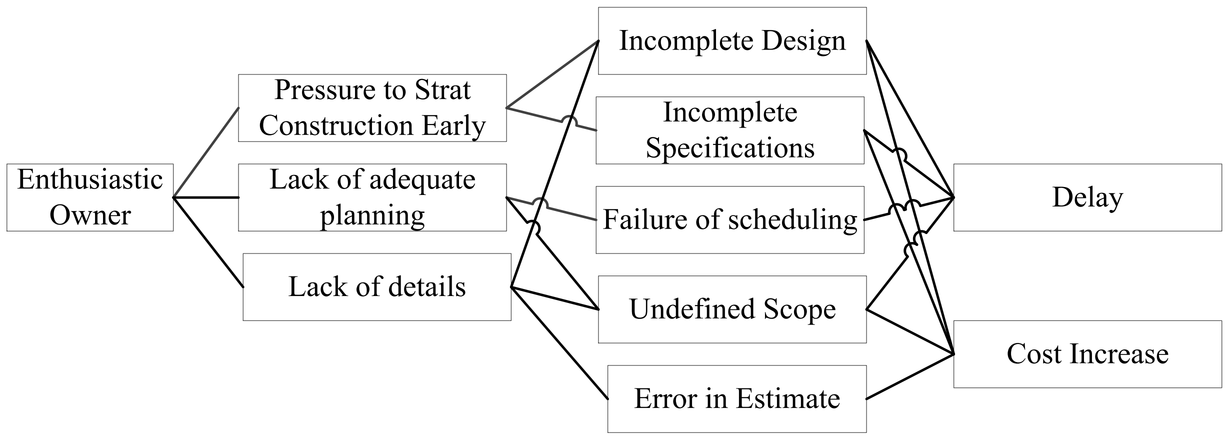


Figure 4.3 Risk Items Associated with Enthusiastic Owner Criterion

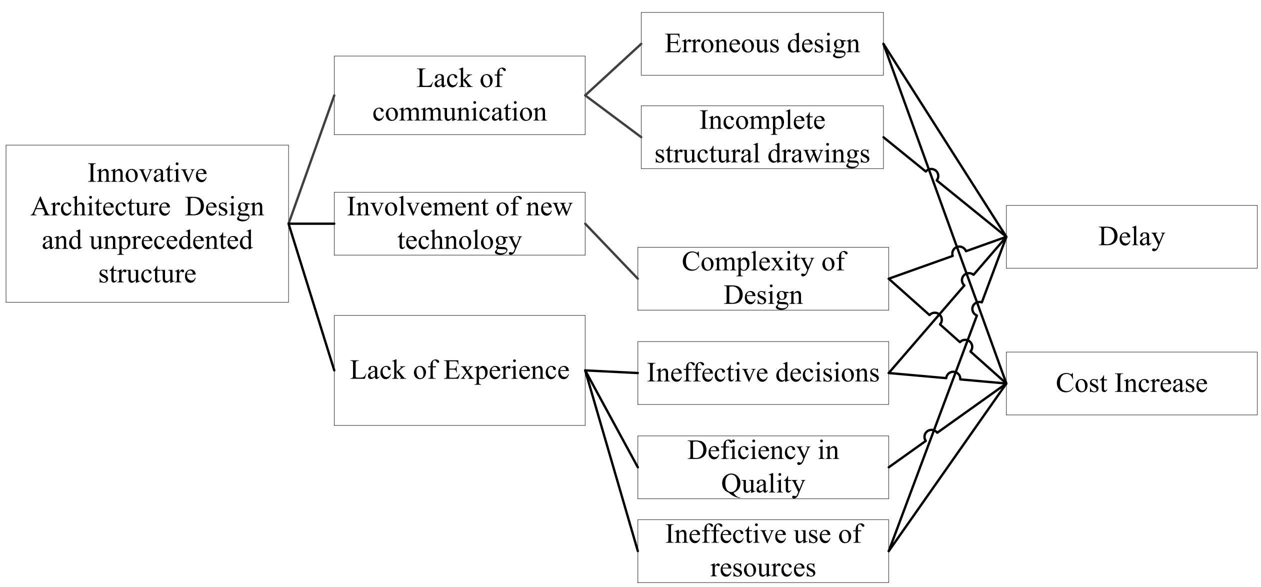


Figure 4.4 Risks Associated with Innovative Architecture and Unprecedented Structure

Table 4.1 Comparison between the Traditional method and the developed identification method

Risk identified using traditional identification method (Burtonshaw-Gunn, 2013)	Risk identified using Developed identification method	Actual Situation
Poor Cost Estimate	Error in Estimate	Initial Estimate A$ 7 M
Incomplete Design	Incomplete Design	The roof shells were designed as a series of parabolas which was impossible to construct. Utzon changed the shells to all being created as ribs from a sphere of the same radius (75 m)
Failure to Keep within the cost estimate	(Consequence)	
Failure to achieve the required completion date	(Consequence)	
Changes in Project Scope and requirement	Undefined Scope	Ted Farmer completed the glass walls and interiors including adding three previously unplanned venues underneath the Concert Hall on the western side
Design Change	Design Change	the major hall was changed from dual purpose for concert and opera to a single purpose concert hall
Pressure to deliver the project on accelerated schedule	(Root Cause)	
Inaccurate contract time estimate	Failure of Scheduling	10 years delay
Lack of communication between project participants.	(Root Cause)	
Inadequately defined roles and	Ineffective Decisions	Minister in charge, simply refused to pay Utzon. As a result Utzon resigned in February 1966.

Risk identified using traditional identification method (Burtonshaw-Gunn, 2013)	Risk identified using Developed identification method	Actual Situation
responsibilities.		
Insufficient skilled Staff	Lack of skilled staff	During the project a part-time executive, who did not have the technical competences and skills was appointed to supervise the project
Political Risks	Change in Vision and objectives	The new government considers the SOH as cost blow-out. So, it was tempted to call a halt to control the expenditures.
	Incomplete Specifications	The Sydney Opera House project had no design and cost specifications set by the client
	Ineffective selection of materials	It is relatively dark space, due to the materials used and primarily due to the contrasting harsh sunlight at the eastern and western sides
	Out-sourcing materials	1,056,000 glazed white granite tiles imported from Sweden
	Low productivity	Payments were being delivered and no considerable progress was seen, thus the government began withholding payments to Utzon which slow down the productivity.
	Construction method change	Construction of the shells was one of the most difficult engineering tasks ever to be attempted
	Generation of change orders	The government eventually became an obstacle to the project team by inhibiting changes during the progress of the operations and thus contributed to cost overrun and delays
	Erroneous design	Utzon was pushed to start the construction before the design was even close to finalization which led to erroneous design.
	Incomplete structural drawings	Construction beginning before proper engineering drawings had been prepared
	Deficiency in quality	N/A
	Ineffective use of resources	When Utzon resigns, the government appointed new architects who blew the budget from $18.4 to $102 million
	Complexity of design	Computers were needed to calculate stress points within the roof of the Sydney Opera House

4.2.2 Selection of risk owner

The case study is collected from literature and it was firstly introduced by El Sayegh (2008) and used recently by El Sayegh and Mansour (2015). The case study was used to allocate list of risks to owner or contractor. A set of risks was collected from literature (El-Sayegh & Mansour, 2015; El-Sayegh, 2008) as shown in Table 4.2.

Table 4.2 List of Risk items Associated with Construction Projects

Risk #	Risk # (El-Sayegh, 2008)	Risk # (El-Sayegh & Mansour, 2015)	Description
1	1	20	Owners' delayed payment to contractors
2	4	11	Change of design required by owners
3	5	N/A	Lack of scope of work definition by owner
4	6	10	Delays in obtaining site access and right of way
5	9	2	Defective design
6	13	17	Accidents during construction
7	14	19	Poor quality of work
8	15	8	Low productivity of labor and equipment
9	27	6	Delays in approvals
10	31	N/A	Inflation and sudden changes in prices
11	35	3	Shortage in equipment availability
12	39	21	Delays in resolving disputes
13	40	24	Unfairness in tendering

The developed allocation method was applied on this list of risks taking into consideration two types of ownership candidates; the owner and the contractor. For each risk items, each candidate receives fuzzy evaluations for his capacity, effectiveness, and ability to manage that risk.

For example, risk owner determination for risk #6 is presented to illustrate the process as shown in Table 4.3. Each ownership criterion is evaluated using fuzzy numbers as follows:

$\widetilde{CaI} = [0.5, 0.6, 0.6, 0.7]$

$\widetilde{EfI} = [0.7, 0.8, 0.8, 0.9]$

$\widetilde{AbI} = [0.8, 0.9, 0.9, 1.0]$

The membership function of each criterion is presented in Figure 4.5. The fuzzy calculation is used to calculate the fuzzy risk ownership score as follows:

$\widetilde{ROS} = [2.0, 2.3, 2.4, 2.6]$

The membership calculation is used to calculate the membership function of risk ownership score as shown in Figure 4.6. The centre of area (COA) defuzzification method presented in Eq. 3.11 was used to calculate the defuzzified value of risk ownership score as shown in Table 4.3.

Similar process is followed to calculate the ownership score for each candidate as shown in Table 4.4. Subsequently for each risk item, the ownership candidate with highest ROS is selected as the owner as shown in Table 4.5. A comparison of the developed method with the methods proposed by El-Sayegh (2008) and El-Sayegh and Mansour (2015) is presented in Table 4.6. For calculation of risk ownership score for all risk item please refer to Appendix B.

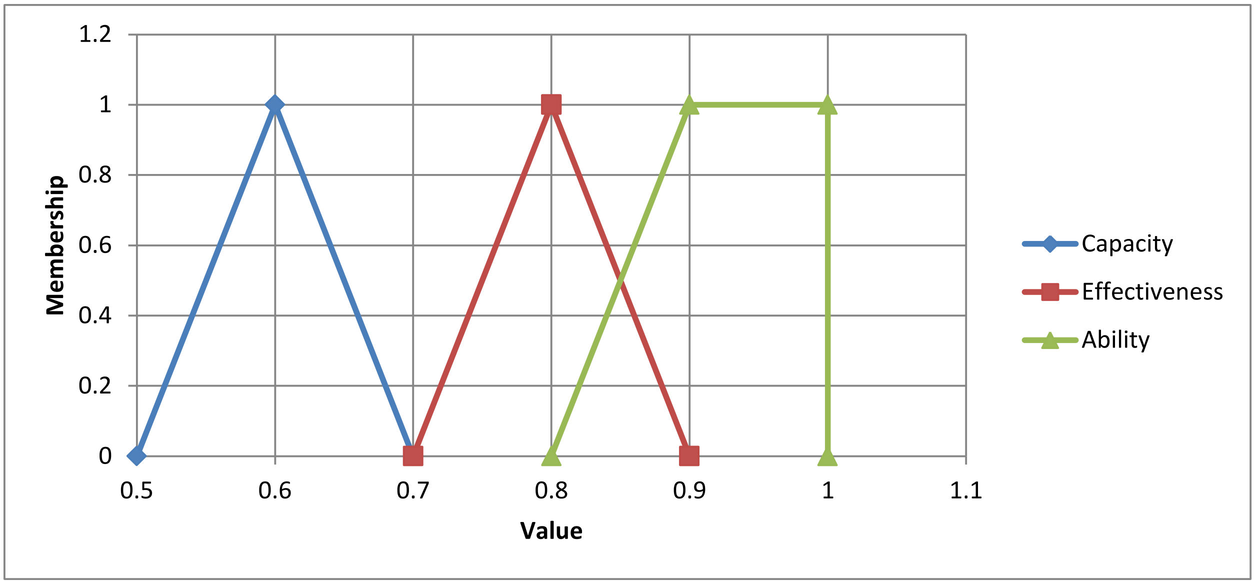


Figure 4.5 Fuzzy Evaluation of Ownership Criteria of Contractor as Candidate for Risk # 6

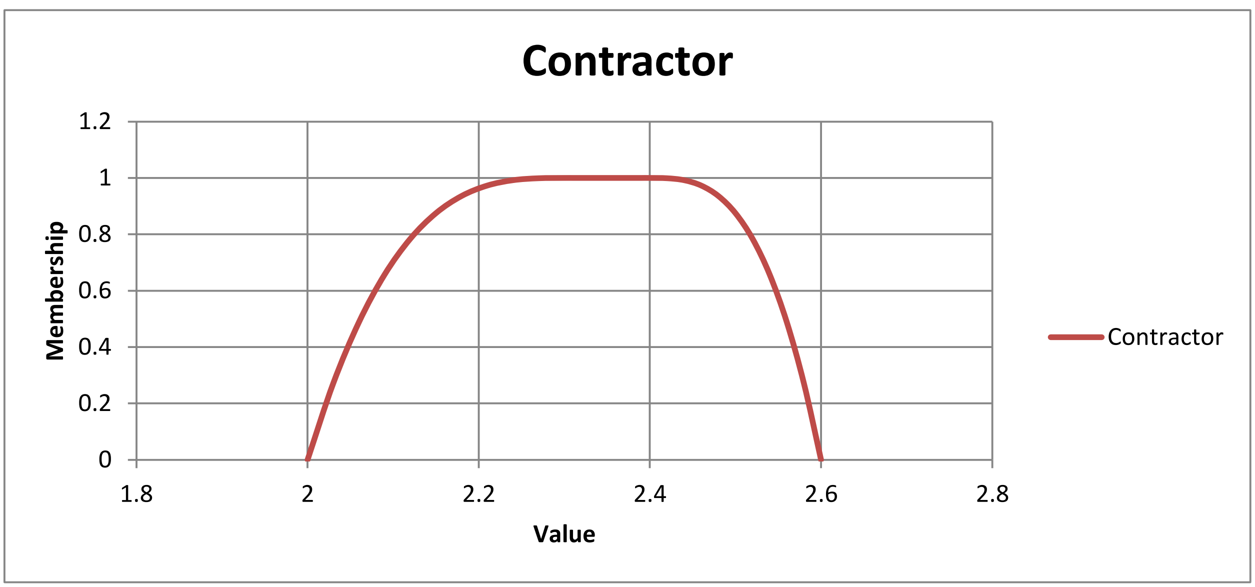


Figure 4.6Membership Function for Fuzzy Risk Ownership Score of Contractor for Risk #6

Table 4.3 Example of Defuzzification of Contractor ROS for Risk # 6

Defuzzification of Contractor ROS for Risk # 6														
X	2.000	2.030	Hidden Cells	2.270	2.300	2.310	Hidden Cells	2.390	2.400	2.420	Hidden Cells	2.580	2.600	∑
DY	0.000	0.100		0.900	1.000	1.000		1.000	1.000	0.900		0.100	0.000	
Y	0.000	0.271		0.999	1.000	1.000		1.000	1.000	0.999		0.271	0.000	
Area	0.000	0.004		0.030	0.030	0.010		0.010	0.010	0.020		0.008	0.003	0.474
X.Area		0.008		0.067	0.069	0.023		0.024	0.024	0.048		0.02	0.007	1.095
													ROS	2.311

Table 4.4 Ownership Determination For Each Risk Item in Table 4-2

Risk	Candidate	Capacity				Effectiveness				Ability				ROS				ROS
1	Contractor	0.2	0.4	0.5	0.6	0.2	0.2	0.4	0.4	0.1	0.1	0.2	0.2	0.5	0.7	1.1	1.2	0.86
	Owner	0.8	0.8	0.9	0.9	0.7	0.8	0.9	0.9	0.8	0.9	1.0	1.0	2.3	2.5	2.8	2.8	2.57
2	Contractor	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.2	0.2	0.4	0.4	1.10	1.10	1.50	1.50	1.3
	Owner	0.8	0.8	1.0	1.0	0.8	0.8	0.9	0.9	0.8	0.8	0.9	0.9	2.40	2.40	2.80	2.80	2.6
3	Contractor	0.7	0.7	0.9	0.9	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	1.4	1.5	1.8	1.9	1.65
	Owner	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.7	0.8	0.9	0.9	1.9	2.2	2.3	2.5	2.21
4	Contractor	0.2	0.2	0.3	0.3	0.5	0.5	0.6	0.6	0.4	0.4	0.5	0.5	1.1	1.1	1.4	1.4	1.25
	Owner	0.7	0.7	0.8	0.9	0.6	0.7	0.9	1.0	0.6	0.7	0.7	0.8	1.9	2.1	2.4	2.7	2.21
5	Contractor	0.5	0.5	0.6	0.6	0.5	0.6	0.6	0.7	0.5	0.5	0.6	0.6	1.5	1.6	1.8	1.9	1.70
	Owner	0.6	0.7	0.7	0.8	0.6	0.6	0.7	0.7	0.5	0.5	0.6	0.6	1.7	1.8	2.0	2.1	1.90
6	Contractor	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.8	0.9	1.0	1.0	2.0	2.3	2.4	2.6	2.31
	Owner	0.5	0.5	0.6	0.7	0.3	0.4	0.5	0.6	0.5	0.5	0.6	0.6	1.3	1.4	1.7	1.9	1.50
7	Contractor	0.8	0.9	0.9	1.0	0.8	0.8	0.9	0.9	0.7	0.8	0.8	1.0	2.3	2.5	2.6	2.9	2.59
	Owner	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	1.9	2.0	2.2	2.3	2.10
8	Contractor	0.7	0.8	0.8	0.9	0.7	0.8	0.9	1.0	0.8	0.9	0.9	1.0	2.2	2.5	2.6	2.9	2.55

Risk	Candidate	Capacity				Effectiveness				Ability				ROS				ROS
	Owner	0.4	0.5	0.6	0.7	0.5	0.6	0.6	0.7	0.6	0.7	0.7	0.9	1.5	1.8	1.9	2.3	1.89
9	Contractor	0.3	0.3	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.5	0.6	0.7	1.1	1.2	1.6	1.7	1.40
	Owner	0.8	0.8	0.9	0.9	0.7	0.8	0.9	1.0	0.7	0.7	0.9	0.9	2.2	2.3	2.7	2.8	2.50
10	Contractor	0.7	0.8	0.8	0.9	0.6	0.7	0.8	0.9	0.8	0.9	0.9	1.0	2.1	2.4	2.5	2.8	2.45
	Owner	0.7	0.8	0.8	0.9	0.7	0.8	0.9	1.0	0.5	0.6	0.6	0.7	1.9	2.2	2.3	2.6	2.20
11	Contractor	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.7	0.8	0.9	1.0	2.2	2.3	2.6	2.7	2.45
	Owner	0.3	0.3	0.4	0.4	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.7	0.9	1.1	1.3	1.5	1.20
12	Contractor	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.4	0.5	0.6	0.7	1.6	1.7	2.0	2.1	1.85
	Owner	0.7	0.7	0.9	0.9	0.8	0.9	0.9	1.0	0.6	0.7	0.7	0.8	2.1	2.3	2.5	2.7	2.40
13	Contractor	0.6	0.6	0.7	0.7	0.6	0.7	0.7	0.8	0.5	0.5	0.6	0.7	1.7	1.8	2.0	2.2	1.94
	Owner	0.7	0.7	0.8	0.8	0.5	0.5	0.6	0.6	0.8	0.8	0.9	0.9	2.0	2.0	2.3	2.3	2.15

Table 4.5 Comparison of Results of Risk Ownership Determination

Risk	Developed Model		El-Sayegh and Mansour (2015)		Khazaeni et al. (2012)			El-Sayegh (2008)			Actual Allocation in Port Complex (Khazaeni et al., 2012)
	O	C	O	C	O	C	S	O	C	S	
1	2.56	0.85	26	25	71	2	27	32.31	36.92	30.77	Shared
2	2.6	1.3	34	17	66	20	14	50.77	10.77	38.46	Contractor
3	2.19	1.64	N/A		N/A			30.77	18.46	50.77	N/A
4	2.27	1.25	37	14	63	19	18	24.62	33.85	41.54	Undecided
5	1.89	1.69	36	15	83	3	14	26.15	18.46	55.38	Contractor
6	1.57	2.298	12	39	4	84	12	3.08	87.69	9.23	Contractor
7	2.095	2.577	16	35	0	78	22	4.62	64.62	30.77	Contractor
8	1.872	2.535	17	34	0	90	10	0	83.08	16.92	Contractor
9	2.392	1.395	31	20	N/A			30.91	30.91	38.18	N/A
10	2.235	2.435	N/A		71	2	27	6.15	38.46	55.38	Undecided
11	1.19	2.445	7	44	7	82	11	0	75.38	24.62	Undecided
12	2.39	1.845	16	35	32	11	57	6.15	24.62	69.23	Contractor
13	2.15	1.931	34	17	72	16	12	30.77	21.54	47.69	Owner

Table 4.6 Relative Accuracy Rates of Developed Method

Methods	Developed Model	El-Sayegh and Mansour (2015)	Khazaeni et al. (2012)	El-Sayegh (2008)	Actual Allocation
Developed Model	1				
El-Sayegh and Mansour (2015)	9/10 [a]	1			
Khazaeni et al. (2012)	9/10 [a,b]	8/10[a,b]	1		
El-Sayegh (2008)	5/5 [a,b,c]	6/10 [a,b]	6/8 [a,c]	1	
Actual Allocation ****	4/6 [a,b,c]	5/9 [a,b]	4/8 [a, c]	4/11 [a]	1

a: N/A is neglected, b: Shared is neglected , c: Undecided is neglected

4.2.3 Qualitative Assessment

Three case studies were collected from literature to validate he developed qualitative assessment method and to illustrate its essential features. The first case study is Sydney opera house (SOH) that was assessed qualitatively by Burtonshaw-Gunn (2013). The second is Rehabilitation for University of Cartagena Buildings (Nieto-Morote & Ruz-Vila, 2011), and the third is road construction project (Mahamid, 2011).

The first case study is the SOH project which was used to illustrate applicability of the developed qualitative assessment method. The risks associated with SOH project, shown in Table 4.7, were assessed by Burtonshaw-Gunn (2013) using a scale from 1(Low) to 4 (critical) for probability of occurrence as shown in Table 4.7. The risk matrix followed by Burtonshaw-Gunn (2013) is shown in Table 4.9 where; green, yellow, red and brown colours denote respectively low, medium, high, and critical.

Table 4.7 SOH Qualitative Risk Assessment (Adopted with Burtonshaw-Gunn (2013))

Risk	P	I	Risk
Poor Cost Estimate	3	3	Critical
Incomplete Design	1	4	High
Changes in Project Scope and requirement	1	3	High
Design Change	2	2	Low
Inaccurate contract time estimate	3	4	Critical
Inadequately defined roles and responsibilities.	1	4	High
Insufficient skilled Staff	1	2	Low
Political Risks	4	2	Medium

In the application of the developed, a similar scale to that of Burtonshaw-Gunn (2013) is used to input qualitative variables (i.e. 3 = High) as show in Table 4.8. The linguistic term were converted into numeric using the FLNCS presented in Figure 4.7. The color mapping scale used in the developed method is shown in Table 4.9. The results of linguistic-numeric conversion for probability of occurrence and impact are presented in Table 4.8. The fuzzy risk value, shown in Table 4.8, of each risk item is calculated using Eq. 3.19. The centre of area (COA) defuzzification method presented in Eq. 3.22 was used to calculate the defuzzified risk value as presented in Table 4.10.

Table 4.8 SOH Qualitative Risk Assessment Using the Developed method

Risk	**P**	**I**	**FLNCS(P)**	**FLNCS(I)**	**Fuzzy Risk Value**
Poor Cost Estimate	H	H	(5,7,7,9)	(3,5,8,9)	(0.15,0.35,0.56,0.81)
Incomplete Design	L	VH	(0,0,3,4)	(8,9,10,10)	(0,0,0.3,0.4)
Changes in Project Scope and requirement	L	H	(0,0,3,4)	(3,5,8,9)	(0,0,0.24,0.36)
Design Change	M	M	(3,4,5,7)	(1,3,3,5)	(0.03,0.12,0.15,0.35)
Inaccurate contract time estimate	H	VH	(5,7,7,9)	(8,9,10,10)	(0.4,0.63,0.7,0.9)
Inadequately defined roles and responsibilities.	M	VH	(3,4,5,7)	(8,9,10,10)l	(0.24,0.36,0.5,0.7)
Insufficient skilled Staff	L	M	(0,0,3,4)	(1,3,3,5)	(0,0,0.09,0.2)
Political Risks	VH	M	(7,9,10,10)	(1,3,3,5)	(0.07,0.27,0.3,0.5)

Table 4.9 Color Mapping Scale.

Mapping Scale	Mapping Color
R<0.2	Low
0.2<R<0.30	Medium
0.30<R<0.50	High
R>0.50	Critical

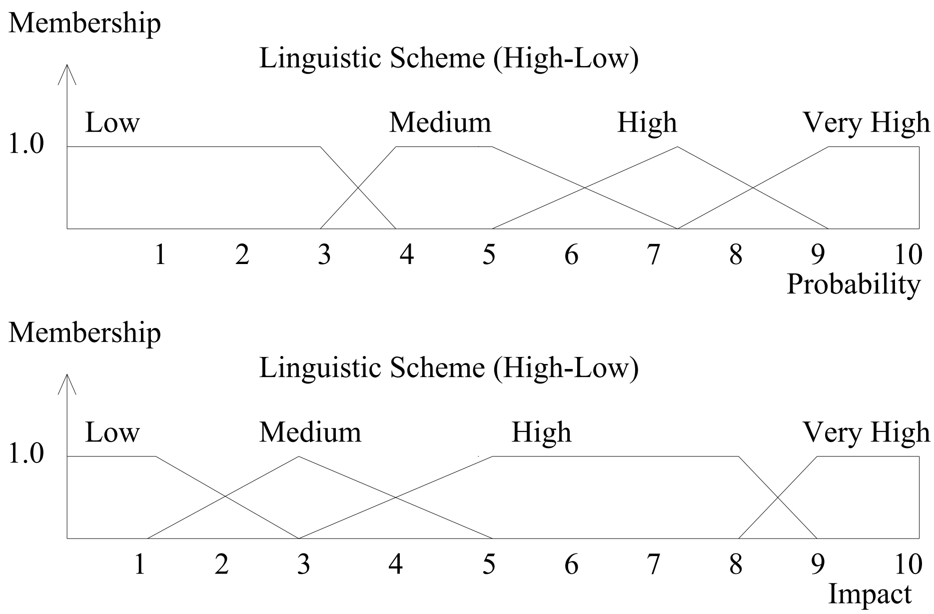


Figure 4.7 FLNCS for probability and consequence of SOH Case Study

Table 4.10 Comparison Between The Developed Method and Burtonshaw-Gunn (2013)

Risk	**Fuzzy Risk Value**	**Defuzzified Value**	**Wi**	**Developed Method**	**Burtonshaw-Gunn** (2013)
1 Poor Cost Estimate	(0.15,0.35,0.56,0.81)	0.518	0.18	Critical	Critical
2 Incomplete Design	(0,0,0.3,0.4)	0.302	0.11	High	High
3 Changes in Project Scope and requirement	(0,0,0.24,0.36)	0.259	0.09	Medium	High
4 Design Change	(0.03,0.12,0.15,0.35)	0.191	0.07	Low	Low
5 Inaccurate contract time estimate	(0.4,0.63,0.7,0.9)	0.67	0.23	Critical	Critical
6 Inadequately defined roles and responsibilities.	(0.24,0.36,0.5,0.7)	0.473	0.16	High	High
7 Insufficient skilled Staff	(0,0,0.09,0.2)	0.126	0.04	Low	Low
8 Political Risks	(0.07,0.27,0.3,0.5)	0.320	0.11	High	Medium

Despite the difference in assessment results of "Changes in Project Scope and Requirement" and "Political Risks", this case study demonstrates the applicability of proposed method and illustrates its flexibility to use linguistic terms instead of numeric. Also, the developed method, unlike other method, incorporates uncertainty associated with the assessment of risk items. It also calculates the risk level associated with the project using Eq. 3.23a assuming that this list of risks represents the risks associated with the project as shown in Table 4.11. The fuzzy risk value and defuzzified risk value of SOH project, shown in Table 4.11, are calculated using Eqs. 3.19 and 3.22, respectively.

Table 4.11 Risk Mapping for SOH Project

Project	**Risks**	**Fuzzy Risk Value of each risk**	**Fuzzy risk Value of Project**	**Risk Value**	**Mapping**
SOH	Poor Cost Estimate	(0.25,0.49,0.56,0.72)	(0,0,0.7,0.9)	0.442	High
	Incomplete Design	(0,0,0.3,0.4)			
	Changes in Project Scope and requirement	(0,0,0.24,0.36)			
	Design Change	(0.03,0.12,0.15,0.35)			
	Inaccurate contract time estimate	(0.4,0.63,0.7,0.9)			
	Inadequately defined roles and responsibilities.	(0.24,0.36,0.5,0.7)			
	Insufficient skilled Staff	(0,0,0.09,0.2)			
	Political Risks	(0.07,0.27,0.3,0.5)			

The second case study represents a rehabilitation project of a building in University of Cartagena is collected from literature (Nieto-Morote & Ruz-Vila, 2011) and selected to demonstrate the applicability of developed qualitative risk assessment methodology. Completing the project on schedule was the most important issue for this project; therefore, risk items associated with project delay were investigated. At that time, thirteen risks associated with project delay were identified and grouped into 4 categories: Management, engineering, execution, and supply as shown in Table 4.12. Four experts with high experience in this kind of projects are selected to evaluate the identified risks using fuzzy numbers as shown in Table 4.12. The fuzzy impact, probability, and risk value of each risk item are calculated using Eqs. 3.15, 3.17, and 3.19 respectively as shown in Table 4.13 .

Table 4.12 Fuzzy Evaluations of Risks Associated with Management Category

Category	Risks		Measure of RI	Measure of RP
Management	Lack of adequate process	E1	(0.1, 0.25, 0.25, 0.4)	(0, 0,0.1,0.2)
		E2	(0, 0, 0.1, 0.2)	(0, 0,0.1,0.2)
		E3	(0.3, 0.5, 0.5, 0.7)	(0.2, 0.5, 0.5, 0.8)
		E4	(0.6, 0.75, 0.75, 0.9)	(0.2, 0.5, 0.5, 0.8)
	Lack of resources	E1	(0, 0, 0.1, 0.2)	(0.2, 0.5, 0.5, 0.8)
		E2	(0.3, 0.5, 0.5, 0.7)	(0, 0,0.1,0.2)
		E3	(0.3, 0.5, 0.5, 0.7)	(0.7, 0.9, 1, 1)
		E4	(0.1, 0.25, 0.25, 0.4)	(0.2, 0.5, 0.5, 0.8)
	Inexperienced team members	E1	(0.3, 0.5, 0.5, 0.7)	(0.2, 0.5, 0.5, 0.8)
		E2	(0.6, 0.75, 0.75, 0.9)	(0.2, 0.5, 0.5, 0.8)
		E3	(0.3, 0.5, 0.5, 0.7)	(0, 0,0.1,0.2)
		E4	(0.6, 0.75, 0.75, 0.9)	(0.2, 0.5, 0.5, 0.8)
	Lack of motivation attitudes	E1	(0.3, 0.5, 0.5, 0.7)	(0.2, 0.5, 0.5, 0.8)
		E2	(0.1, 0.25, 0.25, 0.4)	(0.7, 0.9, 1, 1)
		E3	(0.3, 0.5, 0.5, 0.7)	(0.7, 0.9, 1, 1)
		E4	(0.6, 0.75, 0.75, 0.9)	(0.7, 0.9, 1, 1)

Table 4.13 Fuzzy Calculation Using Developed Method

Category	Risks	Fuzzy Impact	Fuzzy Probability	Fuzzy Risk Value
Management	Lack of adequate process	(0, 0, 0.75, 0.9)	(0, 0,0.5,0.8)	(0, 0,0.375,0.72)
	Lack of	(0, 0, 0.5, 0.7)	(0, 0, 1.0, 1.0)	(0, 0, 0.5, 0.7)

Category	Risks	Fuzzy Impact	Fuzzy Probability	Fuzzy Risk Value
	resources			
	Inexperienced team members	(0.3, 0.5, 0.75, 0.9)	(0, 0, 0.5, 0.8)	(0, 0, 0.375, 0.72)
	Lack of motivation attitudes	(0.1, 0.25, 0.75, 0.9)	(0.2, 0.5, 1.0, 1.0)	(0.2, 0.125, 0.75, 0.9)

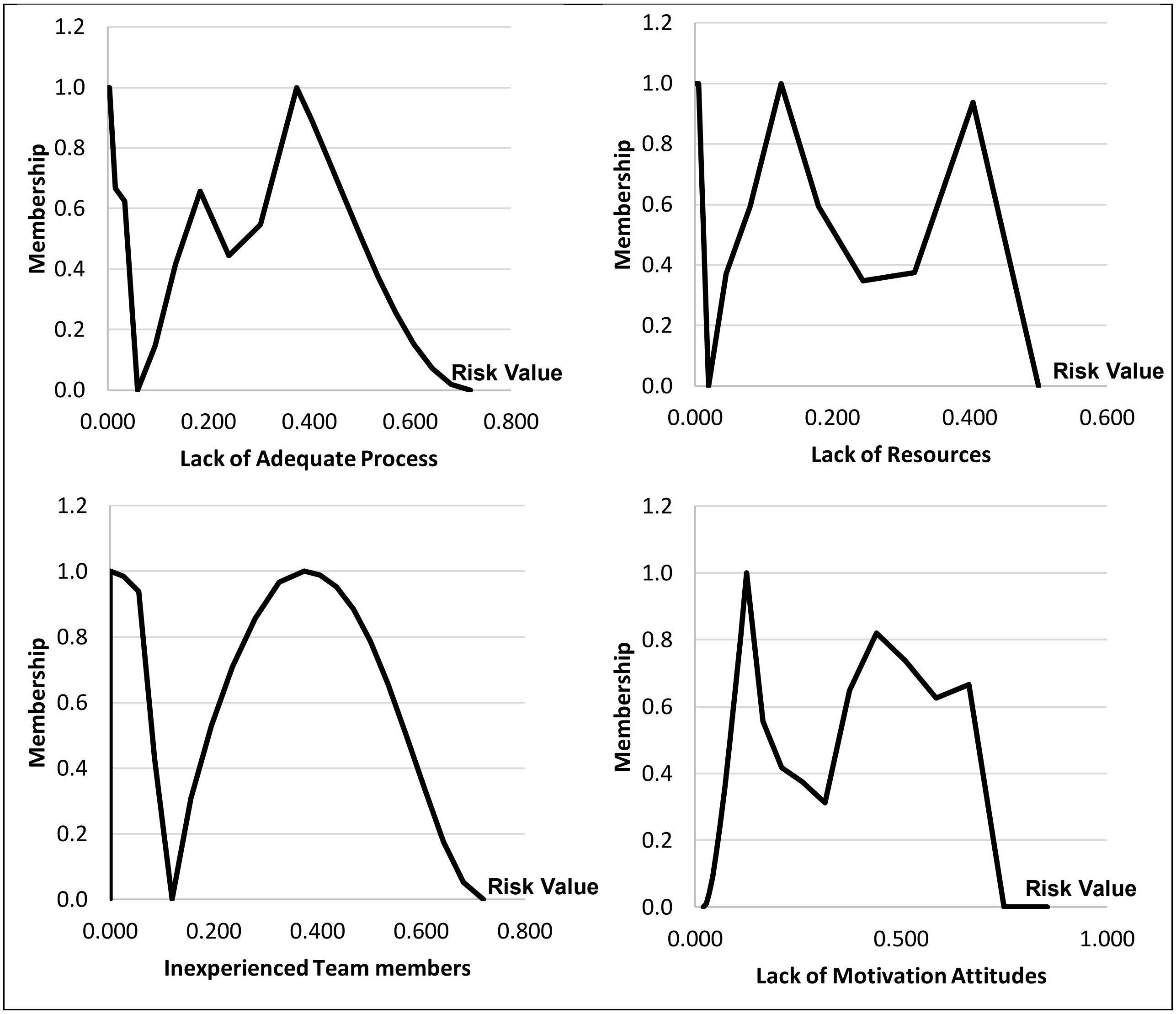


Figure 4.8 Membership Functions for Risk Values of Each Category

Table 4.14 Ranking of Risk Items Using Developed Method

Category	Risks	Deffuzzified Risk Value	Ranking using Developed method	Ranking by Nieto-Morote (2011)	Deffuzzified Risk Value
Management	Lack of adequate process	0.318	2	1	0.331
	Lack of resources	0.244	4	3	
	Inexperienced team members	0.325	3	2	
	Lack of motivation attitudes	0.399	1	4	

The only difference in ranking is the "Lack of motivation attitudes" that is ranked #1 in the developed method and #4 in Nieto-Morote and Vila (2011). The developed method was able to generate similar ranking for 3 out of 4 risks. In addition, the developed method provided information about the level of risks associated with management group as shown in Table 4.14. It should be noted that the Nieto-Morote and Vila (2011) assumed the evaluations provided by experts as dependent while the developed method consider them as independent. All details of calculation are presented in Appendix C.

The third case study focus on a road construction projects and it was collected from literature (Mahamid, 2011). The case presents an evaluation of 43 factors which contribute in delaying the road construction projects. The 43 factors were grouped into five groups: Logic and environment, managerial, consultant, financial, external. These factors were evaluated using questionnaires from 18 public owners. Then, the average was used to calculate the level of impact and probability as shown in Table 4.16. The same procedure, presented in the second case, is followed to evaluation of fuzzy risk value of each risk factor, defuzzification, and calculation of risk level associated with each group.

The fuzzy linguistic numeric conversion scheme is generated based on the linguistic evaluation used by Mahamid (2011) as shown in Table 4.15. The FLNCS used in the conversion procedure is presented in Figure 4.9. The mapping scale presented in Table 4.18 is based on the evaluation scale for probability and impact used by Mahamid (2011) as shown in

Table 4.19.

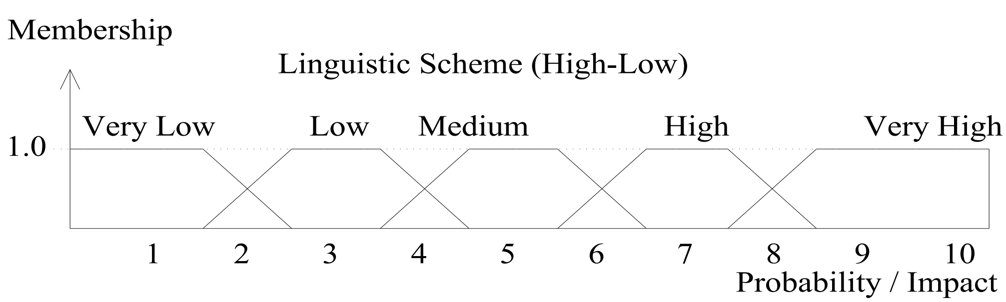


Figure 4.9 Fuzzy Linguistic Numeric Conversion Scheme

Table 4.15 Fuzzy Linguistic Conversion Scheme

Groups	Factors	Averages		FLNCS	
		I	P	I	P
Consultant	Late design works	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Mistake in design	M	L	(5.5,6.5,7.5,8.5)	(1.5,2.5,3.5,4.5)
	Inappropriate design	M	L	(5.5,6.5,7.5,8.5)	(1.5,2.5,3.5,4.5)
	Late inspection	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Late approval	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Insufficient inspectors	H	L	(5.5,6.5,7.5,8.5)	(1.5,2.5,3.5,4.5)
	Incapable inspectors	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
Logic and Environmental	Insufficient labors	M	L	(5.5,6.5,7.5,8.5)	(1.5,2.5,3.5,4.5)
	Rework from poor material quality	H	L	(5.5,6.5,7.5,8.5)	(1.5,2.5,3.5,4.5)
	Rework from poor workmanship	H	M	(5.5,6.5,7.5,8.5)	(3.5,4.5,5.5,6.5)
	Disturbance to public activities	M	L	(5.5,6.5,7.5,8.5)	(1.5,2.5,3.5,4.5)
	Unavailable construction material	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	High competition in bids	L	M	(1.5,2.5,3.5,4.5)	(3.5,4.5,5.5,6.5)
	Limited construction area	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Poor terrain condition	M	L	(3.5,4.5,5.5,6.5)	(1.5,2.5,3.5,4.5)
	Poor ground condition	M	L	(3.5,4.5,5.5,6.5)	(1.5,2.5,3.5,4.5)
	Poor soil suitability	L	M	(1.5,2.5,3.5,4.5)	(3.5,4.5,5.5,6.5)
Managerial	Delays in decision making	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Postponement of project	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Late land hand-over	M	L	(3.5,4.5,5.5,6.5)	(1.5,2.5,3.5,4.5)
	Late submission of nominated materials	M	L	(3.5,4.5,5.5,6.5)	(1.5,2.5,3.5,4.5)
	Poor communication between construction parties	H	M	(5.5,6.5,7.5,8.5)	(3.5,4.5,5.5,6.5)
	Unreasonable project time frame	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Poor resource management	H	M	(5.5,6.5,7.5,8.5)	(3.5,4.5,5.5,6.5)

Groups	Factors	Averages		FLNCS	
		I	P	I	P
	Changes in management ways	M	L	(3.5,4.5,5.5,6.5)	(1.5,2.5,3.5,4.5)
	Design changes	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Internal administrative problems	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Undefined scope of working	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Late documentation	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Delay in commencement	H	M	(5.5,6.5,7.5,8.5)	(3.5,4.5,5.5,6.5)
	Improper construction method	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Late issuing of approval documents	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
Financial	Payments delay	H	L	(5.5,6.5,7.5,8.5)	(1.5,2.5,3.5,4.5)
	Exchange rate fluctuation	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Monopoly	L	L	(1.5,2.5,3.5,4.5)	(1.5,2.5,3.5,4.5)
	Financial status of owner	L	L	(1.5,2.5,3.5,4.5)	(1.5,2.5,3.5,4.5)
	Financial status of contractor	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Changing of bankers policy for loans	L	L	(1.5,2.5,3.5,4.5)	(1.5,2.5,3.5,4.5)
External	Segmentation of the West Bank	M	H	(3.5,4.5,5.5,6.5)	(5.5,6.5,7.5,8.5)
	Closure	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Political situation	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Weather condition	M	M	(3.5,4.5,5.5,6.5)	(3.5,4.5,5.5,6.5)
	Natural disaster	L	L	(1.5,2.5,3.5,4.5)	(1.5,2.5,3.5,4.5)

Table 4.16 Risk Mapping Using Developed Method

Groups	Factors	Fuzzy Risk Value	Defuzzified Risk Value	Wi	Developed Method	Mahamid (2011)
Consultant	Late design works	(0.1225,0,2025,0.3025,0.4225)	0.3	0.162		

Groups	Factors	Fuzzy Risk Value	Defuzzified Risk Value	Wi	Developed Method	Mahamid (2011)
	Mistake in design	(0.0525,0.1125,0.1925,0.2925)	0.197	0.107		
	Inappropriate design	(0.0525,0.1125,0.1925,0.2925)	0.197	0.107		
	Late inspection	(0.1225,0,2025,0.3025,0.4225)	0.3	0.162		
	Late approval	(0.1225,0,2025,0.3025,0.4225)	0.3	0.162		
	Insufficient inspectors	(0.0825,0.1625,0.2625,0.3825)	0.255	0.138		
	Incapable inspectors	(0.1225,0,2025,0.3025,0.4225)	0.3	0.162		
Logic and Environmental	Insufficient labors	(0.0525,0.1125,0.1925,0.2925)	0.197	0.081		
	Rework from poor material quality	(0.0825,0.1625,0.2625,0.3825)	0.255	0.105		
	Rework from poor workmanship	(0.1925,0.2925,0.4125,0.5525)	0.385	0.159		
	Disturbance to public activities	(0.0525,0.1125,0.1925,0.2925)	0.197	0.081		
	Unavailable construction material	(0.1225,0,2025,0.3025,0.4225)	0.3	0.124		
	High competition in bids	(0.0525,0.1125,0.1925,0.2925)	0.197	0.081		
	Limited construction area	(0.1225,0,2025,0.3025,0.4225)	0.3	0.124		
	Poor terrain condition	(0.0525,0.1125,0.1925,0.2925)	0.197	0.081		
	Poor ground condition	(0.0525,0.1125,0.1925,0.2925)	0.197	0.081		
	Poor soil suitability	(0.0525,0.1125,0.1925,0.2925)	0.197	0.081		
Managerial	Delays in decision making	(0.1225,0,2025,0.3025,0.4225)	0.3	0.067		
	Postponement of project	(0.1225,0,2025,0.3025,0.4225)	0.3	0.067		
	Late land hand-over	(0.0525,0.1125,0.1925,0.2925)	0.197	0.044		
	Late submission of nominated materials	(0.0525,0.1125,0.1925,0.2925)	0.197	0.044		
	Poor communication between construction parties	(0.1925,0.2925,0.4125,0.5525)	0.385	0.087		
	Unreasonable project time frame	(0.1225,0,2025,0.3025,0.4225)	0.3	0.067		

Groups	Factors	Fuzzy Risk Value	Defuzzified Risk Value	Wi	Developed Method	Mahamid (2011)
	Poor resource management	(0.1925,0.2925,0.4125,0.5525)	0.385	0.087		
	Changes in management ways	(0.0525,0.1125,0.1925,0.2925)	0.197	0.044		
	Design changes	(0.1225,0,2025,0.3025,0.4225)	0.3	0.067		
	Internal administrative problems	(0.1225,0,2025,0.3025,0.4225)	0.3	0.067		
	Undefined scope of working	(0.1225,0,2025,0.3025,0.4225)	0.3	0.067		
	Late documentation	(0.1225,0,2025,0.3025,0.4225)	0.3	0.067		
	Delay in commencement	(0.1925,0.2925,0.4125,0.5525)	0.385	0.087		
	Improper construction method	(0.1225,0,2025,0.3025,0.4225)	0.3	0.067		
	Late issuing of approval documents	(0.1225,0,2025,0.3025,0.4225)	0.3	0.067		
Financial	Payments delay	(0.0825,0.1625,0.2625,0.3825)	0.255	0.200		
	Exchange rate fluctuation	(0.1225,0,2025,0.3025,0.4225)	0.3	0.236		
	Monopoly	(0.0225,0.0625,0.01225,0.2025)	0.139	0.109		
	Financial status of owner	(0.0225,0.0625,0.01225,0.2025)	0.139	0.109		
	Financial status of contractor	(0.1225,0,2025,0.3025,0.4225)	0.3	0.236		
	Changing of bankers policy for loans	(0.0225,0.0625,0.01225,0.2025)	0.139	0.109		
External	Segmentation of the West Bank	(0.1925,0.2925,0.4125,0.5525)	0.385	0.270		
	Closure	(0.1225,0,2025,0.3025,0.4225)	0.3	0.211		
	Political situation	(0.1225,0,2025,0.3025,0.4225)	0.3	0.211		
	Weather condition	(0.1225,0,2025,0.3025,0.4225)	0.3	0.211		
	Natural disaster	(0.0225,0.0625,0.01225,0.2025)	0.139	0.098		

Table 4.17 Risk Mapping at Group Level

Groups (j)	Fuzzy Risk Value=$\sum_{i=1}^{i=n} W_i \times \widetilde{R_{ij}}$	Defuzzified Risk Value	Mapping
Logic and Environmental	(0.1021,0.1778,0.2735,0.3893)	0.2433	
Consultant	(0.0953,0.1687,0.2621,0.3755)	0.2335	
Managerial	(0.0935,0.1513,0.2229,0.3082)	0.1999	
Financial	(0.0817,0.1486,0.1993,0.3424)	0.2070	
External	(0.1317,0.2132,0.3040,0.4362)	0.3393	

The result of risk mapping shows a considerable level of accuracy (~82%) as compared to traditional risk matrix method. In addition, the developed method represents a decision support for managers since it highlights the high-risk categories within the project as shown in Table 4.17.

Table 4.18 Color Mapping Scale.

Mapping Scale	Mapping Color
R<0.16	
0.16<R<0.32	
R>0.32	

Table 4.19 Probability and Impact Linguistic Evaluation (Mahamid, 2011)

Value	Probability / Impact
X<0.2	Very Low
0.2<X<0.4	Low
0.4<X<0.6	Medium
0.6<X<0.8	High
X>0.8	Very High

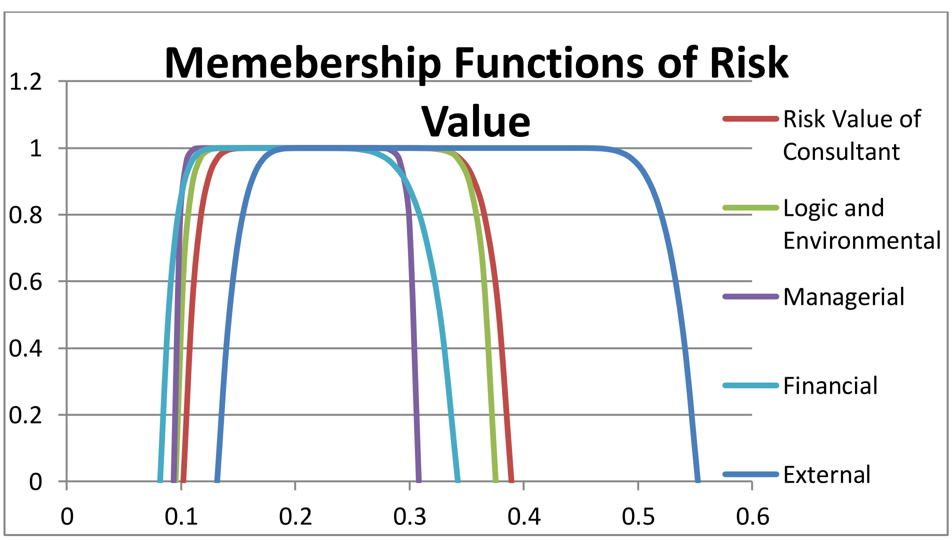


Figure 4.10 Membership Function of Risk Value for Each Group of Risk

The fuzzy risk values for each group are presented in Figure 4.10. The centre of area is used to defuzzify the fuzzy risk value and the mapping scale presented in Table 4.17 is used to map the risk level of each group. For more details about the calculation please refer to appendix D.

4.2.4 Quantitative Assessment

The developed quantitative assessment method utilizes the fuzzy set and fuzzy probability theories. Two case studies were collected from literature to evaluate quantitatively the risk items associated with construction projects. The first case study is a highway construction project (Paek, Lee, & Ock, 1993), and the second North Edmonton Sanitary Trunk (NEST) project (Shaheen, Robinson, & AbouRizk, 2007). The data sets used in both case studies are similar to the set of data required by the developed quantitative method, thus, these case studies were selected.

The first case study, referred to as UHCOC project, is collected from literature (Paek, Lee, & Ock, 1993). This case study, which represents a real project for urban highway construction, is used to validate the developed quantitative risk assessment. The UHCOC project consists of 32.18 km highway with 80 various types of bridge structures. It includes approximately 21,870,000 m^3 of excavation material, 90,000 m^2 of retaining wall, and 45,000 m of various sizes of drainage pipes. The cost of the project was projected to be around $800 million, and it was scheduled to be completed within 1500 calendar days including the design phase. UHCOC represents a private partnership project that was financed by private owners; the fund was raised by issuing local bonds and the investment planned to be recouped by charging road tolls. The estimators, from the construction firm that bid the project, provided their own assessment of the major risk elements and the monetary consequences associated with each risk element are shown in Table 4.20. Qualitative information does not exist or it was not provided by Paek et al. (1993), therefore, calculation of Pre-mitigation contingency assumed that the qualitative risk values of each risk element equals to 1. The fuzzy calculations are used to calculate the fuzzy risk value associated with each component of UHCOC project as shown in Table 4.21. Figure 4.11 shows the membership functions for; estimation and non-estimation related risks, positive and negative risks, and the total risks associated with UHCOC project. Table 4.22 shows the defuzzified value of pre-mitigation contingency for each project component. The results show that the pre-mitigation contingency required for managing all risk elements associated with UHCOC project equals to 28,850,100$. Table 4.23 shows comparison between the results of developed method and that of Paek et al. (1993), Salah and Moselhi (2012), and Moselhi (1997). For more details about the calculation please refer to Appendix E.

Table 4.20 Data for UHCOC Project (Paek et al., 1993)

	Category	Package	Risks	a	b	c	d
UHCOC	Positive Risks	Estimation Risk	1 Top soil quantity overrun	255	285	315	345
			2 Additional retaining walls and Pilings under retaining walls	3500	4500	5250	5500
			3 Additional wick drain pipe	120	142	150	150
			4 Additional remedial excavation in lieu of wick drain pipe	1400	1800	2000	2400
			5 Rock quantity overrun - drill and shoot by 25%	2550	3230	3570	4250
			6 Additional 1 mi hauling distance of drill and shoot rock	2000	2375	2625	3000
			7 Disposal fee $1.0/cu. Yd. for drill and shoot rock	4165	4752	5047	5625
			8 Increase in all storm drainage pipe by 6 in	1040	1170	1430	1560
			9 Increase in reinforced concrete pipe by 15%	1360	1615	1700	1700
		Non estimation Risks	10 Schedule acceleration	5250	6750	7500	8625
			11 DBE by 20%	800	900	1000	1150
			12 Design Growth	3000	5100	6600	7500
			13 Design/approval delays	2800	3600	4400	5200
			14 Regulatory agencies	3750	4750	5250	6000
			15 Disposal of excess materials	4250	4750	5000	5500
	Negative Risks	Estimation Risk	16 Less remedial excavation in lieu of wick-drain pipe	285	297	300	300
			17 less retaining walls and pilings under retaining walls	3200	3800	4200	4600
			18 Fatten slopes on site waste from drill and shoot rock	2400	2700	3000	3000
			19 Less tire/ track / repair cost	935	1067	1133	1265
			20 Less equipment maintenance cost	996	1140	1260	1404
			21 Piling reduction by 6ft per pile under bridge	720	873	900	900
			22 Replace 78R-value rock with 50R-value rock	1725	2185	2300	2415
		Non estimation Risks	23 Schedule deceleration	3750	4750	5000	5750
			24 Less Design/approval delays	1400	1800	2200	2600

Table 4.21 Fuzzy Calculation of UHCOC Project and its Components

<table>
<tr><th></th><th>Type</th><th>Group</th><th>Fuzzy Risk Value of Groups</th><th>Fuzzy Risk Value of Types</th><th>Fuzzy Risk Value of Project</th></tr>
<tr><td rowspan="4">UHCOC</td><td rowspan="2">Positive Risks</td><td>Estimation Risk</td><td>(16390, 19869, 22087, 24530)</td><td rowspan="2">(36240, 45719, 51837, 58505)</td><td rowspan="4">(20829, 27107, 31544, 36271)</td></tr>
<tr><td>Non estimation Risks</td><td>(19850, 25850, 29750, 33975)</td></tr>
<tr><td rowspan="2">Negative Risks</td><td>Estimation Risk</td><td>(10261, 12062, 13093, 13884)</td><td rowspan="2">(15411, 18612, 20293, 22234)</td></tr>
<tr><td>Non estimation Risks</td><td>(5150, 6550, 7200, 8350)</td></tr>
</table>

Table 4.22 Defuzzified Risk Values for UHCOC and its Components

<table>
<tr><th></th><th>Type</th><th>Group</th><th>Defuzzified Risk Valueof Groups ($)</th><th>Defuzzified Risk Value of Types ($)</th><th>Defuzzified Risk Value of Project ($)</th></tr>
<tr><td rowspan="4">UHCOC</td><td rowspan="2">Positive Risks</td><td>Estimation Risk</td><td>20671.08</td><td rowspan="2">47934.18</td><td rowspan="4">28850.1</td></tr>
<tr><td>Non Estimation Risks</td><td>27194.5</td></tr>
<tr><td rowspan="2">Negative Risks</td><td>Estimation Risk</td><td>12211.32</td><td rowspan="2">19036.11</td></tr>
<tr><td>Non Estimation Risks</td><td>6806.76</td></tr>
</table>

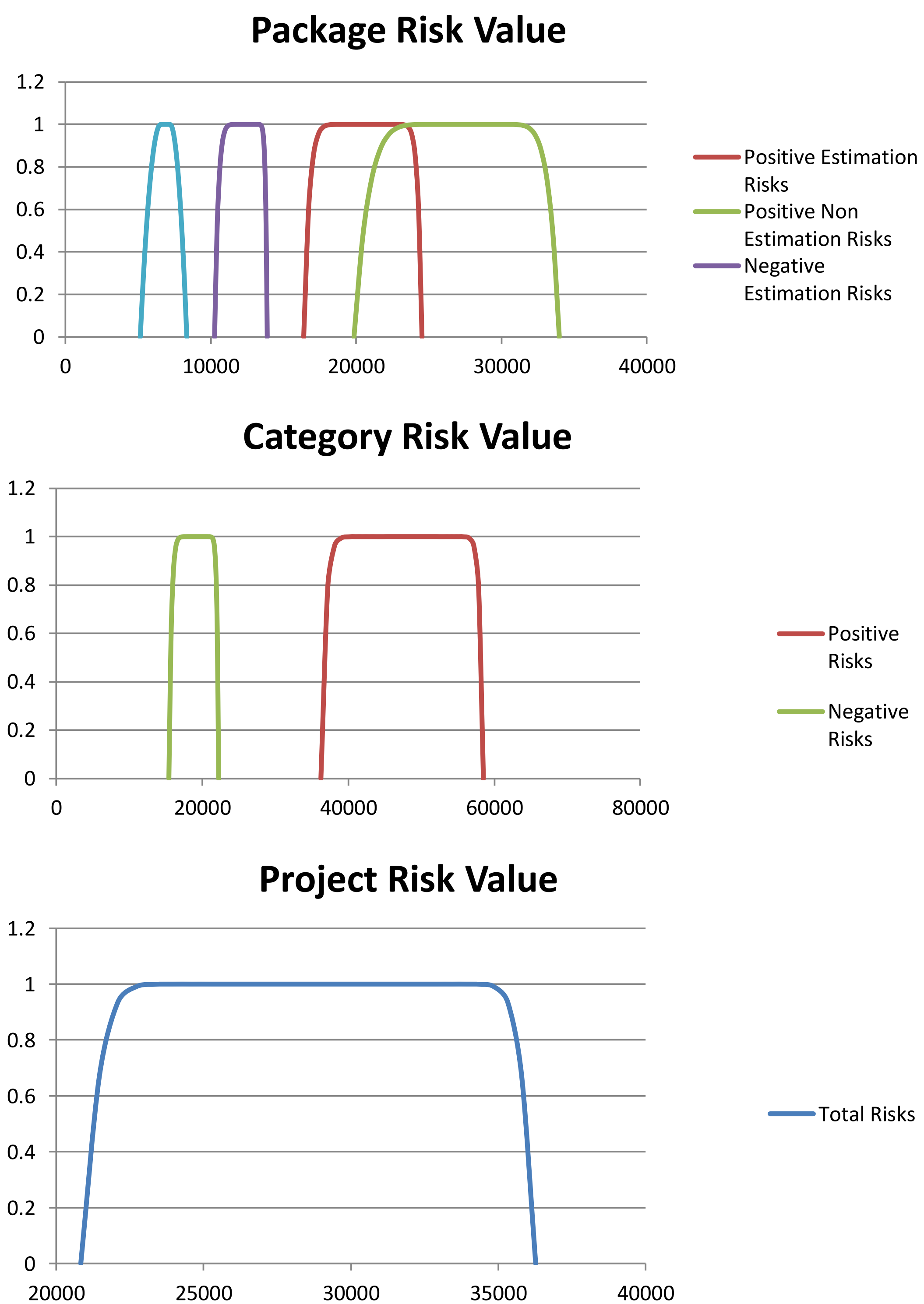


Figure 4.11 Fuzzy Membership for UHCOC Project and its Components

Table 4.23 Comparison of UHCOC Results

	Developed Method ($)	Salah (2012)	Moselhi (1997) using PERT ($)	Paek et al. (1993) ($)
UHCOC Project	28,850,100	28,872,500	29,292,000	28,968,350.00

The second case study represents a tunnelling project for the city of Edmonton "North Edmonton Sanitary Trunk" (NEST) which was collected from literature (Shaheen, Robinson, & AbouRizk, 2007). The city had an initial estimate of $6 million and a maximum allocated budget of $8.8 million (Shaheen, Robinson, & AbouRizk, 2007). The data, used in this case study, shown in Table 4.24, was prepared by the City of Edmonton for its tunnelling project. The NEST project is a tunnel, with 3.6 km length and interior diameter of 2.34 m, which aims to provide sanitary servicing to neighbourhoods in northern city of Edmonton, Alberta. The City of Edmonton had concerns about meeting the budgeted cost of the project. Therefore a study was conducted using Monte Carlo simulation. This case study was also used by Salah and Moselhi (2015), and Shaheen et al. (2007) to estimate the range cost of a project. For more details about the calculation please refer to Appendix F.

Table 4.24 Cost Estimation Data for NEST Project

Activity Name	A ($)	B ($)	C ($)	D ($)
Mobilization	40000	70000	70000	100000
Power Installation	89000	89000	89000	89000
Power - 156 Str.	15000	15000	50000	50000
Excavate Work Shaft	97600	122000	122000	146400
Excavate under cut	200000	269000	269000	350000
excavate tail tunnel to east	100000	123000	123000	150000
form and pour undercut	80000	80000	80000	80000
form and pour tail undercut	39000	39000	39000	39000
form and pour shaft	100000	120000	120000	150000
excavate access shaft	16000	16000	16000	16000

Activity Name	A ($)	B ($)	C ($)	D ($)
backfill shaft and install segments	44000	44000	44000	44000
tunnel install segments (866m)	1951964	2142484	2142484	2909760
patch and rub tunnel crown	80.000	134.000	134.000	140.000
patch and rub tunnel final cleanup	161.000	188.000	188.000	215.000
spoil removal	5.4	8.1	8.1	9.7
access manhole shaft	61000	61000	61000	61000
tunnel and install segments (756m)	1704024	1870344	1870344	2540160
patch and rub tunnel crown	80	134	134	140
patch and rub tunnel final cleanup	161	188	188	215
spoil removal	5.4	8.1	8.1	9.7
removal shaft	101000	101000	101000	101000
Fuzzy Cost Range of NEST	4639080.8	5162488.2	5197488.2	6827049.4
Defuzzified Value of NEST	5,638,099			

Table 4.25 Results of Cost Range Estimating Case Study

	Developed Method ($)	Salah and Moselhi (2015)	Shaheen et al.(2007) ($)	Monte carlo Simulation ($)
NEST	$ 5, 638, 099	$ 5, 456, 373	$ 6,054,474	$ 6, 059, 350

The results shown in Table 4.25 shows that the developed method can be applied also to estimating cost range of construction projects. The fuzzy membership function that represents the cost range estimate of the NEST project, using the developed method, is presented in Figure 4.12. The shape of the membership functions is generated using the fuzzy multiplication presented in Eq.3.2b However, in case of multiple fuzzy evaluations are used the shape of fuzzy membership function could differs than trapezoidal as assumed by Shaheen et al. (2007), and Salah & Moselhi (2015). Thus, the fuzzy membership calculation used in the developed method in that case may lead to more accurate results as compared to other methods.

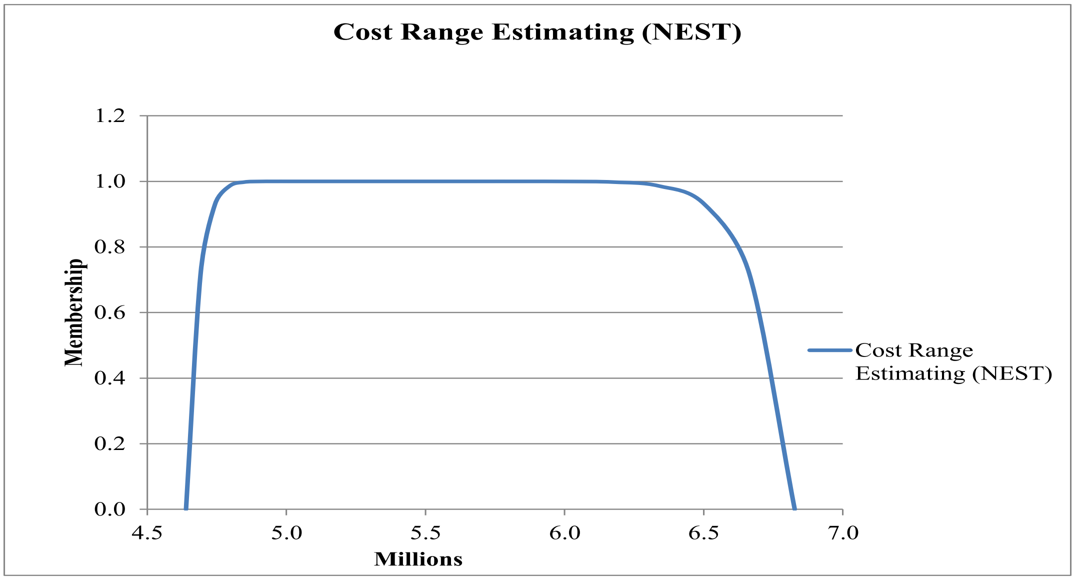


Figure 4.12 Fuzzy Membership Function for Range Cost Estimating of NEST Project

4.2.5 Mitigation

The case study is collected from literature (Abdelgawad & Fayek, 2012). The scope of the selected project includes the installation of a new crude oil pipeline with an initial capacity of 350,000 bpd. The total length of the pipeline is 380 km. Horizontal directional drilling (HDD) failure to meet the project objectives was identified as a critical risk event. Three strategies were identified and selected to mitigate the three risk factors associated with the as shown in Table 4.26.

Table 4.26 HDD Mitigation DATA (Adopted with Abdelgawad and Fayek (2012))

Risk Event	Risk Factors	Basic Event	Mitigations	P
HDD failure	Failure to select the right contractor	Non availability of HDD contractor with the required experience at the time and location required	Establish a proper prequalification strategy to select the right contractor	M

Risk Event	Risk Factors	Basic Event	Mitigations	P
		Failure to establish objective selection criteria and enforce them during bidding stage		M
	Failure to select the most appropriate drilling location	Failure to establish complete geotechnical studies	Establish a proper procedure to select the right drilling location	H
		Right of Way (ROW) constraints		M
	Failure to establish proper contingency plan to control the risk event if realized	Poor project management	Establish a contingency plan to control the risk, if realized	L
		Unavailability of skilled resources		M

Abdelgawad and Fayek (2012) estimate the expected risk magnitude (ERM) of HDD failure after consideration of three mitigation strategies. The fuzzy event tree analysis was selected to calculation the overall probability; assuming that all three strategies have potential to get failed or succeeded. Considering the available data, HDD case study was analysed and calibrated to apply the developed mitigation method as shown in Table 4.27. The fuzzy linguistic conversion scheme, presented in Figure 4.13, is used to convert the linguistic terms. However, this FLNCS represents a variable and it can differ from one organization or project type to another. The results of the conversion are presented in Table 4.28.

Table 4.27 Post Analysis of HDD Case Study Data (Abdelgawad and Fayek (2012))

Risk Event	Preventive Actions (PA)	MEFP	Remedial Actions (RA)	MEFC
HDD failure	1. Establish a proper prequalification strategy to select the right contractor	M	1. Establish a contingency plan to control the risk, if realized	M
	2. Establish a proper procedure to select the right drilling location	L		

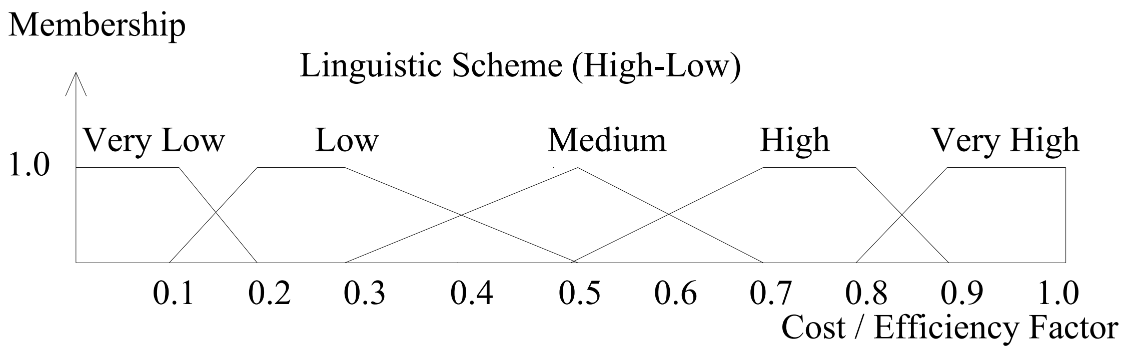


Figure 4.13 FLNCS for HDD Case Study

Table 4.28 Converted Linguistic Evaluation of Preventive and Remedial Actions

Risk Event	PA	MEFP	Defuzzified MEFP	RA	MEFC	Defuzzified MEFC
HDD failure	PA1	[0.3,0.5,0.5,0.7]	0.5	RA1	[0.3,0.5,0.5,0.7]	0.5
	PA2	[0.1,0.2,0.3,0.5]	0.28			

Table 4.29 Generation and Identification of Possible Mitigation Strategies

Possible Mitigation Strategy	Actions	MEF	MSC	PREMC	PEF	POSTMC
MS1	PA1	0.5	0	1	0.5	0.5
MS2	PA2	0.28			0.28	0.72
MS3	RA1	0.5			0.5	0.5
MS4	MS1+MS2	0.36			0.36	0.64
MS5	MS1+MS3	0.75			0.75	0.25
MS6	MS2+MS3	0.64			0.64	0.36
MS7	MS3+MS4	0.82			0.82	0.18

The data did not include details about cost of each mitigation strategy and the pre-mitigation contingency in case of HDD failure. Thus, cost of the mitigation strategies and the pre-mitigation contingency are considered equal to 0 and 1 respectively. In this case, the post mitigation contingency is calculated as percentage of the risk cost of HDD failure. The PEF for each mitigation strategy is calculated using Eq. 3.52. The mitigation strategy MS7 (i.e. similar to the case study) is selected as the most effective mitigation strategy for HDD failure as shown in Table 4.29. Thus, the post mitigation contingency is calculated using Eq. 3.53 as follows:

POSTMC = (1-PEF) x PREMC ➔ POSTMC = (1-0.82)*1 = 0.18 (18%)

The difference between MS5 and MS7 is relatively low, thus, the use of MS5 elevates the post mitigation contingency from 18(%) to 25(%). However, the cost of each mitigation strategy and the pre-mitigation contingency value could lead to different selection. Assuming the pre-mitigation contingency of the HDD failure risk is 1% of the total cost of the HDD project that means the post mitigation contingency equals to 0.18% (0.25%) of the baseline cost of the project which is considered as comparable results obtained by the case study (0.27%). For more details about the calculation of MEF please refer to Appendix G.

4.3 Numerical Example

Lack of monitoring and control methods in literature generates lack of data which can be used to validate the developed monitoring and control methods. Thus, a numerical example is used to illustrate the complete process of the developed CRMM and to highlight its essential features including monitoring and control.

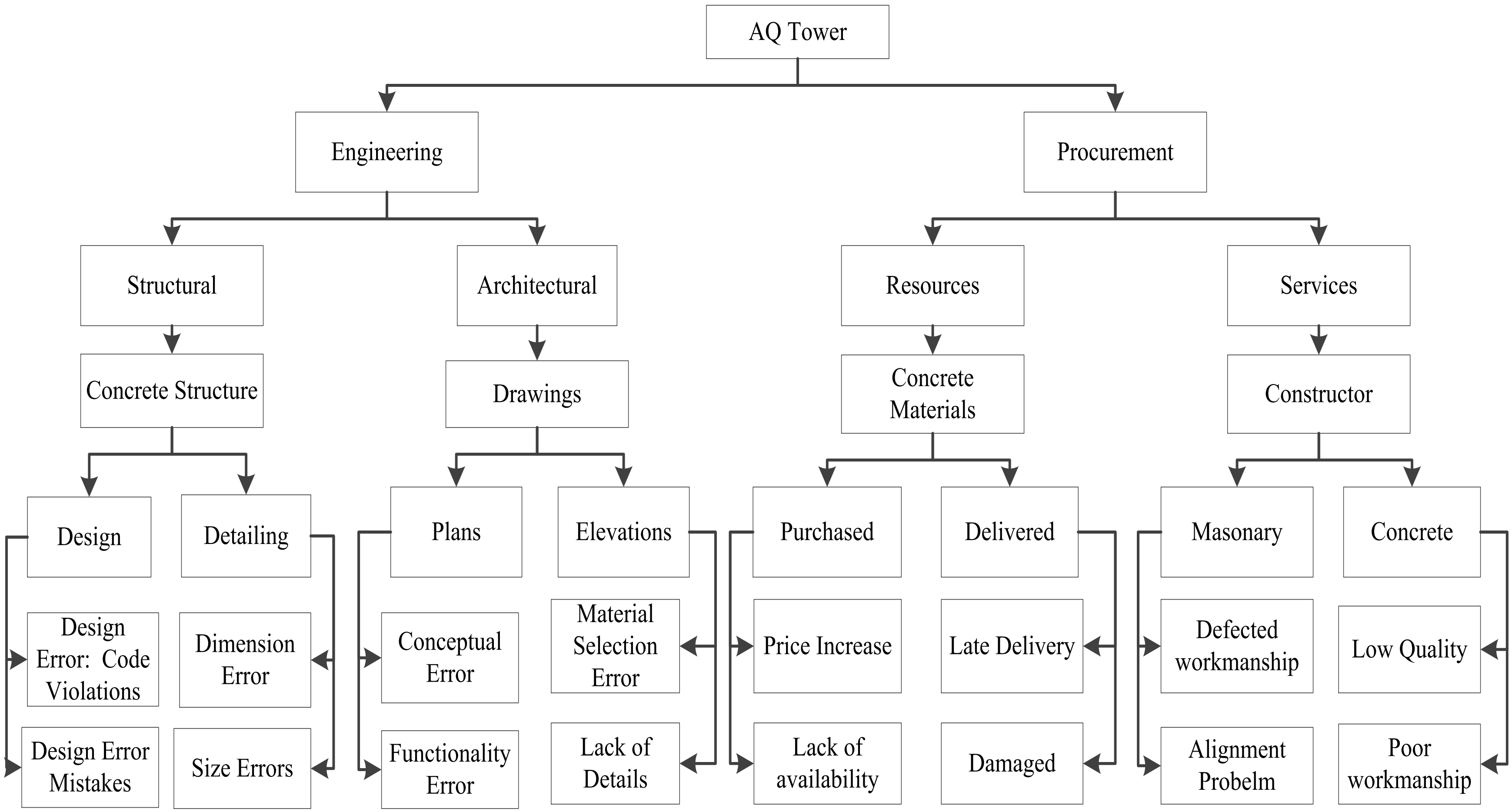


Figure 4.14 Project Risk Breakdown Structure at Micro Level

Table 4.30 UIDN Generation For each Project Component

Projects	Categories	Packages	Activities	Tasks	Risks	UIDN
1 AQ Tower	1 Engineering	1 Structural	1 Concrete Structures	1 Design	1 Design Error: Code Violation	1.1.1.1.1.1
					2 Design Error: Mistakes	1.1.1.1.1.2
				2 Detailing	1 Dimensions Error	1.1.1.1.2.1
					2 Error in Size Selection	1.1.1.1.2.2
		2 Architectural	1 Drawings	1 Plans	1 Conceptual Error	1.1.2.1.1.1
					2 Functionality Error	1.1.2.1.1.2
				2 Elevations	1 Material Selection Error	1.1.2.1.2.1
					2 Lack of Details	1.1.2.1.2.2
	2 Procurement	1 Resources	1 Concrete Material	1 Purchased	1 Price Increase	1.2.1.1.1.1
					2 Lack of availability	1.2.1.1.1.2
				2 Delivered	1 Late Delivery	1.2.1.1.2.1
					2 Damaged Materials	1.2.1.1.2.2
		2 Services	1 Constructor	1 Masonry	1 Defected Workmanship	1.2.2.1.1.1
					2 Alignment Problem	1.2.2.1.1.2
				2 Concrete	1 Low Quality	1.2.2.1.2.1
					2 Poor Workmanship	1.2.2.1.2.2

Table 4.31 Consequences, Preventive Actions, and Remedial Actions of Each Risk Item

UIDN	Consequences						Preventive Actions					Remedial Actions	
	Design Change	Rework	Waste of material	Shortage of Material	Delay of work	Lack of fund	3rd Party Design Review	Quality Assurance	Multi Supplier	Increase Communication	Stock	Resources Increase	Waste Management
1.1.1.1.1.1	✓	✓	✓				✓						✓
1.1.1.1.1.2		✓	✓		✓			✓					✓
1.1.1.1.2.1			✓					✓		✓			✓
1.1.1.1.2.2			✓	✓			✓			✓			✓
1.1.2.1.1.1		✓					✓			✓			
1.1.2.1.1.2	✓	✓			✓		✓			✓			
1.1.2.1.2.1			✓					✓					✓
1.1.2.1.2.2		✓	✓		✓		✓						✓
1.2.1.1.1.1						✓			✓		✓		
1.2.1.1.1.2				✓					✓		✓		
1.2.1.1.2.1					✓				✓	✓		✓	
1.2.1.1.2.2				✓				✓			✓		
1.2.2.1.1.1		✓						✓		✓			
1.2.2.1.1.2		✓	✓					✓		✓			✓
1.2.2.1.2.1		✓						✓		✓			
1.2.2.1.2.2					✓			✓				✓	

4.3.1 Identification phase

The first step is to generate the MRBS as shown in Figure 4.14. The numerical example consists of small project that has in total 16 risks associated with 8 tasks, 4 activities, 4 packages, and 2 categories. Based on the hierarchy the project components an UIDN is assigned to each risk item as shown in Table 4.30. After generation of MRBS, the risk consequences, preventive actions, remedial actions and control actions are identified as shown in Table 4.31.

4.3.2 Assessment Phase

The assessment phase follows the identification phase and it consists of three steps: Qualitative assessment, risk mapping, and quantitative assessment. Each step was treated separately to demonstrate the interconnections among these steps.

The first step is the qualitative assessment of risk items. The experts evaluate the probability and impact of each risk using fuzzy theory as shown in Table 4.32. The linguistic evaluations of probability or impact are converted into numeric using the FLNCS shown in Figure 4.15. Fuzzy calculation is used to calculate the fuzzy probability, fuzzy impact, and fuzzy risk value as shown in Table 4.33. For more details about the calculation please refer to Appendix H

Table 4.32 Fuzzy Evaluation of Impact, Probability and Consequences of Each Risk

Risk	E	Impact				Probability				Consequences											
										C1				C2				C3			
		a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
1.1.1.1.1.1	E1	6	7	7	8	1	2	4	5	10	20	30	50	15	25	30	35	10	15	20	25
	E2	3	5	5	7	3	5	6	7	30	40	40	60	10	20	20	25	15	30	30	35
	E3	3	4	4	6	2	4	4	7	15	25	25	50	30	40	50	60	20	25	25	40
1.1.1.1.1.2	E1	1	3	5	6	1	3	5	6	10	20	30	40	10	15	25	30	10	30	30	40
	E2	2	4	4	7	2	4	6	7	30	50	50	60	20	30	30	40	30	40	40	50
	E3	1	2	2	3	2	3	3	6	10	20	40	60	30	40	40	60	15	25	25	30
1.1.1.1.2.1	E1	6	7	8	10	1	2	4	5	20	30	40	50	-	-	-	-	-	-	-	-
	E2	3	5	5	7	3	5	6	7	30	30	40	40	-	-	-	-	-	-	-	-

Risk	E	Impact				Probability				Consequences											
										C1				C2				C3			
		a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
	E3	3	5	7	8	3	4	5	5	15	25	30	50	-	-	-	-	-	-	-	-
1.1.1.1.2.2	E1	3	5	5	8	1	3	5	6	30	40	40	60	15	25	25	30	-	-	-	-
	E2	2	3	3	6	2	4	4	7	20	30	40	50	20	30	40	50	-	-	-	-
	E3	2	4	4	7	1	2	2	3	30	30	40	40	30	30	40	40	-	-	-	-
1.1.2.1.1.1	E1	3	5	7	8	3	4	5	5	10	30	30	40	-	-	-	-	-	-	-	-
	E2	2	4	4	7	3	5	6	7	30	40	40	50	-	-	-	-	-	-	-	-
	E3	3	4	4	6	2	3	3	6	15	25	25	30	-	-	-	-	-	-	-	-
1.1.2.1.1.2	E1	2	3	3	6	1	2	4	5	15	25	30	50	30	30	40	40	30	40	40	60
	E2	3	5	6	7	2	4	4	7	10	30	30	40	15	25	25	30	40	50	50	60
	E3	1	3	5	6	2	3	5	6	30	40	40	60	20	30	40	50	10	20	20	50
1.1.2.1.2.1	E1	1	2	2	3	3	4	5	5	10	20	20	25	-	-	-	-	-	-	-	-
	E2	2	3	3	6	1	3	5	6	30	40	50	60	-	-	-	-	-	-	-	-
	E3	3	4	4	6	2	4	4	7	10	15	25	30	-	-	-	-	-	-	-	-
1.1.2.1.2.2	E1	2	3	3	6	1	2	4	5	15	25	30	50	30	30	40	40	30	40	40	60
	E2	2	4	4	7	2	4	6	7	30	50	50	60	20	30	30	40	30	40	40	50
	E3	3	5	5	7	3	5	6	7	30	40	40	60	10	20	20	25	15	30	30	35
1.2.1.1.1.1*	E1	2	3	5	6	1	3	5	6	30	40	50	60	-	-	-	-	-	-	-	-
	E2	1	3	3	5	2	3	5	6	20	30	30	50	-	-	-	-	-	-	-	-
	E3	3	4	4	6	3	5	7	8	20	25	35	40	-	-	-	-	-	-	-	-
1.2.1.1.1.2	E1	3	5	7	8	3	4	5	6	20	30	40	50	-	-	-	-	-	-	-	-
	E2	6	8	8	9	2	3	3	5	15	25	30	40	-	-	-	-	-	-	-	-
	E3	3	4	4	6	5	6	6	7	30	40	50	60	-	-	-	-	-	-	-	-
1.2.1.1.2.1*	E1	2	4	4	6	3	4	7	8	20	25	35	40	-	-	-	-	-	-	-	-
	E2	3	6	6	8	3	4	5	6	20	30	40	50	-	-	-	-	-	-	-	-
	E3	6	7	8	9	1	3	3	5	15	25	30	40	-	-	-	-	-	-	-	-
1.2.1.1.2.2	E1	3	6	7	8	3	4	5	6	20	30	40	50	-	-	-	-	-	-	-	-
	E2	2	4	4	6	2	4	4	7	10	15	25	30	-	-	-	-	-	-	-	-
	E3	3	5	5	7	3	5	6	7	30	40	40	60	-	-	-	-	-	-	-	-
1.2.2.1.1.1*	E1	6	7	7	10	1	2	4	5	40	70	70	80	-	-	-	-	-	-	-	-
	E2	4	5	5	6	3	5	6	7	50	60	60	90	-	-	-	-	-	-	-	-
	E3	5	7	8	9	3	4	5	5	30	50	50	70	-	-	-	-	-	-	-	-
1.2.2.1.1.2*	E1	5	7	7	8	8	9	10	10	30	40	40	60	20	30	40	50	-	-	-	-
	E2	5	6	6	7	5	6	7	8	30	40	40	50	30	30	40	40	-	-	-	-
	E3	6	7	8	9	5	7	8	9	15	30	30	35	15	25	30	50	-	-	-	-
1.2.2.1.2.1*	E1	2	3	4	6	1	3	4	5	15	25	30	50	-	-	-	-	-	-	-	-
	E2	2	4	4	7	3	5	6	7	30	40	40	70	-	-	-	-	-	-	-	-
	E3	4	6	6	8	4	5	6	7	30	50	50	80	-	-	-	-	-	-	-	-
1.2.2.1.2.2*	E1	6	7	8	10	4	5	5	6	50	60	60	90	-	-	-	-	-	-	-	-
	E2	5	6	6	9	6	7	8	9	30	40	50	70	-	-	-	-	-	-	-	-
	E3	5	7	7	8	5	8	8	10	30	35	45	60	-	-	-	-	-	-	-	-

Green: Low, Yellow=Medium, Orange= High, Red = Very High

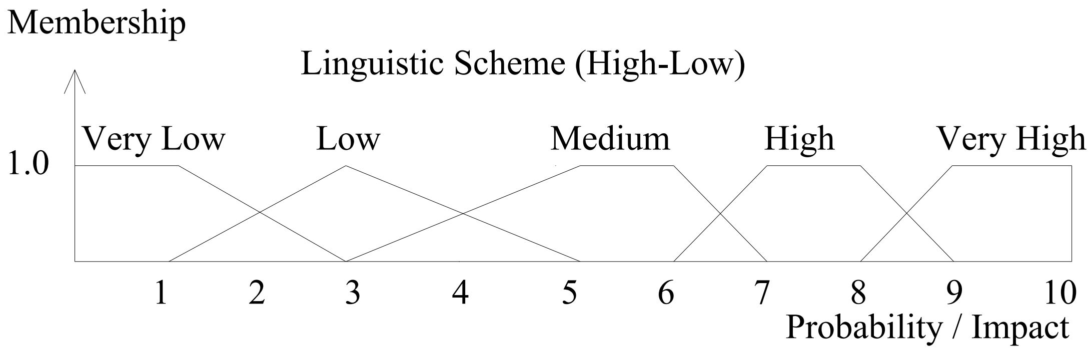


Figure 4.15 Fuzzy Linguistic Conversion Scheme

Table 4.33 Fuzzy Calculation of Risk Item

Risk	Fuzzy Impact	Fuzzy Probability	Fuzzy Risk Value	Defuzzified Risk Value
1.1.1.1.1.1	[3,4,7,8]	[1,2,6,7]	[0.03,0.08,0.42,0.56]	0.26
1.1.1.1.1.2	[1,2,5,7]	[1,3,6,7]	[0.01,0.06,0.3,0.49]	0.2
1.1.1.1.2.1	[3,5,8,10]	[1,2,6,7]	[0.03,0.1,0.48,0.7]	0.31
1.1.1.1.2.2	[2,3,5,7]	[1,2,5,8]	[0.02,0.06,0.25,0.56]	0.2
1.1.2.1.1.1	[2,4,7,8]	[2,3,6,7]	[0.04,0.12,0.42,0.56]	0.28
1.1.2.1.1.2	[1,2,4,6]	[1,3,5,7]	[0.01,0.06,0.2,0.42]	0.163
1.1.2.1.2.1	[2,3,5,7]	[1,2,6,7]	[0.02,0.06,0.3,0.49]	0.22
1.1.2.1.2.2	[1,2,4,6]	[1,3,7,8]	[0.01,0.06,0.28,0.48]	0.2
1.2.1.1.1.1	[1,3,5,6]	[3,5,7,8]	[0.01,0.09,0.35,0.48]	0.225
1.2.1.1.1.2	[3,4,8,9]	[2,3,6,7]	[0.06,0.12,0.48,0.63]	0.31
1.2.1.1.2.1	[2,4,8,9]	[1,2,7,8]	[0.02,0.08,0.56,0.72]	0.33
1.2.1.1.2.2	[2,4,7,8]	[2,4,6,7]	[0.04,0.16,0.42,0.56]	0.29
1.2.2.1.1.1	[4,5,8,10]	[1,2,6,7]	[0.04,0.1,0.48,0.7]	0.33
1.2.2.1.1.2	[5,6,8,9]	[5,6,10,10]	[0.25,0.36,0.8,0.9]	0.54
1.2.2.1.2.1	[2,3,6,8]	[1,3,6,7]	[0.02,0.09,0.36,0.56]	0.25
1.2.2.1.2.2	[5,6,8,10]	[4,5,8,10]	[0.2,0.3,0.64,1.0]	0.54

The risk mapping method is used to illustrate graphically the risk level associated with each project component as shown in Table 4.34 and Table 4.36 respectively. Subsequently the risk items are mapped as shown in using the mapping scale presented in Table 4.35. The Fuzzy Risk value of each task is also calculates using Eq. 3.23a. Similarly, the risk level associated with each activity, package, and category is calculated and mapped as shown in.

Table 4.34 Risk Mapping at Risk and Task Levels

Risk	Defuzzified Risk Value	Risk Mapping	Weight of risk value	Fuzzy Risk Value of Task	Defuzzified Risk Value of Task
1.1.1.1.1.1	0.26		0.57	[0.021,0.071,0.368,0.53]	0.235
1.1.1.1.1.2	0.2		0.43		
1.1.1.1.2.1	0.31		0.61	[0.026,0.084,0.39,0.645]	0.268
1.1.1.1.2.2	0.2		0.39		
1.1.2.1.1.1	0.28		0.63	[0.029,0.098,0.339,0.508]	0.235
1.1.2.1.1.2	0.163		0.37		
1.1.2.1.2.1	0.22		0.52	[0.11,0.35,0.175,0.286]	0.128
1.1.2.1.2.2	0.2		0.06		
1.2.1.1.1.1	0.225		0.42	[0.039,0.107,0.425,0.567]	0.275
1.2.1.1.1.2	0.31		0.58		
1.2.1.1.2.1	0.33		0.53	[0.029,0.117,0.457,0.645]	0.31
1.2.1.1.2.2	0.29		0.47		
1.2.2.1.1.1	0.33		0.38	[0.169,0.26,0.579,0.823]	0.45
1.2.2.1.1.2	0.53		0.62		
1.2.2.1.2.1	0.25		0.32	[0.143,0.234,0.551,0.86]	0.45
1.2.2.1.2.2	0.54		0.68		

Table 4.35 Risk Mapping Scale

Mapping Scale	Mapping Color
R<0.05	
0.05<R<0.2	
0.2<R<0.35	
0.35<R<0.5	
R>0.5	

Table 4.36 Fuzzy Calculation and Mapping for Packages and Categories

Risk	Fuzzy Risk Value of Activity / Package	Defuzzified Risk Value of Activity /Package	Fuzzy Risk Value of Category	Defuzzified Risk Value of Category
1.1.1.1.1.1	[0.024,0.078,0.38,0.591]	0.253	[0.023,0.077,0.336,0.521]	0.229
1.1.1.1.1.2				
1.1.1.1.2.1				
1.1.1.1.2.2				
1.1.2.1.1.1	[0.023,0.076,0.281,0.430]	0.198		
1.1.2.1.1.2				
1.1.2.1.2.1				
1.1.2.1.2.2				
1.2.1.1.1.1	[0.034,0.113,0.442,0.608]	0.291	[0.108,0.194,0.517,0.75]	0.386
1.2.1.1.1.2				
1.2.1.1.2.1				
1.2.1.1.2.2				
1.2.2.1.1.1	[0.156,0.247,0.565,0.842]	0.448		
1.2.2.1.1.2				
1.2.2.1.2.1				
1.2.2.1.2.2				

The fuzzy risk level of the project equals to [0.0766, 0.151, 0.445, 0.665] and its respective defuzzified value equals to 0.328. That means the overall risk level associated with the project is medium. Thus, mapping of the “AQ Tower” project item and its respective components is presented in Figure 4.16. The quantitative assessment step aims to calculate the contingency fund required to manage a risk as shown in Table 4.37. The pre-mitigation contingency for project components can be also calculated using series of Eqs. 3.30 – 3.34 as shown in Table 4.38. However, pre-mitigation contingency is decreased by implementing a mitigation strategy.

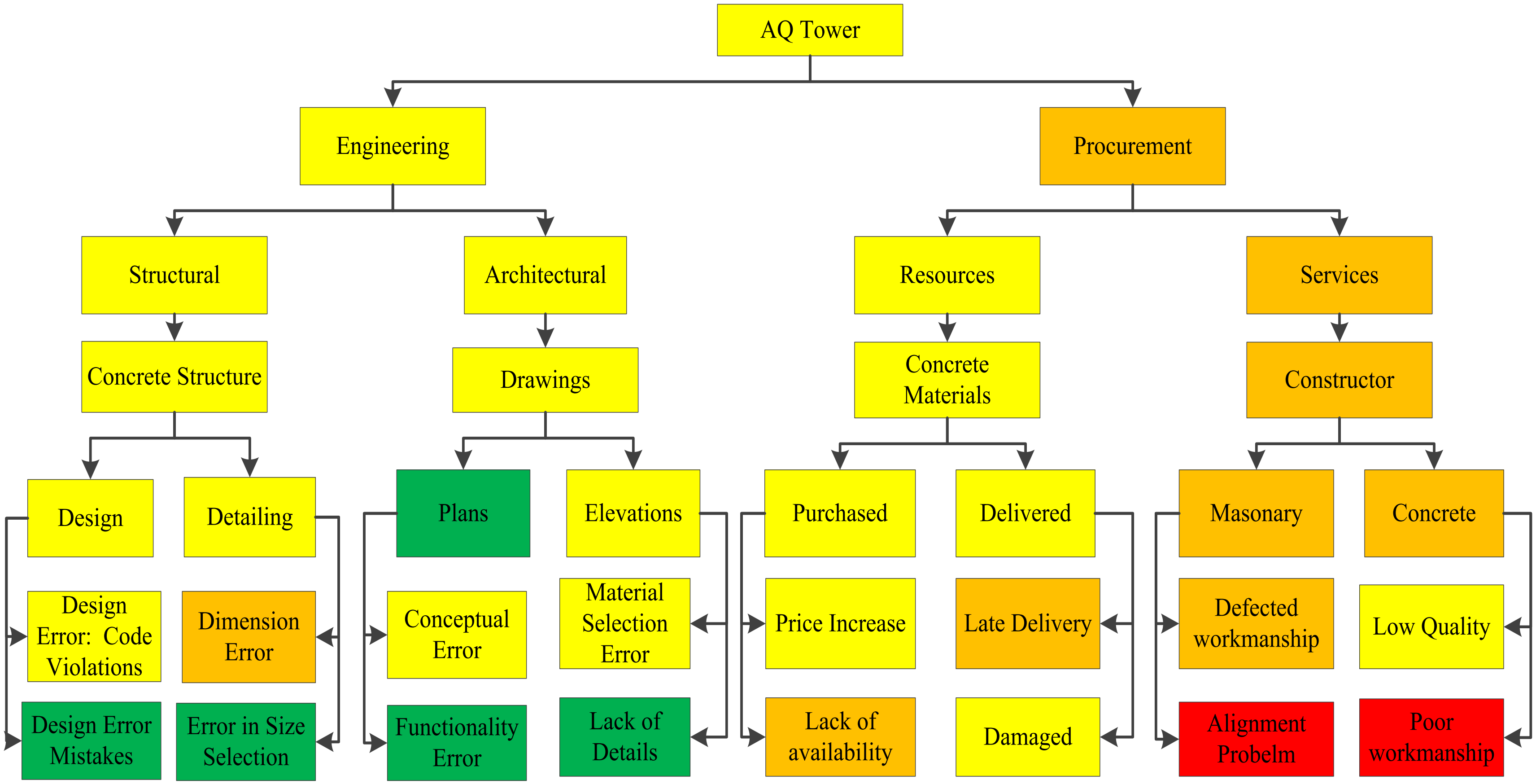


Figure 4.16 Mapped Micro-Risk Breakdown Structure

Table 4.37 Pre-mitigation Contingency Calculation at Risk Level

Risk	Fuzzy EMV	Fuzzy PREMC	Defuzzified PREMC (x1000$)
1.1.1.1.1.1	[30,55,120,160]	[0.9,4.4,50.4,89.6]	34.13
1.1.1.1.1.2	[30,60,130,170]	[0.3,3.6,39,83.3]	26.52
1.1.1.1.2.1	[15,25,40,50]	[0.45,2.5,19.2,35]	12.6
1.1.1.1.2.2	[35,55,80,110]	[0.7,3.3,20,61.6]	16.83
1.1.2.1.1.1	[10,25,40,50]	[0.4,3,16.8,28]	10.84
1.1.2.1.1.2	[10,15,50,60]	[0.1,0.9,10,25.2]	83.85
1.1.2.1.2.1	[40,75,130,160]	[0.8,4.5,39,78.4]	22.4
1.1.2.1.2.2	[15,25,35,50]	[0.15,1.5,9.8,24]	7.4
1.2.1.1.1.1	[20,25,50,60]	[0.2,2.25,17.5,28.8]	10.94
1.2.1.1.1.2	[15,25,50,60]	[0.9,3,24,37.8]	14.67
1.2.1.1.2.1	[15,25,40,50]	[0.3,2,19.6,36]	13.08
1.2.1.1.2.2	[10,15,40,60]	[0.4,2.4,16.8,33.6]	11.8
1.2.2.1.1.1	[30,50,70,90]	[1.2,5,33.6,63]	23.33
1.2.2.1.1.2	[30,55,70,110]	[7.5,19.8,51.2,99]	40.14
1.2.2.1.2.1	[15,25,50,80]	[0.3,2.25,18,44.8]	14.4
1.2.2.1.2.2	[30,35,60,90]	[6,10.5,38.4,90]	32.6

Table 4.38 Calculation of Pre-mitigation Contingency for Project Components

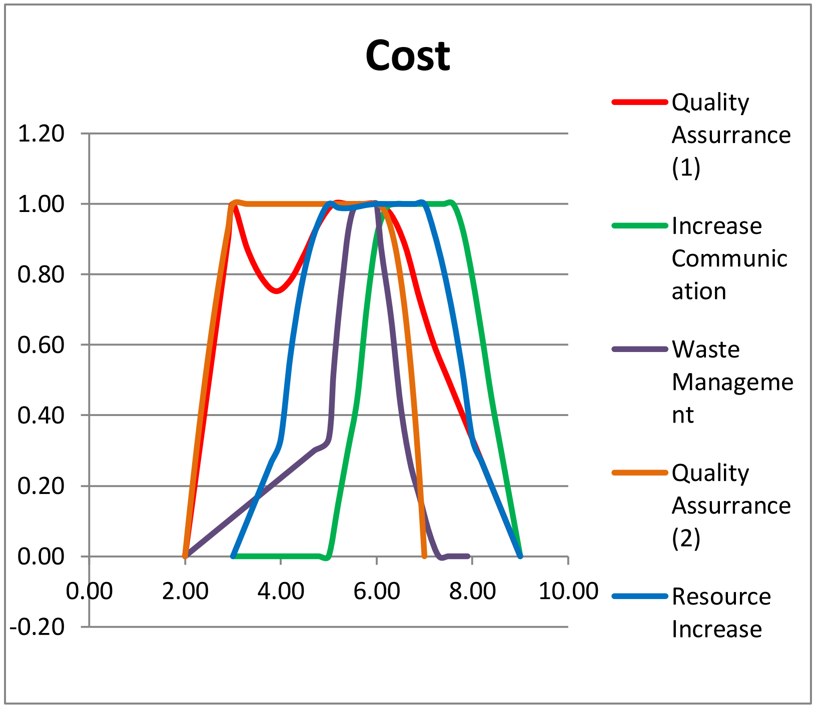
Risk	PREMC at Risk Level (x1000$)	PREMC at Task Level (x1000$)	PREMC Activity / Package Level (x1000$)	PREMC at Category Level (x1000$)	PREMC at Project Level (x1000$)
1.1.1.1.1.1	34.13	60.65	90.08	214.56	375.52
1.1.1.1.1.2	26.52				
1.1.1.1.2.1	12.6	29.43			
1.1.1.1.2.2	16.83				
1.1.2.1.1.1	10.84	94.69	124.48		
1.1.2.1.1.2	83.85				
1.1.2.1.2.1	22.4	29.8			
1.1.2.1.2.2	7.4				
1.2.1.1.1.1	10.94	25.61	50.49	160.96	
1.2.1.1.1.2	14.67				
1.2.1.1.2.1	13.08	24.88			
1.2.1.1.2.2	11.8				
1.2.2.1.1.1	23.33	63.47	110.47		
1.2.2.1.1.2	40.14				
1.2.2.1.2.1	14.4	47			
1.2.2.1.2.2	32.6				

Table 4.39 Evaluation of Preventive and Remedial Actions

R	E	Preventive Actions				Remedial Actions			
		Quality Assurance		Increase Communications		Waste Management		Resource Increase	
		Cost (PAC) (x1000$)	Efficiency Factor (MEFP)	Cost (PAC) (x1000$)	Efficiency Factor (MEFP)	Cost (RAC) (x1000$)	Efficiency Factor (MEFC)	Cost (RAC) (x1000$)	Efficiency Factor (MEFC)
1.2.2.1.1.2	E1	[3,5,6,9]	[0.2,0.3,0.4,0.5]	[4,5,5,8]	[0.6,0.7,0.8,0.9]	[3,5,6,7]	[0.4,0.5,0.5,0.6]	-	-
	E2	[4,6,6,7]	[0.4,0.7,0.7,0.8]	[4,6,7,9]	[0.5,0.6,0.6,0.8]	[2,4,5,6]	[0.5,0.7,0.7,0.8]	-	-
	E3	[2,3,3,5]	[0.4,0.6,0.6,0.7]	[3,5,6,7]	[0.5,0.8,0.8,0.9]	[4,5,5,8]	[0.5,0.6,0.7,0.9]	-	-
1.2.2.1.2.2	E1	[2,3,5,6]	[0.4,0.5,0.6,0.8]	-	-	-	-	[3,6,6,9]	[0.3,0.4,0.4,0.5]
	E2	[3,4,4,7]	[0.3,0.4,0.4,0.7]	-	-	-	-	[4,5,5,7]	[0.5,0.7,0.7,0.9]
	E3	[2,5,6,7]	[0.5,0.6,0.6,0.8]	-	-	-	-	[4,6,7,8]	[0.4,0.5,0.6,0.8]

Table 4.40 Fuzzy Calculation for Preventive and Remedial Actions

R	Preventive Actions				Remedial Actions			
	Quality Assurance		Increase Communications		Waste Management		Resource Increase	
	Cost (PAC) (x1000$)	Efficiency Factor (MEFP)	Cost (PAC) (x1000$)	Efficiency Factor (MEFP)	Cost (RAC) (x1000$)	Efficiency Factor (MEFC)	Cost (RAC) (x1000$)	Efficiency Factor (MEFC)
1.2.2.1.1.2	[2,3,6,9]	[0.2,0.3,0.7,0.8]	[3,5,7,9]	[0.5,0.6,0.8,0.9]	[2,4,6,8]	[0.4,0.5,0.7,0.9]	-	-
1.2.2.1.2.2	[2,3,6,7]	[0.3,0.4,0.6,0.8]	-	-	-	-	[3,5,7,9]	[0.3,0.4,0.4,0.5]



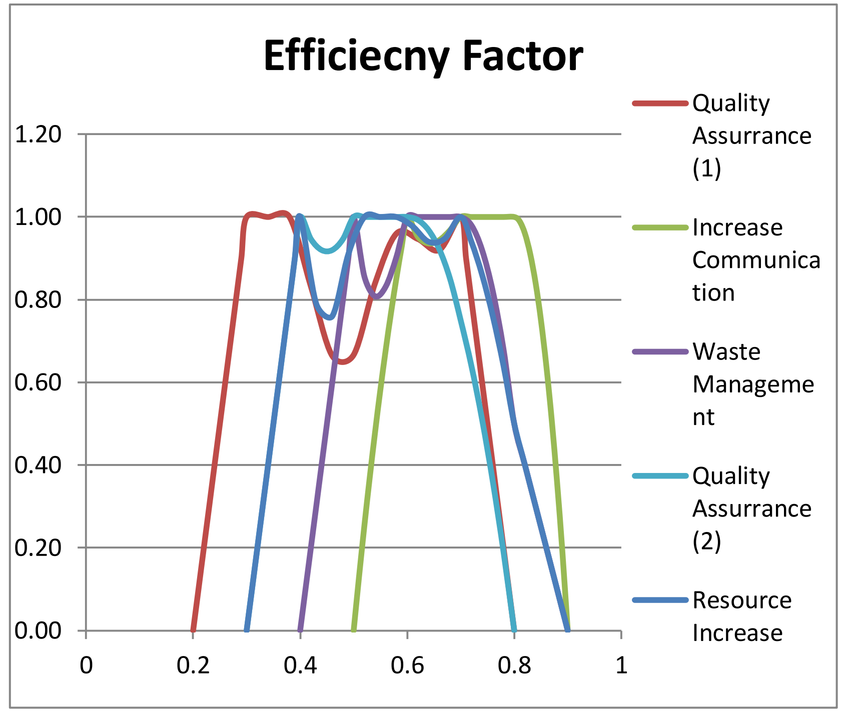


Figure 4.17 Memebership Function of Costs and Efficiency factors of Preventive and Remedial Actions

The mitigation process aims to identify, evaluate and select the most effective mitigation strategy to decrease the contingency fund required for managing a risk. The focus in the remaining part of this example is on the most critical risks: Alignment problem (1.2.2.1.1.2) and Poor Workmanship (1.2.2.1.2.2). The identified preventive and remedial actions, shown in Table 4.39, are used to generate a list of possible mitigation strategies for each risk. Thus, the first step is evaluation of these actions as presented in Table 4.39. Three experts were involved in the evaluation process of mitigation strategy using fuzzy set theory. Thus, the cost and the efficiency factors of preventive and remedial actions are evaluated as shown in Table 4.40. The membership functions of cost and efficiency factor of each action are presented in Figure 4.17.

Table 4.41 Defuzzification of Cost and Efficiency Factors of Preventive and Remedial Actions

R	Preventive Actions				Remedial Actions			
	Quality Assurance		Increase Communication		Waste Management		Resource Increase	
	PAC	MEFP	PAC	MEFP	RAC	MEFC	RAC	MEFC
1.2.2.1.1.2	5.15	0.50	6.98	0.71	5.36	0.63	-	-
1.2.2.1.2.2	4.56	0.55	-	-	-	-	5.99	0.58

The defuzzified cost and efficiency factor of each action is presented in The mitigation process aims to identify, evaluate and select the most effective mitigation strategy to decrease the contingency fund required for managing a risk. The focus in the remaining part of this example is on the most critical risks: Alignment problem (1.2.2.1.1.2) and Poor Workmanship (1.2.2.1.2.2). The identified preventive and remedial actions, shown in Table 4.39, are used to generate a list of possible mitigation strategies for each risk. Thus, the first step is evaluation of these actions as presented in Table 4.39. Three experts were involved in the evaluation process of mitigation strategy using fuzzy set theory. Thus, the cost and the efficiency factors of

preventive and remedial actions are evaluated as shown in Table 4.40. The membership functions of cost and efficiency factor of each action are presented in Figure 4.17.

Table 4.41. Generation of possible mitigation strategies for each risk item is presented in Table 4.42. The mitigation strategy cost (MSC), mitigation efficiency factor (MEF), and planned efficiency factor (PEF) for each strategy are calculated using Eqs. 3.50, 3.51, and 3.52 respectively. Based on PEF, MS6 and MS3 were selected as the most effective strategies for mitigating Alignment problem (1.2.2.1.1.2) and Poor Workmanship (1.2.2.1.2.2) respectively. Thus, the post mitigation contingency is calculated using Eq. 3.53 as presented in Table 4.42.

Table 4.42 Mitigation of "Poor Workmanship" and "Alignment Problem"

Risk	Possible Mitigation Strategies	Actions	MEF	MSC	PREMC	PEF	POSTMC
1.2.2.1.1.2	MS1	PA1	0.5	5.15	40.14	0.37	16.76
	MS2	PA2	0.71	6.98		0.54	
	MS3	RA1	0.63	5.36		0.50	
	MS4	MS1+MS2	0.86	12.13		0.56	
	MS5	MS1+MS3	0.82	10.51		0.56	
	MS6	MS2+MS3	0.89	12.34		0.58	
	MS7	MS1+MS2+MS3	0.95	17.49		0.51	
1.2.2.1.2.2	MS1	PA1	0.55	4.56	32.6	0.41	16.74
	MS2	RA1	0.58	5.99		0.40	
	MS3	MS1+MS2	0.81	10.55		0.49	

The monitoring process aims to evaluate the risk acceptance factor that represents the monitoring criterion as the acceptable tolerance in mitigating each risk. Three experts evaluate the risk acceptance factor using fuzzy theory as shown in Table 4.43.

Table 4.43 Evaluation of Risk Acceptance Factor

R	E	Fuzzy RAij (%)	Fuzzy RAi	Defuzzified RAi (%)
1.2.2.1.1.2	E1	[1,2,2,3]	[1,2,3,5]	2.8
	E2	[1,3,3,4]		
	E3	[2,3,3,5]		
1.2.2.1.2.2	E1	[2,3,3,5]	[2,3,4,6]	4.6
	E2	[2,3,4,5]		
	E3	[2,4,4,6]		

The monitoring process requires actual data to evaluate the selected mitigation strategy. The data includes actual mitigation depleted and actual percentage of completion which assumed to be gathered using an automatic acquisition system as shown in Table 4.44. The monitoring process continuously calculates the actual efficiency factor and compare to the planned efficiency factor using risk acceptance (RA) criterion as shown in Table 4.44. Once the planned-actual ratio is higher than 1+RA the system send an alert to risk owner to initiate the control process. Once the risk control process is initiated the monitoring system calculates the risk residual using Eq. 3.67 as follows:

RR = 17.55-13 = $4.55 K

The control process aims to decrease the risk residual in order to not exceed the post mitigation contingency. In this numerical example, the experts identified two possible control actions "Change concrete contractor" and "Excessive Quality Supervision" to control the "Poor workmanship" risk.

Table 4.44 Monitoring Process Calculation

R	PREMC	POSTMC	MSC	ACTMC (Periodic)	% Of Completion	ACTMC at Completion	AEF	PEF/AEF	1+RAi	Alert
1.2.2.1.1.2	40.14	16.76	12.34	14	80%	14.42	0.64	0.91	1.028	No alert should be issued
1.2.2.1.2.2	32.6	16.74	10.55	13	35%	17.55	0.46	1.054	1.046	Alert should be issued

The experts evaluated those actions using fuzzy set theory as shown in Table 4.45. Fuzzy calculation is used to calculate the control efficiency factor and its defuzzified value for each control action as shown in Table 4.46 and

Table **4.47** respectively. The post control factor (PCF) is calculated using Eq. 3.70 as shown in Table **4.47**.

Table 4.45 Control Actions Evaluations

R	E	Preventive Actions			
		Change Concrete Contractor		Excessive Quality Supervision	
		CAC	CEF	CAC	CEF
1.2.2.1.1.2	E1	[1,1.5,1.5,2]	[0.4,0.7,0.7,0.9]	[1,1.5,1.5,2.5]	[0.5,0.6,0.8,0.9]
	E2	[0.5,1,1.5,2]	[0.5,0.6,0.7,0.8]	[1,2,2,2.5]	[0.6,0.7,0.8,0.9]
	E3	[0.5,1,1,2]	[0.5,0.7,0.7,0.9]	[0.5,1,1,1.5]	[0.7,0.8,0.8,1.0]

Table 4.46 Control Actions Fuzzy Calculation

R	Control Actions			
	Change Concrete Contractor		Excessive Quality Supervision	
	CAC	CEF	CAC	CEF
1.2.2.1.1.2	[0.5,1,1.5,2]	[0.4,0.6,0.7,0.9]	[0.5,1,1.5,2.5]	[0.5,0.6,0.8,0.9]

Table 4.47 Control Actions Defuzzified Evaluations

R	Control Actions					
	Change Concrete Contractor			Excessive Quality Supervision		
	CAC	CEF	PCF	CAC	CEF	PCF
1.2.2.1.1.2	1.2	0.7	0.44	1.6	0.8	0.45

The excessive quality supervision has the highest PCF; however, the difference between the two actions is negligible. Therefore, it is important to check the efficiency of combining these two control actions. The project risk cost using "Excessive Quality Supervision" is calculated using Eq. 3.71. The updated PCF of "Change concrete contractor" control action needs to be calculated using Eq. 3.72. Subsequently, efficiency of the combination of these two actions is investigated using Eq. 3.72. Based on the available data and current situation the combination of "Excessive Quality Supervision" along with "Change concrete contractor" is effective and can be used to control the "Poor Workmanship" as presented in Table 4.48. The post risk cost, updated actual mitigation contingency, and updated actual efficiency factor are calculated using Eqs. 3.73, 3.74, and 3.75 respectively as shown Table 4.48.

Table 4.48 Control Process Output for Poor Workmanship Risk

R	Ranked Control Actions	$PCF_{i,s,k}$	$PCF'_{i,s,K}$	$PRC_{i,s,K}$ ($)	$ACTMC'_{i,s,K}$ ($)	$AEF'_{i,s,K}$	PEF/AEF	Alert
1.2.2.1.1.2	Excessive Quality Supervision	0.45	0.45	2.5	14.95	0.54	0.91	Risk is controlled successfully
	Change Concrete Contractor	0.44	0.22	1.95				

The final actual efficiency factor can be used to update the planned efficiency factor and post mitigation contingency of non-occurred risk that is mitigated with the same strategy (i.e. MS6) using Eq. 3.76 and 3.77. This dynamic update allows user to keep the risk management plan up-to-date and to take proactive decisions if deemed necessary.

4.4 Summary

In this chapter, numerous case studies were used to demonstrate the applicability of the developed model and to illustrate its essential features. In addition, a numerical example is presented to illustrate the complete process of developed model from identification process up to control. The results of developed method as compared to case studies show that the developed model is highly applicable and efficient. Also, the numerical example shows the systematic application of the developed model.

CHAPTER 5: AUTOMATION OF PROPOSED RISK MANAGEMENT METHOD

5.1 Overview

This chapter presents the computer implementation of the developed risk management model. It also highlights the frameworks, modules, algorithms, and the interactions among developed model components. It describes the Graphical User Interface (GUI) that is designed to allow users with various levels of experience to use the developed software. The GUI enables users to input new data for each project component, to copy initial data from another project, or to collect data from a central database. The Figure 5.1depicts the chapter 5 overview.

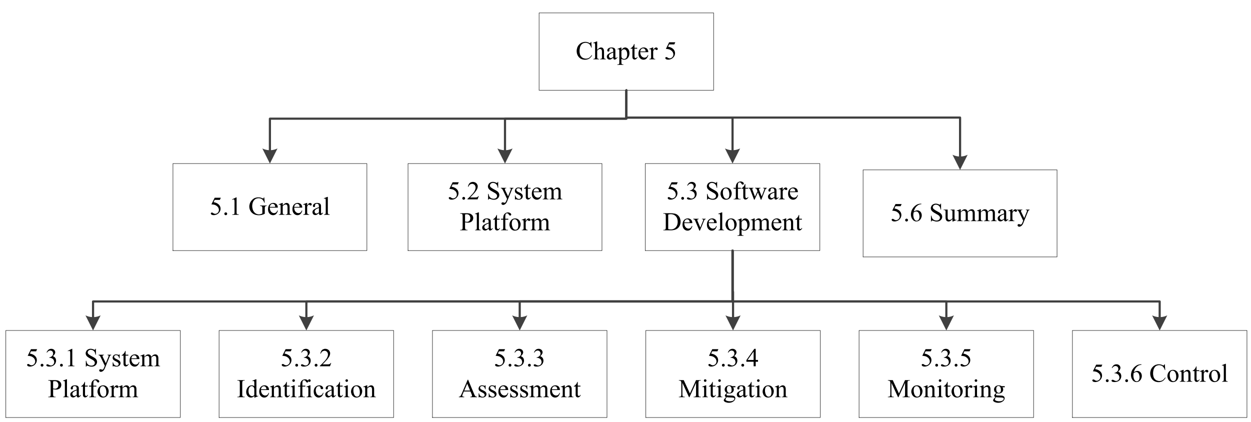


Figure 5.1 Chapter 5 Overview

5.2 System Platform

The developed model was implemented in prototype software, which has similar structure to the developed model, as described in Chapter 3. The developed model represents standalone risk management software under windows platform. It integrates the fuzzy set and fuzzy probability theories within its architecture, which makes it free of dependencies to other software or tools. The developed software is coded using .NET framework version 4.5 using visual basic (VB) programming language solely. The source code of the software is logically organized into namespaces, regions, classes, methods, and modules, which facilitate the integration of new functionality in the future. The Graphical User Interface (GUI) of the developed software is designed in a manner that minimizes the level of user experience requirement. It is manipulated using interactive screens that permit users with minimum experience, in risk management and/or fuzzy theory, to apply the developed software.

The developed software provides an automated application for the developed dynamic risk management methodology for construction projects using fuzzy set theory. However, it has an expandable feature, which allows incorporation of other projects (e.g. infrastructure) with minor manipulations. The developed software utilizes the Model-View-Controller (MVC) paradigm, shown in Figure 5.2, as its main architectural pattern (Kupp & Makris, 2012).

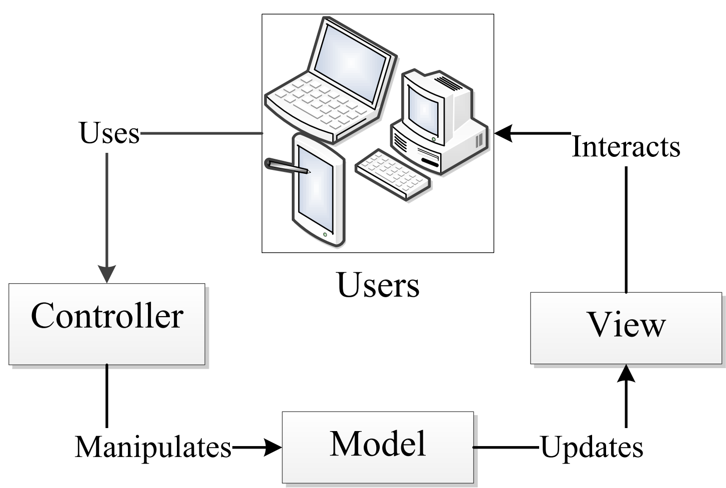


Figure 5.2 Paradigm of Model View Controller

The controller allows users to send commands to update the model's state or to change the view's presentation. Once the model receives an update, it notifies the view to produce updated output, and the controller to change the available set of commands. The developed software utilizes three-tier architecture, shown in Figure 5.3, which consists of MVC paradigm (i.e. Tier-1), data processing at application server (i.e. Tier-2), and data synchronization at central database server (i.e. Tier-3). The application logic integrates between the three tiers throughout developed algorithms and data elements.

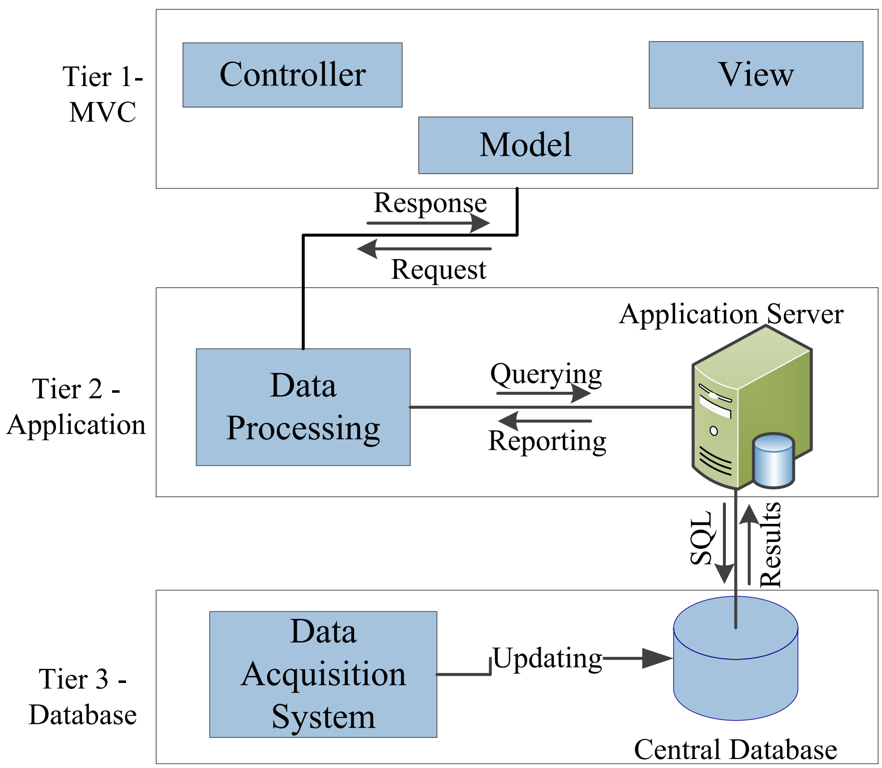


Figure 5.3 Developed System Architecture

5.3 Software Development

The software is developed using vb.net language and it consists of five modules: Identification, assessment, mitigation, monitoring, and control. Each module has its own classes, attributes, functions, and subroutines. Also, each module provides a list of interactive screens to notify users when input or feedbacks are required. The prototype of developed software is named FuzzyRM, which stands for Fuzzy Risk Management. Start-up Screen of FuzzyRM is presented in Figure 5.4. The identification process is integrated within the start-up screen, which provides a set of controls to add project, category, package, activity, task, risk, consequence, actions, probability, and impact. It also allows the removal and editing of selected project components as shown in Figure 5.5. The identification process allows the generation of micro risk breakdown structure.

The evaluation process provides an assessment of each project component, such as probability, impact, risk value, and pre-mitigation contingency, as shown in Figure 5.6. It also shows the risk mapping, making use of the mapping scale presented in Table 3.4. The graphical presentation illustrates the fuzzy memberships which represent the probability, impact, risk value, expected monetary value (EMV), pre-mitigation contingency, and contingency monitoring curves of selected risk components, as shown in Figure 5.7. The contingency monitoring curves include pre-mitigation, post-mitigation, and actual mitigation contingency curves.

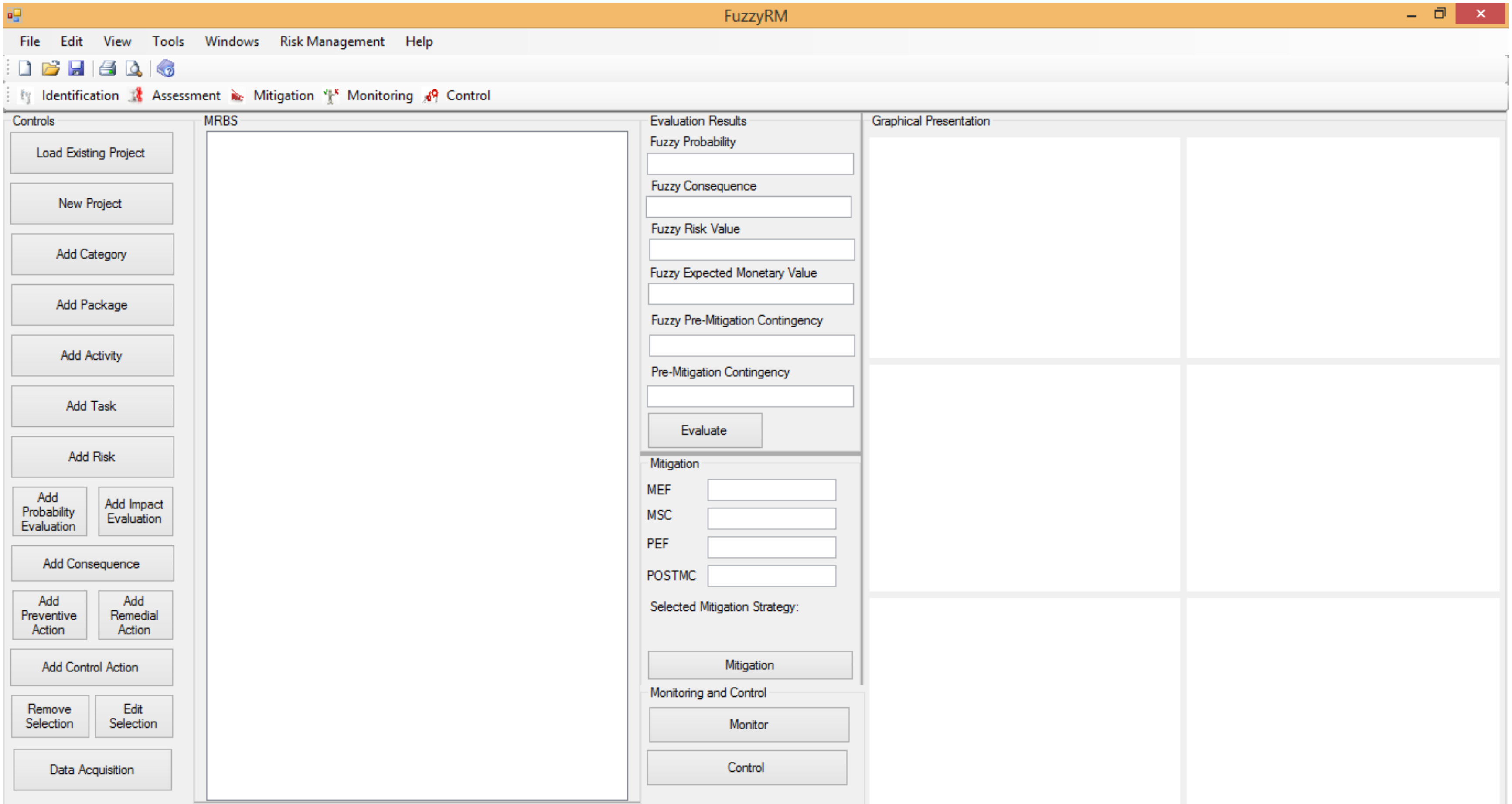


Figure 5.4 Start-up Screen of FuzzyRM

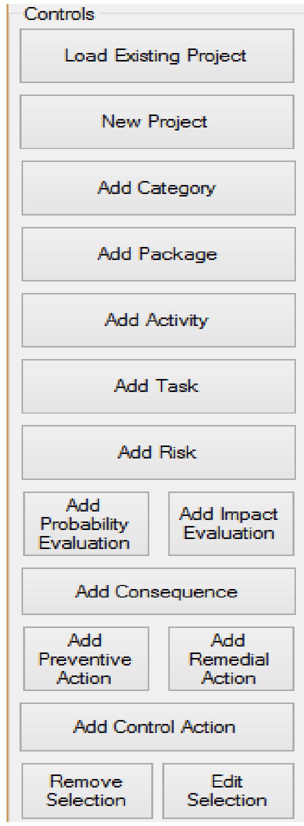


Figure 5.5Risk Identification Controls

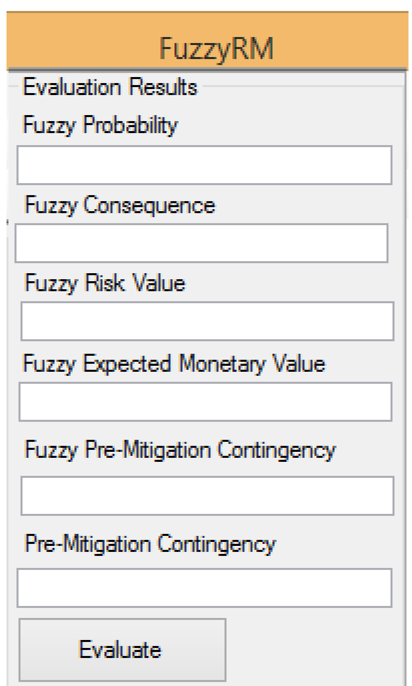


Figure 5.6Risk Evaluation Information

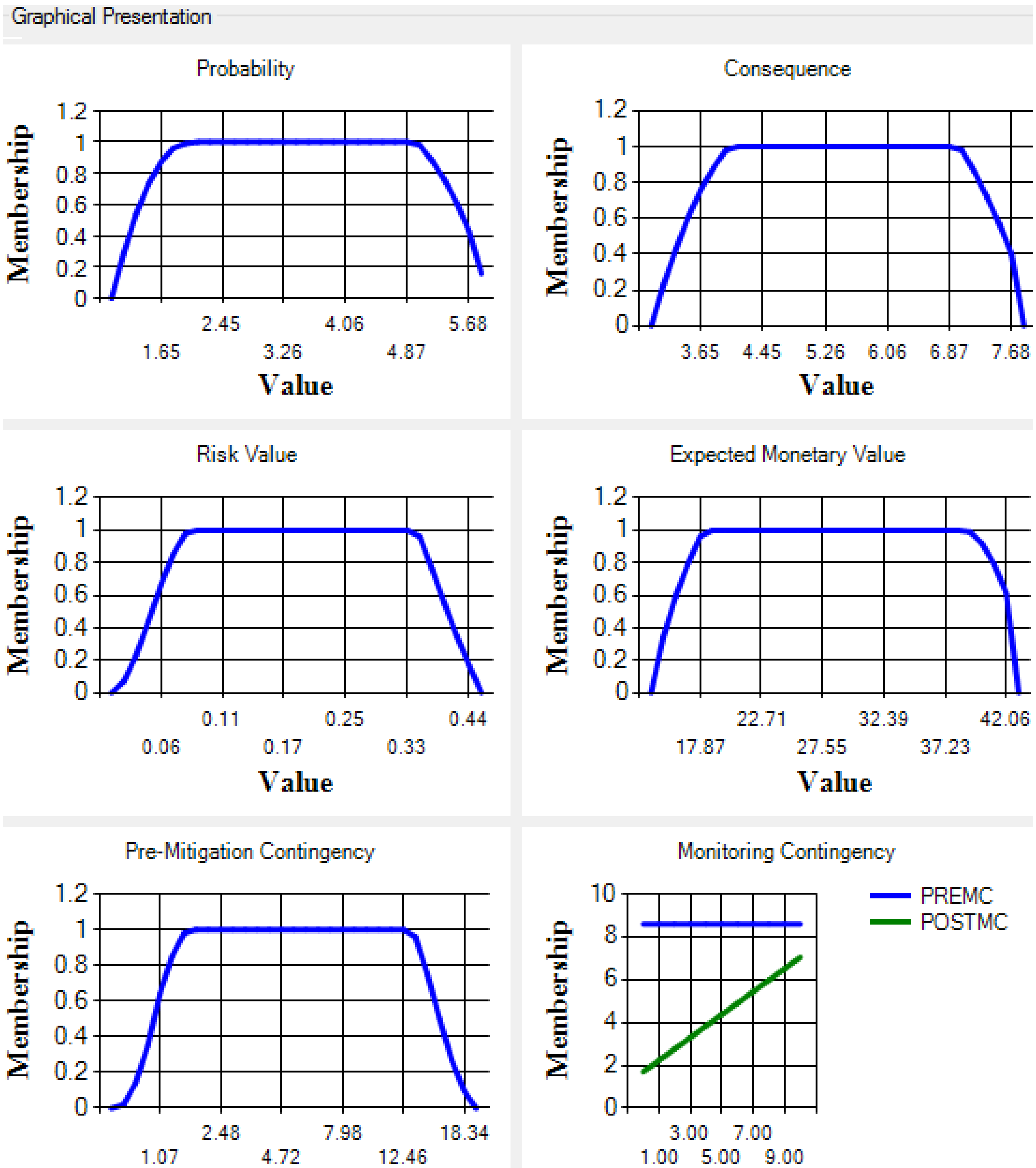


Figure 5.7Graphical Presentation

The mitigation process provides information about the results of mitigation process, such as: The selected mitigation strategy and its respective mitigation efficiency factor (MEF), planned efficiency factor (PEF), mitigation strategy cost (MSC), and post mitigation contingency of project component, as shown in Figure 5.8.

Figure 5.8 Mitigation Process Information

The monitoring process provides information about the actual status of the risk being considered. Two types of periodic inputs are required in the monitoring process. The developed software assumes the number of monitoring periods equals to 10. For each monitoring period, the user is requested to input actual mitigation contingency (ACTMC) that represents the contingency depleted, up to the current monitoring period, to prevent or to remediate respectively the root causes and consequences of the risk. The second is actual percentage of completion of a risk. Thus, the monitoring process outputs include information about the actual efficiency factor (AEF) of selected strategy in mitigating the risk being considered as shown in Figure 5.9. It also indicates whether the initiation of control process is required or not; utilizing the risk acceptance factor that represents the accepted tolerance between planned and actual efficiency factors.

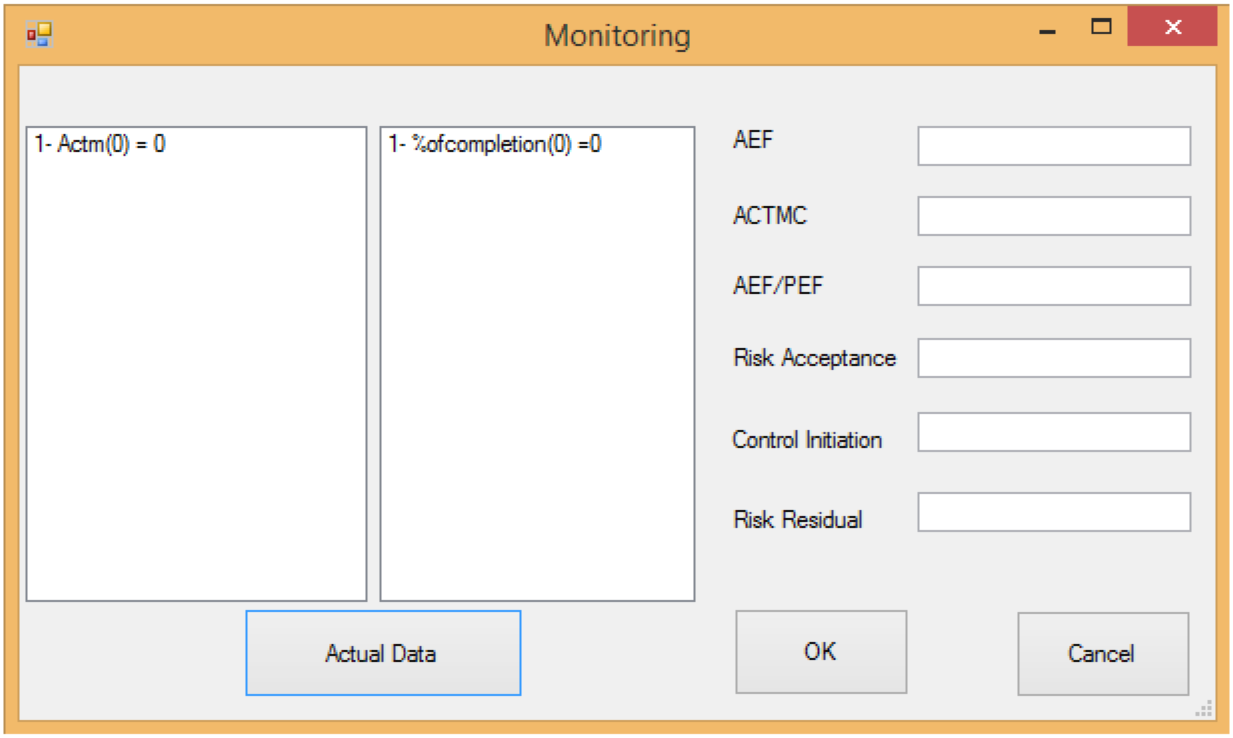


Figure 5.9 Monitoring Process Information

Prior to initiation, the control process calculates the risk residual (RR) that represents the difference between the actual mitigation contingency (ACTMC) at completion and the periodic actual mitigation contingency of the risk being considered, as shown in Figure 5.9. The control process identifies, evaluates, and selects the most effective control action. It also provides information about the effect of this control action on RR, as shown in Figure 5.10. It also provides the post control risk value (PRC) and thus the updated value for actual mitigation contingency at completion is calculated, as shown in Figure 5.10. It also provides early warning about possible failure of risk item that is similar to the risk being considered.

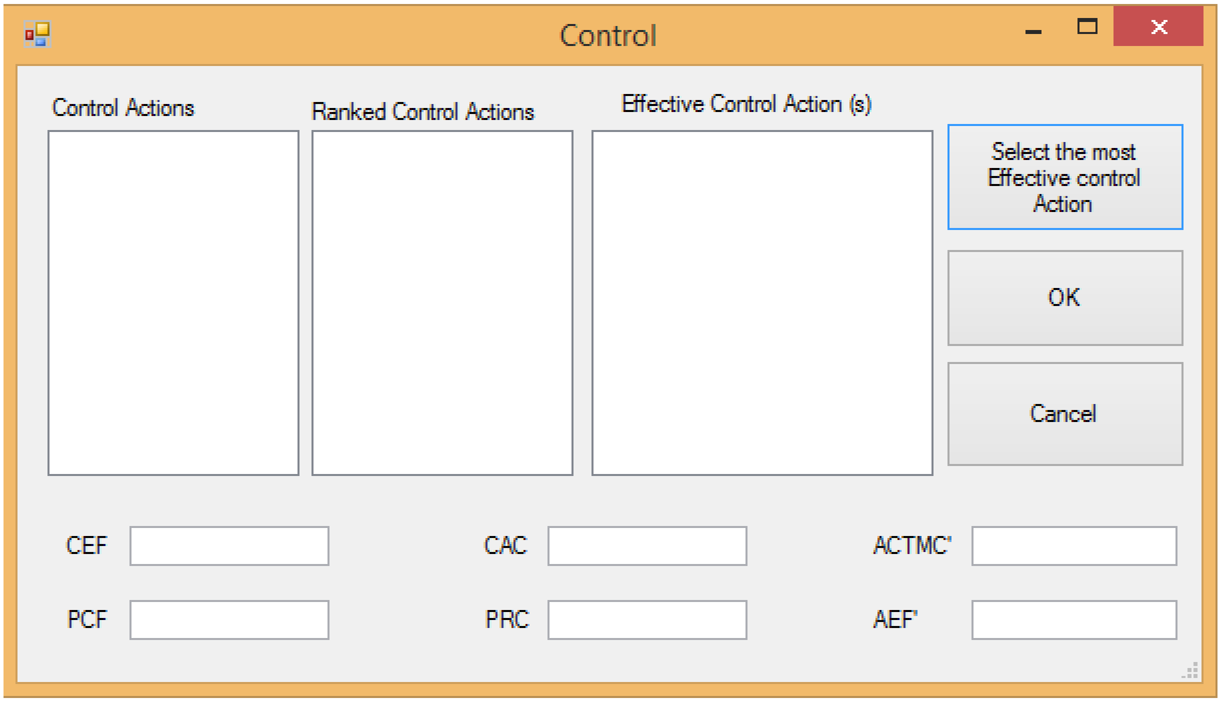


Figure 5.10 Control Process Information Form

5.3.1 MRBS Generation Module

Several interactive screens are included in the developed software, which allow user to generate a non-erroneous micro risk breakdown structure. The generation procedure include two sets of interactive screens: Adding forms and guide forms. The adding forms allow users to add project components and their respective sub-components.

The generation of MRBS starts by adding a new project to the hierarchy and then subsequently adds categories, packages, activities, tasks, and risks. However, the adding procedure can be performed only when users provide all information required, as shown in Figure 5.11.

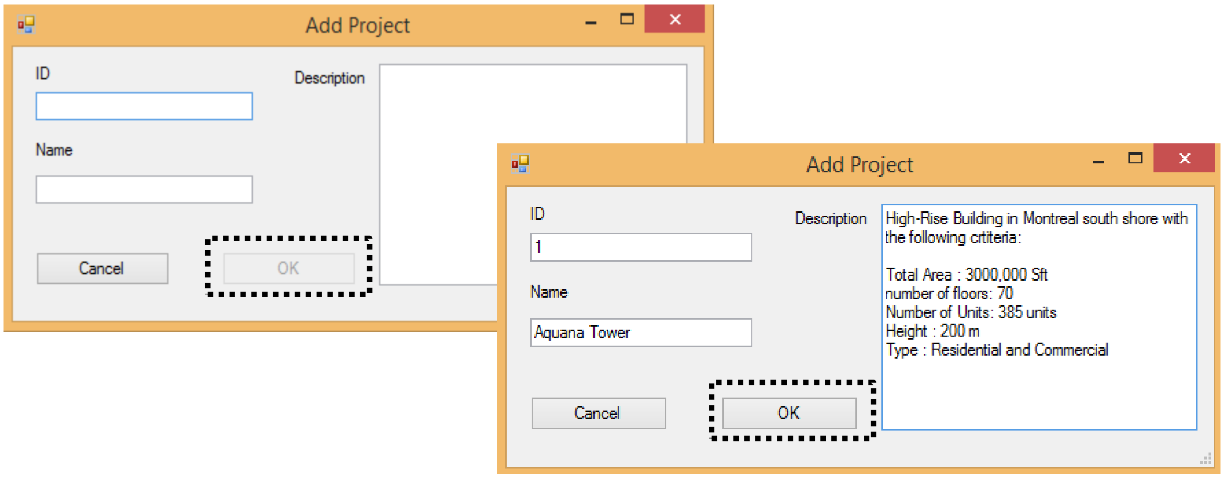


Figure 5.11 Adding a Project

Once an error in selection is committed by a user, the software identifies this error and notifies the user about this error; using guiding forms, as shown in Figure 5.12. The guiding forms are represented by a message that indicates and highlights the type of error. Once the user is notified, the previous erroneous selection is cancelled, and the software returns to its previous state; awaiting for a new and non-erroneous command.

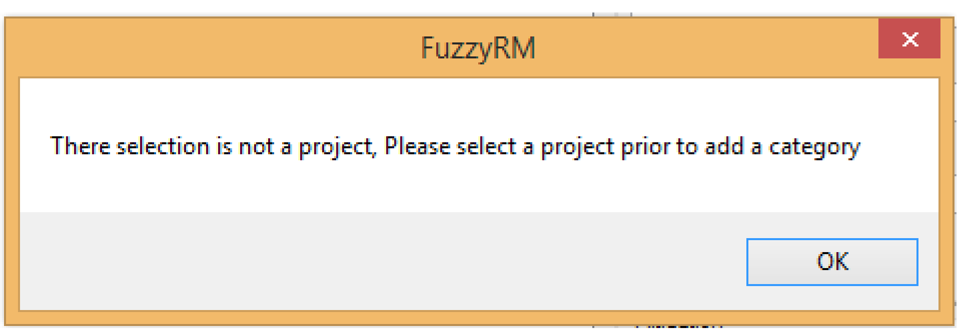


Figure 5.12 Error in Adding a Category

Generations of micro risk breakdown structure provides a list of tasks associated with the project being considered, as shown in Figure 5.13. Risk identification process is performed on each of these tasks to generate the risks associated.

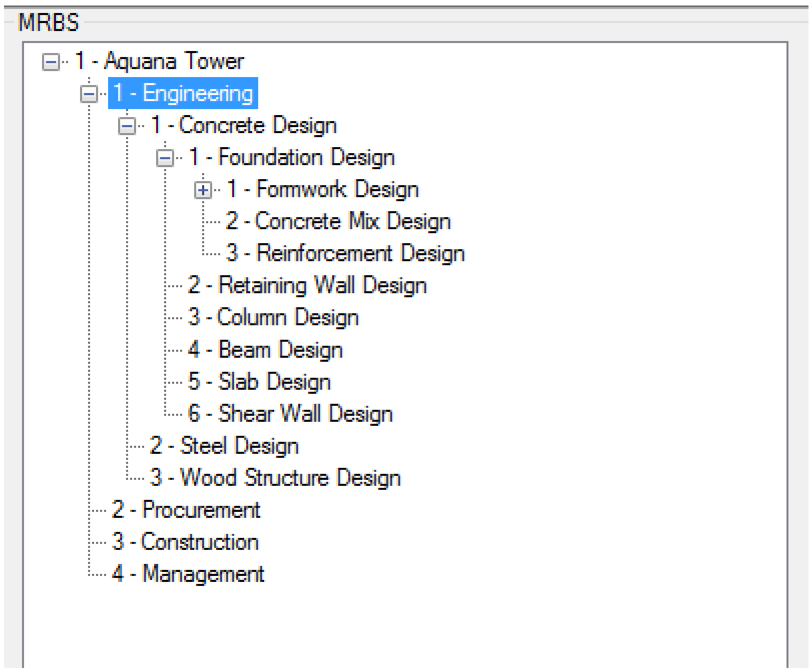


Figure 5.13 Example of Micro Risk Breakdown Structure for Construction project

5.3.2 Identification Module

Once generation of micro risk breakdown structure is completed, the risk identification process is initiated. Each risk receives a deep analysis using the developed method for risk identification, using PRCER procedure Figure 3.9. The output of risk identification method provides information about each risk, such as: Name, consequences, preventive actions, remedial actions, start date, finish date, and risk owner, as shown in Figure 5.14. Provided information is integrated within the developed software as input.

Add Risk Form: This form includes the information input of risk, such as: ID, name, Description, start date, finish date, and risk owner, as shown in Figure 5.14. Start date and finish date of a task represents start and finish dates of all risk items associated with it.

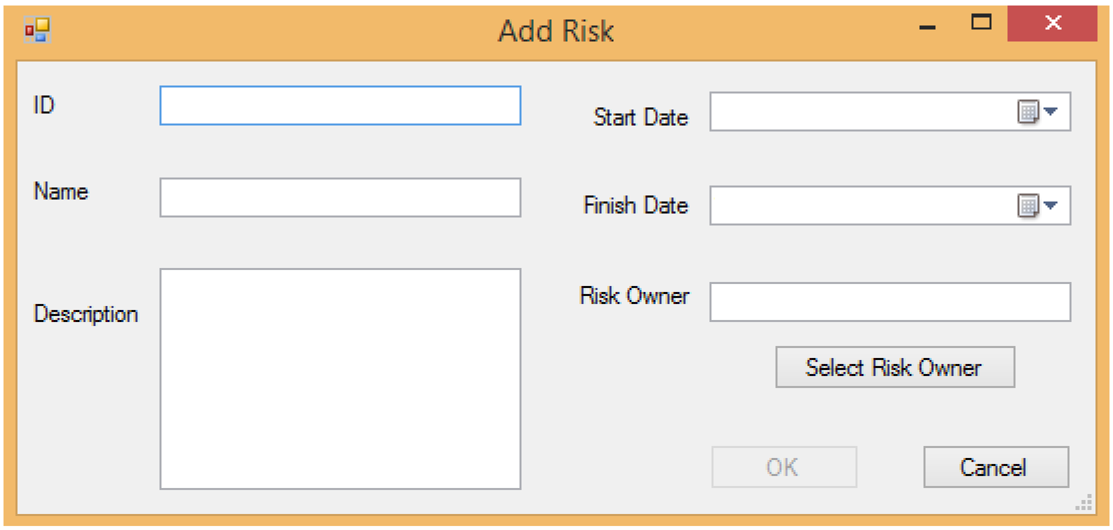


Figure 5.14 Add Risk Form

Select risk owner form: The selection of risk owner procedure is accessible through “Select risk owner” button. It allows users to select, among several ownership candidates, the most effective owner for the risk being considered. The selection is based on three criteria: Ability, Efficiency, and Capacity. Fuzzy theory is adopted to evaluate the three criteria as show in Figure 5.15. The fuzzy calculation is used to integrate the fuzzy evaluations of criteria into risk ownership score (ROS). Each candidate receives an ROS, and that with the highest ROS is selected as the risk owner, as shown in Figure 5.15.

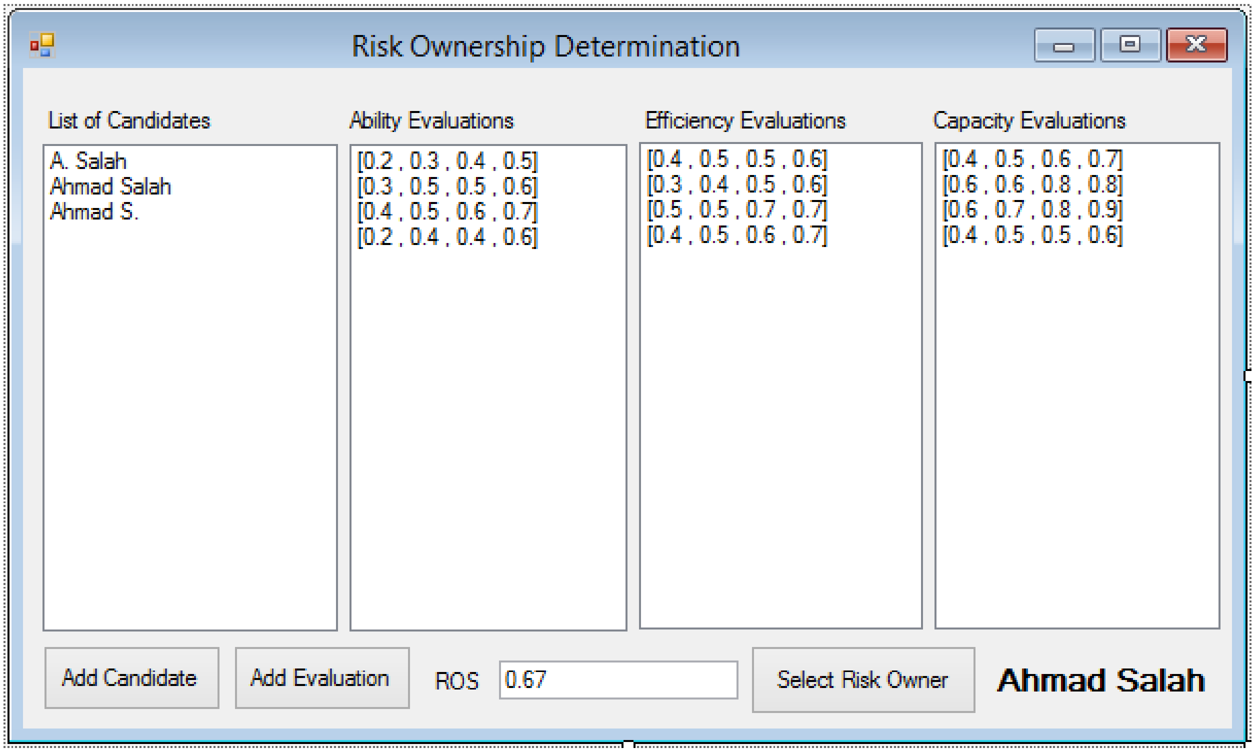


Figure 5.15 Risk Ownership Determination Form

After adding the basic information and selection of the owner, the identified consequences shown in Figure 5.16 and the actions shown in Figure 5.17are added to the risk being considered.

Add Consequence Form: This form includes the information about the consequence such as: ID, Name, and Description. It allows user to evaluate cost of the consequence. The evaluation form is initiated by clicking on“>>”, as shown in Figure 5.16.

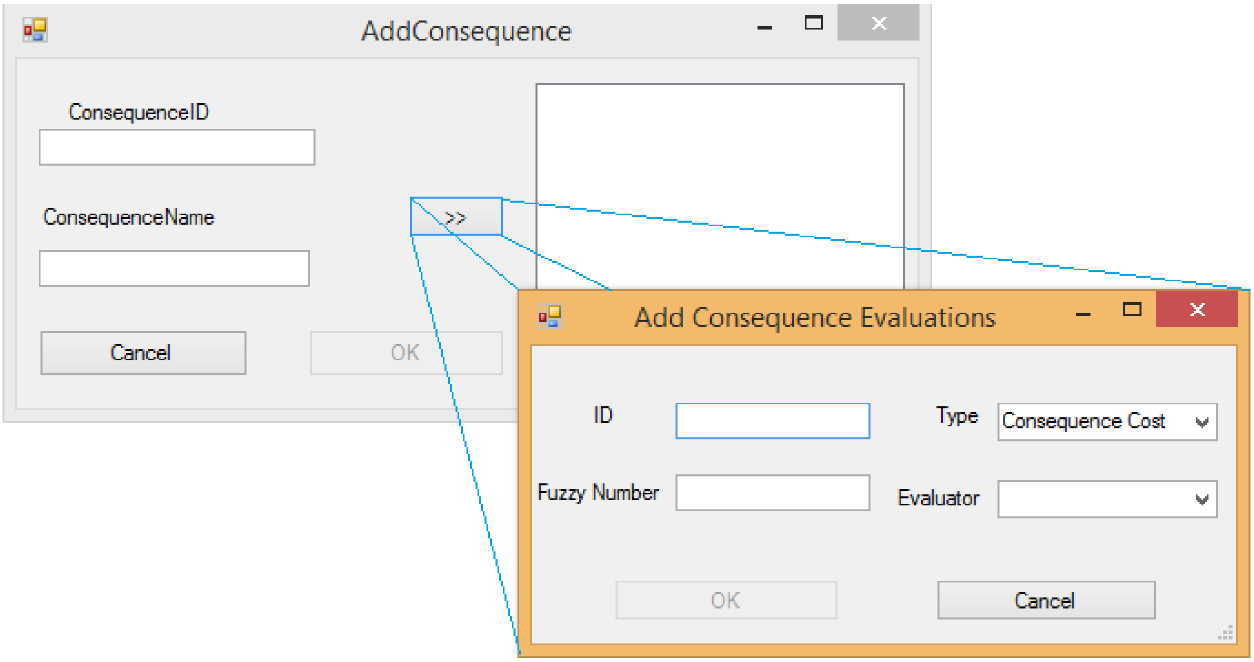


Figure 5.16 Add Consequence Form

Add Action form: This form allows the user to input basic information for preventive, remedial, and control actions. It also allows the user to initiate the evaluation process for efficiency factor and cost of each action using the buttons "<<" and ">>" respectively.

Once the risk being considered receives all the required input, such as basic information, consequences, and actions, the assessment process can be initiated to evaluate the risk being considered.

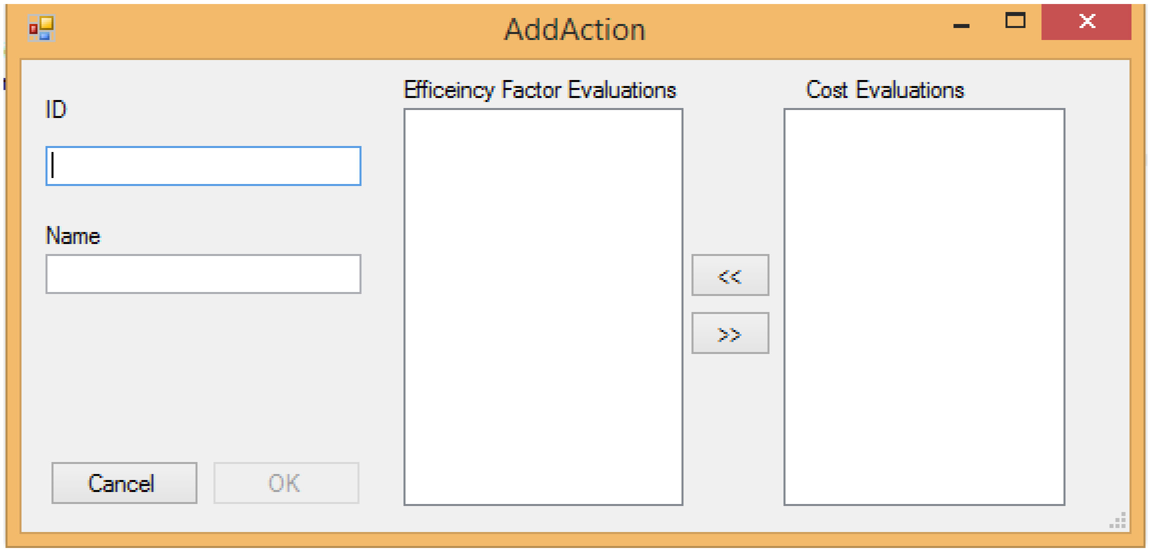


Figure 5.17 Add Action Form

The identification process has two main functions: Add component and edit component. The following two examples show the functions for adding and editing the project details.

Add Project:

```
Public Sub addproject(ByVal MRBS As TreeView)
        Dim projectForm As New AddComponent
    projectForm.Text = "Add Project"
        If (projectForm.ShowDialog() = Windows.Forms.DialogResult.OK) Then
              Dim project As New Project(CInt(projectForm.TxtID.Text), projectForm.TxtName.Text,
        projectForm.TxtDescription.Text)

        MRBS.Nodes.Add(project.DisplayMember)
        MRBS.Nodes(0).Tag = project
             End If
End Sub
```

Edit Project

```
Public Function editProject(ByVal MRBS As Object, ByVal node As TreeNode) As Object
      Dim project As Project = node.Tag
      Dim projectForm As New AddComponent
      projectForm.Text = "Edit Project"
      projectForm.TxtID.Text = CStr(project.ID)
      projectForm.TxtName.Text = project.Name
      projectForm.TxtDescription.Text = project.Description
      If (projectForm.ShowDialog() = Windows.Forms.DialogResult.OK) Then
        project.ID = CInt(projectForm.TxtID.Text)
        project.Name = projectForm.TxtName.Text
```

```
            project.Description = projectForm.TxtDescription.Text
            MRBS.nodes(node.Index).text = project.DisplayMember
            MRBS.nodes(node.Index).tag = project
        End If
    End If
    Return MRBS
End Function
```

5.3.3 Assessment Module

The assessment procedure consists of six components: Probability (P), impact (C), Consequences (k), preventive actions (PA), remedial actions (RA), and control actions (ca). The evaluation procedure utilizes fuzzy set theory and fuzzy probability theory.

Add Evaluation Form: this form allows experts to express their knowledge and to evaluate the risk components, consequences, and actions using fuzzy set theory. Each evaluation includes an ID, fuzzy representation, evaluator name, and evaluation type. Probability (P) and impact (C) receive one type of evaluation, as show in Figure 5.18. Each consequence receives one set of evaluations, which represent its cost, as shown in Figure 5.16.

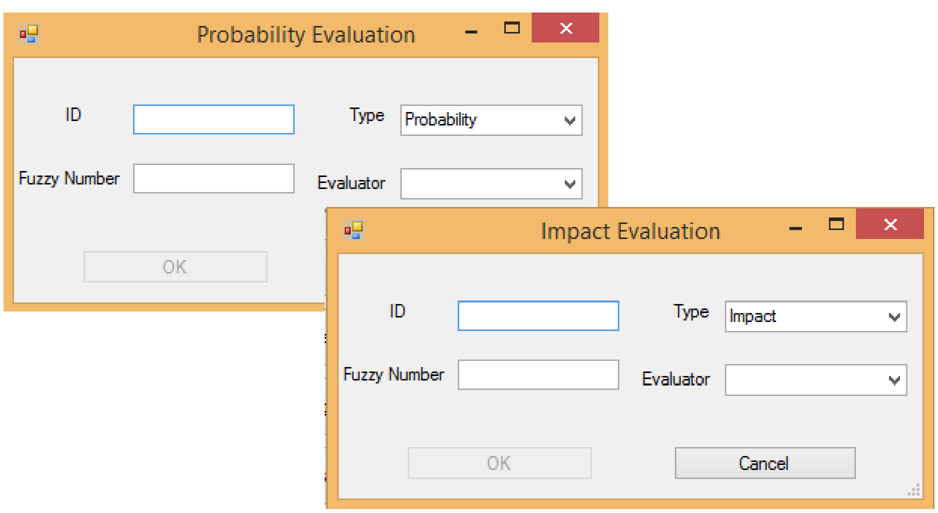


Figure 5.18 Probability and Impact Evaluation Forms

Each preventive, remedial, and control actions receive two sets of evaluations: The first is for efficiency factor, and the second is for the cost of the action being evaluated, as shown in Figure 5.19.

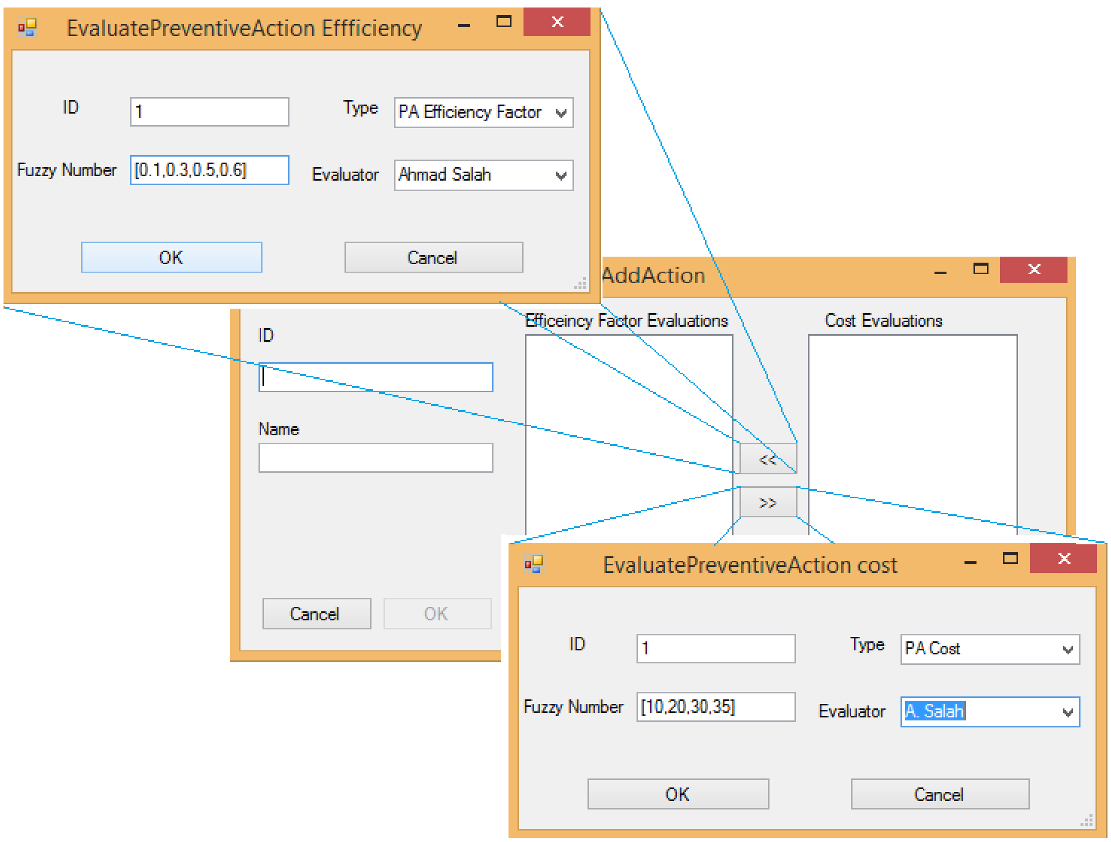


Figure 5.19 Action Evaluation Form

The micro risk breakdown structure shown in Figure 5.20 illustrates the evaluation of probability, impact, consequences, and actions of error in concrete columns formwork design using fuzzy set theory.

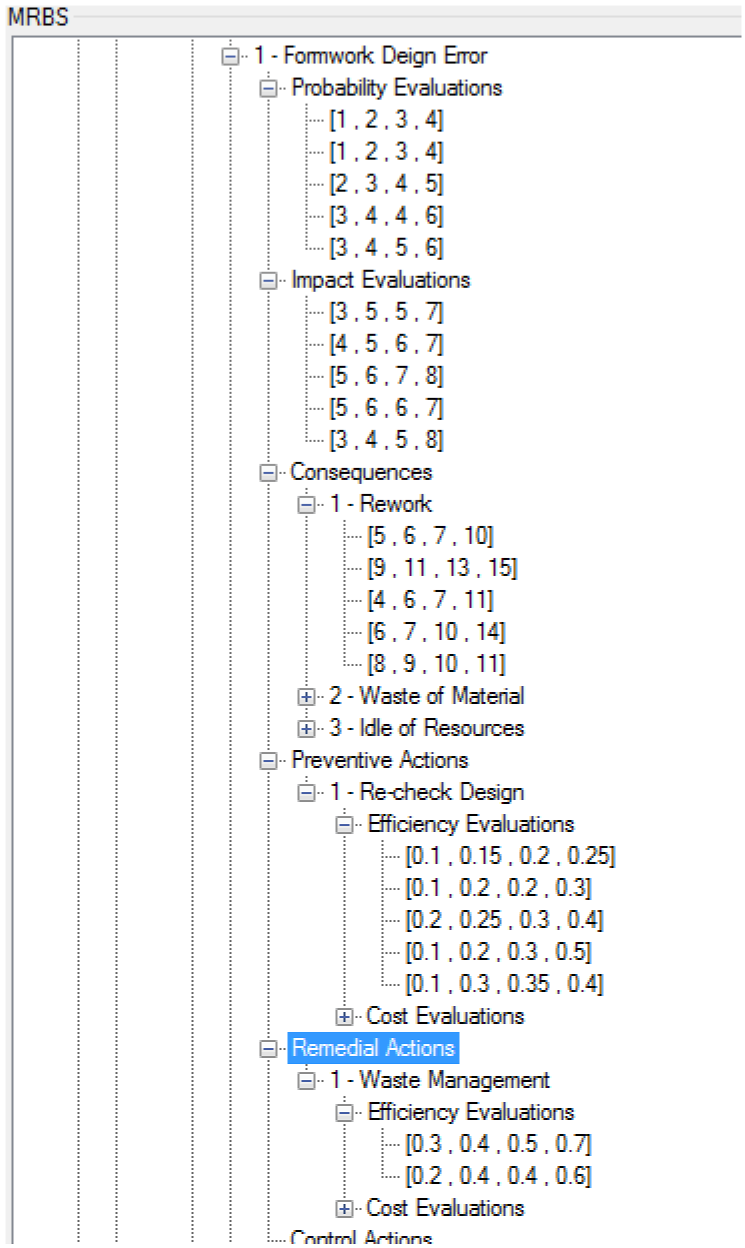


Figure 5.20 Design Error in Concrete Column Formwork (DECCF)

The assessment process calculates the probability, consequence, expected monetary value, risk value, and pre-mitigation contingency of DECCF using fuzzy calculation, as shown in Figure 5.21. The risk level of DECCF is medium, as shown in Figure 5.21, based on the mapping scale represented in Table 3.4.

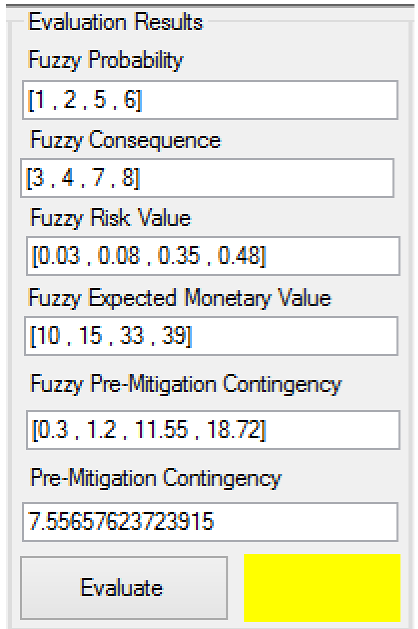


Figure 5.21 Evaluation Results of DECCF

The assessment module includes four main group of functions: Qualitative assessment, risk mapping, quantitative assessment, and generation of PREMC curve. These functions are coded as follows:

Qualitative assessment functions:

```
Private Function P() As fuzzynumber
    Dim fn As New fuzzynumber
    With Me
      If .PEvaluations IsNot Nothing Then
        For i = 0 To .PEvaluations.Count - 1
          If i = 0 Then
            fn = .PEvaluations(i).FNEvaluation
          Else
            fn = add(fn, .PEvaluations(i).FNEvaluation)
          End If
        Next
      End If
        End With
    Return fn
  End Function
  Private Function C() As fuzzynumber
    Dim fn As New fuzzynumber
    With Me
```

```
            If .CEvaluations IsNot Nothing Then
                For i = 0 To .CEvaluations.Count - 1
                    If i = 0 Then
                        fn = .CEvaluations(i).FNEvaluation
                    Else
                        fn = add(fn, .CEvaluations(i).FNEvaluation)
                    End If
                Next
            End If
        End With
        Return fn
    End Function
    Private Function R() As fuzzynumber
        Dim fn As New fuzzynumber
        fn = (Me.P() * Me.C()) & (1 / (ScaleP * ScaleC))
        Return fn
    End Function
```

Risk mapping function:

```
Public Function MappingScale(ByVal dbl As Double) As System.Drawing.Color
        If dbl <= 0.05 Then
            Return System.Drawing.Color.Blue
        ElseIf dbl <= 0.2 Then
            Return System.Drawing.Color.Green
        ElseIf dbl <= 0.5 Then
            Return System.Drawing.Color.Yellow
        ElseIf dbl <= 0.8 Then
            Return System.Drawing.Color.Orange
        ElseIf dbl <= 1.0 Then
            Return System.Drawing.Color.Red
        Else : Return System.Drawing.Color.Black
        End If
    End Function
```

Quantitative assessment functions

```
    Private Function ExpectedMonetaryValue() As fuzzynumber
        Dim fn1, fn2 As New fuzzynumber
        With Me
            For i = 0 To .Consequences.Count - 1
                For j = 0 To .Consequences(i).ConsequenceEvaluations.Count - 1
                    If j > 0 Then
                        fn1 = add(fn1, .Consequences(i).ConsequenceEvaluations(j).FNEvaluation)
                    Else
                        fn1 = .Consequences(i).ConsequenceEvaluations(j).FNEvaluation
                    End If
                Next
                If i = 0 Then
                    fn2 = fn1
                Else
                    fn2 += fn1
                End If
```

```
        Next
      End With
      Return fn2
    End Function
    Private Function FuzzyPreMitigationContingency() As fuzzynumber
      With Me
        Dim fn As New fuzzynumber
        fn = .EMV() * .R()
        Return fn
      End With
    End Function
    Private Function PreMitigationContingency() As Double
      With Me
        Dim m As Double = Defuzzification(.FuzzyPreMitigationContingency())
        Return m
      End With
    End Function
```

<u>Generation of PREMC curve function:</u>

```
Public Function preMCserie(ByVal risk As Risk) As List(Of Point)
      Dim pts As New List(Of Point)
      For i = 0 To numberofmonitoringperiods
        pts.Add(New Point(i, risk.PreMC()))
      Next
      Return pts
    End Function
```

After evaluation of all risks associated with the project, the risk mitigation process is initiated to select the most effective mitigation strategy toward the risk being considered.

5.3.4 Mitigation Module

Risk mitigation process calculates the post mitigation contingency that represents the contingency required to mitigate a risk in a case where a mitigation strategy is implemented. A list of possible mitigation strategies are generated using the lists of preventive and remedial actions of the risk being considered, as shown in Figure 5.22.

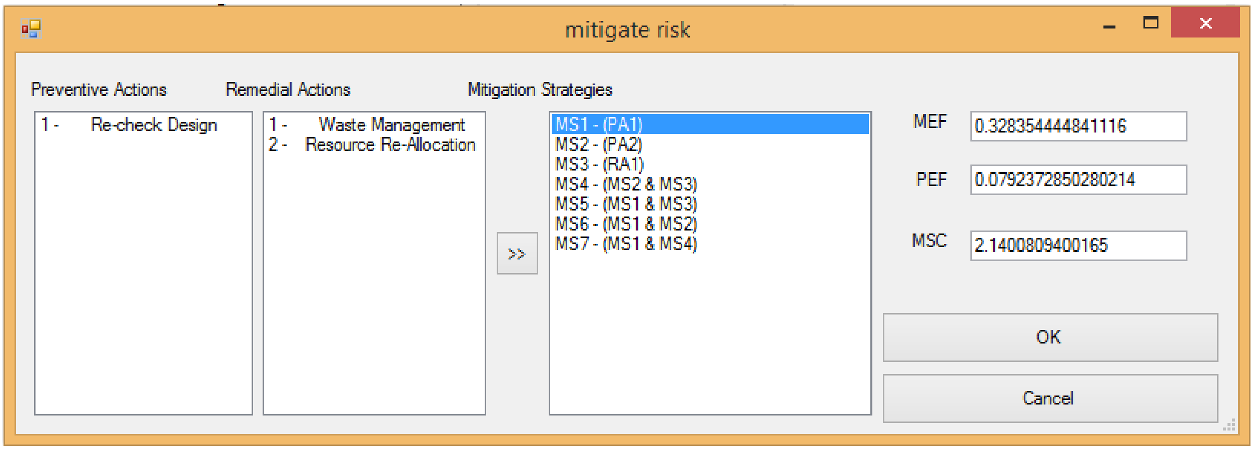


Figure 5.22 Generation of Possible Mitigation Strategy

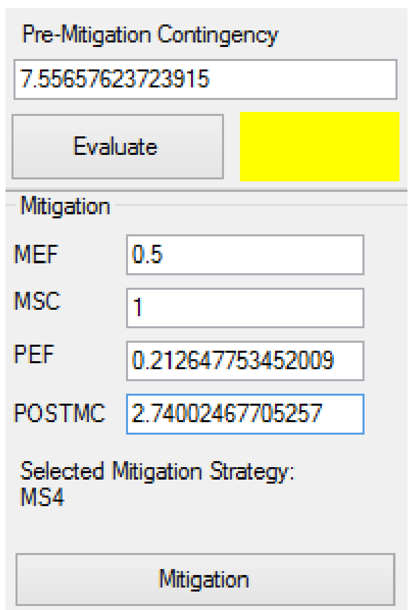


Figure 5.23Example of Mitigation Process Results

The mitigation efficiency factor (MEF), mitigation strategy cost (MSC), and planned efficiency factor (PEF) for each mitigation strategy are calculated using fuzzy set theory, as shown in Figure 5.23. The mitigation strategy with the highest PEF is selected as the most effective mitigation strategy, as shown in Figure 5.23. Post mitigation contingency is calculated using planned efficiency factor of selected mitigation strategy and pre-mitigation of the risk being considered, as expressed in Eq. 3.53. The risk mitigation module has three main functions: Generation of possible mitigation strategies, select the most effective mitigation strategy, calculation of post-mitigation contingency and generation of POSTMC curve.

Generation of possible mitigation strategies function:

```
    '//Combination of two list of actions into one list of strategies
Public Function GenerateListOfPossibleStrategies(ByVal preventiveactions As List(Of Action), ByVal remedialactions
As List(Of Action)) As List(Of Strategy)
        Dim result As New List(Of Strategy)
        For i = 0 To preventiveactions.Count + remedialactions.Count - 1
            If i < preventiveactions.Count Then
                result.Add(New Strategy("MS" & CStr(i + 1), preventiveactions(i), "PA" & CStr(preventiveactions(i).ID)))
            Else
                result.Add(New Strategy("MS" & CStr(i + 1), remedialactions(i - preventiveactions.Count), "RA" &
CStr(remedialactions(i - preventiveactions.Count).ID)))
            End If
        Next
        Return result
End Function

'end of combinations of two list of actions into one list of strategies
```

Selection of the most effective mitigation strategy function:

```
Public Function SelectedMS() As Strategy
        Dim SMS As New Strategy
        SMS = MitigationStrategies(0)
        For i = 1 To Me.MitigationStrategies().Count - 1
            If PEF(Me.MitigationStrategies(i), Me) > PEF(SMS, Me) Then
                SMS = Me.MitigationStrategies(i)
            End If
        Next
        Return SMS
    End Function
```

Calculation of Post Mitigation Contingency function:

```
Private Function PostMitigationContingency() As Double
        Return Me.PreMitigationContingency() * (1 - PEF(Me.SelectedMS, Me))
    End Function

Public Function PEF(ByVal strategy As Strategy, ByVal risk As Risk) As Double
        Return strategy.MEF - Defuzzification(strategy.Cost) / risk.PreMC()
    End Function
```

Generation of POSTMC Curve function:

```
Public Function postMCserie(ByVal risk As Risk) As List(Of Point)
        Dim pts As New List(Of Point)
        Dim p As New Point
        With risk
            For i = 0 To numberofmonitoringperiods
                If i = 0 Then
                    pts.Add(New Point(0, .SelectedMS.MScost))
                Else
           pts.Add(New Point(i, pts(i - 1).Y + (.PostMC - .SelectedMS.MScost) / numberofmonitoringperiods))
                End If
            Next
        End With
        Return pts
    End Function
```

5.3.5 Monitoring Module

Risk monitoring module evaluates the performance of the selected mitigation strategy at the end of each monitoring period. The number of monitoring periods depends on the project duration, and it is calculated based on preset monitoring frequency (e.g., one month). The monitoring module requires two types of inputs: Actual cumulative mitigation contingency (ACTMC) and the percentage of completion, as shown in Figure 5.24. However, these inputs can be acquired from an automatic data acquisition system.

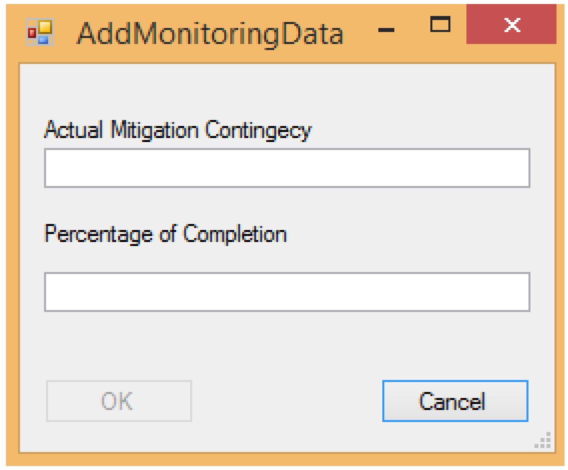


Figure 5.24 Data Entry for Monitoring Period

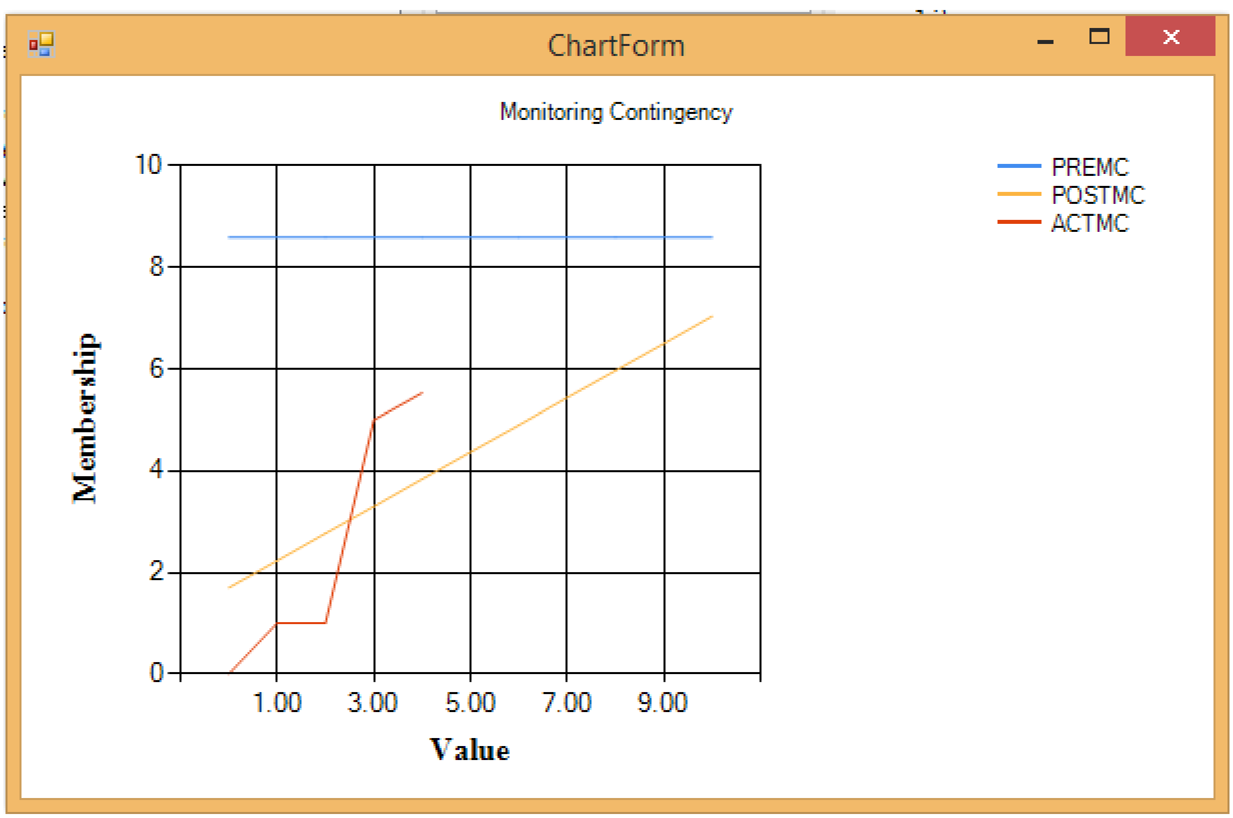


Figure 5.25 Risk Monitoring of Contingency Depletion

The pre-mitigation contingency of a risk represents the upper limit of contingency depletion which denotes, in case of exceeding it, the failure of a risk management plan. Depletion curve of post mitigation contingency over the life cycle of the risk being considered is assumed equally distributed over the monitoring periods. The cumulative post mitigation contingency is represented using a straight line, as shown in Figure 5.25. Exceeding the post mitigation contingency at any monitoring period denotes the possible failure of mitigation strategy and indicates the risk being considered as critical, and it should be monitored closely. Once actual contingency curve exceeds the post mitigation limit, the monitoring module notifies the risk owner that control process needs to be initiated, as shown in Figure 5.26. However, the decision whether to initiate or not, the control process remains the risk owner responsibility propped by support and approval members.

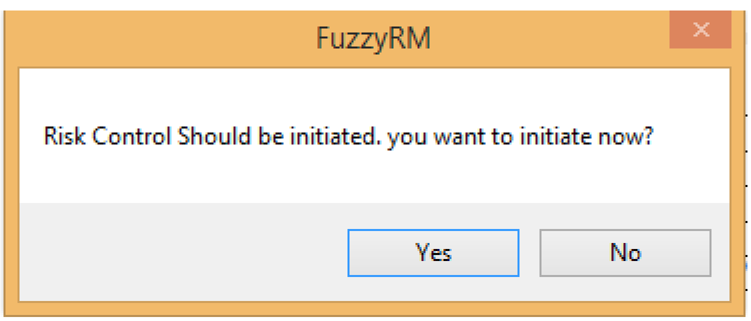


Figure 5.26 Notification for Control Process Initiation

Generation of actual mitigation contingency (ACTMC) curve, comparison of risk acceptance factor represents the main function of monitoring module. However, once the initiation of control process is required, the monitoring module calculates the risk residual using the residual function. Generation ACTMC curve and calculation of risk residual function are coded as follows:

Generation of Actual Mitigation Contingency Curve

```
Public Function ActMCserie(ByVal risk As Risk) As List(Of Point)
        Dim pts As New List(Of Point)
        pts.Add(New Point(0, 0))
        With risk
            For i = 1 To numberofmonitoringperiods
                If .PeriodicactMC(i) <> 0 Then
                    pts.Add(New Point(i, .PeriodicactMC(i)))
                End If
            Next
        End With
        Return pts
    End Function
```

Calculation of Risk Residual

```
Public Function residual(ByVal risk As Risk) As Double
        Dim j As Integer
        For i = 1 To numberofmonitoringperiods
            If risk.PeriodicactMC(i) = 0 Then
                j = i - 1
                Exit For
            End If
        Next
        Return risk.ActMC - risk.PeriodicactMC(j)
    End Function
```

5.3.6 Control Module

The control module consists of three main phases: rank control actions, select the most effective control action or combination of actions, and evaluate the effect of control actions on residual of the risk being considered. Subsequently, the post control factor and projected risk cost are evaluated. Also, the post control actual mitigation contingency and update value of its respective actual efficiency factor, as shown in Figure 5.27.

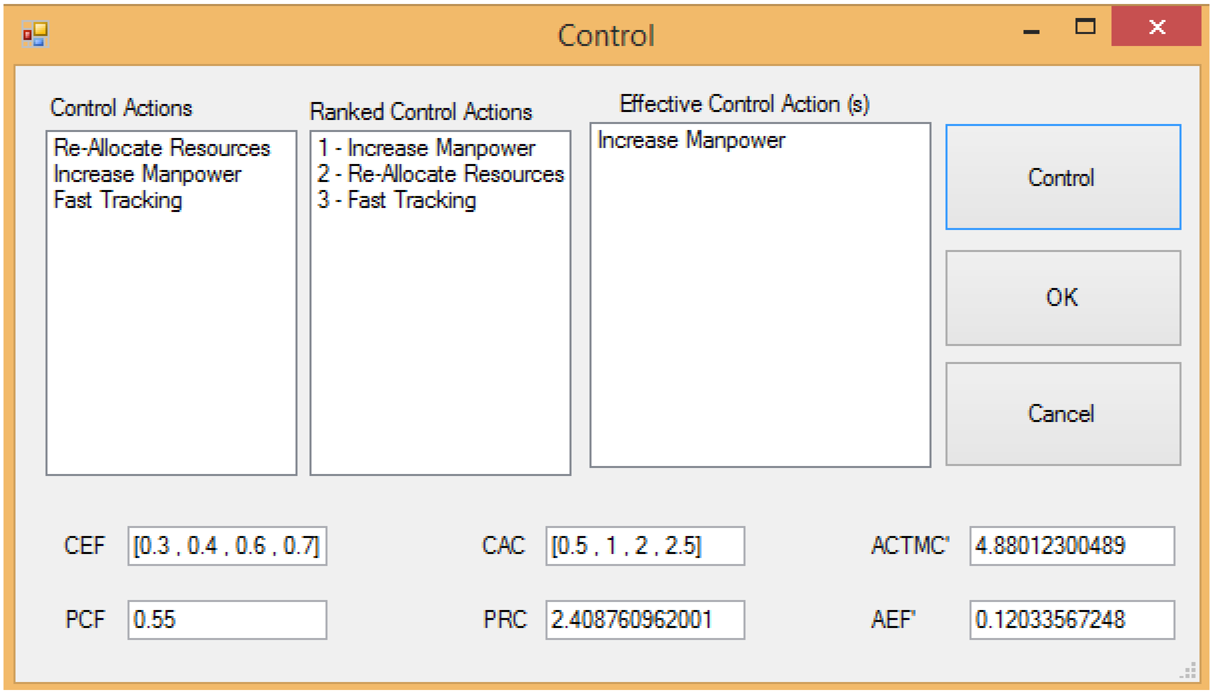


Figure 5.27 Risk Control Module

The control module consists of three functions, ranking of control actions, calculation of PCF, and updating actual mitigation contingency and actual efficiency factor as follows:

<u>Ranking of Control Actions</u>

```
Public Function ranking(ByVal lst As List(Of Action)) As List(Of Action)
      Dim rankedlist As New List(Of Action)
      Dim a As New Action
      For i = 0 To lst.Count - 1
         For j = i + 1 To lst.Count - 1
           If Defuzzification(lst(i).Efactor) >= Defuzzification(lst(j).Efactor)
           Then
            a = lst(i)
      Else
            a = lst(j)
      End If
      Next
         a.ID = i + 1
         rankedlist.Add(a)
      Next
      Return rankedlist
   End Function
```

<u>Calculation of Post Control Factor</u>

```
  Public Function PCF(ByVal action As Action, ByVal residual As Double) As Double
     Return Defuzzification(action.Efactor) - Defuzzification(action.Cost) / residual
  End Function
```

Updating the Actual Mitigation Contingency

```
Public Function UpdatedACTMC(ByVal risk As Risk, ByVal action As Action, ByVal residual As Double) As Double
     Dim j As Integer
     For i = 1 To numberofmonitoringperiods
        If risk.PeriodicactMC(i) = 0 Then
           j = i - 1
        End If
     Next
     Return risk.PeriodicactMC(j) + PCF(action, residual)
  End Function
```

5.4 Summary

This chapter presents the developed software that automates the application of developed model. The modules and main functions of each module are presented to illustrate the essential feature of the developed software. User-friendly graphical interface is coded to minimize the level of user experience and to facilitate the use of developed software. However, complete code of the developed software is provided in Appendix B.

CHAPTER 6: ANALYSIS AND DISCUSSION

6.1 Overview

This chapter presents analysis of the results of case studies and numerical example presented in chapter 4. It also highlights and discusses the findings to highlights the essential features of developed method as compared to others. The discussion of results elaborates on the potential of developed method beyond the existing methods. At the end a summary that summarizes the main findings of analysis and discussion. The overview of chapter 6 is presented in Figure 6.1 as follows:

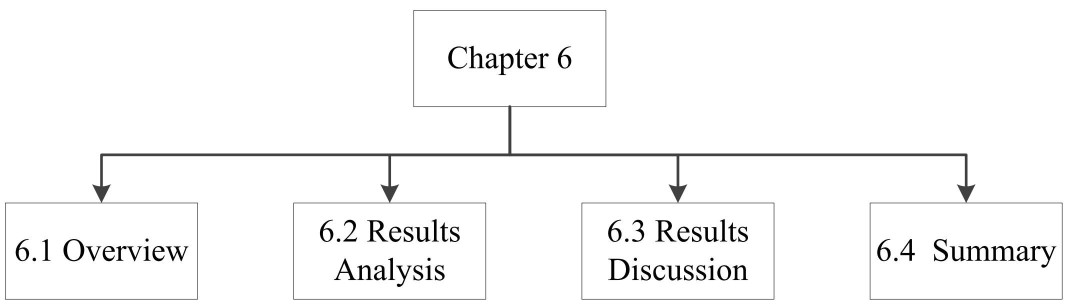


Figure 6.1 Overview of Chapter 6

6.2 Discussion and Analysis – Case Studies

The case studies and numerical example presented in chapter 4 illustrates the applicability and validates the results of developed model. Each case study is analysed separately to illustrate the features of developed model correspond to that case study.

The Sydney Opera House (SOH) case study was used to validate the developed identification method. The results show that considering the facts associated with SOH project at that time 20 risks were identified using the developed method as shown in Figure 6.2 (Please refer to Chapter 4 section 4.2.3). Burtonshaw-Gunn (2013) identified 12 risks that represents 60% identification rate as compared to the developed method. Out of the 20 identified risks 19 (rate of identification 95%) of them were occurred. The developed identification method proves its efficiency in identifying the risks associated with SOH project considering the facts only. However a deep root-cause analysis is largely depends on availability of data may lead to identify more risks.

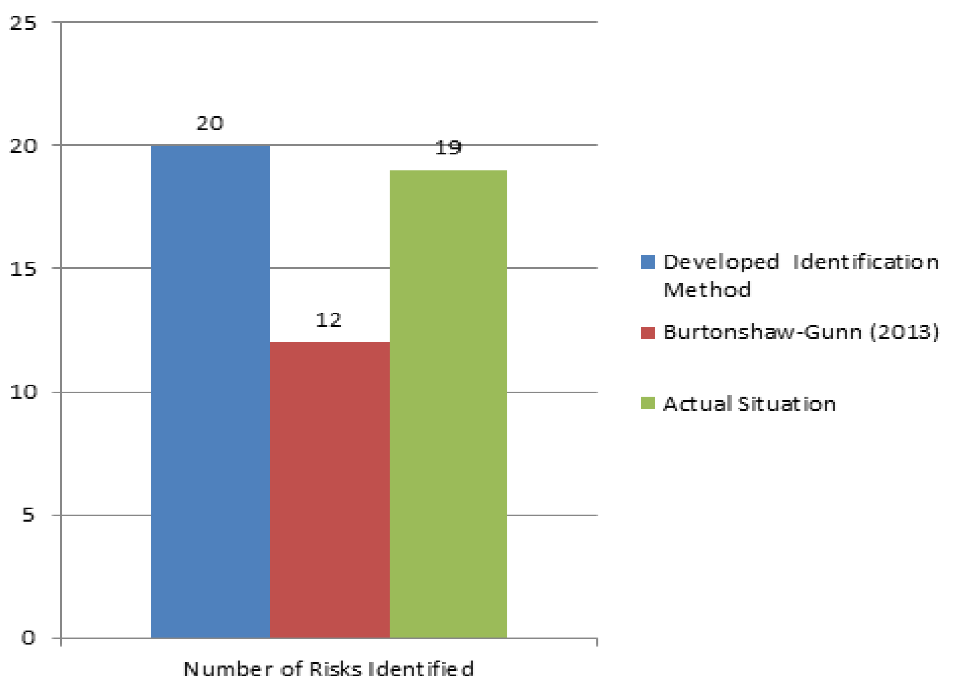


Figure 6.2 Comparison Between Numbers of Risks Identified Using the Developed Method and Burtonshaw-Gunn (2013)

As result the developed method is considered efficient and its efficiency may increase considerably in case data is available. Identification of these 20 risks at earlier stage of SOH project may save lot of money (1300% overrun) and lot of time (10 years delay).

The SOH case study was also used to validate the developed qualitative assessment method. the results of the developed method was compared to those of risk matrix method used by

Burtonshaw-Gunn (2013) to evaluate qualitatively the risks associated with SOH project (Please refer to Chapter 4 section 4.2.3). The both methods evaluate the risks using same scale (Refer to Table 4.7 and Table 4.8). However, the developed method use the linguistic value for assessment; the linguistic was converted and using FLNCS. The fuzzy calculation was used to calculate the fuzzy risk value of each risk using Eq. 3.19. The defuzzified value was calculated using Eq. 3.22 and scaled using the mapping scale presented in Table 4.9.

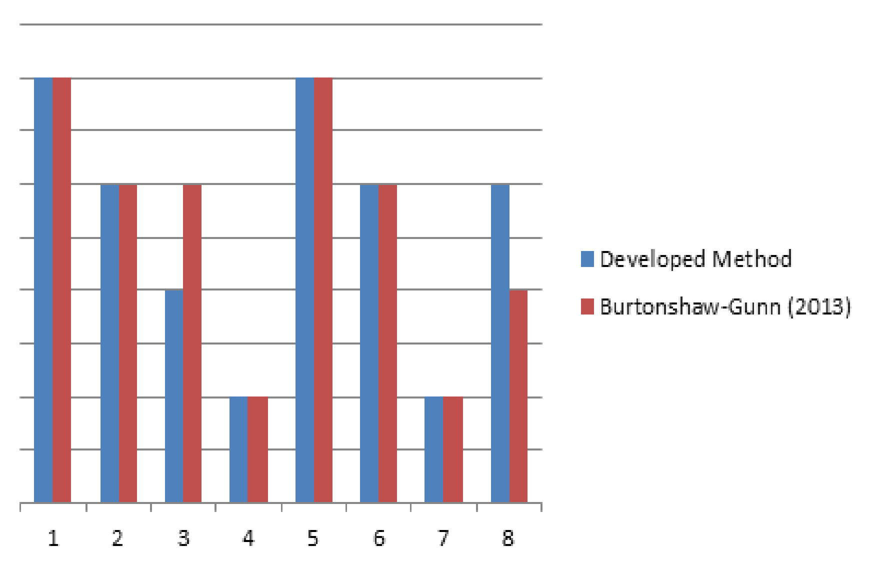


Figure 6.3 Qualitative Risk Assessment

Figure 6.3 shows that 2 out of 8 receive different values of qualitative assessment from developed method and the method used by Burtonshaw-Gunn (2013).

This case study represents a rehabilitation project for one of the University of Cartagena buildings (Nieto-Morote & Ruz-Vila, 2011). It was used to validate the ranking capability of the developed method (Please refer to Chapter 4 section 4.2.3). The method shows 75% accuracy rate for ranking 4 risks as presented by Nieto-Morote and Vila (2011). The only risk that was ranked differently was “lack of motivation attitude” because Nieto-Morote and Vila (2011) assumed the interdependencies among experts’ evaluations. However, the developed method did not consider the interdependencies among experts’ evaluations assuming that each expert has a unique experience and it is independent from the experience of others.

The third case study focused on road construction project. It was used to validate the developed risk mapping method (Please refer to Chapter 4 section 4.2.3). The developed risk mapping provides 82% (35 out of 43) accuracy as compared to the risk matrix method used by Mahamid (2011). It should also be noted that Mahamid (2011) uses a risk matrix that has two shared points among green, red, and yellow risk levels as shown in Figure 6.4.

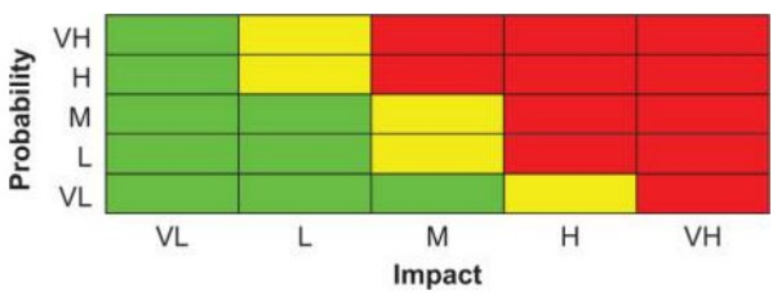


Figure 6.4 Risk Matrix Used by Mahamid (2011)

The three case studies demonstrate the accuracy of the developed method for qualitative risk assessment as compared to one of the most commonly used method in qualitative assessment (i.e. risk matrix). However, unlike the risk matrix, the developed method can represent the risk level associated with each project component as shown in Figure 4.16. This method provides a decision making support that highlights the risky components and allows user to take a proactive action. In addition, the uncertainty associated with the experts’ input are modeled using fuzzy set theory that allows the combination of linguistic and numeric evaluations.

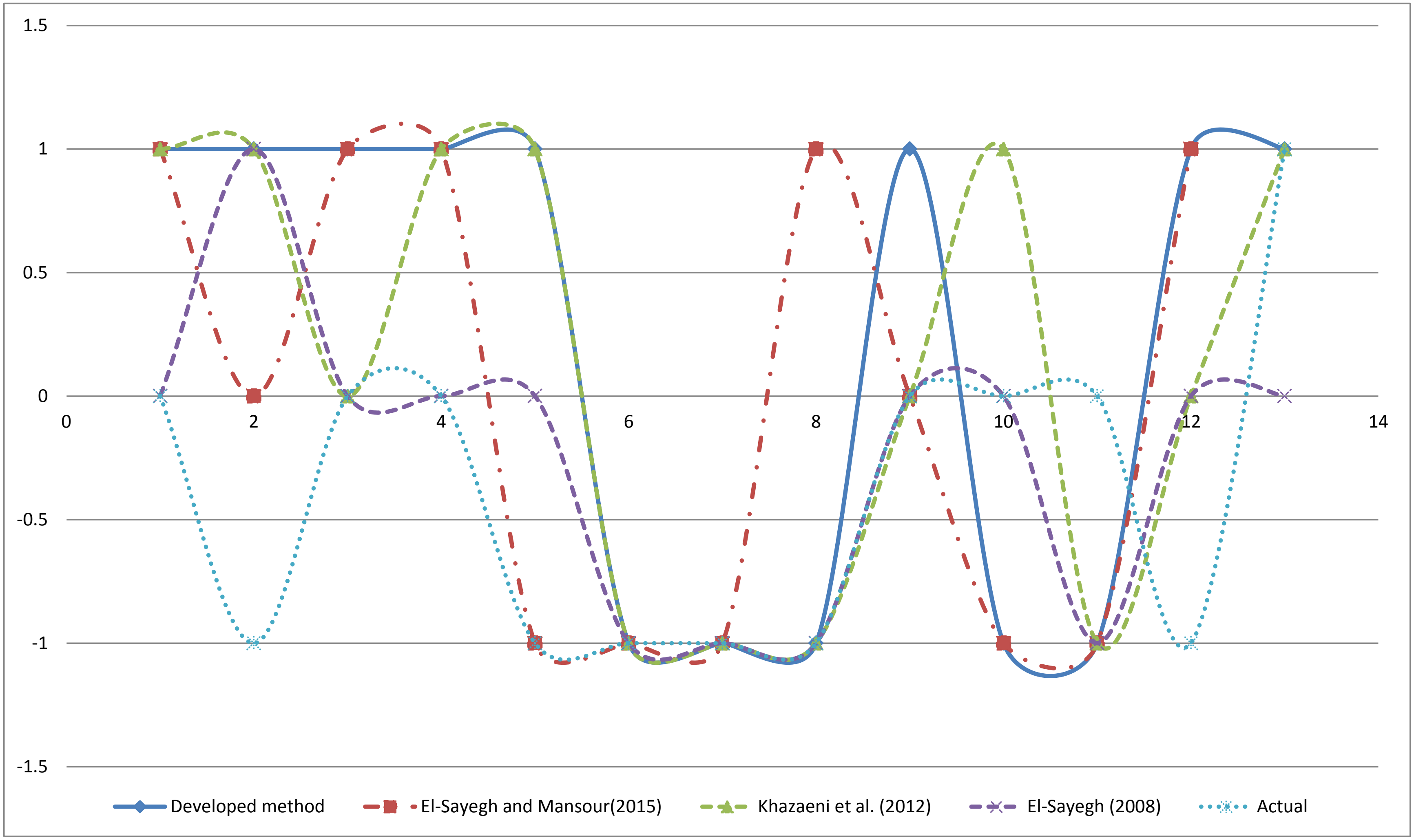


Figure 6.5 Comparison Between Developed Method and Other Methods for Risk Ownership Determination

The port complex project was used as a case study for validating the developed method for risk ownership determination. The application of the developed method on the case study shows higher efficiency as compared to the methods introduced by EL-Sayegh and Mansour (2015), Khazaeni et al. (2012), and El-Sayegh (2008) (please refer to Chapter 4 section 4.2.2) . The results were also compared to the actual allocation in port complex project that demonstrates the efficiency of developed method. The introduced one-risk one-owner eliminates the possibility for shared or unallocated risks which may generate conflicts. Figure 6.5 shows the comparison between the developed method, actual selection, and the methods proposed by EL-Sayegh and Mansour (2015), Khazaeni et al. (2012), and El-Sayegh (2008). The results show that the developed method has a considerable accuracy in selection of risk owner. However, it should be noted that investigation of other criteria may elevates the accuracy of developed method for risk owner determination.

A case study, focused a highway construction projects, was collected from literature (Paek, Lee, & Ock, 1993). This case study was used to validate the developed method for quantitative assessment (Please refer to Chapter 4 section 4.2.4). The method applied by Paek et al. (1993) has a complicated procedure and it prevent its application. The results of the developed method for UHCOC are compared to the methods developed by Salah (2012), Moselhi (1997), and Paek et al. (1993). The relative error analysis of these four methods is presented in Table 6.1 as follows:

Table 6.1 Relative Error Analysis for UHCOC Project

UHCOC	Developed Method	Salah (2012)	Moselhi (1997) - PERT	Paek et al. (1993)
Developed	0			

UHCOC	Developed Method	Salah (2012)	Moselhi (1997) - PERT	Paek et al. (1993)
Method				
Salah(2012)	0.1%	0		
Moselhi (1997) - PERT	1.5%	1.45%	0	
Paek et al. (1993)	0.4%	0.32%	1.1%	0

The relative error demonstrates the capability of proposed method to quantify the risk associated with construction projects with high level of accuracy. However this method can also be applied on cost range estimating as presented in the following case study.

Another case study was also collected from literature (Shaheen, Robinson, & AbouRizk, 2007) to evaluate the cost range estimating of North Edmonton Sanitary Trunk (NEST) (Please refer to Chapter 4 section 4.2.4). The results of developed method were comparable to the methods developed by Salah and Moselhi (2015), Shaheen et al. (2007) and Monte Carlo Simulation as shown in Table 4.25. The relative error analysis of these methods is presented in Table **6.2** as follows:

Table 6.2 Relative Error Analysis for NEST Project

NEST Project	Developed Method ($)	Salah and Moselhi (2015)	Shaheen et al.(2007) ($)	Monte carlo Simulation($)
Developed Method ($)	0			
Salah and Moselhi (2015)	3.22%	0		

NEST Project	Developed Method ($)	Salah and Moselhi (2015)	Shaheen et al.(2007) ($)	Monte carlo Simulation($)
Shaheen et al.(2007) ($)	7.38%	1.7%	0	
Monte carlo Simulation ($)	7.4%	11%	9.2%	0

The relative error analysis shows that the developed method provides a result similar to the fuzzy based methods estimated the NEST project with a range of relative error that varies from 1.7% - 7.38 %. The results are, also, close to those generated by MCS (~7.4%). It should be noted the difference between the results obtained using fuzzy set theory based on the developed method and those based on the methods of Salah and Moselhi (2015) and Shaheen et al. (2007) can be attributed to the use of algebraic sum and product in the fuzzy membership calculations. The developed method does not use trapezoidal and triangular membership functions like the other two methods but generate general mathematical formulation of these functions as described in Section 3.2. The application of the developed quantitative method on NEST project highlights the challenge associated with the integration of crisp numbers. Because, the membership function of a crisp number (a) equals to 0 and at the same time equals to 1 at x=a. This makes it difficult to represent the membership functions of crisp numbers for addition with other types of membership functions. Thus, it is recommended to investigate the integration of crisp numbers in the developed model.

The Case study of HDD project was collected from literature to investigate the developed risk mitigation method. The application of the developed method on HDD case study leads to comparable results as compared to the method of Abdelgawad and Fayek (2012) (Please refer to

Chapter 4 section 4.2.5). However, the selection of mitigation strategy could differ if the cost of strategies and pre-mitigation contingency of risk were available. In all case, the case study demonstrates the applicability and the efficiency of developed mitigation method. In addition, the developed method allows the selection of the most effective mitigation strategy and allows generation of post mitigation contingency baseline (Figure 3.22) baseline of contingency that allows at later stage monitoring and evaluate the performance of selected mitigation strategy.

6.3 Discussion and Analysis – Numerical Example

The numerical example is presented to demonstrate the application of CRMM using a small structured project as presented in Figure 4.14. The generation of MRBS that helps in identification all risk items associated with project at the task level (i.e. micro level). It also allows identification of consequences, preventive actions, and remedial actions associated with the project as presented in Table 4.31. The developed qualitative assessment method provides information about criticality of each project component from task (Table 4.34) up to category (Table 4.36) level. Based on criticality, owners are able to identify the high-risk project component and accordingly take a proactive action (e.g. Sub-contract).

The numerical example provides a detailed application of the developed model including monitoring, and control methods. It also illustrates the interactions between users and CRMM in respect to input, output, feedbacks and alerts. The CRMM shows potentials to be a core solution for the risk management in construction projects. However, it is recommended to investigate the capabilities of CRMM in a real project to identify the potential for improvements. It should be noted also that building a risk database with such amount of data represents a challenge for practitioners.

The CRMM is developed in a way that integrates all the processes in one comprehensive framework. The interconnections among the various processes and the flow of information from one to another facilitate the investigation of results if deemed necessary. The automated tool also supports the applicability of the proposed model and keeps the user updated with all necessary information about performance of the risk management plan.

6.4 Summary

This chapter presents discussions of results of the case studies and numerical example presented in chapter 4. It highlights the essential feature of developed CRMM to manage the risk effectively in a systematic manner. This chapter also illustrates the potential of the developed modes to effectively manage the risk. However, the limitations and potentials for future improvement of the developed model are presented in Chapter 7.

CHAPTER 7: SUMMARY AND CONCLUSIONS

7.1 Overview

This chapter summarizes the research developments, findings, and contributions; focusing on the developed risk management model. The developed model represents a comprehensive risk management framework that helps users to manage risks associated with construction projects more effectively. The developed model provides advancements to the risk management practice through the development of new methods for identification, assessment, mitigation, monitoring, and control. Despite its many features, the developed model has some limitations which are outlined in this chapter. Recommendations for potential improvements and extension of the developed model are also provided in this chapter. Conclusions are drawn to highlight the major findings of this research and to indicate the application domains of the developed model.

7.2 Summary

The developed CRMM model was firstly introduces to manage risks associated with a construction projects (i.e. EPCM). However, it can easily be adapted to other types of projects. The developed model includes new methods for identification, assessment, mitigation, monitoring, and control. It utilized a micro-system approach to generate a micro-risk breakdown structure that allows for risk management at the micro level. It also provides a risk ownership procedure that allocates each risk to one owner. Owner's selection is based on a set of criteria that describes the ability, effectiveness and capacity of the owner to manage the risk being considered. The developed model includes a risk responsibility matrix (RRM) that combines the responsibility matrix with the micro-risk breakdown structure. The RRM assigns project team members as support and approves members assigned to help each risk owner in the management of the assigned risk. The developed model utilizes fuzzy set theory to model uncertainties associated with the nature of risk as well as uncertainty associated with the model's input. The model provides a systematic qualitative and quantitative risk assessment by integrating fuzzy set theory and fuzzy probability theory. The qualitative assessment indicates the criticality of risk items. A new methodology for risk mapping is introduced, which not only identifies critical risks but all the risky project components as well. A new method for risk mitigation is developed to generate a list of possible strategies and to select from them the most effective one. Making use of the selected mitigation strategy performance, the monitoring system indicates the potential failures and alerts risk owners about the necessity for risk control initiation. The developed control method provides a systematic identification, evaluation, and selection procedure that provide a comprehensive analysis for the effectiveness of each selected control action. Based on the analysis results, the control method notifies users whether it is beneficial to process with a risk control measure or if it represents a waste of time and resources.

A new computational platform is developed and coded using VB.net programming. This platform provides a user-friendly software tool that facilitates the application of the developed model and highlights its essential features. Several case studies were used to validate the developed identification and assessment methods. The model was also implemented using hypothetical numerical example to demonstrate the complete application process and to illustrate its essential features. The results of the developed model were compared to the results of existing methods, where possible, and that comparison shows its consistency. These results were analysed to highlight the essential features of the developed model and to investigate the potential for prospective future development.

7.3 Main Contributions

The output of this research represents an integrated and dynamic risk management methodology for construction projects. However, the developed model has a generic feature and it can be easily adapted to apply in various industries rather than only in the construction industry. The main contributions of this research can be described as follows:

1. Development Micro risk identification and fuzzy allocation procedure that encompasses generation of a micro risk breakdown structure that facilitates the identification of the known and the majority of the unknown risks. It also includes development of an identification procedure using root cause analysis and cause effect diagram along with brainstorming to identify the root-causes and consequences of each risk item along with their respective preventive and remedial actions. Also, it includes development of a systematic procedure for the determination of risk ownership using fuzzy set theory risk responsibility matrix that defines the responsibilities of team members toward each risk;
2. Development Micro-Fuzzy risk assessment procedure that facilitates the use of linguistic terms and provides a development procedure for converting linguistic term into numeric. This procedure encompasses a qualitative assessment method that utilizes fuzzy set and fuzzy probability theory, and a risk mapping methodology that highlights the risk level associated with each project component. It also encompasses a quantitative assessment that evaluates the pre-mitigation contingency required, before selecting a mitigation strategy, for each risk item.
3. Development Micro-Fuzzy risk mitigation procedure that encompasses generation of the list of possible mitigation strategies using the identified lists of preventive and remedial actions, selection of the most effective mitigation strategy using a newly-introduced set of qualitative

and quantitative factors, and evaluation of post-mitigation contingency (POSTMC) required for each risk item.

4. Development Micro-Fuzzy risk monitoring procedure that encompasses a dynamic and systematic monitoring procedure that monitors the risk items at micro-level making use of the performance of the selected mitigation strategy. Also, It includes an evaluation procedure for risk acceptance (RA) tolerance for each risk item using fuzzy set theory. This procedure introduces the mitigation performance index (MPI), which evaluates the performance of the risk management plan, at a strategic level, of each project;
5. Development Micro-Fuzzy risk control procedure that includes a systematic procedure for the identification, evaluation and selection of the most effective control action using a newly-introduced set of qualitative factors. It also provides a systematic procedure to update the risk management plan based on actually collected data.
6. Development of automated standalone software that integrates all these procedures in a comprehensive and systematic model for risk management. The software provides a user-friendly graphical interface to facilitate its application.

7.4 Conclusions

The developed model provides a new method for comprehensive risk management. The model encompasses a number of methods and algorithms to perform risk identification, qualitative and quantitative risk assessment, mitigation, monitoring, and control procedures. These methods can be used independently for risk identification, the assessment of a cost range, ownership determination, selection of a mitigation strategy, and for selection of a control action, as presented in the various case studies presented in Chapter 4. They can also be used collectively as presented in the hypothetical numerical example. . The introduced post-mitigation and pre-mitigation contingencies provide an indication about the criticality of the risk being considered. The post and pre-mitigation values represent the contingency baselines for the project. These baselines in turn represent an evaluation system that indicates the performance of the selected mitigation strategy. The developed risk mapping method provides a decision support tool that identifies high-risk project components. It also can be implemented as a risk-based selection procedure that allows the identification and ranking of risk-prone projects. The monitoring system indicates the exact time for optimal risk control initiation and it allows for the evaluation of each situation separately, which may avoid the unnecessary depletion of resources. Despite all these features and capabilities, the developed method remains imperfect, and it has limitations which are highlighted in the next section. The developed model provides a step-by-step risk management framework that supports decisions to be made at different project stages: conceptual, design, bidding, and construction, as well post-completion. The developed model is dynamic and allows for prediction of possible failures of non-occurred risk items based on the collected data. This can help users to make proactive decisions. These predictions make it possible to continuously update the risk management plan to avoid surprises and better manage projects.

7.5 Limitations and Future work

The developed risk management model has several limitations which should be considered for future work. These limitations are:

1. A limited number of MRBS levels is used in this research. Additional levels can be used. However, it is recommended to fix the number of levels in each organization to avoid the generation of different UIDNs for each risk.

2. The application of the model is time consuming, as a large number of inputs are required, especially at the first application. However, a centralized risk database can reduce the time required for input data.
3. Three criteria have been considered in the developed procedure for risk ownership determination. This criteria can be revised, if deemed necessary, to suit each project environment.
4. The developed mapping procedure considers five mapping scales (i.e. Blue, green, yellow, orange, and red). An investigation into the use of different mapping scales is recommended to identify the most effective mapping scale that represents the risk level in construction projects and their respective components.
5. The integration of crisp numbers within the developed quantitative assessment method needs more investigation with respect to their membership functions.
6. The expert opinions are considered equally important however aggregating the evaluations of experts using different importance factors can be considered.
7. The application of developed CRMM model was demonstrated using several case studies and a hypothetical example. However, the application of CRMM in a real project may further validate the model and indicate the potentials for improvements.
8. The developed model utilizes the algebraic operations for adding and multiplying fuzzy numbers (Zadeh, 1965). However, other types of fuzzy calculations such as α-cut can be integrated with the developed CRMM model.
9. The developed model can be extended to account directly for opportunities.

REFERENCES

Abdelgawad, M., & Fayek, A. (2010). Risk Management in the Construction Industry Using Combined Fuzzy FMEA and Fuzzy AHP. *Contruction Enginering and Management*, 1028-1036.

Abdelgawad, M., & Fayek, A. (2012). Comprehensive Hybrid Framework for Risk Analysis in the Construction Industry Using Combined Failure Mode and Effect Analysis, Fault Trees, Event Trees, and Fuzzy Logic. *Journal of Construction Engineering and Management, 138*(5), 642-651.

Abdelgawad, M., Fayek, A. R., & Martinez, F. (2010). Quantitative Assessment of Horizontal Directional Drilling Project Risk Using Fuzzy Fault Tree Analysis. *Construction Research Congress 2010* (pp. 1274-1283). Reston, VA: ASCE.

Abdul-Rahman, H., Loo, S. C., & Wang, C. (2012). Risk identification and mitigation for architectural, engineering, and construction firms operating in the Gulf region. *Canadian Journal of Civil Engineering, 39*(1), 55-71.

Agrawal, A. (2012). Risk Mitigation Strategies for Renewable Energy Project Financing. *Strategic Planning for Energy and the Environment, 32*(2), 9-20.

Aminbakhsh, S., Gunduz, M., & Sonmez, R. (2013). Safety risk assessment using analytic hierarchy process (AHP) during planning and budgeting of construction projects. *Journal of Safety Research*, In Press.

Arikan, R., Dağdeviren, M., & Kurt, M. (2013). A Fuzzy Multi-Attribute Decision Making Model for Strategic Risk Assessment. *International Journal of Computational Intelligence Systems, 6*(3), 487-502.

Badri, A., Gbodossou, A., & Nadeau, S. (2012). Occupational health and safety risks: Towards the integration into project management. *Safety Science*, 190-198.

Bajaj, D., Oluwoye, J., & Lenard, D. (1997). An analysis of contractors' approaches to risk identification in New South Wales, Australia. *Construction Management and Economics, Vol. 15*, 363-369.

Baker, S., Ponniah, D., & Smith, S. (1999). Risk response techniques employed currently for major projects. *Construction Management and Economics, 17*(2), 205-213.

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

Banaitiene, N., & Banaitis, A. (2012). *Risk Management in Construction Projects.* Rijeka, Croatia: Intech Open Access.

Beckers, F., Chiara, N., Flesch, A., Maly, J., Silva, E., & Stegemann, U. (2013). *A risk-management approach to a successful infrastructure project.* Singapore: McKinsey & Company.

Bi, X., & Tan, H. (2010). The Study on Risk Assessment of EPC Contractor Based on Fuzzy Analytic Hierarchy Process. *Industrial Engineering and Engineering Management (IE&EM)* (pp. 1129-1132). Xiamen, China: IEEE.

Borghesi, A., & Gaudenzi, B. (2013). *Risk Management, Perspectives in Business Culture.* Verlag, Italy: Springer.

Burns, C. (2012). *Globak Risk Technology Survey.* Atlanta, USA: Aon E-Solutions.

Burtonshaw-Gunn, S. (2013). *Management of Risk in Construction.* Greater Manchester, England: University of Salford.

Cagno, E., Caron, F., & Mancini, M. (2007). A Multi-Dimensional Analysis of Major Risks in Complex Projects. *Risk Management, 9*(2007), 1-18.

Carlsson, C., Fedrizzi, M., & Fuller, R. (2004). *Fuzzy Logic in Management.* Boson: Kluwer Acedemic Publishers.

Carvalho, M. M., & Rabechini Junior, R. (2015). Impact of risk management on project performance: the importance of soft skills. *International Journal of Production Research, 53*(2), 321-340.

Cervone, H. (2006). Project Risk Management. *OCLC Systems and Services, 22*(4), 256-262.

Chan, J. H., Chan, D. W., Chan, A. P., & Lam, P. T. (2012). Risk mitigation strategies for guaranteed maximum price and target cost contracts in construction: A factor analysis approach. *Journal of Facilities Management, 10*(1), 6-25.

Chan, J. H., Chan, D., Chan, A. P., & Lam, P. T. (2011). Developing a fuzzy risk assessment model for guaranteed maximum price and target cost contracts in construction. *Journal of Facilities Management, 9*(1), 34-51.

Chapman, C., & Ward, S. (2003). *Project Risk Management. Processes, Techniques and Insights.* Chichester, England: John Wiley & Sons, Ltd.

Chapman, R. J. (1998). The Effectiveness of Working Group Risk Identification and Assessment Techniques. *International Journal of Project Management, Vol. 16,*, 333-343.

Chapman, R. J. (2001). The Controlling Influences on Effective Risk Identification and Assessment for Construction Design Management. *International Journal of Project Management, Vol. 19*, 147-160.

Curtis, E., & Turley, S. (2007). The business risk audit – A longitudinal case study of an audit engagement. *Accounting, Organizations and Society, 32*(4-5), 439-461.

Delbecq, A. L., & VandeVen, A. H. (1971). A Group Process Model for Problem Identification and Program Planning. *Journal Of Applied Behavioral Science VII*, 466-492.

Deloitte. (2012). *Key Risks Not Being Continually monitored: Deloitte Survey .* New York: Deloitte Development LLC.

Deniz, K., & Kaymak, M. (2007). Risk Identification Step of the Project Risk Management. *PICMET 2007 Proceedings* (pp. 2116-2120). Portland, Oregon: PICMET.

Department of Education Training and Employment. (2012). *Enterprise Risk Management Framework 2012–2016.* Queensland: Queensland Government.

Dey, P. K. (2012). Project Risk Management Using Multiple Criteria Decision-Making Technique and Decision Tree Analysis: a Case Study of Indian Oil Refinery. *Production Planning and Control*, 903-921.

Dey, P. K., Kinch, J., & Ogunlana, S. O. (2007). Managing risk in software development projects: a case study. *Industrial Management & Data Systems, 107*(2), 284-303.

Dhar, M., Chutia, R., & Mahanta, S. (2012). A Note on the Existing Definition of Fuzzy Entropy. *International Journal of Energy, Information and Communications, 3*(1), 17-22.

Dikmen, I., Birgonul, M., & Han, S. (2007). Using fuzzy risk assessment to rate cost overrun risk in international construction projects. *International Journal of Project Management, 25*(2007), 494-505.

Ebrahimnejad, S., Mousavi, S., & Seyrafianpour, H. (2010). Risk identification and assessment for build–operate–transfer projects: A fuzzy multi attribute decision making model. *Expert Systems with Applications*, 575-586.

Ehsan, N., Alam, M., Mirza, E., & Ishaque, A. (2010). Risk Management in construction industry. *Computer Science and Information Technology (ICCSIT), 2010* (pp. 16-21). Chendgu, China: IEEE.

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

El-Sayegh, S. M., & Mansour, M. H. (2015). Risk Assessment and Allocation in Highway Construction Projects in the UAE. *Journal of Management in Engineering*, 04015004(11).

Faber, M. H., & Stewart, M. G. (2003). Risk assessment for civil engineering facilities: critical overview and discussion. *Reliability Engineering & System Safety, 80*(2), 173-184.

Fan, Z. P., Li, Y. H., & Zhang, Y. (2015). Generating project risk response strategies based on CBR: A case study. *Expert Systems with Applications, 42*(6), 2870-2883.

Fang, C., & Marle, F. (2012). A simulation-based risk model for decision support for project risk management. *Decision Support Systems*, 635-644.

Fang, C., Marle, F., Xie, M., & Zio, E. (2013). An Integrated Framework for Risk Response Planning Under Resource Constraints in Large Engineering Projects. *IEEE Transactions on Engineering Management, 60*(3), 627-639.

Hallowell, M. R., & Gambatese, J. A. (2009). Construction Safety Risk Mitigation. *JOURNAL OF CONSTRUCTION ENGINEERING AND MANAGEMENT, 135*(2009), 1316-1323.

Han, S. H., Kim, D. Y., Kim, H., & Jang, W. S. (2008). A web-based integrated system for international project risk management. *Automation in Construction, 17*(2008), 342-356.

Hanna, A. S., & Swanson, J. R. (2006). *Contracting to appropriately allocate risk.* Wisconsin-Madison: Constrcution Industry Institute.

Hanna, A. S., Thomas, G., & Swanson, J. R. (2013). Construction Risk Identification and Allocation: Cooperative Approach. *JOURNAL OF CONSTRUCTION ENGINEERING AND MANAGEMENT, ASCE*, 1098-1107.

Hanna, A., Swanson, J., & Aoun, D. (2014). Proper Risk Allocation during Construction: Differing Site Conditions. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 6*(4), 04514003.

Hassanein, A. A., & Afifi, H. M. (2007). A risk identification procedure for construction contracts- a case study of power projects in egypt. *Civil Engineering and Environmental Sysytems, 24*(1), 3-14.

Hopkin, P. (2014). *Fundamentals of Risk Management.* London, UK: The Institute of Risk Management.

ISO. (2009). *Risk Management - Principles and guidlines.* Geneva - Switzerland: International Standard Organization.

Jannadi, O., & Almishari, S. (2003). Risk Assessment in Construction. *Journal of Construction Engineering and Management, 129*(5), 492-500.

Jun-yan, L., Feng, R., & Yan, L. (2011). Research on Monitoring-based Risk Management of Deep Excavation Engineering. *Management and Service Science (MASS), 2011 International Conference* (pp. 1-4). Wuhan, China: IEEE.

Kangari, R., & Riggs, L. (1989). Construction Risk Assessment by Linguistics. *IEEE Transactions on Engineering Management*, 126-131.

Kaplan, R., & Mikes, A. (2012). Managing Risk : A New Framework. *Harvard Business Review*, 48-60.

Kelmeti, A. (2006). *Risk Management in Construction Project Networks.* Helsinki, Finland: Helsinki University of Technology.

Kerzner, H. (2013). *Project management: a systems approach to planning, scheduling, and controlling / Harold Kerzner.* Hoboken, NJ, USA: John Wiley & Sons.

Khazaeni, G., Khanzadi, M., & Afshar, A. (2012). Fuzzy adaptive decision making model for selection balanced risk allocation. *International Journal of Project Management*, 511-522.

Kong, D. P., Lu, S. X., Kang, Q. S., Lo, S. M., & Xie, Q. M. (2011). Fuzzy Risk Assessment for Life Safety Under Building Fires. *Fire Technology*, 1-14.

Kupp, N., & Makris, Y. (2012). Applying the Model-View-Controller Paradigm to Adaptive Test. *IEEE Design & Test of computers, 29*(1), 28-35.

Kwan, T., & Leung, H. (2011). A Risk Management Methodology for Project Risk Dependencies. *IEEE Transactions on Software Engineering, 37*(5), 635-648.

Lazzerini, B., & Mkrtchyan, L. (2011). Analyzing Risk Impact Factors Using Extended Fuzzy Cognitive Maps. *IEEE Systems Journal, 5*(2), 288-297.

Lee, E., Park, Y., & Shin, J. (2009). Large engineering project risk management using a Bayesian beleif network. *Expert Systems with Applications*, 5880-5887.

Li, J., & Zou, P. (2012). Risk Identification and Assessment in PPP Infrastructure Projects using Fuzzy Analytical Hierarchy Process and Life-Cycle Methodology. *Australasian Journal of Construction Economics and Building, 8*(1), 34-48.

Ling, F., & Low, S. (2007). Legal Risks Faced by Foreign Architectural, Engineering, and Construction Firms in China. *Journal of Professional Issues in Engineering Education and Practice, 133*(3), 238-245.

Lingard, H., Saunders, L., Pirzadeh, P., Blismas, N., Kleiner, B., & Wakefield, R. (2015). The relationship between pre-construction decision-making and the effectiveness of risk control - Testing the time-safety influence curve. *Journal of Engineering, Construction and Architectural Management, 22*(1), 108 - 124.

Liu, B. (2015). *Uncertainty Theory.* Berlin, Germany: Springer-Verlag.

Liu, H., & Tsai, Y. (2012). A fuzzy risk assessment approach for occupational hazards in the construction industry. *Safety Science, 50*, 1067-1078.

Liu, J. Y., Ren, F., & Liu, Y. (2011). Research on Monitoring-based Risk Management of Deep Excavation Engineering. *Management and Service Science (MASS), 2011* (pp. 1-4). Wuhan, China: IEEE.

Loosemore, M., Raftery, J., Reilly, C., & Higgon, D. (2006). *Risk and Uncertainty in Projects.* New York, NY, USA: Taylor & Francis.

Lyons, T., & Skitmore, M. (2004). Project risk management in the Queensland engineeing construction industry: a survey. *International Journal of Project Management, 22*, 51-61.

Mahamid, I. (2011). Risk matrix for factors affecting time delay in road construction projects: owners' perspective. *Engineering, Construction and Architectural Management, 18*(6), 609-617.

Mahendra, P. A., Pitroda, J. R., & Bhavsar, J. J. (2013). A Study of Risk Management Techniques for Construction Projects in Developing Countries. *International Journal of Innovative Technology and Exploring Engineering (, 3*(5), 139-142.

Marcelino Sádaba, S., Pérez-Ezcurdia, A., Echeverría-Lazcano, A., & Benito-Amurrio, M. (2014). Project risk management methodology for small firms. *International Journal of Project Management, 32*(2), 327-340.

Marhavilas, P., Koulouriotis, D., & Gemeni, V. (2011a). Risk Analysis and Assessment Methodologies in the Work Sites: On a Review, Classification,and Comparative Study of the Sientific Literature of the Period 2000-2009. *Journal of Loss Prevention in the Process Industries, 24*(5), 477-523.

McCaffrey, J. (2006). *.Net Test Automation Recipes.* New York, NY, USA: Springer.

Morris, S. (2014). Mitigating risk. *Renewable Energy Focus, 15*(2), 22-24.

Morton, T. (2010). *The Basic Principles of Compiling a Risk Register for Smaller Companies.* London, UK: The Association of Chartered Certified Accountants.

Moselhi, O. (1997). Risk Assessment and Contingency Estimating. *AACE International TRasactions*, 90-95.

Moselhi, O., & Salah, A. (2012). Fuzzy Sets-Based Contingency Estimation and Management. *ISARC 29th Proceedings.* Eindhoven, The Netherlands: IAARC.

Nieto-Morote, A., & Ruz-Vila, F. (2011). A fuzzy approach to construction project risk assessment. *International Journal of Project Management, Vol. 29,*, 220-231.

Nilsen, T., & Aven, T. (2003). *Reliability Engineering & System Safety, 79*(3), 309-317.

Ning, Y. C., & Mao, Y. Y. (2011). The Risk Monitoring of Coal Construction Project Based on System Dynamics Model. *Information Systems for Crisis Response and Management* (pp. 330-334). Harbin, China: IEEE.

Opricovic, S. (2011). Fuzzy VIKOR with an application to water resources planning. *Expert Systems with Applications, 38*(10), 12983-12990.

Paek, J. H., Lee, Y. W., & Ock, J. H. (1993). Pricing Construction Risks: Fuzzy Set Application. *Journal of Construction Engineering and Management, 119*(4), 743-756.

Peckiene, A., Komarovska, A., & Ustinovicius, L. (2013). Overview of Risk Allocation between Construction Parties. *Procedia Engineering, 57*(2013), 889-894.

Pinto, A., Nunes, I. L., & Ribeiro, R. A. (2011). Occupational risk assessment in construction industry – Overview and reflection. *Safety Science, 49*(5), 616-624.

PMI. (2013). *A Guide to the Project Management Body of Knowledge.* Atlanta, USA: Project Management Institute.

PMI. (2013). *A Guide to the Project Management Body of Knowledge.* Atlanta, USA: Project Management Institute.

PMSolutions. (2011). *Strategies for Project Recoveries.* Glen Mills, PA, USA: Project Management Solutions Inc.

Polat, G., & Bingol, B. N. (2013). A Comparison of Fuzzy Logic and Multiple Regression Analysis Models in Determining Contingency in International Construction Projects. *Construction Innovation, 13*(4), 445-462.

Pritchard, C. L. (2015). *Risk Management - Concepts and Guidance.* Boca Raton, FL, USA: Taylor and Francis Group LLC.

Raftery, J. (1994). *Risk Analysis in Project Management.* London: E & FN Spon.

Raspotnig, C., & Opdahl, A. (2013). Comparing risk identification techniques for safety and security requirements. *The Journal of Systems and Software, 86*, 1124-1151.

Raydugin, Y. (2010). *Unknown Unknowns in Project Probabilistic Cost and Schedule Risk Models.* Calgary, AB, Canada: Risk Services & Solutions Inc.

Rezakhani, R. (2012). *CLASSIFYING KEY RISK FACTORS IN CONSTRUCTION.* Korea: Kyungpook National University.

Risk Management Capabilities, L. (2011). *Risk Ownership.* Winchester, UK: Risk Management Capabilities Ltd.

Rolstadås, A., Hetland, P. W., Jergeas, G. F., & Westney, R. E. (2011). A New Strategic Planning Model. *Risk Navigation Strategies for Major Capital Projects*, 10-117.

Rounds, J. L., & Segner, R. O. (2011). *Construction Supervision.* Hoboken, NJ, USA: John Wiley & Sons Inc.

Sadeghi, N., Fayek, A. R., & Pedrycz, W. (2010). Fuzzy Monte Carlo Simulation and Risk Assessment in Construction. *Computer-Aided Civil and Infrastructure Engineering, Vol. 25,*, 238-252.

Salah, A. (2012). *FUZZY SET-BASED CONTINGENCY ESTIMATING AND MANAGEMENT.* Montreal: Concordia University.

Salah, A., & Moselhi, O. (2013). Quantitative and qualitative risk in EPCM projects using fuzzy set theory. *IFSA World Congress and NAFIPS Annual Meeting (IFSA/NAFIPS)* (pp. 1177,1181). Edmonton, AB: IEEE.

Salah, A., & Moselhi, O. (2014). Estimating Post and Pre-mitigation contingency in construction. *Risk Analysis 2014* (pp. 243-250). New Forest, UK: Wessex Institute of Technology.

Salah, A., & Moselhi, O. (2014). Risk Mitigation for EPCM projects. *Canadian Society of Civil Engineers Annual Conference* (pp. 1-8). Halifax, NS, Canada: CSCE.

Salah, A., & Moselhi, O. (2015). Contingency Modeling for Construction Projects Using Fuzzy Set Theory. *Engineering Construction and Architectural Management, 22*(2), 214-241.

Schaufelberger, J. (2009). *Construction Business Management.* New Jersey, USA: Pearson Prentice Hall.

Serpella, A. F., Ferrada, X., Howard, R., & Rubio, L. (2014). Risk management in construction projects: a knowledge-based approach. *IPMA World Congress. 119*, pp. 653-662. Dubrovnik, Croatia: ELSEVIER.

Shaheen, A., Robinson, A. F., & AbouRizk, S. M. (2007). Fuzzy Numbers in Cost Range Estimating. *Construction Engineering and Management, 133*(4), 325-334.

StrategicRisk. (2014). *Risk Innovation - Showcasing Risk Management.* London, UK: Newsquest Specialist Media Ltd.

Sweeting, P. (2011). *Financial Enterprise Risk Management.* Cambridge: University Press.

Tang, W., Qiang, M., Duffield, C. F., Young, D. M., & Lu, Y. (2007). Risk Management in the Chinese Construction Industry. *Journal of Construction Engineering and Management, 133*(12), 944-956.

Taroun, A. (2014). Towards a better modelling and assessment of construction risk: Insights from a literature review. *International Journal of Project Management, 32*(1), 101-115.

Tavakkoli-Moghaddam, R., Mousavi, S., & Hashemi, H. (2011). A Fuzzy Comprehensive Approach for Risk Identification and Prioritization Simultaneously in EPC Projects. In M. M. Savino, *Risk Management in Environment, Production and Economy* (pp. 123-146). Rijeka, Croatia: InTech.

Taylor, L. (2014). *Practical Enterprise Risk Management.* Philadelphia, PA, USA: Kogan Page Limited.

Thamhain, H. (2013). Managing Risks in Complex Projects. *Project Management Journal, 44*(2), 20-35.

Tmošaitienė, J., Zavadskas, K., & Turskis, Z. (2013). Multi-criteria risk assessment of a construction project. *Information Technology and Quantitative n Management, 17*(2013), 129-133.

Tong-yin, H., Wei, H., & Ying-hua, S. (2011). Risk Evaluation of Public-Private Partnership Projects of Urban Rail Transit Based on Fuzzy Comprehensive Evaluation Method. *Management and Service Science (MASS), 2011* (pp. 1-4). Wuhan, China: IEEE.

Tworek, P. (2010). Methods of risk identification in companies' investment projects. *5th International Scientific Conference "Managing and Modeling of Financial Risks".* Ostrava: VŠB-Technická Univerzita.

Tworek, P. (2012). Risk In Production Activities of the Largest Construction and Assembly Companies in Poland - Survey Research. *Business and Management* (pp. 1247-1252). Vilnius, Lithuania: International Scientific Confernece.

Vidal, L. A., & Marle, F. (2012). A systems thinking approach for project vulnerability management. *Kybernetes, 41*(2012), 206-228.

Williams, T. (1999). Allocation of Contingency in Activity Duration Networks. *Journal of Construction Management and Economics, 17*(4), 447-447.

Wilson, R. (2015). *Mastering Risk and Procurement in Project Management.* New Jersey: Pearson Education LTD.

Xu, Y., Yeung, J. C., Chan, D., Wang, S., & Ke, Y. (2010). Developing a risk assessment model for PPP projects in China -A fuzzy synthetic evaluation approach. *Automation in Construction, 19*(7), 929-943.

Yoon, Y., Tamer, Z., & Hastak, M. (2014). Protocol to Enhance Profitability by Managing Risks in Construction Projects. *Journal of Management in Engineering*, 1-10.

Zadeh, L. (1965). Fuzzy Sets. *Information and Control, Vol. 8,*, 338-353.

Zadeh, L. (2008). Is there a need for a fuzzy logic? *Information Sciences*, 2751-2779.

Zeng, J., An, M., & Smith, N. J. (2007). Application of a fuzzy based decision making methodology to construction project risk assessment. *International Journal of Project Management, Vol. 25,*, 589-600.

Zhang, J. (2007). A redefinition of the project risk process: using vulnerability to open up the event-consequence link. *International Journal of Project Management, 25*(2007), 694-701.

Zhang, Y., & Fan, Z. P. (2014). An optimization method for selecting project risk response strategies. *International Journal of Project Management, 32*(2014), 412-422.

Zhao, X., Hwang, B. G., & Low, S. P. (2013). Developing Fuzzy Enterprise Risk Management Maturity Model for Construction Firms. *Jouranl of Construction and Engineering Management*, 1179–1189.

Zhao, X., Hwang, B., & Low, S. (2012). Implementing Enterprise Risk Management in a Chinese Construction Firm Bases in Singapore. *Proceedings of World Construction Conference 2012* (pp. 434-444). Colombo, Sri Lanka: Ceylon Institute of Builders (CIB).

Zhou, H., & Zhang, H. (2010). Dynamic Risk Management System for Large Project Construction in China. *GeoFlorida:Advances in Analysius, Modeling, and Design* (pp. 1992-2001). Florida, USA: ASCE.

Zi-mei, L., & Ke-fan, X. (2013). Research on the Early-warning for Construction Project Cost Risk. *International Conference on Digital Manufacturing & Automatio* (pp. 1127-1129). Qingdao, China: IEEE.

APPENDIX A : NUMERIC EXAMPLE FOR GENERATION OF FLNCS

This appendix introduces a methodology to customize the fuzzy linguistic numeric conversion scheme based on organizational requirements. This methodology can be summarized by collecting the data, in respect to fuzzy probability and fuzzy consequences, from the organization experts. This can decrease the subjectivity input and increase the reliability of output because each expert has to express himself separately and confidentially. After completion of data collection the fuzzy linguistic numeric conversion scheme can be generated by following these steps:

4. A uniform fuzzy number can be generated for each category using the lower and upper boundaries as shown in
5. Table A. 2 based on experts input. The lower boundary represent the minimum entry and the upper boundary represent the maximum entry among all the experts input (Table A. 1).
6. A fuzzy system uses the uniform fuzzy number, confined by lower and upper boundaries of each category, can be drawn as shown in Figure A. 1
7. The intersection between categories shows a fuzzy area located between two consecutive categories. This fuzzy area has a lower and upper boundary which can be linked using a straight line.

The output of this procedure represents the customized fuzzy linguistic numeric conversion scheme based on organization need (Figure A. 2). The same procedure can be used to generate the FLNCS of fuzzy probability and fuzzy consequence of risk.

Table A. 1 shows an example of input from experts which has been used to develop a customized FLNCS as shown in Figure A. 2.

Customization procedure started by collecting the input from experts, Table A. 1 shows the input from 4 experts nominated by their organization. They evaluate each fuzzy category based on their experience using to boundaries lower and upper. After that, the lower and upper boundaries are identified and the uniform fuzzy number which represents each fuzzy category has been generated as shown in Table A. 2.

Table A. 1 Experts Input for Lower and Upper Boundaries

Fuzzy System								
Experts	VL	Low		Medium		High		Very High
	Less than	Between		Between		Between		Higher than
E1	1	1	4	3	6	6	9	8
E2	2	2	5	3	7	7	10	9
E3	2	2	4	4	8	7	9	10
E4	3	2	5	3	7	7	10	10

Table A. 2 Uniform Fuzzy Numbers Representation

	Lower Bound	Upper Bound	Uniform Fuzzy Number
Very Low	0	3	[0,3]
Low	1	5	[1,5]
Medium	3	8	[3,8]
High	6	10	[6,10]

Very High	8	10	[8,10]

The uniform fuzzy numbers, generated in the previous step, are used to generate the preliminary fuzzy linguistic numeric conversion scheme (FLNCS). This scheme shows a fuzzy area which belongs to two consecutive fuzzy categories as shown in Figure A. 1.

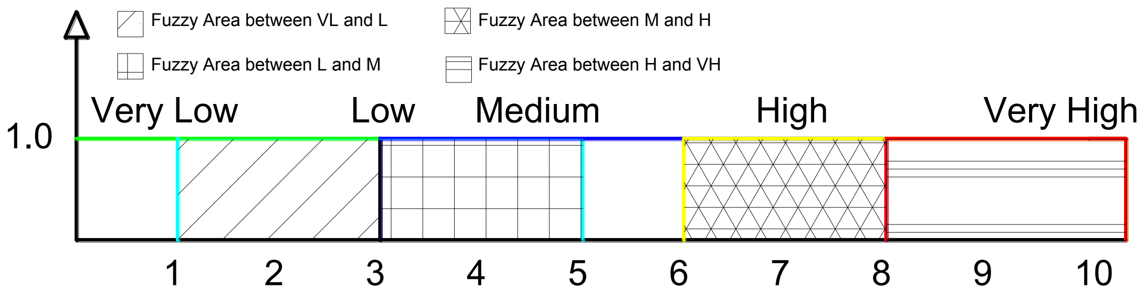


Figure A. 1 Fuzzy Areas Between Consecutive Categories

The lower and upper boundaries of each are should be linked by two straight lines. The first line belong to predecessor fuzzy categories started with a membership equals to 1 at the lower boundary and it is ended at the upper boundary with a membership equals to 0. In contrast, successor fuzzy category is linked to the lower and upper boundaries of the fuzzy area with a line started with memberships equal to 0 and 1 respectively as shown in Figure A. 2.

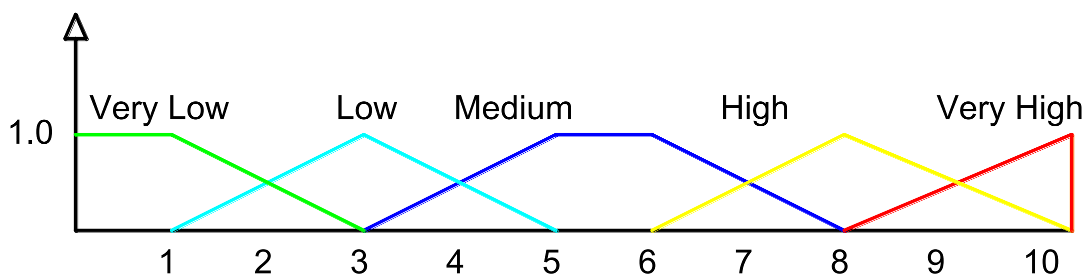


Figure A. 2 Customized Fuzzy Linguistic Numeric Conversion Scheme

APPENDIX B : RISK OWNERSHIP SELECTION CALCULATIONS

Risk #1	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.2	0.4	0.5	0.6	0.2	0.2	0.4	0.4	0.1	0.1	0.2	0.2	0.5	0.7	1.1	1.2	0.86
Owner	0.8	0.8	0.9	0.9	0.7	0.8	0.9	0.9	0.8	0.9	1.0	1.0	2.3	2.5	2.8	2.8	2.57

Contractor	0.500	0.700	1.100	1.200	Owner	2.300	2.500	2.800	2.800
X	dy	Y	A	XA	X	dy	Y	A	XA
0.500	0.000	0.000	0.000	0.000	2.300	0.000	0.000	0.000	0.000
0.520	0.100	0.271	0.003	0.001	2.320	0.100	0.271	0.003	0.006
0.540	0.200	0.488	0.008	0.004	2.340	0.200	0.488	0.008	0.018
0.560	0.300	0.657	0.011	0.006	2.360	0.300	0.657	0.011	0.027
0.580	0.400	0.784	0.014	0.008	2.380	0.400	0.784	0.014	0.034
0.600	0.500	0.875	0.017	0.010	2.400	0.500	0.875	0.017	0.040
0.620	0.600	0.936	0.018	0.011	2.420	0.600	0.936	0.018	0.044
0.640	0.700	0.973	0.019	0.012	2.440	0.700	0.973	0.019	0.046
0.660	0.800	0.992	0.020	0.013	2.460	0.800	0.992	0.020	0.048
0.680	0.900	0.999	0.020	0.013	2.480	0.900	0.999	0.020	0.049
0.700	1.000	1.000	0.020	0.014	2.500	1.000	1.000	0.020	0.050
0.740	1.000	1.000	0.040	0.029	2.530	1.000	1.000	0.030	0.075
0.780	1.000	1.000	0.040	0.030	2.560	1.000	1.000	0.030	0.076
0.820	1.000	1.000	0.040	0.032	2.590	1.000	1.000	0.030	0.077
0.860	1.000	1.000	0.040	0.034	2.620	1.000	1.000	0.030	0.078
0.900	1.000	1.000	0.040	0.035	2.650	1.000	1.000	0.030	0.079
0.940	1.000	1.000	0.040	0.037	2.680	1.000	1.000	0.030	0.080
0.980	1.000	1.000	0.040	0.038	2.710	1.000	1.000	0.030	0.081
1.020	1.000	1.000	0.040	0.040	2.740	1.000	1.000	0.030	0.082
1.060	1.000	1.000	0.040	0.042	2.770	1.000	1.000	0.030	0.083
1.100	1.000	1.000	0.040	0.043	2.800	1.000	1.000	0.030	0.084
1.110	0.900	0.999	0.010	0.011	2.800	0.900	0.999	0.000	0.000
1.120	0.800	0.992	0.010	0.011	2.800	0.800	0.992	0.000	0.000
1.130	0.700	0.973	0.010	0.011	2.800	0.700	0.973	0.000	0.000
1.140	0.600	0.936	0.010	0.011	2.800	0.600	0.936	0.000	0.000
1.150	0.500	0.875	0.009	0.010	2.800	0.500	0.875	0.000	0.000
1.160	0.400	0.784	0.008	0.010	2.800	0.400	0.784	0.000	0.000
1.170	0.300	0.657	0.007	0.008	2.800	0.300	0.657	0.000	0.000
1.180	0.200	0.488	0.006	0.007	2.800	0.200	0.488	0.000	0.000
1.190	0.100	0.271	0.004	0.004	2.800	0.100	0.271	0.000	0.000
1.200	0.000	0.000	0.001	0.002	2.800	0.000	0.000	0.000	0.000

Contractor	
A	0.624
XA	0.538
ROS	0.862
Owner	
ΣA	0.449
ΣXA	1.157
ROS	2.573

Risk #2	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.2	0.2	0.4	0.4	1.1	1.1	1.5	1.5	1.30
Owner	0.8	0.8	1.0	1.0	0.8	0.8	0.9	0.9	0.8	0.8	0.9	0.9	2.4	2.4	2.8	2.8	2.60

Contractor	1.100	1.100	1.500	1.500	Owner	2.400	2.400	2.800	2.800
X	dy	Y	A	XA	X	dy	Y	A	XA
1.100	0.000	0.000	0.000	0.000	2.400	0.000	0.000	0.000	0.000
1.100	0.100	0.271	0.000	0.000	2.400	0.100	0.271	0.000	0.000
1.100	0.200	0.488	0.000	0.000	2.400	0.200	0.488	0.000	0.000
1.100	0.300	0.657	0.000	0.000	2.400	0.300	0.657	0.000	0.000
1.100	0.400	0.784	0.000	0.000	2.400	0.400	0.784	0.000	0.000
1.100	0.500	0.875	0.000	0.000	2.400	0.500	0.875	0.000	0.000
1.100	0.600	0.936	0.000	0.000	2.400	0.600	0.936	0.000	0.000
1.100	0.700	0.973	0.000	0.000	2.400	0.700	0.973	0.000	0.000
1.100	0.800	0.992	0.000	0.000	2.400	0.800	0.992	0.000	0.000
1.100	0.900	0.999	0.000	0.000	2.400	0.900	0.999	0.000	0.000
1.100	1.000	1.000	0.000	0.000	2.400	1.000	1.000	0.000	0.000
1.140	1.000	1.000	0.040	0.045	2.440	1.000	1.000	0.040	0.097
1.180	1.000	1.000	0.040	0.046	2.480	1.000	1.000	0.040	0.098
1.220	1.000	1.000	0.040	0.048	2.520	1.000	1.000	0.040	0.100
1.260	1.000	1.000	0.040	0.050	2.560	1.000	1.000	0.040	0.102
1.300	1.000	1.000	0.040	0.051	2.600	1.000	1.000	0.040	0.103
1.340	1.000	1.000	0.040	0.053	2.640	1.000	1.000	0.040	0.105
1.380	1.000	1.000	0.040	0.054	2.680	1.000	1.000	0.040	0.106
1.420	1.000	1.000	0.040	0.056	2.720	1.000	1.000	0.040	0.108
1.460	1.000	1.000	0.040	0.058	2.760	1.000	1.000	0.040	0.110
1.500	1.000	1.000	0.040	0.059	2.800	1.000	1.000	0.040	0.111
1.500	0.900	0.999	0.000	0.000	2.800	0.900	0.999	0.000	0.000
1.500	0.800	0.992	0.000	0.000	2.800	0.800	0.992	0.000	0.000
1.500	0.700	0.973	0.000	0.000	2.800	0.700	0.973	0.000	0.000
1.500	0.600	0.936	0.000	0.000	2.800	0.600	0.936	0.000	0.000
1.500	0.500	0.875	0.000	0.000	2.800	0.500	0.875	0.000	0.000
1.500	0.400	0.784	0.000	0.000	2.800	0.400	0.784	0.000	0.000
1.500	0.300	0.657	0.000	0.000	2.800	0.300	0.657	0.000	0.000
1.500	0.200	0.488	0.000	0.000	2.800	0.200	0.488	0.000	0.000
1.500	0.100	0.271	0.000	0.000	2.800	0.100	0.271	0.000	0.000
1.500	0.000	0.000	0.000	0.000	2.800	0.000	0.000	0.000	0.000

Contractor	
A	0.400
XA	0.520
ROS	1.300
Owner	
ΣA	0.400
ΣXA	1.040
ROS	2.600

Risk #3	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.7	0.7	0.9	0.9	0.3	0.3	0.4	0.4	0.4	0.5	0.5	0.6	1.4	1.5	1.8	1.9	1.65
Owner	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.7	0.8	0.9	0.9	1.9	2.2	2.3	2.5	2.21

Contractor	1.400	1.500	1.800	1.900	Owner	1.900	2.200	2.300	2.500
X	dy	Y	A	XA	X	dy	Y	A	XA
1.400	0.000	0.000	0.000	0.000	1.900	0.000	0.000	0.000	0.000
1.410	0.100	0.271	0.001	0.002	1.930	0.100	0.271	0.004	0.008
1.420	0.200	0.488	0.004	0.005	1.960	0.200	0.488	0.011	0.022
1.430	0.300	0.657	0.006	0.008	1.990	0.300	0.657	0.017	0.034
1.440	0.400	0.784	0.007	0.010	2.020	0.400	0.784	0.022	0.043
1.450	0.500	0.875	0.008	0.012	2.050	0.500	0.875	0.025	0.051
1.460	0.600	0.936	0.009	0.013	2.080	0.600	0.936	0.027	0.056
1.470	0.700	0.973	0.010	0.014	2.110	0.700	0.973	0.029	0.060
1.480	0.800	0.992	0.010	0.014	2.140	0.800	0.992	0.029	0.063
1.490	0.900	0.999	0.010	0.015	2.170	0.900	0.999	0.030	0.064
1.500	1.000	1.000	0.010	0.015	2.200	1.000	1.000	0.030	0.066
1.530	1.000	1.000	0.030	0.045	2.210	1.000	1.000	0.010	0.022
1.560	1.000	1.000	0.030	0.046	2.220	1.000	1.000	0.010	0.022
1.590	1.000	1.000	0.030	0.047	2.230	1.000	1.000	0.010	0.022
1.620	1.000	1.000	0.030	0.048	2.240	1.000	1.000	0.010	0.022
1.650	1.000	1.000	0.030	0.049	2.250	1.000	1.000	0.010	0.022
1.680	1.000	1.000	0.030	0.050	2.260	1.000	1.000	0.010	0.023
1.710	1.000	1.000	0.030	0.051	2.270	1.000	1.000	0.010	0.023
1.740	1.000	1.000	0.030	0.052	2.280	1.000	1.000	0.010	0.023
1.770	1.000	1.000	0.030	0.053	2.290	1.000	1.000	0.010	0.023
1.800	1.000	1.000	0.030	0.054	2.300	1.000	1.000	0.010	0.023
1.810	0.900	0.999	0.010	0.018	2.320	0.900	0.999	0.020	0.046
1.820	0.800	0.992	0.010	0.018	2.340	0.800	0.992	0.020	0.046
1.830	0.700	0.973	0.010	0.018	2.360	0.700	0.973	0.020	0.046
1.840	0.600	0.936	0.010	0.018	2.380	0.600	0.936	0.019	0.045
1.850	0.500	0.875	0.009	0.017	2.400	0.500	0.875	0.018	0.043
1.860	0.400	0.784	0.008	0.015	2.420	0.400	0.784	0.017	0.040
1.870	0.300	0.657	0.007	0.013	2.440	0.300	0.657	0.014	0.035
1.880	0.200	0.488	0.006	0.011	2.460	0.200	0.488	0.011	0.028
1.890	0.100	0.271	0.004	0.007	2.480	0.100	0.271	0.008	0.019
1.900	0.000	0.000	0.001	0.003	2.500	0.000	0.000	0.003	0.007

Contractor	
A	0.450
XA	0.742
ROS	1.650
Owner	
ΣA	0.474
ΣXA	1.047
ROS	2.211

Risk #4	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.2	0.2	0.3	0.3	0.5	0.5	0.6	0.6	0.4	0.4	0.5	0.5	1.1	1.1	1.4	1.4	1.25
Owner	0.7	0.7	0.8	0.9	0.6	0.7	0.9	1.0	0.6	0.7	0.7	0.8	1.9	2.1	2.4	2.7	2.21

Contractor	1.100	1.100	1.400	1.400	Owner	1.900	2.100	2.400	2.700
X	dy	Y	A	XA	X	dy	Y	A	XA
1.100	0.000	0.000	0.000	0.000	1.900	0.000	0.000	0.000	0.000
1.100	0.100	0.271	0.000	0.000	1.930	0.100	0.271	0.004	0.008
1.100	0.200	0.488	0.000	0.000	1.960	0.200	0.488	0.011	0.022
1.100	0.300	0.657	0.000	0.000	1.990	0.300	0.657	0.017	0.034
1.100	0.400	0.784	0.000	0.000	2.020	0.400	0.784	0.022	0.043
1.100	0.500	0.875	0.000	0.000	2.050	0.500	0.875	0.025	0.051
1.100	0.600	0.936	0.000	0.000	2.080	0.600	0.936	0.027	0.056
1.100	0.700	0.973	0.000	0.000	2.110	0.700	0.973	0.029	0.060
1.100	0.800	0.992	0.000	0.000	2.140	0.800	0.992	0.029	0.063
1.100	0.900	0.999	0.000	0.000	2.170	0.900	0.999	0.030	0.064
1.100	1.000	1.000	0.000	0.000	2.200	1.000	1.000	0.030	0.066
1.130	1.000	1.000	0.030	0.033	2.210	1.000	1.000	0.010	0.022
1.160	1.000	1.000	0.030	0.034	2.220	1.000	1.000	0.010	0.022
1.190	1.000	1.000	0.030	0.035	2.230	1.000	1.000	0.010	0.022
1.220	1.000	1.000	0.030	0.036	2.240	1.000	1.000	0.010	0.022
1.250	1.000	1.000	0.030	0.037	2.250	1.000	1.000	0.010	0.022
1.280	1.000	1.000	0.030	0.038	2.260	1.000	1.000	0.010	0.023
1.310	1.000	1.000	0.030	0.039	2.270	1.000	1.000	0.010	0.023
1.340	1.000	1.000	0.030	0.040	2.280	1.000	1.000	0.010	0.023
1.370	1.000	1.000	0.030	0.041	2.290	1.000	1.000	0.010	0.023
1.400	1.000	1.000	0.030	0.042	2.300	1.000	1.000	0.010	0.023
1.400	0.900	0.999	0.000	0.000	2.320	0.900	0.999	0.020	0.046
1.400	0.800	0.992	0.000	0.000	2.340	0.800	0.992	0.020	0.046
1.400	0.700	0.973	0.000	0.000	2.360	0.700	0.973	0.020	0.046
1.400	0.600	0.936	0.000	0.000	2.380	0.600	0.936	0.019	0.045
1.400	0.500	0.875	0.000	0.000	2.400	0.500	0.875	0.018	0.043
1.400	0.400	0.784	0.000	0.000	2.420	0.400	0.784	0.017	0.040
1.400	0.300	0.657	0.000	0.000	2.440	0.300	0.657	0.014	0.035
1.400	0.200	0.488	0.000	0.000	2.460	0.200	0.488	0.011	0.028
1.400	0.100	0.271	0.000	0.000	2.480	0.100	0.271	0.008	0.019
1.400	0.000	0.000	0.000	0.000	2.500	0.000	0.000	0.003	0.007

Contractor	
A	0.300
XA	0.375
ROS	1.250
Owner	
ΣA	0.474
ΣXA	1.047
ROS	2.211

Risk #5	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.5	0.5	0.6	0.6	0.5	0.6	0.6	0.7	0.5	0.5	0.6	0.6	1.5	1.6	1.8	1.9	1.70
Owner	0.6	0.7	0.7	0.8	0.6	0.6	0.7	0.7	0.5	0.5	0.6	0.6	1.7	1.8	2.0	2.1	1.90

Contractor	1.500	1.600	1.800	1.900	Owner	1.700	1.800	2.000	2.100
X	dy	Y	A	XA	X	dy	Y	A	XA
1.500	0.000	0.000	0.000	0.000	1.700	0.000	0.000	0.000	0.000
1.510	0.100	0.271	0.001	0.002	1.710	0.100	0.271	0.001	0.002
1.520	0.200	0.488	0.004	0.006	1.720	0.200	0.488	0.004	0.007
1.530	0.300	0.657	0.006	0.009	1.730	0.300	0.657	0.006	0.010
1.540	0.400	0.784	0.007	0.011	1.740	0.400	0.784	0.007	0.013
1.550	0.500	0.875	0.008	0.013	1.750	0.500	0.875	0.008	0.014
1.560	0.600	0.936	0.009	0.014	1.760	0.600	0.936	0.009	0.016
1.570	0.700	0.973	0.010	0.015	1.770	0.700	0.973	0.010	0.017
1.580	0.800	0.992	0.010	0.015	1.780	0.800	0.992	0.010	0.017
1.590	0.900	0.999	0.010	0.016	1.790	0.900	0.999	0.010	0.018
1.600	1.000	1.000	0.010	0.016	1.800	1.000	1.000	0.010	0.018
1.620	1.000	1.000	0.020	0.032	1.820	1.000	1.000	0.020	0.036
1.640	1.000	1.000	0.020	0.033	1.840	1.000	1.000	0.020	0.037
1.660	1.000	1.000	0.020	0.033	1.860	1.000	1.000	0.020	0.037
1.680	1.000	1.000	0.020	0.033	1.880	1.000	1.000	0.020	0.037
1.700	1.000	1.000	0.020	0.034	1.900	1.000	1.000	0.020	0.038
1.720	1.000	1.000	0.020	0.034	1.920	1.000	1.000	0.020	0.038
1.740	1.000	1.000	0.020	0.035	1.940	1.000	1.000	0.020	0.039
1.760	1.000	1.000	0.020	0.035	1.960	1.000	1.000	0.020	0.039
1.780	1.000	1.000	0.020	0.035	1.980	1.000	1.000	0.020	0.039
1.800	1.000	1.000	0.020	0.036	2.000	1.000	1.000	0.020	0.040
1.810	0.900	0.999	0.010	0.018	2.010	0.900	0.999	0.010	0.020
1.820	0.800	0.992	0.010	0.018	2.020	0.800	0.992	0.010	0.020
1.830	0.700	0.973	0.010	0.018	2.030	0.700	0.973	0.010	0.020
1.840	0.600	0.936	0.010	0.018	2.040	0.600	0.936	0.010	0.019
1.850	0.500	0.875	0.009	0.017	2.050	0.500	0.875	0.009	0.019
1.860	0.400	0.784	0.008	0.015	2.060	0.400	0.784	0.008	0.017
1.870	0.300	0.657	0.007	0.013	2.070	0.300	0.657	0.007	0.015
1.880	0.200	0.488	0.006	0.011	2.080	0.200	0.488	0.006	0.012
1.890	0.100	0.271	0.004	0.007	2.090	0.100	0.271	0.004	0.008
1.900	0.000	0.000	0.001	0.003	2.100	0.000	0.000	0.001	0.003

Contractor	
A	0.350
XA	0.594
ROS	1.700
Owner	
ΣA	0.349
ΣXA	0.664
ROS	1.900

Risk #6	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.8	0.9	1.0	1.0	2.0	2.3	2.4	2.6	2.31
Owner	0.5	0.5	0.6	0.7	0.3	0.4	0.5	0.6	0.5	0.5	0.6	0.6	1.3	1.4	1.7	1.9	1.50

Contractor	2.000	2.300	2.400	2.600	Owner	1.300	1.400	1.700	1.870
X	dy	Y	A	XA	X	dy	Y	A	XA
2.000	0.000	0.000	0.000	0.000	1.300	0.000	0.000	0.000	0.000
2.030	0.100	0.271	0.004	0.008	1.310	0.100	0.271	0.001	0.002
2.060	0.200	0.488	0.011	0.023	1.320	0.200	0.488	0.004	0.005
2.090	0.300	0.657	0.017	0.036	1.330	0.300	0.657	0.006	0.008
2.120	0.400	0.784	0.022	0.045	1.340	0.400	0.784	0.007	0.010
2.150	0.500	0.875	0.025	0.053	1.350	0.500	0.875	0.008	0.011
2.180	0.600	0.936	0.027	0.059	1.360	0.600	0.936	0.009	0.012
2.210	0.700	0.973	0.029	0.063	1.370	0.700	0.973	0.010	0.013
2.240	0.800	0.992	0.029	0.066	1.380	0.800	0.992	0.010	0.014
2.270	0.900	0.999	0.030	0.067	1.390	0.900	0.999	0.010	0.014
2.300	1.000	1.000	0.030	0.069	1.400	1.000	1.000	0.010	0.014
2.310	1.000	1.000	0.010	0.023	1.420	1.000	1.000	0.020	0.028
2.320	1.000	1.000	0.010	0.023	1.440	1.000	1.000	0.020	0.029
2.330	1.000	1.000	0.010	0.023	1.460	1.000	1.000	0.020	0.029
2.340	1.000	1.000	0.010	0.023	1.480	1.000	1.000	0.020	0.029
2.350	1.000	1.000	0.010	0.023	1.500	1.000	1.000	0.020	0.030
2.360	1.000	1.000	0.010	0.024	1.520	1.000	1.000	0.020	0.030
2.370	1.000	1.000	0.010	0.024	1.540	1.000	1.000	0.020	0.031
2.380	1.000	1.000	0.010	0.024	1.560	1.000	1.000	0.020	0.031
2.390	1.000	1.000	0.010	0.024	1.580	1.000	1.000	0.020	0.031
2.400	1.000	1.000	0.010	0.024	1.600	1.000	1.000	0.020	0.032
2.420	0.900	0.999	0.020	0.048	1.610	0.900	0.999	0.010	0.016
2.440	0.800	0.992	0.020	0.048	1.620	0.800	0.992	0.010	0.016
2.460	0.700	0.973	0.020	0.048	1.630	0.700	0.973	0.010	0.016
2.480	0.600	0.936	0.019	0.047	1.640	0.600	0.936	0.010	0.016
2.500	0.500	0.875	0.018	0.045	1.650	0.500	0.875	0.009	0.015
2.520	0.400	0.784	0.017	0.042	1.660	0.400	0.784	0.008	0.014
2.540	0.300	0.657	0.014	0.036	1.670	0.300	0.657	0.007	0.012
2.560	0.200	0.488	0.011	0.029	1.680	0.200	0.488	0.006	0.010
2.580	0.100	0.271	0.008	0.020	1.690	0.100	0.271	0.004	0.006
2.600	0.000	0.000	0.003	0.007	1.700	0.000	0.000	0.001	0.002

Contractor	
A	0.474
XA	1.095
ROS	2.311
Owner	
ΣA	0.350
ΣXA	0.524
ROS	1.500

Risk #7	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.8	0.9	0.9	1.0	0.8	0.8	0.9	0.9	0.7	0.8	0.8	1.0	2.3	2.5	2.6	2.9	2.59
Owner	0.6	0.6	0.7	0.7	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	1.9	2.0	2.2	2.3	2.10

Contractor	2.300	2.500	2.600	2.900	Owner	1.900	2.000	2.200	2.300
X	dy	Y	A	XA	X	dy	Y	A	XA
2.300	0.000	0.000	0.000	0.000	1.900	0.000	0.000	0.000	0.000
2.320	0.100	0.271	0.003	0.006	1.910	0.100	0.271	0.001	0.003
2.340	0.200	0.488	0.008	0.018	1.920	0.200	0.488	0.004	0.007
2.360	0.300	0.657	0.011	0.027	1.930	0.300	0.657	0.006	0.011
2.380	0.400	0.784	0.014	0.034	1.940	0.400	0.784	0.007	0.014
2.400	0.500	0.875	0.017	0.040	1.950	0.500	0.875	0.008	0.016
2.420	0.600	0.936	0.018	0.044	1.960	0.600	0.936	0.009	0.018
2.440	0.700	0.973	0.019	0.046	1.970	0.700	0.973	0.010	0.019
2.460	0.800	0.992	0.020	0.048	1.980	0.800	0.992	0.010	0.019
2.480	0.900	0.999	0.020	0.049	1.990	0.900	0.999	0.010	0.020
2.500	1.000	1.000	0.020	0.050	2.000	1.000	1.000	0.010	0.020
2.510	1.000	1.000	0.010	0.025	2.020	1.000	1.000	0.020	0.040
2.520	1.000	1.000	0.010	0.025	2.040	1.000	1.000	0.020	0.041
2.530	1.000	1.000	0.010	0.025	2.060	1.000	1.000	0.020	0.041
2.540	1.000	1.000	0.010	0.025	2.080	1.000	1.000	0.020	0.041
2.550	1.000	1.000	0.010	0.025	2.100	1.000	1.000	0.020	0.042
2.560	1.000	1.000	0.010	0.026	2.120	1.000	1.000	0.020	0.042
2.570	1.000	1.000	0.010	0.026	2.140	1.000	1.000	0.020	0.043
2.580	1.000	1.000	0.010	0.026	2.160	1.000	1.000	0.020	0.043
2.590	1.000	1.000	0.010	0.026	2.180	1.000	1.000	0.020	0.043
2.600	1.000	1.000	0.010	0.026	2.200	1.000	1.000	0.020	0.044
2.630	0.900	0.999	0.030	0.078	2.210	0.900	0.999	0.010	0.022
2.660	0.800	0.992	0.030	0.079	2.220	0.800	0.992	0.010	0.022
2.690	0.700	0.973	0.029	0.079	2.230	0.700	0.973	0.010	0.022
2.720	0.600	0.936	0.029	0.077	2.240	0.600	0.936	0.010	0.021
2.750	0.500	0.875	0.027	0.074	2.250	0.500	0.875	0.009	0.020
2.780	0.400	0.784	0.025	0.069	2.260	0.400	0.784	0.008	0.019
2.810	0.300	0.657	0.022	0.060	2.270	0.300	0.657	0.007	0.016
2.840	0.200	0.488	0.017	0.049	2.280	0.200	0.488	0.006	0.013
2.870	0.100	0.271	0.011	0.033	2.290	0.100	0.271	0.004	0.009
2.900	0.000	0.000	0.004	0.012	2.300	0.000	0.000	0.001	0.003

Contractor	
A	0.474
XA	1.227
ROS	2.589
Owner	
ΣA	0.349
ΣXA	0.734
ROS	2.100

Risk #8	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.7	0.8	0.8	0.9	0.7	0.8	0.9	1.0	0.8	0.9	0.9	1.0	2.2	2.5	2.6	2.9	2.55
Owner	0.4	0.5	0.6	0.7	0.5	0.6	0.6	0.7	0.6	0.7	0.7	0.9	1.5	1.8	1.9	2.3	1.89

Contractor	2.200	2.500	2.600	2.900	Owner	1.500	1.800	1.900	2.300
X	dy	Y	A	XA	X	dy	Y	A	XA
2.200	0.000	0.000	0.000	0.000	1.500	0.000	0.000	0.000	0.000
2.230	0.100	0.271	0.004	0.009	1.530	0.100	0.271	0.004	0.006
2.260	0.200	0.488	0.011	0.026	1.560	0.200	0.488	0.011	0.018
2.290	0.300	0.657	0.017	0.039	1.590	0.300	0.657	0.017	0.027
2.320	0.400	0.784	0.022	0.050	1.620	0.400	0.784	0.022	0.035
2.350	0.500	0.875	0.025	0.058	1.650	0.500	0.875	0.025	0.041
2.380	0.600	0.936	0.027	0.064	1.680	0.600	0.936	0.027	0.045
2.410	0.700	0.973	0.029	0.069	1.710	0.700	0.973	0.029	0.049
2.440	0.800	0.992	0.029	0.071	1.740	0.800	0.992	0.029	0.051
2.470	0.900	0.999	0.030	0.073	1.770	0.900	0.999	0.030	0.052
2.500	1.000	1.000	0.030	0.075	1.800	1.000	1.000	0.030	0.054
2.510	1.000	1.000	0.010	0.025	1.810	1.000	1.000	0.010	0.018
2.520	1.000	1.000	0.010	0.025	1.820	1.000	1.000	0.010	0.018
2.530	1.000	1.000	0.010	0.025	1.830	1.000	1.000	0.010	0.018
2.540	1.000	1.000	0.010	0.025	1.840	1.000	1.000	0.010	0.018
2.550	1.000	1.000	0.010	0.025	1.850	1.000	1.000	0.010	0.018
2.560	1.000	1.000	0.010	0.026	1.860	1.000	1.000	0.010	0.019
2.570	1.000	1.000	0.010	0.026	1.870	1.000	1.000	0.010	0.019
2.580	1.000	1.000	0.010	0.026	1.880	1.000	1.000	0.010	0.019
2.590	1.000	1.000	0.010	0.026	1.890	1.000	1.000	0.010	0.019
2.600	1.000	1.000	0.010	0.026	1.900	1.000	1.000	0.010	0.019
2.630	0.900	0.999	0.030	0.078	1.940	0.900	0.999	0.040	0.077
2.660	0.800	0.992	0.030	0.079	1.980	0.800	0.992	0.040	0.078
2.690	0.700	0.973	0.029	0.079	2.020	0.700	0.973	0.039	0.079
2.720	0.600	0.936	0.029	0.077	2.060	0.600	0.936	0.038	0.078
2.750	0.500	0.875	0.027	0.074	2.100	0.500	0.875	0.036	0.075
2.780	0.400	0.784	0.025	0.069	2.140	0.400	0.784	0.033	0.070
2.810	0.300	0.657	0.022	0.060	2.180	0.300	0.657	0.029	0.062
2.840	0.200	0.488	0.017	0.049	2.220	0.200	0.488	0.023	0.050
2.870	0.100	0.271	0.011	0.033	2.260	0.100	0.271	0.015	0.034
2.900	0.000	0.000	0.004	0.012	2.300	0.000	0.000	0.005	0.012

Contractor	
A	0.548
XA	1.399
ROS	2.550
Owner	
ΣA	0.623
ΣXA	1.178
ROS	1.890

Risk #9	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.3	0.3	0.5	0.5	0.4	0.4	0.5	0.5	0.4	0.5	0.6	0.7	1.1	1.2	1.6	1.7	1.40
Owner	0.8	0.8	0.9	0.9	0.7	0.8	0.9	1.0	0.7	0.7	0.9	0.9	2.2	2.3	2.7	2.8	2.50

Contractor	1.100	1.200	1.600	1.700	Owner	2.200	2.300	2.700	2.800
X	dy	Y	A	XA	X	dy	Y	A	XA
1.100	0.000	0.000	0.000	0.000	2.200	0.000	0.000	0.000	0.000
1.110	0.100	0.271	0.001	0.001	2.210	0.100	0.271	0.001	0.003
1.120	0.200	0.488	0.004	0.004	2.220	0.200	0.488	0.004	0.008
1.130	0.300	0.657	0.006	0.006	2.230	0.300	0.657	0.006	0.013
1.140	0.400	0.784	0.007	0.008	2.240	0.400	0.784	0.007	0.016
1.150	0.500	0.875	0.008	0.009	2.250	0.500	0.875	0.008	0.019
1.160	0.600	0.936	0.009	0.010	2.260	0.600	0.936	0.009	0.020
1.170	0.700	0.973	0.010	0.011	2.270	0.700	0.973	0.010	0.022
1.180	0.800	0.992	0.010	0.012	2.280	0.800	0.992	0.010	0.022
1.190	0.900	0.999	0.010	0.012	2.290	0.900	0.999	0.010	0.023
1.200	1.000	1.000	0.010	0.012	2.300	1.000	1.000	0.010	0.023
1.240	1.000	1.000	0.040	0.049	2.340	1.000	1.000	0.040	0.093
1.280	1.000	1.000	0.040	0.050	2.380	1.000	1.000	0.040	0.094
1.320	1.000	1.000	0.040	0.052	2.420	1.000	1.000	0.040	0.096
1.360	1.000	1.000	0.040	0.054	2.460	1.000	1.000	0.040	0.098
1.400	1.000	1.000	0.040	0.055	2.500	1.000	1.000	0.040	0.099
1.440	1.000	1.000	0.040	0.057	2.540	1.000	1.000	0.040	0.101
1.480	1.000	1.000	0.040	0.058	2.580	1.000	1.000	0.040	0.102
1.520	1.000	1.000	0.040	0.060	2.620	1.000	1.000	0.040	0.104
1.560	1.000	1.000	0.040	0.062	2.660	1.000	1.000	0.040	0.106
1.600	1.000	1.000	0.040	0.063	2.700	1.000	1.000	0.040	0.107
1.610	0.900	0.999	0.010	0.016	2.710	0.900	0.999	0.010	0.027
1.620	0.800	0.992	0.010	0.016	2.720	0.800	0.992	0.010	0.027
1.630	0.700	0.973	0.010	0.016	2.730	0.700	0.973	0.010	0.027
1.640	0.600	0.936	0.010	0.016	2.740	0.600	0.936	0.010	0.026
1.650	0.500	0.875	0.009	0.015	2.750	0.500	0.875	0.009	0.025
1.660	0.400	0.784	0.008	0.014	2.760	0.400	0.784	0.008	0.023
1.670	0.300	0.657	0.007	0.012	2.770	0.300	0.657	0.007	0.020
1.680	0.200	0.488	0.006	0.010	2.780	0.200	0.488	0.006	0.016
1.690	0.100	0.271	0.004	0.006	2.790	0.100	0.271	0.004	0.011
1.700	0.000	0.000	0.001	0.002	2.800	0.000	0.000	0.001	0.004

Contractor	
A	0.550
XA	0.769
ROS	1.400
Owner	
ΣA	0.549
ΣXA	1.374
ROS	2.500

Risk #10	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.7	0.8	0.8	0.9	0.6	0.7	0.8	0.9	0.8	0.9	0.9	1.0	2.1	2.4	2.5	2.8	2.45
Owner	0.7	0.8	0.8	0.9	0.7	0.8	0.9	1.0	0.5	0.6	0.6	0.7	1.9	2.2	2.3	2.6	2.20

Contractor	2.100	2.400	2.500	2.800	Owner	1.900	2.200	2.300	2.600
X	dy	Y	A	XA	X	dy	Y	A	XA
2.100	0.000	0.000	0.000	0.000	1.900	0.000	0.000	0.000	0.000
2.130	0.100	0.271	0.004	0.009	1.910	0.100	0.271	0.001	0.003
2.160	0.200	0.488	0.011	0.024	1.920	0.200	0.488	0.004	0.007
2.190	0.300	0.657	0.017	0.037	1.930	0.300	0.657	0.006	0.011
2.220	0.400	0.784	0.022	0.048	1.940	0.400	0.784	0.007	0.014
2.250	0.500	0.875	0.025	0.056	1.950	0.500	0.875	0.008	0.016
2.280	0.600	0.936	0.027	0.062	1.960	0.600	0.936	0.009	0.018
2.310	0.700	0.973	0.029	0.066	1.970	0.700	0.973	0.010	0.019
2.340	0.800	0.992	0.029	0.069	1.980	0.800	0.992	0.010	0.019
2.370	0.900	0.999	0.030	0.070	1.990	0.900	0.999	0.010	0.020
2.400	1.000	1.000	0.030	0.072	2.000	1.000	1.000	0.010	0.020
2.410	1.000	1.000	0.010	0.024	2.040	1.000	1.000	0.040	0.081
2.420	1.000	1.000	0.010	0.024	2.080	1.000	1.000	0.040	0.082
2.430	1.000	1.000	0.010	0.024	2.120	1.000	1.000	0.040	0.084
2.440	1.000	1.000	0.010	0.024	2.160	1.000	1.000	0.040	0.086
2.450	1.000	1.000	0.010	0.024	2.200	1.000	1.000	0.040	0.087
2.460	1.000	1.000	0.010	0.025	2.240	1.000	1.000	0.040	0.089
2.470	1.000	1.000	0.010	0.025	2.280	1.000	1.000	0.040	0.090
2.480	1.000	1.000	0.010	0.025	2.320	1.000	1.000	0.040	0.092
2.490	1.000	1.000	0.010	0.025	2.360	1.000	1.000	0.040	0.094
2.500	1.000	1.000	0.010	0.025	2.400	1.000	1.000	0.040	0.095
2.530	0.900	0.999	0.030	0.075	2.410	0.900	0.999	0.010	0.024
2.560	0.800	0.992	0.030	0.076	2.420	0.800	0.992	0.010	0.024
2.590	0.700	0.973	0.029	0.076	2.430	0.700	0.973	0.010	0.024
2.620	0.600	0.936	0.029	0.075	2.440	0.600	0.936	0.010	0.023
2.650	0.500	0.875	0.027	0.072	2.450	0.500	0.875	0.009	0.022
2.680	0.400	0.784	0.025	0.066	2.460	0.400	0.784	0.008	0.020
2.710	0.300	0.657	0.022	0.058	2.470	0.300	0.657	0.007	0.018
2.740	0.200	0.488	0.017	0.047	2.480	0.200	0.488	0.006	0.014
2.770	0.100	0.271	0.011	0.031	2.490	0.100	0.271	0.004	0.009
2.800	0.000	0.000	0.004	0.011	2.500	0.000	0.000	0.001	0.003

Contractor	
A	0.548
XA	1.344
ROS	2.450
Owner	
ΣA	0.549
ΣXA	1.209
ROS	2.200

Risk #11	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.7	0.8	0.9	1.0	2.2	2.3	2.6	2.7	2.45
Owner	0.3	0.3	0.4	0.4	0.2	0.3	0.3	0.4	0.4	0.5	0.6	0.7	0.9	1.1	1.3	1.5	1.20

Contractor	2.200	2.300	2.600	2.700	Owner	0.900	1.100	1.300	1.500
X	dy	Y	A	XA	X	dy	Y	A	XA
2.200	0.000	0.000	0.000	0.000	0.900	0.000	0.000	0.000	0.000
2.210	0.100	0.271	0.001	0.003	0.920	0.100	0.271	0.003	0.002
2.220	0.200	0.488	0.004	0.008	0.940	0.200	0.488	0.008	0.007
2.230	0.300	0.657	0.006	0.013	0.960	0.300	0.657	0.011	0.011
2.240	0.400	0.784	0.007	0.016	0.980	0.400	0.784	0.014	0.014
2.250	0.500	0.875	0.008	0.019	1.000	0.500	0.875	0.017	0.016
2.260	0.600	0.936	0.009	0.020	1.020	0.600	0.936	0.018	0.018
2.270	0.700	0.973	0.010	0.022	1.040	0.700	0.973	0.019	0.020
2.280	0.800	0.992	0.010	0.022	1.060	0.800	0.992	0.020	0.021
2.290	0.900	0.999	0.010	0.023	1.080	0.900	0.999	0.020	0.021
2.300	1.000	1.000	0.010	0.023	1.100	1.000	1.000	0.020	0.022
2.330	1.000	1.000	0.030	0.069	1.120	1.000	1.000	0.020	0.022
2.360	1.000	1.000	0.030	0.070	1.140	1.000	1.000	0.020	0.023
2.390	1.000	1.000	0.030	0.071	1.160	1.000	1.000	0.020	0.023
2.420	1.000	1.000	0.030	0.072	1.180	1.000	1.000	0.020	0.023
2.450	1.000	1.000	0.030	0.073	1.200	1.000	1.000	0.020	0.024
2.480	1.000	1.000	0.030	0.074	1.220	1.000	1.000	0.020	0.024
2.510	1.000	1.000	0.030	0.075	1.240	1.000	1.000	0.020	0.025
2.540	1.000	1.000	0.030	0.076	1.260	1.000	1.000	0.020	0.025
2.570	1.000	1.000	0.030	0.077	1.280	1.000	1.000	0.020	0.025
2.600	1.000	1.000	0.030	0.078	1.300	1.000	1.000	0.020	0.026
2.610	0.900	0.999	0.010	0.026	1.320	0.900	0.999	0.020	0.026
2.620	0.800	0.992	0.010	0.026	1.340	0.800	0.992	0.020	0.026
2.630	0.700	0.973	0.010	0.026	1.360	0.700	0.973	0.020	0.027
2.640	0.600	0.936	0.010	0.025	1.380	0.600	0.936	0.019	0.026
2.650	0.500	0.875	0.009	0.024	1.400	0.500	0.875	0.018	0.025
2.660	0.400	0.784	0.008	0.022	1.420	0.400	0.784	0.017	0.023
2.670	0.300	0.657	0.007	0.019	1.440	0.300	0.657	0.014	0.021
2.680	0.200	0.488	0.006	0.015	1.460	0.200	0.488	0.011	0.017
2.690	0.100	0.271	0.004	0.010	1.480	0.100	0.271	0.008	0.011
2.700	0.000	0.000	0.001	0.004	1.500	0.000	0.000	0.003	0.004

Contractor	
A	0.449
XA	1.101
ROS	2.450
Owner	
ΣA	0.499
ΣXA	0.599
ROS	1.200

Risk #12	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.4	0.5	0.6	0.7	1.6	1.7	2.0	2.1	1.85
Owner	0.7	0.7	0.9	0.9	0.8	0.9	0.9	1.0	0.6	0.7	0.7	0.8	2.1	2.3	2.5	2.7	2.40

Contractor	1.600	1.700	2.000	2.100	Owner	2.100	2.300	2.500	2.700
X	dy	Y	A	XA	X	dy	Y	A	XA
1.600	0.000	0.000	0.000	0.000	2.100	0.000	0.000	0.000	0.000
1.610	0.100	0.271	0.001	0.002	2.120	0.100	0.271	0.003	0.006
1.620	0.200	0.488	0.004	0.006	2.140	0.200	0.488	0.008	0.016
1.630	0.300	0.657	0.006	0.009	2.160	0.300	0.657	0.011	0.025
1.640	0.400	0.784	0.007	0.012	2.180	0.400	0.784	0.014	0.031
1.650	0.500	0.875	0.008	0.014	2.200	0.500	0.875	0.017	0.036
1.660	0.600	0.936	0.009	0.015	2.220	0.600	0.936	0.018	0.040
1.670	0.700	0.973	0.010	0.016	2.240	0.700	0.973	0.019	0.043
1.680	0.800	0.992	0.010	0.016	2.260	0.800	0.992	0.020	0.044
1.690	0.900	0.999	0.010	0.017	2.280	0.900	0.999	0.020	0.045
1.700	1.000	1.000	0.010	0.017	2.300	1.000	1.000	0.020	0.046
1.730	1.000	1.000	0.030	0.051	2.320	1.000	1.000	0.020	0.046
1.760	1.000	1.000	0.030	0.052	2.340	1.000	1.000	0.020	0.047
1.790	1.000	1.000	0.030	0.053	2.360	1.000	1.000	0.020	0.047
1.820	1.000	1.000	0.030	0.054	2.380	1.000	1.000	0.020	0.047
1.850	1.000	1.000	0.030	0.055	2.400	1.000	1.000	0.020	0.048
1.880	1.000	1.000	0.030	0.056	2.420	1.000	1.000	0.020	0.048
1.910	1.000	1.000	0.030	0.057	2.440	1.000	1.000	0.020	0.049
1.940	1.000	1.000	0.030	0.058	2.460	1.000	1.000	0.020	0.049
1.970	1.000	1.000	0.030	0.059	2.480	1.000	1.000	0.020	0.049
2.000	1.000	1.000	0.030	0.060	2.500	1.000	1.000	0.020	0.050
2.010	0.900	0.999	0.010	0.020	2.520	0.900	0.999	0.020	0.050
2.020	0.800	0.992	0.010	0.020	2.540	0.800	0.992	0.020	0.050
2.030	0.700	0.973	0.010	0.020	2.560	0.700	0.973	0.020	0.050
2.040	0.600	0.936	0.010	0.019	2.580	0.600	0.936	0.019	0.049
2.050	0.500	0.875	0.009	0.019	2.600	0.500	0.875	0.018	0.047
2.060	0.400	0.784	0.008	0.017	2.620	0.400	0.784	0.017	0.043
2.070	0.300	0.657	0.007	0.015	2.640	0.300	0.657	0.014	0.038
2.080	0.200	0.488	0.006	0.012	2.660	0.200	0.488	0.011	0.030
2.090	0.100	0.271	0.004	0.008	2.680	0.100	0.271	0.008	0.020
2.100	0.000	0.000	0.001	0.003	2.700	0.000	0.000	0.003	0.007

Contractor	
A	0.449
XA	0.832
ROS	1.850
Owner	
ΣA	0.499
ΣXA	1.198
ROS	2.400

Risk #13	Capacity				Effectiveness				Ability				ROS				ROS
Contractor	0.6	0.6	0.7	0.7	0.6	0.7	0.7	0.8	0.5	0.5	0.6	0.7	1.7	1.8	2.0	2.2	1.94
Owner	0.7	0.7	0.8	0.8	0.5	0.5	0.6	0.6	0.8	0.8	0.9	0.9	2.0	2.0	2.3	2.3	2.15

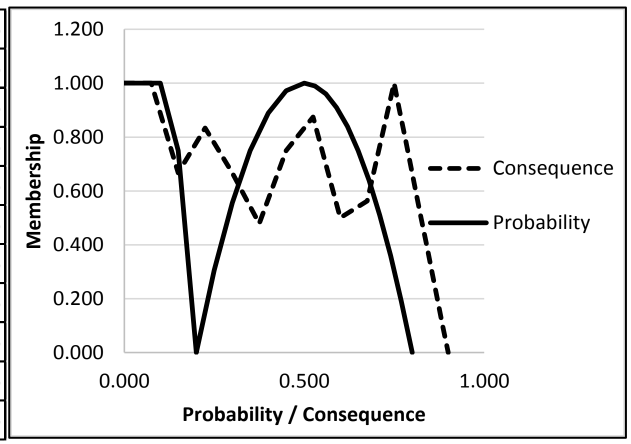
Contractor	1.700	1.800	2.000	2.200	Owner	2.000	2.000	2.300	2.300
X	dy	Y	A	XA	X	dy	Y	A	XA
1.700	0.000	0.000	0.000	0.000	2.000	0.000	0.000	0.000	0.000
1.710	0.100	0.271	0.001	0.002	2.000	0.100	0.271	0.000	0.000
1.720	0.200	0.488	0.004	0.007	2.000	0.200	0.488	0.000	0.000
1.730	0.300	0.657	0.006	0.010	2.000	0.300	0.657	0.000	0.000
1.740	0.400	0.784	0.007	0.013	2.000	0.400	0.784	0.000	0.000
1.750	0.500	0.875	0.008	0.014	2.000	0.500	0.875	0.000	0.000
1.760	0.600	0.936	0.009	0.016	2.000	0.600	0.936	0.000	0.000
1.770	0.700	0.973	0.010	0.017	2.000	0.700	0.973	0.000	0.000
1.780	0.800	0.992	0.010	0.017	2.000	0.800	0.992	0.000	0.000
1.790	0.900	0.999	0.010	0.018	2.000	0.900	0.999	0.000	0.000
1.800	1.000	1.000	0.010	0.018	2.000	1.000	1.000	0.000	0.000
1.820	1.000	1.000	0.020	0.036	2.030	1.000	1.000	0.030	0.060
1.840	1.000	1.000	0.020	0.037	2.060	1.000	1.000	0.030	0.061
1.860	1.000	1.000	0.020	0.037	2.090	1.000	1.000	0.030	0.062
1.880	1.000	1.000	0.020	0.037	2.120	1.000	1.000	0.030	0.063
1.900	1.000	1.000	0.020	0.038	2.150	1.000	1.000	0.030	0.064
1.920	1.000	1.000	0.020	0.038	2.180	1.000	1.000	0.030	0.065
1.940	1.000	1.000	0.020	0.039	2.210	1.000	1.000	0.030	0.066
1.960	1.000	1.000	0.020	0.039	2.240	1.000	1.000	0.030	0.067
1.980	1.000	1.000	0.020	0.039	2.270	1.000	1.000	0.030	0.068
2.000	1.000	1.000	0.020	0.040	2.300	1.000	1.000	0.030	0.069
2.020	0.900	0.999	0.020	0.040	2.300	0.900	0.999	0.000	0.000
2.040	0.800	0.992	0.020	0.040	2.300	0.800	0.992	0.000	0.000
2.060	0.700	0.973	0.020	0.040	2.300	0.700	0.973	0.000	0.000
2.080	0.600	0.936	0.019	0.040	2.300	0.600	0.936	0.000	0.000
2.100	0.500	0.875	0.018	0.038	2.300	0.500	0.875	0.000	0.000
2.120	0.400	0.784	0.017	0.035	2.300	0.400	0.784	0.000	0.000
2.140	0.300	0.657	0.014	0.031	2.300	0.300	0.657	0.000	0.000
2.160	0.200	0.488	0.011	0.025	2.300	0.200	0.488	0.000	0.000
2.180	0.100	0.271	0.008	0.016	2.300	0.100	0.271	0.000	0.000
2.200	0.000	0.000	0.003	0.006	2.300	0.000	0.000	0.000	0.000

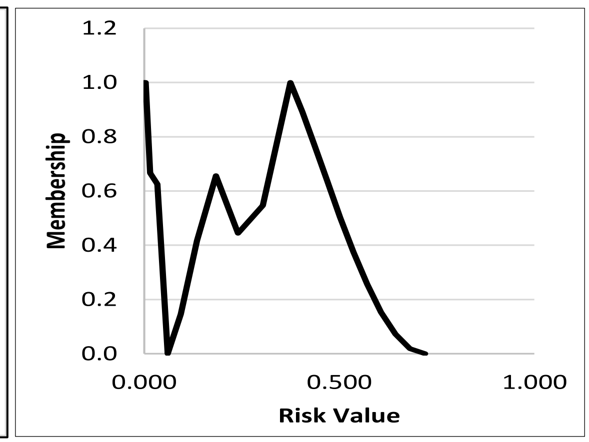
Contractor	
A	0.424
XA	0.823
ROS	1.939
Owner	
ΣA	0.300
ΣXA	0.645
ROS	2.150

APPENDIX C : REHABILITATION FOR UNIVERSITY OF CATAGENA (CASE STUDY)

	Lack of Adequate Process																														
XC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.075	0.150	0.225	0.300	0.375	0.450	0.525	0.600	0.675	0.750	0.765	0.780	0.795	0.810	0.825	0.840	0.855	0.870	0.885	0.900
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.833	0.667	0.167	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.375	0.750	0.875	0.500	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
YC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
XP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.100	0.150	0.200	0.250	0.300	0.350	0.400	0.450	0.500	0.530	0.560	0.590	0.620	0.650	0.680	0.710	0.740	0.770	0.800
	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167	0.333	0.500	0.667	0.833	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
YP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167	0.333	0.500	0.667	0.833	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
XR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.015	0.034	0.060	0.094	0.135	0.184	0.240	0.304	0.375	0.405	0.437	0.469	0.502	0.536	0.571	0.607	0.644	0.681	0.720
YC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.667	0.833	0.667	0.479	0.750	0.875	0.500	0.563	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
YP	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.750	0.000	0.306	0.556	0.750	0.889	0.972	1.000	0.990	0.960	0.910	0.840	0.750	0.640	0.510	0.360	0.190	0.000
YR	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.667	0.625	0.000	0.146	0.417	0.656	0.444	0.547	1.000	0.891	0.768	0.637	0.504	0.375	0.256	0.153	0.072	0.019	0.000
A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.009	0.012	0.008	0.002	0.012	0.026	0.031	0.032	0.055	0.029	0.026	0.023	0.019	0.015	0.011	0.007	0.004	0.002	0.000
XA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.007	0.009	0.019	0.011	0.011	0.010	0.009	0.008	0.006	0.004	0.003	0.001	0.000
A	0.327																														
XA	0.104																														
R	0.318																														

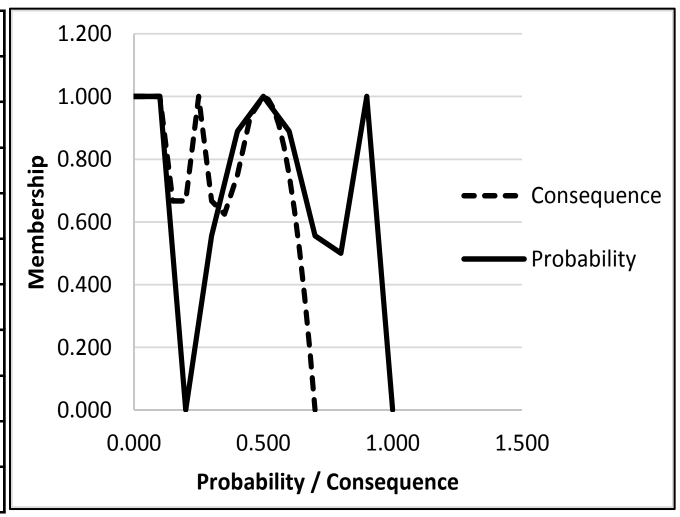
E1	0.100	0.250	0.250	0.400
E2	0.000	0.000	0.100	0.200
E3	0.300	0.500	0.500	0.700
E4	0.600	0.750	0.750	0.900
C	0.000	0.000	0.750	0.900
E1	0.000	0.000	0.100	0.200
E2	0.000	0.000	0.100	0.200
E3	0.200	0.500	0.500	0.800
E4	0.200	0.500	0.500	0.800
P	0.000	0.000	0.500	0.800
R	0.000	0.000	0.375	0.720

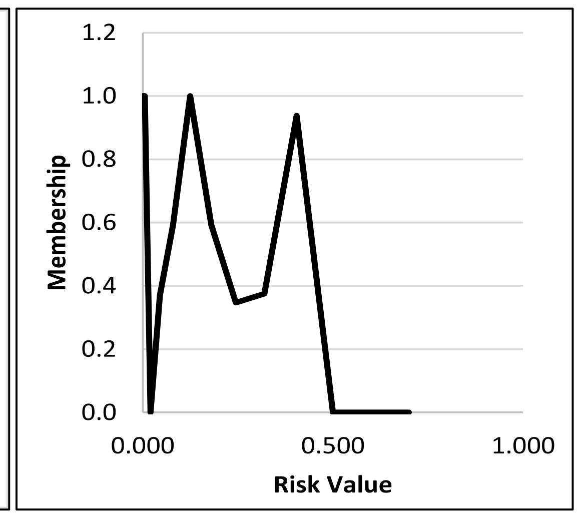




Lack of Resources																															
XC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.100	0.150	0.200	0.250	0.300	0.350	0.400	0.450	0.500	0.520	0.540	0.560	0.580	0.600	0.620	0.640	0.660	0.680	0.700
	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.500	0.750	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.500	0.750	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
YC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.667	1.000	0.667	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
XP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.667	1.000	0.667	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
YP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.667	1.000	0.667	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
XR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.020	0.045	0.080	0.125	0.180	0.245	0.320	0.405	0.500	0.520	0.540	0.560	0.580	0.600	0.620	0.640	0.660	0.680	0.700
YC	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.667	0.667	1.000	0.667	0.625	0.750	0.938	1.000	0.990	0.960	0.910	0.840	0.750	0.640	0.510	0.360	0.190	0.000
YP	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.556	0.889	1.000	0.889	0.556	0.500	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
YR	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	0.370	0.593	1.000	0.593	0.347	0.375	0.938	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.008	0.005	0.017	0.036	0.044	0.031	0.027	0.056	0.045	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
XA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.004	0.007	0.006	0.008	0.020	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A	0.272																														
XA	0.066																														
R	0.244																														

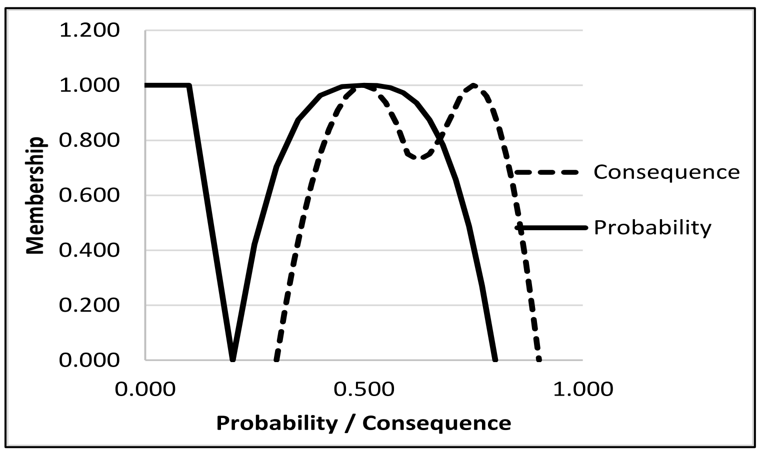
E1	0.000	0.000	0.100	0.200
E2	0.300	0.500	0.500	0.700
E3	0.300	0.500	0.500	0.700
E4	0.100	0.250	0.250	0.400
C	0.000	0.000	0.500	0.700
E1	0.200	0.500	0.500	0.800
E2	0.000	0.000	0.100	0.200
E3	0.700	0.900	1.000	1.000
E4	0.200	0.500	0.500	0.800
P	0.000	0.000	1.000	1.000
R	0.000	0.000	0.500	0.700

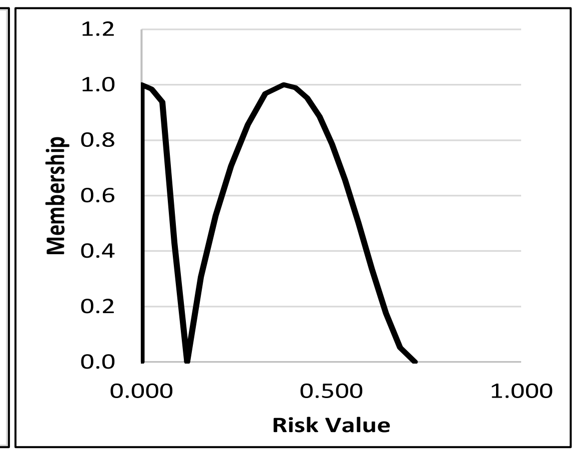




Inexperienced Team Member																															
XC	0.300	0.320	0.340	0.360	0.380	0.400	0.420	0.440	0.460	0.480	0.500	0.525	0.550	0.575	0.600	0.625	0.650	0.675	0.700	0.725	0.750	0.765	0.780	0.795	0.810	0.825	0.840	0.855	0.870	0.885	0.900
	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	0.875	0.750	0.625	0.500	0.375	0.250	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167	0.333	0.500	0.667	0.833	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	0.875	0.750	0.625	0.500	0.375	0.250	0.125	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
YC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167	0.333	0.500	0.667	0.833	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
XP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.050	0.100	0.150	0.200	0.250	0.300	0.350	0.400	0.450	0.500	0.530	0.560	0.590	0.620	0.650	0.680	0.710	0.740	0.770	0.800
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167	0.333	0.500	0.667	0.833	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167	0.333	0.500	0.667	0.833	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
YP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.167	0.333	0.500	0.667	0.833	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
XR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.026	0.055	0.086	0.120	0.156	0.195	0.236	0.280	0.326	0.375	0.405	0.437	0.469	0.502	0.536	0.571	0.607	0.644	0.681	0.720
YC	0.000	0.190	0.360	0.510	0.640	0.750	0.840	0.910	0.960	0.990	1.000	0.984	0.938	0.859	0.750	0.729	0.750	0.809	0.889	0.972	1.000	0.990	0.960	0.910	0.840	0.750	0.640	0.510	0.360	0.190	0.000
YP	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.000	0.421	0.704	0.875	0.963	0.995	1.000	0.999	0.992	0.973	0.936	0.875	0.784	0.657	0.488	0.271	0.000
YR	0.000	0.190	0.360	0.510	0.640	0.750	0.840	0.910	0.960	0.990	1.000	0.984	0.938	0.430	0.000	0.307	0.528	0.708	0.856	0.968	1.000	0.989	0.952	0.885	0.786	0.656	0.502	0.335	0.176	0.051	0.000
A	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.026	0.028	0.021	0.007	0.006	0.016	0.025	0.034	0.042	0.048	0.030	0.030	0.030	0.028	0.025	0.020	0.015	0.009	0.004	0.001
XA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.001	0.003	0.005	0.009	0.013	0.017	0.012	0.013	0.013	0.013	0.013	0.011	0.009	0.006	0.003	0.001
A	0.446																														
XA	0.145																														
R	0.325																														

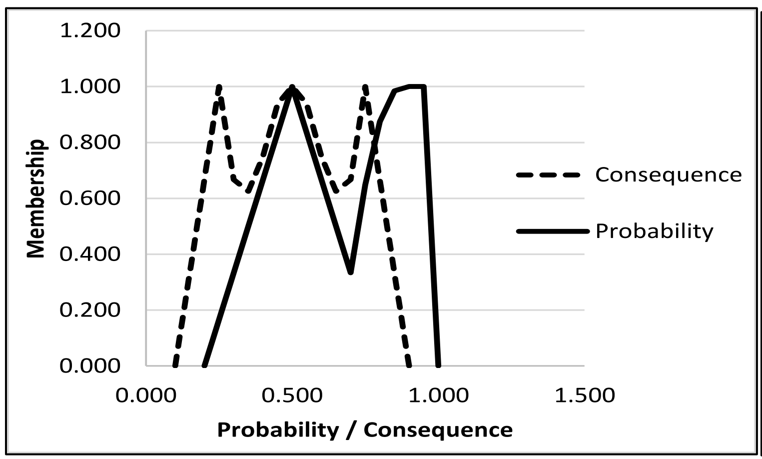
E1	0.300	0.500	0.500	0.700
E2	0.600	0.750	0.750	0.900
E3	0.300	0.500	0.500	0.700
E4	0.600	0.750	0.750	0.900
C	0.300	0.500	0.750	0.900
E1	0.200	0.500	0.500	0.800
E2	0.200	0.500	0.500	0.800
E3	0.000	0.000	0.100	0.200
E4	0.200	0.500	0.500	0.800
P	0.000	0.000	0.500	0.800
R	0.000	0.000	0.375	0.720

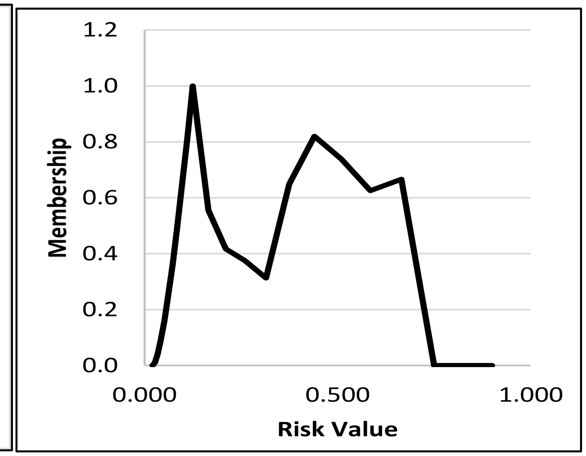




Lack of Motivation Attitudes																															
XC	0.100	0.115	0.130	0.145	0.160	0.175	0.190	0.205	0.220	0.235	0.250	0.300	0.350	0.400	0.450	0.500	0.550	0.600	0.650	0.700	0.750	0.765	0.780	0.795	0.810	0.825	0.840	0.855	0.870	0.885	0.900
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.500	0.750	1.000	0.750	0.500	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	0.667	0.333	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.500	0.750	1.000	0.750	0.500	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
YC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.333	0.667	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
XP	0.200	0.230	0.260	0.290	0.320	0.350	0.380	0.410	0.440	0.470	0.500	0.550	0.600	0.650	0.700	0.750	0.800	0.850	0.900	0.950	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	0.833	0.667	0.500	0.333	0.167	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.500	0.750	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.500	0.750	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
YP	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.250	0.500	0.750	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
XR	0.020	0.026	0.034	0.042	0.051	0.061	0.072	0.084	0.097	0.110	0.125	0.165	0.210	0.260	0.315	0.375	0.440	0.510	0.585	0.665	0.750	0.765	0.780	0.795	0.810	0.825	0.840	0.855	0.870	0.885	0.900
YC	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	0.667	0.625	0.750	0.938	1.000	0.938	0.750	0.625	0.667	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
YP	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	0.833	0.667	0.500	0.333	0.648	0.875	0.984	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
YR	0.000	0.010	0.040	0.090	0.160	0.250	0.360	0.490	0.640	0.810	1.000	0.556	0.417	0.375	0.313	0.648	0.820	0.738	0.625	0.667	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A	0.000	0.000	0.000	0.001	0.001	0.002	0.003	0.005	0.007	0.010	0.013	0.031	0.022	0.020	0.019	0.029	0.048	0.055	0.051	0.052	0.028	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
XA	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.002	0.005	0.004	0.005	0.005	0.010	0.019	0.026	0.028	0.032	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
A	0.397																														
XA	0.158																														
R	0.399																														

E1	0.300	0.500	0.500	0.700
E2	0.100	0.250	0.250	0.400
E3	0.300	0.500	0.500	0.700
E4	0.600	0.750	0.750	0.900
C	0.100	0.250	0.750	0.900
E1	0.200	0.500	0.500	0.800
E2	0.700	0.900	1.000	1.000
E3	0.700	0.900	1.000	1.000
E4	0.700	0.900	1.000	1.000
P	0.200	0.500	1.000	1.000
R	0.020	0.125	0.750	0.900





APPENDIX D : ROAD CONSTRUCTION PROJECT (CASE STUDY)

Logic and Environment																															
XL&E	0.102	0.110	0.117	0.125	0.132	0.140	0.148	0.155	0.163	0.170	0.178	0.187	0.197	0.207	0.216	0.226	0.235	0.245	0.254	0.264	0.274	0.285	0.297	0.308	0.320	0.331	0.343	0.355	0.366	0.378	0.389
Y1	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y2	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y3	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y4	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y5	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y6	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y7	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Ytotal	0.000	0.522	0.790	0.918	0.972	0.992	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.998	0.992	0.972	0.918	0.790	0.522	0.000
Area	0.000	0.002	0.005	0.006	0.007	0.007	0.008	0.008	0.008	0.008	0.008	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.012	0.012	0.012	0.012	0.012	0.011	0.011	0.010	0.008	0.003
x*Area	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.004	0.003	0.001

Consultant Risks																															
XL&E	0.095	0.103	0.110	0.117	0.125	0.132	0.139	0.147	0.154	0.161	0.169	0.178	0.187	0.197	0.206	0.215	0.225	0.234	0.243	0.253	0.262	0.273	0.285	0.296	0.307	0.319	0.330	0.341	0.353	0.364	0.376
Y1	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y2	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y3	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y4	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y5	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y6	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y7	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y8	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y9	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y10	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Ytotal	0.000	0.651	0.893	0.972	0.994	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.994	0.972	0.893	0.651	0.000
Area	0.000	0.002	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.011	0.009	0.004
x*Area	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.003	0.001

Managerial Risks																															
XL&E	0.094	0.099	0.105	0.111	0.117	0.122	0.128	0.134	0.140	0.146	0.151	0.158	0.166	0.173	0.180	0.187	0.194	0.201	0.209	0.216	0.223	0.231	0.240	0.248	0.257	0.266	0.274	0.283	0.291	0.300	0.308
Y1	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y2	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y3	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y4	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y5	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y6	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y7	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y8	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y9	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y10	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y11	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y12	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y13	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y14	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y15	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Ytotal	0.000	0.794	0.965	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.995	0.965	0.794	0.000
Area	0.000	0.002	0.005	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.007	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.008	0.008	0.003
x*Area	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.001

Financial Risks																															
XL&E	0.082	0.088	0.095	0.102	0.108	0.115	0.122	0.129	0.135	0.142	0.149	0.154	0.159	0.164	0.169	0.174	0.179	0.184	0.189	0.194	0.199	0.214	0.228	0.242	0.257	0.271	0.285	0.299	0.314	0.328	0.342
Y1	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y2	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y3	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y4	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y5	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y6	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Ytotal	0.000	0.469	0.738	0.882	0.953	0.984	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.996	0.984	0.953	0.882	0.738	0.469	0.000
Area	0.000	0.002	0.004	0.005	0.006	0.006	0.007	0.007	0.007	0.007	0.007	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.014	0.014	0.014	0.014	0.014	0.014	0.013	0.012	0.009	0.003
x*Area	0.000	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.003	0.003	0.004	0.004	0.004	0.004	0.004	0.003	0.001

External Risks

XL&E	0.132	0.140	0.148	0.156	0.164	0.172	0.181	0.189	0.197	0.205	0.213	0.235	0.258	0.280	0.302	0.325	0.347	0.369	0.392	0.414	0.436	0.448	0.459	0.471	0.483	0.494	0.506	0.518	0.529	0.541	0.553
Y1	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y2	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y3	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y4	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
Y5	0.000	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	0.900	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.800	0.700	0.600	0.500	0.400	0.300	0.200	0.100	0.000
0.553	0.000	0.410	0.672	0.832	0.922	0.969	0.990	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.998	0.990	0.969	0.922	0.832	0.672	0.410	0.000
Area	0.000	0.002	0.004	0.006	0.007	0.008	0.008	0.008	0.008	0.008	0.008	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.022	0.012	0.012	0.012	0.012	0.011	0.011	0.010	0.009	0.006	0.002
x*Area	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.005	0.005	0.006	0.006	0.007	0.007	0.008	0.008	0.009	0.009	0.005	0.005	0.005	0.006	0.006	0.006	0.005	0.005	0.003	0.001

APPENDIX E : UHCOC PROJECT (CASE STUDY)

	Type	Group	Risks	a	b	c	d
Project Risks	Positive Risks	Estimation Risk	Top soil quantity overrun	255	285	315	345
			Additional retaining walls and Pilings under retaining walls	3500	4500	5250	5500
			Additional wick drain pipe	120	142	150	150
			Additional remedial excavation in lieu of wick drain pipe	1400	1800	2000	2400
			Rock quantity overrun - drill and shoot by 25%	2550	3230	3570	4250
			Additional 1 mi hauling distance of drill and shoot rock	2000	2375	2625	3000
			Disposal fee $1.0/cu. Yd for drill and shoot rock	4165	4752	5047	5625
			Increase in all storm drainage pipe by 6 in	1040	1170	1430	1560
			Increase in reinforced concrete pipe by 15%	1360	1615	1700	1700
			Fuzzy Risk Value for Positive Estimation Risks	16390	19869	22087	24530
		Nonestimation Risks	Risks	a	b	c	d
			Schedule acceleration	5250	6750	7500	8625
			DBE by 20%	800	900	1000	1150
			Design Growth	3000	5100	6600	7500
			Design/approval delays	2800	3600	4400	5200
			Regulatory agencies	3750	4750	5250	6000
			Disposal of excess materials	4250	4750	5000	5500
			Fuzzy Risk Value for Positive Non-Estimation Risks	19850	25850	29750	33975
				a	b	c	d
			Fuzzy Risk Value for Positive Risks	36240	45719	51837	58505
	Negative Risks	Estimation Risk	Risks	a	b	c	d
			Less remedial excavation in lieu of wick-drain pipe	285	297	300	300
			less retaining walls and pilings under retaining walls	3200	3800	4200	4600
			Fatten slopes on site waste from drill and shoot rock	2400	2700	3000	3000
			Less tire/ track / repair cost	935	1067	1133	1265
			Less equipment maintenance cost	996	1140	1260	1404
			Piling reduction by 6ft per pile under bridge	720	873	900	900
			Replace 78R-value rock with 50R-value rock	1725	2185	2300	2415
			Fuzzy Risk Value for Negative Estimation Risks	10261	12062	13093	13884
		Non estimation Risks	Risks	a	b	c	d
			Schedule deceleration	3750	4750	5000	5750
			Less Design/approval delays	1400	1800	2200	2600
			Fuzzy Risk Value for Negative Non-Estimation Risks	5150	6550	7200	8350
				a	b	c	d
			Fuzzy Risk Value for Negative Risks	15411	18612	20293	22234
				a	b	c	d
			Total Project Risks	20829	27107	31544	36271

Positive Estimation Risks																														
16390.0	16737.9	17085.8	17433.7	17781.6	18129.5	18477.4	18825.3	19173.2	19521.1	19869.0	20090.8	20312.6	20534.4	20756.2	20978.0	21199.8	21421.6	21643.4	21865.2	22087.0	22331.3	22575.6	22819.9	23064.2	23308.5	23552.8	23797.1	24041.4	24285.7	24530.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.000	0.613	0.866	0.960	0.990	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.998	0.990	0.960	0.866	0.613	0.000
0.0	106.6	257.2	317.5	339.1	345.8	347.5	347.9	347.9	347.9	347.9	221.8	221.8	221.8	221.8	221.8	221.8	221.8	221.8	221.8	221.8	244.3	244.3	244.3	244.3	244.0	242.8	238.1	223.0	180.6	74.8
0.0	2353366.4	4349068.8	5480545.7	5971237.9	6209159.2	6360717.1	6487890.3	6609772.3	6730871.8	6851907.9	4431541.8	4480737.1	4529932.3	4579127.5	4628322.8	4677518.0	4726713.3	4775908.5	4825103.7	4874299.0	5425695.3	5485376.4	5545004.3	5603953.0	5658151.2	5689674.9	5637948.2	5333421.4	4363499.6	2435141.5

Positive Non Estimation Risks																														
19850.0	20450.0	21050.0	21650.0	22250.0	22850.0	23450.0	24050.0	24650.0	25250.0	25850.0	26240.0	26630.0	27020.0	27410.0	27800.0	28190.0	28580.0	28970.0	29360.0	29750.0	30172.5	30595.0	31017.5	31440.0	31862.5	32285.0	32707.5	33130.0	33552.5	33975.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.000	0.469	0.738	0.882	0.953	0.984	0.996	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.996	0.984	0.953	0.882	0.738	0.469	0.000
0.0	140.6	361.9	486.1	550.7	581.3	594.1	598.6	599.8	600.0	600.0	390.0	390.0	390.0	390.0	390.0	390.0	390.0	390.0	390.0	390.0	422.5	422.5	422.3	421.5	418.3	409.3	387.8	342.3	254.9	99.0
0.0	3776585.5	7509933.4	10377425.8	12088051.6	13108669.0	13753037.7	14215621.9	14604207.1	14969513.5	15329992.3	10157550.0	10309650.0	10461750.0	10613850.0	10765950.0	10918050.0	11070150.0	11222250.0	11374350.0	11526450.0	12658621.8	12836717.2	13010479.9	13162316.0	13240792.1	13129169.5	12601739.3	11267058.7	8497189.9	4456053.7

Negative Estimation Risks

10261.0	10441.1	10621.2	10801.3	10981.4	11161.5	11341.6	11521.7	11701.8	11881.9	12062.0	12165.1	12268.2	12371.3	12474.4	12577.5	12680.6	12783.7	12886.8	12989.9	13093.0	13172.1	13251.2	13330.3	13409.4	13488.5	13567.6	13646.7	13725.8	13804.9	13884.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.000	0.522	0.790	0.918	0.972	0.992	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.998	0.992	0.972	0.918	0.790	0.522	0.000
0.0	47.0	118.1	153.8	170.2	176.9	179.2	179.9	180.1	180.1	180.1	103.1	103.1	103.1	103.1	103.1	103.1	103.1	103.1	103.1	103.1	79.1	79.1	79.1	79.0	78.7	77.7	74.7	67.5	51.9	20.6
0.0	648381.0	1244197.6	1647381.1	1853306.7	1958270.0	2016828.5	2056928.4	2091034.1	2123698.5	2156148.1	1248907.0	1259536.6	1270166.2	1280795.8	1291425.4	1302055.1	1312684.7	1323314.3	1333943.9	1344573.5	1038784.7	1045034.8	1051176.6	1056573.1	1058785.0	1050911.3	1016940.4	924487.7	714271.9	380876.7

Negative Non Estimation Risks

5150.0	5290.0	5430.0	5570.0	5710.0	5850.0	5990.0	6130.0	6270.0	6410.0	6550.0	6615.0	6680.0	6745.0	6810.0	6875.0	6940.0	7005.0	7070.0	7135.0	7200.0	7315.0	7430.0	7545.0	7660.0	7775.0	7890.0	8005.0	8120.0	8235.0	8350.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
0.000	0.190	0.360	0.510	0.640	0.750	0.840	0.910	0.960	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.990	0.960	0.910	0.840	0.750	0.640	0.510	0.360	0.190	0.000
0.0	13.3	38.5	60.9	80.5	97.3	111.3	122.5	130.9	136.5	139.3	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	114.4	112.1	107.5	100.6	91.4	79.9	66.1	50.0	31.6	10.9
0.0	92568.0	206360.0	334950.0	454020.0	562394.0	658896.0	742350.0	811580.0	865410.0	902664.0	427862.5	432087.5	436312.5	440537.5	444762.5	448987.5	453212.5	457437.5	461662.5	465887.5	830439.4	826641.6	805093.4	765001.6	705572.4	626012.6	525528.4	403326.6	258613.4	120794.1

Positive Risks																														
36240.0	37187.9	38135.8	39083.7	40031.6	40979.5	41927.4	42875.3	43823.2	44771.1	45719.0	46330.8	46942.6	47554.4	48166.2	48778.0	49389.8	50001.6	50613.4	51225.2	51837.0	52503.8	53170.6	53837.4	54504.2	55171.0	55837.8	56504.6	57171.4	57838.2	58505.0
0.000	0.794	0.965	0.995	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.995	0.965	0.794	0.000
0.0	376.4	833.6	929.0	945.4	947.7	947.9	947.9	947.9	947.9	947.9	611.8	611.8	611.8	611.8	611.8	611.8	611.8	611.8	611.8	611.8	666.8	666.8	666.8	666.8	666.8	666.6	665.1	653.5	586.4	264.8
0.0	18423936.2	31396509.9	35867463.9	37398872.3	38385598.6	39293104.6	40192217.8	41090753.8	41989268.5	42887782.9	28158033.8	28532333.1	28906632.3	29280931.5	29655230.8	30029530.0	30403829.3	30778128.5	31152427.7	31526727.0	34787222.7	35231845.0	35676466.9	36121069.8	36565134.1	37001068.3	37357240.9	37142876.7	33722276.9	20535032.1
Negative Risks																														
15411.0	15731.1	16051.2	16371.3	16691.4	17011.5	17331.6	17651.7	17971.8	18291.9	18612.0	18780.1	18948.2	19116.3	19284.4	19452.5	19620.6	19788.7	19956.8	20124.9	20293.0	20487.1	20681.2	20875.3	21069.4	21263.5	21457.6	21651.7	21845.8	22039.9	22234.0
0.000	0.613	0.866	0.960	0.990	0.998	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.998	0.990	0.960	0.866	0.613	0.000
0.0	98.0	236.6	292.2	312.0	318.2	319.7	320.1	320.1	320.1	320.1	168.1	168.1	168.1	168.1	168.1	168.1	168.1	168.1	168.1	168.1	194.1	194.1	194.1	194.1	193.9	192.9	189.2	177.2	143.5	59.5
0.0	2035517.2	3760033.7	4736276.5	5158251.8	5361701.1	5490524.9	5598288.2	5701483.6	5804003.7	5906469.2	3142806.0	3171063.6	3199321.2	3227578.8	3255836.4	3284094.1	3312351.7	3340609.3	3368866.9	3397124.5	3957708.7	3995382.5	4033017.6	4070159.5	4103857.3	4121142.4	4078261.4	3852961.8	3148250.6	1754747.1
Project Risks																														
20829.0	21456.8	22084.6	22712.4	23340.2	23968.0	24595.8	25223.6	25851.4	26479.2	27107.0	27550.7	27994.4	28438.1	28881.8	29325.5	29769.2	30212.9	30656.6	31100.3	31544.0	32016.7	32489.4	32962.1	33434.8	33907.5	34380.2	34852.9	35325.6	35798.3	36271.0
0.000	0.668	0.934	0.991	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.999	0.991	0.934	0.668	0.000
0.0	209.7	503.0	604.3	624.6	627.5	627.8	627.8	627.8	627.8	627.8	443.7	443.7	443.7	443.7	443.7	443.7	443.7	443.7	443.7	443.7	472.7	472.7	472.7	472.7	472.7	472.5	470.3	455.0	378.7	157.9
0.0	5910997.6	10950092.5	13534813.7	14381902.8	14842644.2	15243695.7	15638292.6	16032442.3	16426575.3	16820708.2	12125810.7	12322680.4	12519550.1	12716419.8	12913289.5	13110159.2	13307028.9	13503898.6	13700768.3	13897638.0	15022571.4	15246016.7	15469461.8	15692890.2	15915850.3	16131755.4	16279470.1	15965103.0	13467756.4	7585440.9

APPENDIX F : NEST PROJECT (CASE STUDY)

Activity Name	A ($)	B ($)	C ($)	D ($)
Mobilization	40000	70000	70000	100000
Power Installation	89000	89000	89000	89000
Power - 156 Str.	15000	15000	50000	50000
Excavate Work Shaft	97600	122000	122000	146400
Excavate under cut	200000	269000	269000	350000
excavate tail tunnel to east	100000	123000	123000	150000
form and pour undercut	80000	80000	80000	80000
form and pour tail undercut	39000	39000	39000	39000
form and pour shaft	100000	120000	120000	150000
excavate access shaft	16000	16000	16000	16000
backfill shaft and install segments	44000	44000	44000	44000
tunnel install segments (866m)	1951964	2142484	2142484	2909760
patch and rub tunnel crown	80	134	134	140
patch and rub tunnel final cleanup	161	188	188	215
spoil removal	5.4	8.1	8.1	9.7
access manhole shaft	61000	61000	61000	61000
tunnel and install segments (756m)	1704024	1870344	1870344	2540160
patch and rub tunnel crown	80	134	134	140
patch and rub tunnel final cleanup	161	188	188	215
spoil removal	5.4	8.1	8.1	9.7
removal shaft	101000	101000	101000	101000
NEST	4639080.8	5162488.2	5197488.2	6827049.4
Area	2001213.96			
X.Area	11283042219888.10			
Defuzzified Value	5638098.90			

40000.0	43000.0	46000.0	49000.0	52000.0	55000.0	58000.0	61000.0	64000.0	67000.0	70000.0	70000.0	70000.0	70000.0	70000.0	70000.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
15000.0	15000.0	15000.0	15000.0	15000.0	15000.0	15000.0	15000.0	15000.0	15000.0	15000.0	18500.0	22000.0	25500.0	29000.0	32500.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
97600.0	100040.0	102480.0	104920.0	107360.0	109800.0	112240.0	114680.0	117120.0	119560.0	122000.0	122000.0	122000.0	122000.0	122000.0	122000.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
200000.0	206900.0	213800.0	220700.0	227600.0	234500.0	241400.0	248300.0	255200.0	262100.0	269000.0	269000.0	269000.0	269000.0	269000.0	269000.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
100000.0	102300.0	104600.0	106900.0	109200.0	111500.0	113800.0	116100.0	118400.0	120700.0	123000.0	123000.0	123000.0	123000.0	123000.0	123000.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
100000.0	102000.0	104000.0	106000.0	108000.0	110000.0	112000.0	114000.0	116000.0	118000.0	120000.0	120000.0	120000.0	120000.0	120000.0	120000.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0
16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
1951964.0	1971016.0	1990068.0	2009120.0	2028172.0	2047224.0	2066276.0	2085328.0	2104380.0	2123432.0	2142484.0	2142484.0	2142484.0	2142484.0	2142484.0	2142484.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
80.0	85.4	90.8	96.2	101.6	107.0	112.4	117.8	123.2	128.6	134.0	134.0	134.0	134.0	134.0	134.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
161.0	163.7	166.4	169.1	171.8	174.5	177.2	179.9	182.6	185.3	188.0	188.0	188.0	188.0	188.0	188.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
5.4	5.7	5.9	6.2	6.5	6.8	7.0	7.3	7.6	7.8	8.1	8.1	8.1	8.1	8.1	8.1
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
1704024.0	1720656.0	1737288.0	1753920.0	1770552.0	1787184.0	1803816.0	1820448.0	1837080.0	1853712.0	1870344.0	1870344.0	1870344.0	1870344.0	1870344.0	1870344.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
80.0	85.4	90.8	96.2	101.6	107.0	112.4	117.8	123.2	128.6	134.0	134.0	134.0	134.0	134.0	134.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
161.0	163.7	166.4	169.1	171.8	174.5	177.2	179.9	182.6	185.3	188.0	188.0	188.0	188.0	188.0	188.0
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
5.4	5.7	5.9	6.2	6.5	6.8	7.0	7.3	7.6	7.8	8.1	8.1	8.1	8.1	8.1	8.1
0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.0	1.0	1.0	1.0	1.0
101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
4639080.8	4691421.5	4743762.3	4796103.0	4848443.8	4900784.5	4953125.2	5005466.0	5057806.7	5110147.5	5162488.2	5165988.2	5169488.2	5172988.2	5176488.2	5179988.2
0.0	0.7	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
0.0	18779.1	43151.0	50180.1	51921.5	52277.4	52333.9	52340.3	52340.7	52340.7	52340.7	3500.0	3500.0	3500.0	3500.0	3500.0
0.0	116812194775.3	203568999094.3	239355669992.2	250379866465.4	254832072534.1	257846821035.5	260617761414.9	263359499450.5	266099122488.5	268838676097.3	18074833700.0	18087083700.0	18099333700.0	18111583700.0	18123833700.0

70000.0	70000.0	70000.0	70000.0	70000.0	70000.0	73000.0	76000.0	79000.0	82000.0	85000.0	88000.0	91000.0	94000.0	97000.0	100000.0
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0	89000.0
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32500.0	36000.0	39500.0	43000.0	46500.0	50000.0	50000.0	50000.0	50000.0	50000.0	50000.0	50000.0	50000.0	50000.0	50000.0	50000.0
1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
122000.0	122000.0	122000.0	122000.0	122000.0	122000.0	124440.0	126880.0	129320.0	131760.0	134200.0	136640.0	139080.0	141520.0	143960.0	146400.0
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
269000.0	269000.0	269000.0	269000.0	269000.0	269000.0	277100.0	285200.0	293300.0	301400.0	309500.0	317600.0	325700.0	333800.0	341900.0	350000.0
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
123000.0	123000.0	123000.0	123000.0	123000.0	123000.0	125700.0	128400.0	131100.0	133800.0	136500.0	139200.0	141900.0	144600.0	147300.0	150000.0
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0	80000.0
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0	39000.0
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
120000.0	120000.0	120000.0	120000.0	120000.0	120000.0	123000.0	126000.0	129000.0	132000.0	135000.0	138000.0	141000.0	144000.0	147000.0	150000.0
1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0	16000.0
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0	44000.0
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2142484.0	2142484.0	2142484.0	2142484.0	2142484.0	2142484.0	2219211.6	2295939.2	2372666.8	2449394.4	2526122.0	2602849.6	2679577.2	2756304.8	2833032.4	2909760.0
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
134.0	134.0	134.0	134.0	134.0	134.0	134.6	135.2	135.8	136.4	137.0	137.6	138.2	138.8	139.4	140.0
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
188.0	188.0	188.0	188.0	188.0	188.0	190.7	193.4	196.1	198.8	201.5	204.2	206.9	209.6	212.3	215.0
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
8.1	8.1	8.1	8.1	8.1	8.1	8.3	8.4	8.6	8.7	8.9	9.1	9.2	9.4	9.5	9.7
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0	61000.0
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1870344.0	1870344.0	1870344.0	1870344.0	1870344.0	1870344.0	1937325.6	2004307.2	2071288.8	2138270.4	2205252.0	2272233.6	2339215.2	2406196.8	2473178.4	2540160.0
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
134.0	134.0	134.0	134.0	134.0	134.0	134.6	135.2	135.8	136.4	137.0	137.6	138.2	138.8	139.4	140.0
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
188.0	188.0	188.0	188.0	188.0	188.0	190.7	193.4	196.1	198.8	201.5	204.2	206.9	209.6	212.3	215.0
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
8.1	8.1	8.1	8.1	8.1	8.1	8.3	8.4	8.6	8.7	8.9	9.1	9.2	9.4	9.5	9.7
1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2	0.1	0.0
101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0	101000.0
1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5179988.2	5183488.2	5186988.2	5190488.2	5193988.2	5197488.2	5360444.3	5523400.4	5686356.6	5849312.7	6012268.8	6175224.9	6338181.0	6501137.2	6664093.3	6827049.4
1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.7	0.0
3500.0	3500.0	3500.0	3500.0	3500.0	3500.0	162956.1	162956.1	162956.1	162954.7	162934.9	162758.9	161651.0	156229.2	134345.2	58466.2
18123833700.0	18136083700.0	18148333700.0	18160583700.0	18172833700.0	18185083700.0	860239859340.1	886794554569.4	913349008865.3	939895816239.3	966332564370.5	991811340164.6	1011402285719.	1002938392420.	884342624180.3	262925503670.7

APPENDIX G : HDD FAILURE (CASE STUDY)

MS	PA1 / MS1				0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
Fuzzy Presentation	0.3	0.5	0.5	0.7	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
A	0.2				0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
XA	0.1				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Deffuzified Value	0.5																																		
MS	PA2 / MS2				0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50
Fuzzy Presentation	0.1	0.2	0.3	0.5	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
A	0.25				0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
XA	0.070025				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deffuzified Value	0.2801																																		
MS	RA1 / MS3				0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.52	0.54	0.56	0.58	0.60	0.62	0.64	0.66	0.68	0.70
Fuzzy Presentation	0.3	0.5	0.5	0.7	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
A	0.2				0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
XA	0.1				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Deffuzified Value	0.5																																		

APPENDIX H : NUMERICAL EXAMPLE

1.1.1.1.1.1					X(I)	3.00	3.10	3.20	3.30	3.40	3.50	3.60	3.70	3.80	3.90	4.00	4.30	4.60	4.90	5.20	5.50	5.80	6.10	6.40	6.70	7.00	7.10	7.20	7.30	7.40	7.50	7.60	7.70	7.80	7.90	8.00
c1	6	7	7	8	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.40	0.70	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
c2	3	5	5	7	Y2	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.65	0.80	0.95	0.90	0.75	0.60	0.45	0.30	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c3	3	4	4	6	Y3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.85	0.70	0.55	0.40	0.25	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	3	4	7	8	X(P)	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.40	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00
p1	1	2	4	5	Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	3	5	6	7	Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.30	0.50	0.70	0.90	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
p3	2	4	4	7	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.87	0.73	0.60	0.47	0.33	0.30	0.27	0.23	0.20	0.17	0.13	0.10	0.07	0.03	0.00
P	1	2	6	7	X(R)	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.10	0.13	0.16	0.19	0.22	0.26	0.29	0.33	0.38	0.42	0.43	0.45	0.46	0.47	0.49	0.50	0.52	0.53	0.55	0.56
R	0.03	0.08	0.42	0.56	Y(I)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	0.95	0.94	0.98	0.94	0.81	0.64	0.51	0.58	0.75	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV1	10	20	30	50	Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.98	1.00	1.00	1.00	0.93	0.85	0.77	0.68	0.58	0.48	0.37	0.25	0.13	0.00
EMV2	30	40	40	60	Y (R)	0.00	0.01	0.06	0.12	0.21	0.31	0.43	0.56	0.70	0.85	1.00	0.95	0.94	0.98	0.94	0.81	0.63	0.49	0.58	0.75	1.00	0.84	0.68	0.54	0.41	0.29	0.19	0.11	0.05	0.01	0.00
EMV3	15	25	25	50	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.03	0.04	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C1	10	20	40	60	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1	15	25	30	35	XEMV(C1)	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	22.00	24.00	26.00	28.00	30.00	32.00	34.00	36.00	38.00	40.00	42.00	44.00	46.00	48.00	50.00	52.00	54.00	56.00	58.00	60.00
EMV2	10	20	20	25	YEMV1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00	0.00	0.00	0.00	0.00	0.00
EMV3	30	40	50	60	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV(C2	10	20	50	60	YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.70	0.90	0.96	0.88	0.80	0.72	0.64	0.56	0.48	0.40	0.32	0.24	0.16	0.08	0.00	0.00	0.00	0.00	0.00	0.00
EMV1	10	15	20	25	YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.64	0.76	0.86	0.94	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.96	0.95	0.96	1.00	0.96	0.89	0.80	0.67	0.50	0.40	0.30	0.20	0.10	0.00
EMV2	15	30	30	35	Area	0.00	0.05	0.15	0.25	0.35	0.45	0.57	0.70	0.81	0.90	0.97	2.00	2.00	2.00	2.00	2.00	1.98	1.93	1.90	1.91	1.96	1.96	1.85	1.69	1.47	1.17	0.90	0.70	0.50	0.30	0.10
EMV3	20	25	25	40	Xarea	0.00	0.53	1.73	3.13	4.73	6.53	8.84	11.55	14.18	16.65	18.92	42.00	46.00	50.00	54.00	58.00	61.31	63.84	66.64	70.51	76.38	80.33	79.67	76.14	68.96	57.27	45.90	37.10	27.50	17.10	5.90
EMV(C3	10	15	30	40	XEMV(C2)	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	23.00	26.00	29.00	32.00	35.00	38.00	41.00	44.00	47.00	50.00	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00
EMV	30	55	120	160	YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.70	0.90	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	0.90	4.40	50.40	89.60	YEMV2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	49.2383				YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00
Xarea	1680.4865				YEMV(C2)	0.00	0.10	0.20	0.30	0.40	0.50	0.64	0.76	0.86	0.94	1.00	0.88	0.92	1.00	1.00	1.00	0.68	0.52	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00
Defuzzified PREMC	34.1297				Area	0.00	0.05	0.15	0.25	0.35	0.45	0.57	0.70	0.81	0.90	0.97	2.82	2.70	2.88	3.00	3.00	2.52	1.80	1.68	2.10	2.70	1.00	1.00	1.00	1.00	1.00	0.90	0.70	0.50	0.30	0.10
					Xarea	0.00	0.53	1.73	3.13	4.73	6.53	8.84	11.55	14.18	16.65	18.92	60.63	66.15	79.20	91.50	100.50	91.98	71.10	71.40	95.55	130.95	50.50	51.50	52.50	53.50	54.50	49.95	39.55	28.75	17.55	5.95
					XEMV(C3)	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	14.00	14.50	15.00	16.50	18.00	19.50	21.00	22.50	24.00	25.50	27.00	28.50	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00	39.00	40.00
					YEMV1	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.13	0.20	0.27	0.33	0.47	0.60	0.73	0.87	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.80	0.93	0.80	0.67	0.53	0.40	0.27	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.87	0.94	0.98	0.97	1.00	0.81	0.52	0.27	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.05	0.15	0.25	0.35	0.45	0.50	0.50	0.50	0.50	0.50	1.40	1.36	1.44	1.47	1.48	1.36	1.00	0.59	0.30	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.51	1.61	2.81	4.11	5.51	6.38	6.63	6.88	7.13	7.38	22.11	23.39	26.98	29.70	32.19	31.62	24.75	15.49	8.33	2.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					X(EMV)	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	52.50	55.00	61.50	68.00	74.50	81.00	87.50	94.00	100.50	107.00	113.50	120.00	124.00	128.00	132.00	136.00	140.00	144.00	148.00	152.00	156.00	160.00
					Y(EMV)	0.00	0.35	0.62	0.80	0.93	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00	0.88	0.72	0.52	0.28	0.00
					Area	0.00	0.44	1.21	1.78	2.17	2.41	2.50	2.50	2.50	2.50	2.50	6.50	6.50	6.50	6.50	6.50	6.50	6.46	6.42	6.43	6.48	4.00	4.00	4.00	4.00	4.00	3.76	3.20	2.48	1.60	0.56
					Xarea	0.00	13.75	40.84	64.34	83.89	99.41	109.38	115.63	121.88	128.13	134.38	378.63	420.88	463.13	505.38	547.63	589.48	628.56	665.80	708.49	756.14	488.00	504.00	520.00	536.00	552.00	533.92	467.20	372.00	246.40	88.48
					X PREMC	0.90	1.11	1.34	1.61	1.90	2.23	2.59	2.99	3.42	3.89	4.40	6.35	8.76	11.68	15.16	19.25	23.99	29.43	35.61	42.59	50.40	53.70	57.14	60.71	64.41	68.25	72.23	76.35	80.62	85.04	89.60
					YPREMC	0.00	0.01	0.03	0.10	0.19	0.31	0.43	0.56	0.70	0.85	1.00	0.95	0.94	0.98	0.94	0.81	0.63	0.49	0.57	0.74	1.00	0.84	0.68	0.54	0.41	0.29	0.17	0.08	0.03	0.00	0.00
					Area	0.00	0.00	0.00	0.02	0.04	0.08	0.13	0.20	0.27	0.37	0.47	1.90	2.28	2.80	3.34	3.58	3.42	3.04	3.28	4.57	6.80	3.04	2.61	2.18	1.75	1.34	0.92	0.51	0.23	0.07	0.01
					Xarea	0.00	0.00	0.01	0.03	0.08	0.17	0.32	0.55	0.88	1.34	1.96	10.19	17.19	28.64	44.80	61.62	73.84	81.20	106.60	178.72	316.03	157.98	144.64	128.41	109.68	89.11	64.39	38.11	17.80	5.48	0.73

1.1.1.1.2					X(I)	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.30	2.60	2.90	3.20	3.50	3.80	4.10	4.40	4.70	5.00	5.20	5.40	5.60	5.80	6.00	6.20	6.40	6.60	6.80	7.00
c1	1	3	5	6	Y1	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.65	0.80	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00
c2	2	4	4	7	Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.30	0.45	0.60	0.75	0.90	0.97	0.87	0.77	0.67	0.60	0.53	0.47	0.40	0.33	0.27	0.20	0.13	0.07	0.00
c3	1	2	2	3	Y3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.70	0.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	1	2	5	7	X(P)	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00
p1	1	3	5	6	Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.60	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	2	4	6	7	Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.65	0.80	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
p3	2	3	3	6	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	1	3	6	7	X(R)	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.08	0.09	0.11	0.13	0.16	0.18	0.21	0.24	0.27	0.30	0.32	0.33	0.35	0.37	0.39	0.41	0.43	0.45	0.47	0.49
R	0.01	0.06	0.30	0.49	Y(I)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	0.91	0.92	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.81	0.68	0.52	0.33	0.27	0.20	0.13	0.07	0.00
EMV1	10	20	30	40	Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.71	0.86	0.94	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV2	30	50	50	60	Y (R)	0.00	0.01	0.06	0.12	0.21	0.31	0.51	0.69	0.83	0.93	1.00	0.91	0.92	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.83	0.65	0.48	0.31	0.17	0.11	0.06	0.03	0.01	0.00
EMV3	10	20	40	60	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C1)	10	20	50	60	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1	10	15	25	30	XEMV(C1)	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	23.00	26.00	29.00	32.00	35.00	38.00	41.00	44.00	47.00	50.00	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00
EMV2	20	30	30	40	YEMV1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	0.80	0.50	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV3	30	40	40	60	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.25	0.40	0.55	0.70	0.85	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV(C2)	10	15	40	60	YEMV3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.80	0.65	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05	0.00
EMV1	10	30	30	40	YEMV(C1)	0.00	0.19	0.36	0.51	0.64	0.75	0.84	0.91	0.96	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.94	0.95	1.00	0.95	0.88	0.81	0.72	0.63	0.52	0.41	0.28	0.15	0.00
EMV2	30	40	40	50	Area	0.00	0.10	0.28	0.44	0.58	0.70	0.80	0.88	0.94	0.98	1.00	3.00	3.00	3.00	3.00	3.00	3.00	2.97	2.88	2.83	2.92	0.97	0.91	0.84	0.76	0.67	0.57	0.46	0.34	0.21	0.07
EMV3	15	25	25	30	Xarea	0.00	1.00	3.16	5.44	7.76	10.08	12.32	14.44	16.36	18.04	19.40	64.50	73.50	82.50	91.50	100.50	109.50	117.17	122.24	128.82	141.68	49.11	46.99	44.23	40.79	36.65	31.77	26.13	19.69	12.43	4.31
EMV(C3)	10	25	40	50	XEMV(C2)	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	14.00	14.50	15.00	17.50	20.00	22.50	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.00	44.00	46.00	48.00	50.00	52.00	54.00	56.00	58.00	60.00
EMV	30	60	130	170	YEMV1	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	0.30	3.60	39.00	83.30	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.60	0.90	0.80	0.50	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	47.4407				YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.50	0.80	0.95	0.80	0.65	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05	0.00
Xarea	1258.1742				YEMV(C2)	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.92	0.84	0.75	0.84	0.95	0.80	0.65	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05	0.00
Defuzzified					Area	0.00	0.05	0.15	0.25	0.35	0.45	0.50	0.50	0.50	0.50	0.50	2.50	2.40	2.30	2.20	1.99	1.99	2.24	2.19	1.81	1.44	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
PREMC	26.5210				Xarea	0.00	0.51	1.61	2.81	4.11	5.51	6.38	6.63	6.88	7.13	7.38	40.63	45.00	48.88	52.25	52.17	57.14	69.92	73.83	65.70	55.70	38.95	36.55	33.75	30.55	26.95	22.95	18.55	13.75	8.55	2.95
					XEMV(C3)	10.00	11.50	13.00	14.50	16.00	17.50	19.00	20.50	22.00	23.50	25.00	26.50	28.00	29.50	31.00	32.50	34.00	35.50	37.00	38.50	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
					YEMV1	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.65	0.80	0.95	0.80	0.50	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.50	0.80	0.90	0.60	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.80	0.80	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.05	0.10	0.15	0.20	0.25	0.37	0.48	0.58	0.67	0.75	0.93	0.96	0.96	0.84	0.75	0.84	0.90	0.60	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.04	0.11	0.19	0.26	0.34	0.47	0.64	0.80	0.94	1.07	1.26	1.42	1.44	1.35	1.19	1.19	1.31	1.13	0.68	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.40	1.38	2.58	4.00	5.65	8.49	12.59	16.89	21.33	25.83	32.45	38.63	41.40	40.84	37.86	39.65	45.35	40.78	25.48	8.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					X(EMV)	30.00	33.00	36.00	39.00	42.00	45.00	48.00	51.00	54.00	57.00	60.00	67.00	74.00	81.00	88.00	95.00	102.00	109.00	116.00	123.00	130.00	134.00	138.00	142.00	146.00	150.00	154.00	158.00	162.00	166.00	170.00
					Y(EMV)	0.00	0.38	0.65	0.83	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.97	0.93	0.87	0.80	0.72	0.62	0.49	0.35	0.19	0.00
					Area	0.00	0.58	1.56	2.23	2.66	2.91	3.00	3.00	3.00	3.00	3.00	7.00	7.00	7.00	7.00	7.00	7.00	7.00	6.98	6.94	6.95	3.94	3.80	3.60	3.35	3.05	2.67	2.22	1.69	1.08	0.38
					Xarea	0.00	18.16	53.76	83.69	107.88	126.74	139.50	148.50	157.50	166.50	175.50	444.50	493.50	542.50	591.50	640.50	689.50	738.46	785.57	829.11	879.81	520.01	516.19	504.35	483.05	450.73	405.76	346.40	270.80	177.04	63.08
					X PREMC	0.30	0.44	0.60	0.81	1.06	1.35	1.69	2.08	2.53	3.03	3.60	5.09	6.93	9.16	11.83	14.96	18.60	22.79	27.56	32.95	39.00	42.50	46.20	50.10	54.20	58.50	63.02	67.75	72.71	77.89	83.30
					YPREMC	0.00	0.01	0.04	0.10	0.20	0.31	0.51	0.69	0.83	0.93	1.00	0.91	0.92	0.98	1.00	1.00	1.00	1.00	1.00	0.99	1.00	0.80	0.60	0.42	0.25	0.12	0.07	0.03	0.01	0.00	0.00
					Area	0.00	0.00	0.00	0.01	0.04	0.07	0.14	0.24	0.34	0.45	0.55	1.42	1.68	2.11	2.63	3.14	3.64	4.19	4.76	5.34	6.01	3.16	2.60	1.99	1.37	0.80	0.42	0.23	0.10	0.03	0.00
					Xarea	0.00	0.00	0.00	0.01	0.03	0.09	0.21	0.44	0.78	1.24	1.82	6.16	10.10	17.00	27.63	42.00	61.13	86.66	119.79	161.65	216.19	128.76	115.36	95.60	71.21	44.95	25.45	14.76	6.79	2.08	0.27

1.1.1.1.2.1				
c1	6	7	8	10
c2	3	5	5	7
c3	3	5	7	8
C	3	5	8	10
p1	1	2	4	5
p2	3	5	6	7
p3	3	4	5	5
P	1	2	6	7
R	0.03	0.10	0.48	0.70
EMV1	20	30	40	50
EMV2	30	30	40	40
EMV3	15	25	30	50
EMV(C1)	15	25	40	50
EMV1				
EMV2				
EMV3				
EMV(C2)	0	0	0	0
EMV1				
EMV2				
EMV3				
EMV(C3)	0	0	0	0
EMV	15	25	40	50
PREMC	0.45	2.50	19.20	35.00
Area	21.4364			
Xarea	269.9837			
Defuzzified PREMC	12.5946			

X(I)	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.30	5.60	5.90	6.20	6.50	6.80	7.10	7.40	7.70	8.00	8.20	8.40	8.60	8.80	9.00	9.20	9.40	9.60	9.80	10.00
Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.50	0.80	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.85	0.70	0.55	0.40	0.25	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.60	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
X(P)	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.40	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00
Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.30	0.50	0.70	0.90	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.60	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
X(R)	0.03	0.04	0.04	0.05	0.05	0.06	0.07	0.07	0.08	0.09	0.10	0.13	0.16	0.19	0.22	0.26	0.30	0.34	0.38	0.43	0.48	0.50	0.52	0.54	0.56	0.59	0.61	0.63	0.65	0.68	0.70
Y(I)	0.00	0.19	0.36	0.51	0.64	0.75	0.84	0.91	0.96	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y (R)	0.00	0.02	0.07	0.15	0.26	0.38	0.50	0.64	0.77	0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.81	0.64	0.49	0.36	0.25	0.16	0.09	0.04	0.01	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.05	0.05	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
XEMV(C1)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.50	28.00	29.50	31.00	32.50	34.00	35.50	37.00	38.50	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.65	0.80	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	0.95	0.88	0.80	0.73	0.65	0.58	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05	0.00
YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.64	0.76	0.86	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.88	0.81	0.72	0.63	0.52	0.41	0.28	0.15	0.00
Area	0.00	0.05	0.15	0.25	0.35	0.45	0.57	0.70	0.81	0.90	0.97	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0.97	0.91	0.84	0.76	0.67	0.57	0.46	0.34	0.21	0.07
Xarea	0.00	0.78	2.48	4.38	6.48	8.78	11.69	15.05	18.23	21.15	23.77	38.63	40.88	43.13	45.38	47.63	49.88	52.13	54.38	56.63	58.88	39.39	37.87	35.81	33.17	29.93	26.05	21.51	16.27	10.31	3.59
XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
X(EMV)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.50	28.00	29.50	31.00	32.50	34.00	35.50	37.00	38.50	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
Y(EMV)	0.00	0.10	0.20	0.30	0.40	0.50	0.64	0.76	0.86	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.88	0.81	0.72	0.63	0.52	0.41	0.28	0.15	0.00
Area	0.00	0.05	0.15	0.25	0.35	0.45	0.57	0.70	0.81	0.90	0.97	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0.97	0.91	0.84	0.76	0.67	0.57	0.46	0.34	0.21	0.07
Xarea	0.00	0.78	2.48	4.38	6.48	8.78	11.69	15.05	18.23	21.15	23.77	38.63	40.88	43.13	45.38	47.63	49.88	52.13	54.38	56.63	58.88	39.39	37.87	35.81	33.17	29.93	26.05	21.51	16.27	10.31	3.59
X PREMC	0.45	0.56	0.69	0.84	1.01	1.20	1.41	1.65	1.90	2.19	2.50	3.37	4.39	5.57	6.92	8.45	10.17	12.10	14.24	16.60	19.20	20.51	21.87	23.30	24.78	26.33	27.93	29.60	31.33	33.13	35.00
YPREMC	0.00	0.00	0.01	0.05	0.10	0.19	0.32	0.48	0.66	0.84	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.77	0.56	0.39	0.26	0.16	0.08	0.04	0.01	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.01	0.03	0.05	0.09	0.15	0.21	0.29	0.87	1.02	1.18	1.35	1.53	1.72	1.93	2.14	2.36	2.60	1.15	0.91	0.68	0.48	0.32	0.19	0.10	0.04	0.01	0.00
Xarea	0.00	0.00	0.00	0.00	0.01	0.03	0.07	0.14	0.26	0.44	0.67	2.56	3.96	5.87	8.43	11.76	16.04	21.44	28.17	36.45	46.52	22.93	19.22	15.40	11.65	8.20	5.22	2.87	1.26	0.37	0.05

1.1.1.1.2.2				
c1	3	5	5	8
c2	2	3	3	6
c3	2	4	4	7
C	2	3	5	8
p1	1	3	5	6
p2	2	4	4	7
p3	1	2	2	3
P	1	2	5	7
R	0.02	0.06	0.25	0.56
EMV1	30	40	40	60
EMV2	20	30	40	50
EMV3	30	30	40	40
EMV(C1)	20	30	40	60
EMV1	15	25	25	30
EMV2	20	30	40	50
EMV3	30	30	40	40
EMV(C2)	15	25	40	50
EMV1				
EMV2				
EMV3				
EMV(C3)	0	0	0	0
EMV	35	55	80	110
PREMC	0.70	3.30	20.00	61.60
Area	27.4816			
Xarea	462.3465			
Defuzzified PREMC	16.8239			

X(I)	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.30	5.60	5.90	6.20	6.50	6.80	7.10	7.40	7.70	8.00
Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.93	0.87	0.80	0.73	0.67	0.60	0.53	0.47	0.40	0.33	0.23	0.13	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y3	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.60	0.70	0.80	0.90	1.00	0.93	0.87	0.80	0.73	0.67	0.57	0.47	0.37	0.27	0.17	0.07	0.00	0.00	0.00	0.00
X(P)	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.30	2.60	2.90	3.20	3.50	3.80	4.10	4.40	4.70	5.00	5.20	5.40	5.60	5.80	6.00	6.20	6.40	6.60	6.80	7.00
Y1	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.65	0.80	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.30	0.45	0.60	0.75	0.90	0.97	0.87	0.77	0.67	0.60	0.53	0.47	0.40	0.33	0.27	0.20	0.13	0.07	0.00
Y3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.70	0.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
X(R)	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.09	0.10	0.12	0.14	0.16	0.18	0.20	0.23	0.25	0.28	0.30	0.33	0.36	0.39	0.42	0.45	0.49	0.52	0.56
Y(I)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	0.98	0.97	0.97	0.98	1.00	0.99	0.98	0.98	0.98	1.00	0.97	0.91	0.82	0.71	0.58	0.44	0.30	0.20	0.10	0.00
Y(P)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	0.91	0.92	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.81	0.68	0.52	0.33	0.27	0.20	0.13	0.07	0.00
Y (R)	0.00	0.02	0.08	0.16	0.27	0.39	0.52	0.65	0.77	0.89	1.00	0.89	0.89	0.95	0.98	1.00	0.99	0.98	0.98	0.98	1.00	0.89	0.74	0.56	0.37	0.19	0.12	0.06	0.03	0.01	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XEMV(C1)	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00	39.00	40.00	42.00	44.00	46.00	48.00	50.00	52.00	54.00	56.00	58.00	60.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
YEMV2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.92	0.82	0.68	0.50	0.40	0.30	0.20	0.10	0.00
Area	0.00	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.98	1.90	1.74	1.50	1.18	0.90	0.70	0.50	0.30	0.10
Xarea	0.00	1.03	3.23	5.63	8.23	11.03	14.03	17.23	20.63	24.23	28.03	30.50	31.50	32.50	33.50	34.50	35.50	36.50	37.50	38.50	39.50	81.18	81.70	78.30	70.50	57.82	45.90	37.10	27.50	17.10	5.90
XEMV(C2)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.50	28.00	29.50	31.00	32.50	34.00	35.50	37.00	38.50	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
YEMV1	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C2)	0.50	0.64	0.76	0.86	0.94	1.00	0.92	0.88	0.88	0.92	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00
Area	0.00	0.57	0.70	0.81	0.90	0.97	0.96	0.90	0.88	0.90	0.96	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0.90	0.70	0.50	0.30	0.10	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	8.84	11.55	14.18	16.65	18.92	19.68	19.35	19.80	21.15	23.52	38.63	40.88	43.13	45.38	47.63	49.88	52.13	54.38	56.63	58.88	36.45	29.05	21.25	13.05	4.45	0.00	0.00	0.00	0.00	0.00
XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
X(EMV)	35.00	37.00	39.00	41.00	43.00	45.00	47.00	49.00	51.00	53.00	55.00	57.50	60.00	62.50	65.00	67.50	70.00	72.50	75.00	77.50	80.00	83.00	86.00	89.00	92.00	95.00	98.00	101.00	104.00	107.00	110.00
Y(EMV)	0.50	0.68	0.81	0.90	0.96	1.00	0.97	0.96	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.89	0.74	0.50	0.40	0.30	0.20	0.10	0.00
Area	0.00	1.18	1.48	1.71	1.87	1.96	1.97	1.93	1.94	1.97	1.99	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.99	2.95	2.79	2.45	1.87	1.35	1.05	0.75	0.45	0.15
Xarea	0.00	42.34	56.39	68.40	78.37	86.42	90.53	92.74	97.00	102.34	107.57	140.63	146.88	153.13	159.38	165.63	171.88	178.13	184.38	190.63	196.88	244.01	248.94	244.13	222.09	174.47	130.28	104.48	76.88	47.48	16.28
X PREMC	0.70	0.85	1.03	1.23	1.44	1.69	1.96	2.25	2.57	2.92	3.30	4.23	5.30	6.53	7.90	9.45	11.17	13.08	15.18	17.48	20.00	22.87	26.01	29.41	33.08	37.05	41.32	45.89	50.79	56.03	61.60
YPREMC	0.00	0.01	0.06	0.15	0.26	0.39	0.50	0.62	0.76	0.89	1.00	0.89	0.89	0.95	0.98	1.00	0.99	0.98	0.98	0.98	1.00	0.89	0.71	0.50	0.27	0.10	0.05	0.02	0.01	0.00	0.00
Area	0.00	0.00	0.01	0.02	0.04	0.08	0.12	0.17	0.22	0.29	0.36	0.88	0.95	1.12	1.33	1.53	1.71	1.88	2.06	2.26	2.50	2.71	2.51	2.06	1.41	0.74	0.31	0.15	0.06	0.02	0.00
Xarea	0.00	0.00	0.01	0.02	0.06	0.12	0.22	0.35	0.53	0.79	1.11	3.31	4.54	6.62	9.61	13.31	17.66	22.78	29.09	36.93	46.78	58.11	61.25	56.96	44.15	25.78	12.05	6.48	2.76	0.84	0.11

1.1.2.1.1.1					X(I)	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.30	4.60	4.90	5.20	5.50	5.80	6.10	6.40	6.70	7.00	7.10	7.20	7.30	7.40	7.50	7.60	7.70	7.80	7.90	8.00
c1	3	5	7	8	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.65	0.80	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
c2	2	4	4	7	Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c3	3	4	4	6	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.85	0.70	0.55	0.40	0.25	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	2	4	7	8	X(P)	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00
p1	3	4	5	5	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.60	0.90	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	3	5	6	7	Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.30	0.45	0.60	0.75	0.90	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
p3	2	3	3	6	Y3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	2	3	6	7	X(R)	0.04	0.05	0.05	0.06	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.14	0.17	0.19	0.22	0.25	0.28	0.31	0.35	0.38	0.42	0.43	0.45	0.46	0.47	0.49	0.50	0.52	0.53	0.55	0.56
R	0.04	0.12	0.42	0.56	Y(I)	0.00	0.10	0.20	0.30	0.40	0.50	0.71	0.86	0.94	0.99	1.00	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV1	10	30	30	40	Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.94	0.94	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV2	30	40	40	50	Y (R)	0.00	0.01	0.04	0.09	0.16	0.25	0.43	0.60	0.76	0.89	1.00	0.94	0.93	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.81	0.64	0.49	0.36	0.25	0.16	0.09	0.04	0.01	0.00
EMV3	15	25	25	30	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C1)	10	25	40	50	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					XEMV(C1)	10.00	11.50	13.00	14.50	16.00	17.50	19.00	20.50	22.00	23.50	25.00	26.50	28.00	29.50	31.00	32.50	34.00	35.50	37.00	38.50	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
EMV2					YEMV1	0.00	0.08	0.15	0.23	0.30	0.38	0.45	0.53	0.60	0.68	0.75	0.83	0.90	0.98	0.90	0.75	0.60	0.45	0.30	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV3					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.25	0.40	0.55	0.70	0.85	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV(C2)	0	0	0	0	YEMV3	0.00	0.00	0.00	0.00	0.10	0.25	0.40	0.55	0.70	0.85	1.00	0.70	0.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					YEMV(C1)	0.00	0.08	0.15	0.23	0.37	0.53	0.67	0.79	0.88	0.95	1.00	0.95	0.94	0.98	0.91	0.81	0.76	0.75	0.79	0.87	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV2					Area	0.00	0.06	0.17	0.28	0.45	0.68	0.90	1.09	1.25	1.37	1.46	1.46	1.42	1.44	1.42	1.29	1.18	1.13	1.16	1.25	1.40	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
EMV3					Xarea	0.00	0.60	2.07	3.87	6.81	11.32	16.44	21.57	26.56	31.25	35.49	37.61	38.58	41.35	42.82	41.02	39.21	39.42	41.94	47.07	55.12	38.48	35.28	31.88	28.28	24.48	20.48	16.28	11.88	7.28	2.48
EMV(C3)	0	0	0	0	XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV	10	25	40	50	YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	0.40	3.00	16.80	28.00	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	15.3801				YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	166.7511				YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Defuzzified PREMC	10.8420				Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					X(EMV)	10.00	11.50	13.00	14.50	16.00	17.50	19.00	20.50	22.00	23.50	25.00	26.50	28.00	29.50	31.00	32.50	34.00	35.50	37.00	38.50	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
					Y(EMV)	0.00	0.08	0.15	0.23	0.37	0.53	0.67	0.79	0.88	0.95	1.00	0.95	0.94	0.98	0.91	0.81	0.76	0.75	0.79	0.87	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
					Area	0.00	0.06	0.17	0.28	0.45	0.68	0.90	1.09	1.25	1.37	1.46	1.46	1.42	1.44	1.42	1.29	1.18	1.13	1.16	1.25	1.40	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
					Xarea	0.00	0.60	2.07	3.87	6.81	11.32	16.44	21.57	26.56	31.25	35.49	37.61	38.58	41.35	42.82	41.02	39.21	39.42	41.94	47.07	55.12	38.48	35.28	31.88	28.28	24.48	20.48	16.28	11.88	7.28	2.48
					X PREMC	0.40	0.53	0.69	0.87	1.08	1.31	1.58	1.88	2.22	2.59	3.00	3.76	4.64	5.64	6.77	8.04	9.47	11.04	12.79	14.70	16.80	17.76	18.75	19.78	20.84	21.94	23.07	24.25	25.46	26.71	28.00
					YPREMC	0.00	0.00	0.01	0.02	0.06	0.13	0.29	0.47	0.66	0.85	1.00	0.89	0.88	0.95	0.91	0.81	0.76	0.75	0.79	0.87	1.00	0.73	0.51	0.34	0.22	0.13	0.06	0.03	0.01	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.01	0.02	0.06	0.11	0.19	0.28	0.38	0.72	0.77	0.92	1.06	1.10	1.12	1.19	1.34	1.59	1.96	0.83	0.62	0.44	0.30	0.19	0.11	0.05	0.02	0.01	0.00
					Xarea	0.00	0.00	0.00	0.00	0.01	0.03	0.08	0.20	0.39	0.68	1.06	2.42	3.24	4.71	6.55	8.12	9.79	12.24	16.02	21.89	30.92	14.30	11.23	8.46	6.03	4.01	2.42	1.26	0.53	0.15	0.02

1.1.2.1.1.2					X(I)	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.20	5.40	5.60	5.80	6.00
c1	1	2	2	3	Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c2	2	3	3	6	Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.93	0.87	0.80	0.73	0.67	0.60	0.53	0.47	0.40	0.33	0.27	0.20	0.13	0.07	0.00
c3	3	4	4	6	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
C	1	2	4	6	X(P)	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.20	5.40	5.60	5.80	6.00	6.20	6.40	6.60	6.80	7.00
p1	3	4	5	5	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	1	3	5	6	Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00
p3	2	4	4	7	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.93	0.87	0.80	0.73	0.67	0.60	0.53	0.47	0.40	0.33	0.27	0.20	0.13	0.07	0.00
P	1	3	5	7	X(R)	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.07	0.08	0.09	0.11	0.12	0.13	0.15	0.17	0.18	0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.35	0.37	0.39	0.42
R	0.01	0.06	0.20	0.42	Y(I)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.84	0.76	0.76	0.84	1.00	0.95	0.92	0.92	0.95	1.00	0.96	0.91	0.84	0.76	0.67	0.56	0.44	0.31	0.16	0.00
EMV1	10	20	20	25	Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.64	0.76	0.86	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.81	0.68	0.52	0.33	0.27	0.20	0.13	0.07	0.00
EMV2	30	40	50	60	Y (R)	0.00	0.01	0.04	0.09	0.16	0.25	0.38	0.53	0.69	0.85	1.00	0.84	0.76	0.76	0.84	1.00	0.95	0.92	0.92	0.95	1.00	0.88	0.74	0.57	0.40	0.22	0.15	0.09	0.04	0.01	0.00
EMV3	10	15	25	30	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
EMV(C1)	10	15	50	60	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					XEMV(C1)	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	14.00	14.50	15.00	18.50	22.00	25.50	29.00	32.50	36.00	39.50	43.00	46.50	50.00	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00
EMV2					YEMV1	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.85	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV3					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.60	0.95	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV(C2)	0	0	0	0	YEMV3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	0.90	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					YEMV(C1)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	1.00	1.00	0.90	0.20	0.25	0.60	0.95	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV2					Area	0.00	0.04	0.11	0.17	0.23	0.29	0.34	0.38	0.42	0.46	0.49	3.50	3.50	3.33	1.93	0.79	1.49	2.71	3.41	3.50	3.50	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
EMV3					Xarea	0.00	0.37	1.14	1.93	2.72	3.51	4.29	5.05	5.79	6.50	7.17	58.63	70.88	78.97	52.46	24.22	50.95	102.40	140.77	156.63	168.88	47.98	43.78	39.38	34.78	29.98	24.98	19.78	14.38	8.78	2.98
EMV(C3)	0	0	0	0	XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV	10	15	50	60	YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	0.10	0.90	10.00	25.20	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	10.4108				YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	83.8500				YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Defuzzified PREMC	8.0541				Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					X(EMV)	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	14.00	14.50	15.00	18.50	22.00	25.50	29.00	32.50	36.00	39.50	43.00	46.50	50.00	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00
					Y(EMV)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	1.00	1.00	0.90	0.20	0.25	0.60	0.95	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
					Area	0.00	0.04	0.11	0.17	0.23	0.29	0.34	0.38	0.42	0.46	0.49	3.50	3.50	3.33	1.93	0.79	1.49	2.71	3.41	3.50	3.50	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
					Xarea	0.00	0.37	1.14	1.93	2.72	3.51	4.29	5.05	5.79	6.50	7.17	58.63	70.88	78.97	52.46	24.22	50.95	102.40	140.77	156.63	168.88	47.98	43.78	39.38	34.78	29.98	24.98	19.78	14.38	8.78	2.98
					X PREMC	0.10	0.14	0.18	0.24	0.30	0.38	0.46	0.55	0.66	0.77	0.90	1.30	1.80	2.39	3.09	3.90	4.84	5.91	7.12	8.48	10.00	11.14	12.36	13.65	15.03	16.50	18.05	19.70	21.44	23.27	25.20
					YPREMC	0.00	0.00	0.01	0.04	0.08	0.16	0.28	0.43	0.61	0.80	1.00	0.84	0.76	0.68	0.17	0.25	0.57	0.87	0.92	0.95	1.00	0.79	0.59	0.40	0.24	0.11	0.06	0.03	0.01	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.05	0.08	0.12	0.37	0.39	0.43	0.30	0.17	0.38	0.77	1.09	1.27	1.48	1.02	0.84	0.64	0.44	0.26	0.13	0.07	0.03	0.01	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.06	0.10	0.41	0.61	0.89	0.81	0.59	1.68	4.15	7.08	9.91	13.66	10.80	9.90	8.35	6.31	4.03	2.29	1.34	0.62	0.19	0.02

1.1.2.1.2.1					X(I)	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.20	5.40	5.60	5.80	6.00	6.20	6.40	6.60	6.80	7.00
c1	2	3	3	6	Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.93	0.87	0.80	0.73	0.67	0.60	0.53	0.47	0.40	0.33	0.27	0.20	0.13	0.07	0.00	0.00	0.00	0.00	0.00	0.00
c2	2	4	4	7	Y2	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.60	0.70	0.80	0.90	1.00	0.93	0.87	0.80	0.73	0.67	0.60	0.53	0.47	0.40	0.33	0.27	0.20	0.13	0.07	0.00
c3	3	5	5	7	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
C	2	3	5	7	X(P)	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.40	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00
p1	1	2	4	5	Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	2	4	6	7	Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
p3	3	5	6	7	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.30	0.50	0.70	0.90	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
P	1	2	6	7	X(R)	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.08	0.10	0.12	0.14	0.16	0.18	0.21	0.24	0.27	0.30	0.32	0.33	0.35	0.37	0.39	0.41	0.43	0.45	0.47	0.49
R	0.02	0.06	0.30	0.49	Y(I)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	0.98	0.97	0.97	0.98	1.00	0.99	0.98	0.98	0.98	1.00	0.97	0.93	0.86	0.78	0.67	0.56	0.44	0.31	0.16	0.00
EMV1	15	25	30	50	Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.96	0.91	0.84	0.75	0.64	0.51	0.36	0.19	0.00
EMV2	30	50	50	60	Y(R)	0.00	0.01	0.06	0.12	0.21	0.31	0.43	0.56	0.70	0.85	1.00	0.98	0.97	0.97	0.98	1.00	0.99	0.98	0.98	0.98	1.00	0.96	0.89	0.78	0.65	0.50	0.36	0.22	0.11	0.03	0.00
EMV3	30	40	40	60	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00
EMV(C1)	15	25	50	60	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1	30	30	40	40	XEMV(C1)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00
EMV2	20	30	30	40	YEMV1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	0.88	0.75	0.63	0.50	0.38	0.25	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV3	10	20	20	25	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV(C2)	10	20	40	40	YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.75	1.00	0.88	0.75	0.63	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05	0.00
EMV1	30	40	40	60	YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	0.92	0.91	0.94	1.00	0.97	0.95	0.96	1.00	0.95	0.88	0.81	0.72	0.63	0.52	0.41	0.28	0.15	0.00
EMV2	30	40	40	50	Area	0.00	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95	2.50	2.50	2.40	2.28	2.31	2.43	2.46	2.40	2.39	2.45	0.97	0.91	0.84	0.76	0.67	0.57	0.46	0.34	0.21	0.07
EMV3	15	30	30	35	Xarea	0.00	0.78	2.48	4.38	6.48	8.78	11.28	13.98	16.88	19.98	23.28	65.63	71.88	74.92	76.96	83.72	94.04	101.61	105.21	110.54	119.38	49.11	46.99	44.23	40.79	36.65	31.77	26.13	19.69	12.43	4.31
EMV(C3)	15	30	40	60	XEMV(C2)	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	22.00	24.00	26.00	28.00	30.00	32.00	34.00	36.00	38.00	40.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
EMV	40	75	130	160	YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	0.80	4.50	39.00	78.40	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.75	1.00	0.75	0.50	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	37.1088				YEMV3	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	831.0096				YEMV(C2)	0.50	0.60	0.70	0.80	0.90	1.00	0.82	0.68	0.58	0.52	0.50	0.75	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Defuzzified					Area	0.00	0.55	0.65	0.75	0.85	0.95	0.91	0.75	0.63	0.55	0.51	1.25	1.75	2.00	2.00	2.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	22.3939				Xarea	0.00	5.78	7.48	9.38	11.48	13.78	14.11	12.38	11.03	10.18	9.95	26.25	40.25	50.00	54.00	58.00	31.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					XEMV(C3)	15.00	16.50	18.00	19.50	21.00	22.50	24.00	25.50	27.00	28.50	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00	39.00	40.00	42.00	44.00	46.00	48.00	50.00	52.00	54.00	56.00	58.00	60.00
					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.75	1.00	0.88	0.75	0.63	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.75	1.00	0.75	0.50	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.83	1.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.83	1.00	0.72	0.75	0.94	1.00	0.97	0.88	0.72	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05	0.00
					Area	0.00	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95	0.75	0.92	0.86	0.73	0.84	0.97	0.98	0.92	0.80	0.61	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
					Xarea	0.00	0.79	2.59	4.69	7.09	9.79	12.79	16.09	19.69	23.59	27.79	22.88	28.88	27.93	24.60	29.11	34.39	35.93	34.57	30.68	24.07	38.95	36.55	33.75	30.55	26.95	22.95	18.55	13.75	8.55	2.95
					X(EMV)	40.00	43.50	47.00	50.50	54.00	57.50	61.00	64.50	68.00	71.50	75.00	80.50	86.00	91.50	97.00	102.50	108.00	113.50	119.00	124.50	130.00	93.00	97.00	101.00	105.00	109.00	113.00	117.00	121.00	125.00	129.00
					Y(EMV)	0.50	0.66	0.79	0.89	0.96	1.00	0.96	0.95	0.96	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	1.00	0.97	0.93	0.87	0.80	0.72	0.62	0.49	0.35	0.19	0.00
					Area	0.00	2.04	2.55	2.94	3.23	3.42	3.42	3.33	3.34	3.40	3.47	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.48	5.45	5.47	-36.44	3.80	3.60	3.35	3.05	2.67	2.22	1.69	1.08	0.38
					Xarea	0.00	85.04	115.30	143.33	168.61	190.83	202.90	209.26	221.39	237.00	253.91	427.63	457.88	488.13	518.38	548.63	578.88	608.85	637.21	663.80	695.84	-4063.10	360.57	356.65	345.51	325.87	296.31	255.36	201.41	132.78	47.69
					X PREMC	0.80	1.00	1.24	1.51	1.81	2.16	2.54	2.96	3.43	3.94	4.50	6.18	8.19	10.54	13.27	16.40	19.96	23.97	28.46	33.47	39.00	29.50	32.48	35.63	38.98	42.51	46.24	50.17	54.30	58.65	63.21
					YPREMC	0.00	0.01	0.04	0.11	0.20	0.31	0.41	0.53	0.68	0.83	1.00	0.98	0.97	0.97	0.98	1.00	0.99	0.98	0.97	0.97	1.00	0.93	0.82	0.68	0.52	0.36	0.22	0.11	0.04	0.01	0.00
					Area	0.00	0.00	0.01	0.02	0.05	0.09	0.14	0.20	0.28	0.39	0.51	1.66	1.95	2.28	2.67	3.11	3.54	3.95	4.39	4.86	5.46	-9.18	2.61	2.38	2.02	1.56	1.08	0.65	0.31	0.10	0.01
					Xarea	0.00	0.00	0.01	0.03	0.08	0.17	0.32	0.55	0.90	1.43	2.17	8.88	14.00	21.38	31.77	46.07	64.34	86.81	115.07	150.64	197.78	-314.31	80.98	81.11	75.36	63.60	48.01	31.42	16.18	5.47	0.79

1.1.2.1.2.2					X(I)	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.20	5.40	5.60	5.80	6.00
c1	2	3	3	6	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.93	0.87	0.80	0.73	0.67	0.60	0.53	0.47	0.40	0.33	0.27	0.20	0.13	0.07	0.00
c2	1	2	2	3	Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c3	3	4	4	6	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
C	1	2	4	6	X(P)	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.40	3.80	4.20	4.60	5.00	5.40	5.80	6.20	6.60	7.00	7.10	7.20	7.30	7.40	7.50	7.60	7.70	7.80	7.90	8.00
p1	1	3	5	6	Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	2	3	5	6	Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p3	3	5	7	8	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
P	1	3	7	8	X(R)	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.07	0.09	0.11	0.13	0.15	0.17	0.20	0.22	0.25	0.28	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48
R	0.01	0.06	0.28	0.48	Y(I)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.84	0.76	0.76	0.84	1.00	0.95	0.92	0.92	0.95	1.00	0.96	0.91	0.84	0.76	0.67	0.56	0.44	0.31	0.16	0.00
EMV1	15	25	30	40	Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.68	0.82	0.92	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV2	20	30	30	50	Y (R)	0.00	0.01	0.04	0.09	0.16	0.25	0.41	0.57	0.74	0.88	1.00	0.84	0.76	0.76	0.84	1.00	0.95	0.92	0.92	0.95	1.00	0.86	0.73	0.59	0.46	0.33	0.22	0.13	0.06	0.02	0.00
EMV3	20	25	35	40	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
EMV(C1)	15	25	35	50	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					XEMV(C1)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.50	38.00	39.50	41.00	42.50	44.00	45.50	47.00	48.50	50.00
EMV2					YEMV1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.35	0.20	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV3					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.95	0.90	0.85	0.80	0.75	0.68	0.60	0.53	0.45	0.38	0.30	0.23	0.15	0.08	0.00
EMV(C2)	0	0	0	0	YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.70	0.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.71	0.86	0.94	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.94	0.81	0.59	0.45	0.38	0.30	0.23	0.15	0.08	0.00
EMV2					Area	0.00	0.05	0.15	0.25	0.35	0.45	0.61	0.78	0.90	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.45	1.31	1.05	0.78	0.62	0.51	0.39	0.28	0.17	0.06
EMV3					Xarea	0.00	0.78	2.48	4.38	6.48	8.78	12.42	16.86	20.25	22.70	24.35	25.50	26.50	27.50	28.50	29.50	30.50	31.50	32.50	33.50	34.50	51.93	48.74	40.74	31.51	25.83	21.90	17.62	13.01	8.06	2.77
EMV(C3)	0	0	0	0	XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV	15	25	35	50	YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	0.15	1.50	9.80	24.00	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	11.3209				YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	83.7656				YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Defuzzified PREMC	7.3992				Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					X(EMV)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.00	27.00	28.00	29.00	30.00	31.00	32.00	33.00	34.00	35.00	36.50	38.00	39.50	41.00	42.50	44.00	45.50	47.00	48.50	50.00
					Y(EMV)	0.00	0.10	0.20	0.30	0.40	0.50	0.71	0.86	0.94	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.94	0.81	0.59	0.45	0.38	0.30	0.23	0.15	0.08	0.00
					Area	0.00	0.05	0.15	0.25	0.35	0.45	0.61	0.78	0.90	0.97	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.45	1.31	1.05	0.78	0.62	0.51	0.39	0.28	0.17	0.06
					Xarea	0.00	0.78	2.48	4.38	6.48	8.78	12.42	16.86	20.25	22.70	24.35	25.50	26.50	27.50	28.50	29.50	30.50	31.50	32.50	33.50	34.50	51.93	48.74	40.74	31.51	25.83	21.90	17.62	13.01	8.06	2.77
					X PREMC	0.15	0.21	0.29	0.37	0.48	0.60	0.74	0.90	1.08	1.28	1.50	1.94	2.46	3.06	3.74	4.50	5.36	6.31	7.37	8.53	9.80	10.88	12.04	13.26	14.56	15.94	17.39	18.92	20.53	22.22	24.00
					YPREMC	0.00	0.00	0.01	0.03	0.06	0.13	0.29	0.49	0.69	0.87	1.00	0.84	0.76	0.76	0.84	1.00	0.95	0.92	0.92	0.95	1.00	0.81	0.59	0.35	0.21	0.12	0.07	0.03	0.01	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.00	0.01	0.03	0.06	0.11	0.16	0.21	0.41	0.41	0.45	0.54	0.70	0.83	0.89	0.97	1.08	1.24	0.98	0.81	0.57	0.36	0.23	0.14	0.07	0.03	0.01	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.10	0.18	0.29	0.70	0.91	1.25	1.84	2.90	4.11	5.19	6.64	8.62	11.35	10.14	9.23	7.25	5.01	3.46	2.32	1.35	0.62	0.19	0.02

1.2.1.1.1.1					X(I)	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.10	5.20	5.30	5.40	5.50	5.60	5.70	5.80	5.90	6.00
c1	2	3	5	6	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
c2	1	3	3	5	Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c3	3	4	4	6	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.90	0.80	0.70	0.60	0.50	0.45	0.40	0.35	0.30	0.25	0.20	0.15	0.10	0.05	0.00
C	1	3	5	6	X(P)	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.40	3.80	4.20	4.60	5.00	5.40	5.80	6.20	6.60	7.00	7.10	7.20	7.30	7.40	7.50	7.60	7.70	7.80	7.90	8.00
p1	1	3	5	6	Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	2	3	5	6	Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p3	3	5	7	8	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
P	1	3	7	8	X(R)	0.01	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.11	0.13	0.15	0.17	0.20	0.23	0.26	0.29	0.32	0.35	0.36	0.37	0.39	0.40	0.41	0.43	0.44	0.45	0.47	0.48
R	0.01	0.09	0.35	0.48	Y(I)	0.00	0.10	0.20	0.30	0.40	0.50	0.68	0.82	0.92	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.94	0.88	0.80	0.72	0.63	0.52	0.41	0.28	0.15	0.00
EMV1	30	40	50	60	Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.68	0.82	0.92	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV2	20	30	30	50	Y (R)	0.00	0.01	0.04	0.09	0.16	0.25	0.46	0.67	0.85	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.85	0.70	0.56	0.43	0.31	0.21	0.12	0.06	0.01	0.00
EMV3	20	25	35	40	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C1)	20	25	50	60	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					XEMV(C1)	20.00	20.50	21.00	21.50	22.00	22.50	23.00	23.50	24.00	24.50	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00
EMV2					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.75	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV3					YEMV2	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.75	1.00	0.88	0.75	0.63	0.50	0.38	0.25	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C2)	0	0	0	0	YEMV3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					YEMV(C1)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV2					Area	0.00	0.04	0.11	0.17	0.23	0.29	0.34	0.38	0.42	0.46	0.49	2.50	2.50	2.50	2.50	2.44	2.44	2.50	2.50	2.50	2.50	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
EMV3					Xarea	0.00	0.73	2.20	3.64	5.03	6.37	7.65	8.86	10.00	11.06	12.03	65.63	71.88	78.13	84.38	88.50	94.60	103.13	109.38	115.63	121.88	47.98	43.78	39.38	34.78	29.98	24.98	19.78	14.38	8.78	2.98
EMV(C3)	0	0	0	0	XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV	20	25	50	60	YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	0.20	2.25	17.50	28.80	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	18.9503				YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	207.9074				YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Defuzzified PREMC	10.9712				Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					X(EMV)	20.00	20.50	21.00	21.50	22.00	22.50	23.00	23.50	24.00	24.50	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00
					Y(EMV)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
					Area	0.00	0.04	0.11	0.17	0.23	0.29	0.34	0.38	0.42	0.46	0.49	2.50	2.50	2.50	2.50	2.44	2.44	2.50	2.50	2.50	2.50	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
					Xarea	0.00	0.73	2.20	3.64	5.03	6.37	7.65	8.86	10.00	11.06	12.03	65.63	71.88	78.13	84.38	88.50	94.60	103.13	109.38	115.63	121.88	47.98	43.78	39.38	34.78	29.98	24.98	19.78	14.38	8.78	2.98
					X PREMC	0.20	0.30	0.41	0.55	0.71	0.90	1.11	1.35	1.62	1.92	2.25	2.99	3.88	4.91	6.12	7.50	9.07	10.85	12.83	15.05	17.50	18.47	19.47	20.51	21.58	22.69	23.83	25.02	26.24	27.50	28.80
					YPREMC	0.00	0.00	0.01	0.04	0.08	0.16	0.33	0.54	0.74	0.91	1.00	1.00	1.00	1.00	1.00	0.95	1.00	1.00	1.00	1.00	1.00	0.77	0.56	0.39	0.26	0.16	0.08	0.04	0.01	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.11	0.17	0.25	0.31	0.74	0.88	1.04	1.20	1.35	1.54	1.77	1.99	2.21	2.45	0.85	0.67	0.50	0.35	0.23	0.14	0.07	0.03	0.01	0.00
					Xarea	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.13	0.26	0.44	0.65	1.94	3.04	4.56	6.64	9.19	12.72	17.67	23.54	30.87	39.90	15.35	12.62	9.92	7.38	5.10	3.19	1.73	0.75	0.21	0.03

1.2.1.1.1.2				
c1	3	5	7	8
c2	6	8	8	9
c3	3	4	4	6
C	3	4	8	9
p1	3	4	5	6
p2	2	3	3	5
p3	5	6	6	7
P	2	3	6	7
R	0.06	0.12	0.48	0.63
EMV1	20	30	40	50
EMV2	15	25	30	40
EMV3	30	40	50	60
EMV(C1)	15	25	50	60
EMV1				
EMV2				
EMV3				
EMV(C2)	0	0	0	0
EMV1				
EMV2				
EMV3				
EMV(C3)	0	0	0	0
EMV	15	25	50	60
PREMC	0.90	3.00	24.00	37.80
Area	22.3761			
Xarea	328.3542			
Defuzzified PREMC	14.6743			

X(I)	3.00	3.10	3.20	3.30	3.40	3.50	3.60	3.70	3.80	3.90	4.00	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00	8.10	8.20	8.30	8.40	8.50	8.60	8.70	8.80	8.90	9.00
Y1	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.70	0.90	1.00	1.00	1.00	1.00	1.00	0.80	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
X(P)	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00
Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.60	0.90	1.00	1.00	1.00	0.90	0.60	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.85	0.70	0.55	0.40	0.25	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.40	0.70	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
X(R)	0.06	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.11	0.11	0.12	0.15	0.17	0.20	0.24	0.27	0.31	0.35	0.39	0.43	0.48	0.49	0.51	0.52	0.54	0.55	0.57	0.58	0.60	0.61	0.63
Y(I)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	0.94	0.96	1.00	1.00	1.00	1.00	1.00	0.92	0.88	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.90	0.88	0.96	1.00	1.00	1.00	0.91	0.76	0.79	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y (R)	0.00	0.01	0.06	0.12	0.21	0.31	0.43	0.56	0.70	0.85	1.00	0.84	0.84	0.96	1.00	1.00	1.00	0.91	0.70	0.70	1.00	0.81	0.64	0.49	0.36	0.25	0.16	0.09	0.04	0.01	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.03	0.03	0.04	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XEMV(C1)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.75	1.00	1.00	1.00	1.00	1.00	0.75	0.50	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	0.75	0.50	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.75	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.64	0.76	0.86	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Area	0.00	0.05	0.15	0.25	0.35	0.45	0.57	0.70	0.81	0.90	0.97	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
Xarea	0.00	0.78	2.48	4.38	6.48	8.78	11.69	15.05	18.23	21.15	23.77	65.63	71.88	78.13	84.38	90.63	96.88	103.13	109.38	115.63	121.88	47.98	43.78	39.38	34.78	29.98	24.98	19.78	14.38	8.78	2.98
XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
X(EMV)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	51.00	52.00	53.00	54.00	55.00	56.00	57.00	58.00	59.00	60.00
Y(EMV)	0.00	0.10	0.20	0.30	0.40	0.50	0.64	0.76	0.86	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Area	0.00	0.05	0.15	0.25	0.35	0.45	0.57	0.70	0.81	0.90	0.97	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
Xarea	0.00	0.78	2.48	4.38	6.48	8.78	11.69	15.05	18.23	21.15	23.77	65.63	71.88	78.13	84.38	90.63	96.88	103.13	109.38	115.63	121.88	47.98	43.78	39.38	34.78	29.98	24.98	19.78	14.38	8.78	2.98
X PREMC	0.90	1.04	1.20	1.37	1.55	1.75	1.97	2.20	2.45	2.71	3.00	3.99	5.18	6.59	8.23	10.13	12.29	14.74	17.50	20.58	24.00	25.20	26.44	27.71	29.03	30.39	31.79	33.23	34.71	36.23	37.80
YPREMC	0.00	0.00	0.01	0.04	0.08	0.16	0.28	0.43	0.61	0.80	1.00	0.84	0.84	0.96	1.00	1.00	1.00	0.91	0.70	0.70	1.00	0.73	0.51	0.34	0.22	0.13	0.06	0.03	0.01	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.08	0.13	0.19	0.26	0.91	1.00	1.27	1.60	1.89	2.16	2.34	2.22	2.15	2.90	1.04	0.77	0.55	0.37	0.23	0.13	0.07	0.03	0.01	0.00
Xarea	0.00	0.00	0.00	0.01	0.02	0.04	0.09	0.17	0.30	0.48	0.73	3.20	4.61	7.45	11.89	17.37	24.24	31.63	35.75	40.89	64.67	25.50	19.83	14.78	10.44	6.87	4.11	2.13	0.88	0.24	0.03

1.2.1.1.2.1				
c1	2	4	4	6
c2	3	6	6	8
c3	6	7	8	9
C	2	4	8	9
p1	3	4	7	8
p2	3	4	5	6
p3	1	3	3	5
P	1	3	7	8
R	0.02	0.12	0.56	0.72
EMV1	20	25	35	40
EMV2	20	30	40	50
EMV3	15	25	30	40
EMV(C1)	15	25	40	50
EMV1				
EMV2				
EMV3				
EMV(C2)	0	0	0	0
EMV1				
EMV2				
EMV3				
EMV(C3)	0	0	0	0
EMV	15	25	40	50
PREMC	0.30	3.00	22.40	36.00
Area	22.3788			
Xarea	316.6936			
Defuzzified PREMC	14.1515			

X(I)	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.40	4.80	5.20	5.60	6.00	6.40	6.80	7.20	7.60	8.00	8.10	8.20	8.30	8.40	8.50	8.60	8.70	8.80	8.90	9.00
Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.13	0.20	0.27	0.33	0.47	0.60	0.73	0.87	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.80	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
X(P)	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.40	3.80	4.20	4.60	5.00	5.40	5.80	6.20	6.60	7.00	7.10	7.20	7.30	7.40	7.50	7.60	7.70	7.80	7.90	8.00
Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.80	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
X(R)	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.11	0.12	0.15	0.18	0.22	0.26	0.30	0.35	0.39	0.45	0.50	0.56	0.58	0.59	0.61	0.62	0.64	0.65	0.67	0.69	0.70	0.72
Y(I)	0.00	0.10	0.20	0.30	0.40	0.50	0.63	0.74	0.84	0.93	1.00	0.89	0.84	0.84	0.89	1.00	0.88	0.92	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.93	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y(R)	0.00	0.01	0.04	0.09	0.16	0.25	0.38	0.52	0.67	0.83	1.00	0.83	0.83	0.84	0.89	1.00	0.88	0.92	1.00	1.00	1.00	0.81	0.64	0.49	0.36	0.25	0.16	0.09	0.04	0.01	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.06	0.06	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XEMV(C1)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.50	28.00	29.50	31.00	32.50	34.00	35.50	37.00	38.50	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.60	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.65	0.80	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
YEMV3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	0.90	0.75	0.60	0.45	0.30	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.71	0.86	0.94	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Area	0.00	0.05	0.15	0.25	0.35	0.45	0.61	0.78	0.90	0.97	0.99	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
Xarea	0.00	0.78	2.48	4.38	6.48	8.78	12.42	16.86	20.25	22.70	24.35	38.63	40.88	43.13	45.38	47.63	49.88	52.13	54.38	56.63	58.88	38.48	35.28	31.88	28.28	24.48	20.48	16.28	11.88	7.28	2.48
XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
X(EMV)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.50	28.00	29.50	31.00	32.50	34.00	35.50	37.00	38.50	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
Y(EMV)	0.00	0.10	0.20	0.30	0.40	0.50	0.71	0.86	0.94	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Area	0.00	0.05	0.15	0.25	0.35	0.45	0.61	0.78	0.90	0.97	0.99	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0.95	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05
Xarea	0.00	0.78	2.48	4.38	6.48	8.78	12.42	16.86	20.25	22.70	24.35	38.63	40.88	43.13	45.38	47.63	49.88	52.13	54.38	56.63	58.88	38.48	35.28	31.88	28.28	24.48	20.48	16.28	11.88	7.28	2.48
X PREMC	0.30	0.42	0.57	0.75	0.96	1.20	1.48	1.80	2.15	2.55	3.00	3.96	5.11	6.44	7.99	9.75	11.75	14.00	16.52	19.31	22.40	23.58	24.80	26.05	27.35	28.69	30.07	31.49	32.95	34.45	36.00
YPREMC	0.00	0.00	0.01	0.03	0.06	0.13	0.27	0.44	0.63	0.82	1.00	0.83	0.83	0.84	0.89	1.00	0.88	0.92	1.00	1.00	1.00	0.73	0.51	0.34	0.22	0.12	0.06	0.03	0.01	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.11	0.19	0.29	0.41	0.88	0.95	1.11	1.34	1.67	1.88	2.03	2.41	2.79	3.09	1.02	0.76	0.54	0.36	0.23	0.13	0.06	0.03	0.01	0.00
Xarea	0.00	0.00	0.00	0.00	0.01	0.02	0.07	0.18	0.38	0.69	1.13	3.07	4.29	6.43	9.65	14.81	20.21	26.08	36.85	50.07	64.41	23.43	18.28	13.66	9.68	6.39	3.83	1.99	0.82	0.23	0.03

1.2.1.1.2.2					X(I)	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.30	4.60	4.90	5.20	5.50	5.80	6.10	6.40	6.70	7.00	7.10	7.20	7.30	7.40	7.50	7.60	7.70	7.80	7.90	8.00
c1	3	6	7	8	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.13	0.20	0.27	0.33	0.43	0.53	0.63	0.73	0.83	0.93	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
c2	2	4	4	6	Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.85	0.70	0.55	0.40	0.25	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c3	3	5	5	7	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.65	0.80	0.95	0.90	0.75	0.60	0.45	0.30	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	2	4	7	8	X(P)	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.20	5.40	5.60	5.80	6.00	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00
p1	3	4	5	6	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	2	4	4	7	Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.93	0.87	0.80	0.73	0.67	0.60	0.53	0.47	0.40	0.33	0.30	0.27	0.23	0.20	0.17	0.13	0.10	0.07	0.03	0.00
p3	3	5	6	7	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
P	2	4	6	7	X(R)	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.12	0.13	0.14	0.16	0.18	0.20	0.23	0.25	0.28	0.30	0.33	0.36	0.39	0.42	0.43	0.45	0.46	0.47	0.49	0.50	0.52	0.53	0.55	0.56
R	0.04	0.16	0.42	0.56	Y(I)	0.00	0.10	0.20	0.30	0.40	0.50	0.66	0.79	0.89	0.96	1.00	0.97	0.97	0.99	0.98	0.97	0.98	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV1	20	30	40	50	Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.71	0.86	0.94	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.93	0.85	0.77	0.68	0.58	0.48	0.37	0.25	0.13	0.00
EMV2	10	15	25	30	Y(R)	0.00	0.01	0.04	0.09	0.16	0.25	0.47	0.68	0.84	0.94	1.00	0.97	0.97	0.99	0.98	0.97	0.98	1.00	1.00	1.00	1.00	0.84	0.68	0.54	0.41	0.29	0.19	0.11	0.05	0.01	0.00
EMV3	30	40	40	60	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C1)	10	15	40	60	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					XEMV(C1)	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	14.00	14.50	15.00	17.50	20.00	22.50	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.00	44.00	46.00	48.00	50.00	52.00	54.00	56.00	58.00	60.00
EMV2					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.75	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00
EMV3					YEMV2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C2)	0	0	0	0	YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.75	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV1					YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	0.88	1.00	1.00	1.00	1.00	1.00	0.98	0.92	0.82	0.68	0.50	0.40	0.30	0.20	0.10	0.00
EMV2					Area	0.00	0.03	0.08	0.13	0.18	0.23	0.28	0.33	0.38	0.43	0.48	2.50	2.50	2.50	2.50	2.34	2.34	2.50	2.50	2.50	2.50	1.98	1.90	1.74	1.50	1.18	0.90	0.70	0.50	0.30	0.10
EMV3					Xarea	0.00	0.26	0.81	1.41	2.06	2.76	3.51	4.31	5.16	6.06	7.01	40.63	46.88	53.13	59.38	61.52	67.38	78.13	84.38	90.63	96.88	81.18	81.70	78.30	70.50	57.82	45.90	37.10	27.50	17.10	5.90
EMV(C3)	0	0	0	0	XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV	10	15	40	60	YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	0.40	2.40	16.80	33.60	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	19.2476				YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	225.5385				YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Defuzzified					Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC		11.7178			Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					X(EMV)	10.00	10.50	11.00	11.50	12.00	12.50	13.00	13.50	14.00	14.50	15.00	17.50	20.00	22.50	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.00	44.00	46.00	48.00	50.00	52.00	54.00	56.00	58.00	60.00
					Y(EMV)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	0.88	1.00	1.00	1.00	1.00	1.00	0.98	0.92	0.82	0.68	0.50	0.40	0.30	0.20	0.10	0.00
					Area	0.00	0.03	0.08	0.13	0.18	0.23	0.28	0.33	0.38	0.43	0.48	2.50	2.50	2.50	2.50	2.34	2.34	2.50	2.50	2.50	2.50	1.98	1.90	1.74	1.50	1.18	0.90	0.70	0.50	0.30	0.10
					Xarea	0.00	0.26	0.81	1.41	2.06	2.76	3.51	4.31	5.16	6.06	7.01	40.63	46.88	53.13	59.38	61.52	67.38	78.13	84.38	90.63	96.88	81.18	81.70	78.30	70.50	57.82	45.90	37.10	27.50	17.10	5.90
					X PREMC	0.40	0.51	0.63	0.78	0.94	1.13	1.33	1.56	1.81	2.09	2.40	3.16	4.05	5.07	6.24	7.56	9.05	10.71	12.54	14.57	16.80	18.19	19.64	21.16	22.73	24.38	26.08	27.86	29.70	31.62	33.60
					YPREMC	0.00	0.00	0.01	0.03	0.06	0.13	0.28	0.47	0.67	0.85	1.00	0.97	0.97	0.99	0.98	0.85	0.98	1.00	1.00	1.00	1.00	0.82	0.63	0.44	0.28	0.15	0.08	0.03	0.01	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.01	0.02	0.04	0.09	0.15	0.21	0.28	0.75	0.86	1.00	1.15	1.21	1.35	1.64	1.84	2.03	2.23	1.27	1.05	0.81	0.57	0.35	0.19	0.10	0.04	0.01	0.00
					Xarea	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.13	0.25	0.42	0.64	2.08	3.11	4.58	6.53	8.36	11.25	16.17	21.37	27.50	34.94	22.14	19.88	16.52	12.45	8.19	4.80	2.64	1.15	0.34	0.04

1.2.2.1.1.1					X(I)	4.00	4.10	4.20	4.30	4.40	4.50	4.60	4.70	4.80	4.90	5.00	5.30	5.60	5.90	6.20	6.50	6.80	7.10	7.40	7.70	8.00	8.30	8.50	8.70	8.90	9.10	9.30	9.50	9.70	9.90	10.10
c1	6	7	7	10	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.50	0.80	0.97	0.87	0.77	0.67	0.57	0.50	0.43	0.37	0.30	0.23	0.17	0.10	0.03	0.00
c2	4	5	5	6	Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.70	0.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c3	5	7	8	9	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.30	0.45	0.60	0.75	0.90	1.00	1.00	1.00	1.00	0.70	0.50	0.30	0.10	0.00	0.00	0.00	0.00	0.00	0.00
C	4	5	8	10	X(P)	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00	2.40	2.80	3.20	3.60	4.00	4.40	4.80	5.20	5.60	6.00	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00
p1	1	2	4	5	Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	3	5	6	7	Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.30	0.50	0.70	0.90	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
p3	3	4	5	5	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.60	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	1	2	6	7	X(R)	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.09	0.09	0.10	0.13	0.16	0.19	0.22	0.26	0.30	0.34	0.38	0.43	0.48	0.51	0.53	0.55	0.57	0.59	0.61	0.64	0.66	0.68	0.71
R	0.04	0.10	0.48	0.70	Y(I)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.75	0.58	0.51	0.68	0.87	0.98	1.00	1.00	1.00	1.00	0.87	0.75	0.60	0.43	0.30	0.23	0.17	0.10	0.03	0.00
EMV1	40	70	70	80	Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV2	50	60	60	90	Y (R)	0.00	0.01	0.04	0.09	0.16	0.25	0.36	0.49	0.64	0.81	1.00	0.75	0.58	0.51	0.68	0.87	0.98	1.00	1.00	1.00	1.00	0.78	0.60	0.42	0.26	0.15	0.09	0.05	0.02	0.00	0.00
EMV3	30	50	50	70	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.03	0.04	0.04	0.04	0.05	0.05	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C1)	30	50	70	90	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					XEMV(C1)	30.00	32.00	34.00	36.00	38.00	40.00	42.00	44.00	46.00	48.00	50.00	52.00	54.00	56.00	58.00	60.00	62.00	64.00	66.00	68.00	70.00	72.00	74.00	76.00	78.00	80.00	82.00	84.00	86.00	88.00	90.00
EMV2					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.13	0.20	0.27	0.33	0.40	0.47	0.53	0.60	0.67	0.73	0.80	0.87	0.93	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00
EMV3					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	0.93	0.87	0.80	0.73	0.67	0.60	0.53	0.47	0.40	0.33	0.27	0.20	0.13	0.07	0.00
EMV(C2)	0	0	0	0	YEMV3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.63	0.74	0.84	0.93	1.00	0.95	0.94	0.94	0.97	1.00	0.99	0.98	0.98	0.98	1.00	0.92	0.81	0.68	0.52	0.33	0.27	0.20	0.13	0.07	0.00
EMV2					Area	0.00	0.10	0.30	0.50	0.70	0.90	1.13	1.37	1.58	1.77	1.93	1.95	1.89	1.88	1.91	1.97	1.99	1.97	1.96	1.96	1.98	1.92	1.73	1.49	1.20	0.85	0.60	0.47	0.33	0.20	0.07
EMV3					Xarea	0.00	3.10	9.90	17.50	25.90	35.10	46.19	58.77	71.10	83.03	94.41	99.55	100.06	103.40	108.98	116.11	121.35	124.15	127.40	131.50	136.90	136.32	126.53	112.00	92.40	67.41	48.60	38.73	28.33	17.40	5.93
EMV(C3)	0	0	0	0	XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV	30	50	70	90	YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	1.20	5.00	33.60	63.00	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	31.8105				YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	742.0724				YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Defuzzified					Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	23.3279				Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					X(EMV)	30.00	32.00	34.00	36.00	38.00	40.00	42.00	44.00	46.00	48.00	50.00	52.00	54.00	56.00	58.00	60.00	62.00	64.00	66.00	68.00	70.00	72.00	74.00	76.00	78.00	80.00	82.00	84.00	86.00	88.00	90.00
					Y(EMV)	0.00	0.10	0.20	0.30	0.40	0.50	0.63	0.74	0.84	0.93	1.00	0.95	0.94	0.94	0.97	1.00	0.99	0.98	0.98	0.98	1.00	0.92	0.81	0.68	0.52	0.33	0.27	0.20	0.13	0.07	0.00
					Area	0.00	0.10	0.30	0.50	0.70	0.90	1.13	1.37	1.58	1.77	1.93	1.95	1.89	1.88	1.91	1.97	1.99	1.97	1.96	1.96	1.98	1.92	1.73	1.49	1.20	0.85	0.60	0.47	0.33	0.20	0.07
					Xarea	0.00	3.10	9.90	17.50	25.90	35.10	46.19	58.77	71.10	83.03	94.41	99.55	100.06	103.40	108.98	116.11	121.35	124.15	127.40	131.50	136.90	136.32	126.53	112.00	92.40	67.41	48.60	38.73	28.33	17.40	5.93
					X PREMC	1.20	1.44	1.71	2.01	2.34	2.70	3.09	3.52	3.97	4.47	5.00	6.61	8.47	10.57	12.95	15.60	18.55	21.81	25.40	29.32	33.60	36.45	39.00	41.66	44.43	47.32	50.33	53.47	56.73	60.11	63.63
					YPREMC	0.00	0.00	0.01	0.03	0.06	0.13	0.23	0.36	0.54	0.75	1.00	0.71	0.54	0.48	0.66	0.87	0.97	0.98	0.98	0.98	1.00	0.72	0.49	0.29	0.13	0.05	0.02	0.01	0.00	0.00	0.00
					Area	0.00	0.00	0.00	0.01	0.01	0.03	0.07	0.12	0.21	0.32	0.46	1.38	1.16	1.07	1.35	2.03	2.72	3.18	3.51	3.85	4.24	2.45	1.54	1.03	0.58	0.27	0.11	0.05	0.02	0.00	0.00
					Xarea	0.00	0.00	0.00	0.01	0.03	0.09	0.20	0.41	0.77	1.34	2.20	8.01	8.75	10.22	15.83	29.04	46.46	64.19	82.94	105.37	133.53	85.98	57.99	41.54	25.15	12.21	5.51	2.84	1.14	0.29	0.02

1.2.2.1.1.2					X(I)	5.00	5.10	5.20	5.30	5.40	5.50	5.60	5.70	5.80	5.90	6.00	6.20	6.40	6.60	6.80	7.00	7.20	7.40	7.60	7.80	8.00	8.10	8.20	8.30	8.40	8.50	8.60	8.70	8.80	8.90	9.00
c1	5	7	7	8	Y1	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c2	5	6	6	7	Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c3	6	7	8	9	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
C	5	6	8	9	X(P)	5.00	5.10	5.20	5.30	5.40	5.50	5.60	5.70	5.80	5.90	6.00	6.40	6.80	7.20	7.60	8.00	8.40	8.80	9.20	9.60	10.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
p1	8	9	10	10	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.80	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	5	6	7	8	Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	0.80	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p3	5	7	8	9	Y3	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.70	0.90	1.00	1.00	1.00	0.60	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P	5	6	10	10	X(R)	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.32	0.34	0.35	0.36	0.40	0.44	0.48	0.52	0.56	0.60	0.65	0.70	0.75	0.80	0.00	0.01	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08
R	0.25	0.36	0.80	0.90	Y(I)	0.00	0.15	0.28	0.40	0.52	0.62	0.72	0.80	0.88	0.94	1.00	0.94	0.93	0.95	0.98	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV1	30	40	40	60	Y(P)	0.00	0.15	0.28	0.40	0.52	0.62	0.72	0.80	0.88	0.94	1.00	1.00	1.00	1.00	1.00	1.00	0.76	0.84	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV2	30	40	40	50	Y(R)	0.00	0.02	0.08	0.16	0.27	0.39	0.52	0.65	0.77	0.89	1.00	0.94	0.93	0.95	0.98	1.00	0.76	0.84	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV3	15	30	30	35	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C1)	15	30	40	60	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1	20	30	40	50	XEMV(C1)	15.00	16.50	18.00	19.50	21.00	22.50	24.00	25.50	27.00	28.50	30.00	31.00	32.00	33.00	34.00	35.00	36.00	37.00	38.00	39.00	40.00	42.00	44.00	46.00	48.00	50.00	52.00	54.00	56.00	58.00	60.00
EMV2	30	30	40	40	YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV3	15	25	30	50	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C2)	15	25	40	50	YEMV3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.84	0.74	0.71	0.71	0.75	0.84	0.91	0.96	0.99	1.00	0.98	0.92	0.82	0.68	0.50	0.40	0.30	0.20	0.10	0.00
EMV2					Area	0.00	0.08	0.23	0.38	0.53	0.68	0.83	0.98	1.13	1.28	1.43	0.92	0.79	0.73	0.71	0.73	0.80	0.88	0.94	0.98	1.00	1.98	1.90	1.74	1.50	1.18	0.90	0.70	0.50	0.30	0.10
EMV3					Xarea	0.00	1.18	3.88	7.03	10.63	14.68	19.18	24.13	29.53	35.38	41.68	28.03	24.92	23.56	23.75	25.22	28.22	31.94	35.06	37.54	39.30	81.18	81.70	78.30	70.50	57.82	45.90	37.10	27.50	17.10	5.90
EMV(C3)	0	0	0	0	XEMV(C2)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	26.50	28.00	29.50	31.00	32.50	34.00	35.50	37.00	38.50	40.00	41.00	42.00	43.00	44.00	45.00	46.00	47.00	48.00	49.00	50.00
EMV	30	55	80	110	YEMV1	0.00	0.00	0.00	0.00	0.10	0.25	0.40	0.55	0.70	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	7.50	19.80	64.00	99.00	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	44.1381				YEMV3	0.00	0.15	0.30	0.45	0.60	0.75	0.90	1.00	1.00	1.00	1.00	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.40	0.30	0.20	0.10	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	1655.1396				YEMV(C2)	0.00	0.15	0.30	0.45	0.64	0.81	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.88	0.72	0.52	0.28	0.00	0.00	0.00	0.00	0.00	0.00
Defuzzified					Area	0.00	0.08	0.23	0.38	0.55	0.73	0.88	0.97	1.00	1.00	1.00	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	0.94	0.80	0.62	0.40	0.14	0.00	0.00	0.00	0.00	0.00
PREMC	37.4991				Xarea	0.00	1.16	3.71	6.56	10.08	14.16	17.96	20.86	22.50	23.50	24.50	38.63	40.88	43.13	45.38	47.63	49.88	52.13	54.38	56.63	58.88	38.07	33.20	26.35	17.40	6.23	0.00	0.00	0.00	0.00	0.00
					XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					X(EMV)	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	52.50	55.00	57.50	60.00	62.50	65.00	67.50	70.00	72.50	75.00	77.50	80.00	83.00	86.00	89.00	92.00	95.00	98.00	101.00	104.00	107.00	110.00
					Y(EMV)	0.00	0.24	0.44	0.62	0.78	0.91	0.98	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.91	0.77	0.50	0.40	0.30	0.20	0.10	0.00
					Area	0.00	0.29	0.84	1.32	1.75	2.11	2.35	2.47	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	3.00	2.96	2.84	2.52	1.90	1.35	1.05	0.75	0.45	0.15
					Xarea	0.00	9.18	28.48	47.80	67.76	87.15	102.94	114.24	121.88	128.13	134.38	140.63	146.88	153.13	159.38	165.63	171.88	178.13	184.38	190.63	196.88	244.21	250.36	248.22	228.49	178.06	130.28	104.48	76.88	47.48	16.28
					X PREMC	7.50	8.45	9.46	10.53	11.66	12.86	14.11	15.43	16.82	18.28	19.80	22.82	26.11	29.70	33.59	37.80	42.34	47.21	52.44	58.03	64.00	0.00	0.71	1.48	2.32	3.23	4.21	5.27	6.41	7.62	8.91
					YPREMC	0.00	0.00	0.03	0.10	0.21	0.35	0.51	0.65	0.77	0.89	1.00	0.94	0.93	0.95	0.98	1.00	0.76	0.84	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.00	0.02	0.07	0.18	0.34	0.54	0.76	0.99	1.21	1.44	2.92	3.07	3.37	3.77	4.17	3.99	3.90	4.81	5.59	2.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.02	0.18	0.72	1.96	4.14	7.28	11.26	15.91	21.29	27.48	62.21	75.15	94.12	119.22	149.01	159.94	174.65	239.65	308.88	182.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

1.2.2.1.2.1				
c1	2	3	4	6
c2	2	4	4	7
c3	4	6	6	8
C	2	3	6	8
p1	1	3	4	5
p2	3	5	6	7
p3	4	5	6	7
P	1	3	6	7
R	0.02	0.09	0.36	0.56
EMV1	15	25	30	50
EMV2	30	40	40	70
EMV3	30	50	50	80
EMV(C1)	15	25	50	80
EMV1				
EMV2				
EMV3				
EMV(C2)	0	0	0	0
EMV1				
EMV2				
EMV3				
EMV(C3)	0	0	0	0
EMV	15	25	50	80
PREMC	0.30	2.25	18.00	44.80
Area	22.8971			
Xarea	330.6135			
Defuzzified PREMC	14.4391			

X(I)	2.00	2.10	2.20	2.30	2.40	2.50	2.60	2.70	2.80	2.90	3.00	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00	6.20	6.40	6.60	6.80	7.00	7.20	7.40	7.60	7.80	8.00
Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	0.90	0.75	0.60	0.45	0.30	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y2	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.65	0.80	0.95	0.93	0.83	0.73	0.63	0.53	0.43	0.33	0.27	0.20	0.13	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.25	0.40	0.55	0.70	0.85	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
X(P)	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.30	3.60	3.90	4.20	4.50	4.80	5.10	5.40	5.70	6.00	6.10	6.20	6.30	6.40	6.50	6.60	6.70	6.80	6.90	7.00
Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	0.80	0.50	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.30	0.45	0.60	0.75	0.90	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.50	0.80	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
X(R)	0.02	0.03	0.03	0.04	0.04	0.05	0.06	0.06	0.07	0.08	0.09	0.11	0.13	0.15	0.18	0.20	0.23	0.26	0.29	0.32	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.52	0.54	0.56
Y(I)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	1.00	1.00	1.00	0.99	0.97	0.94	0.91	0.90	0.93	1.00	0.93	0.84	0.74	0.63	0.50	0.40	0.30	0.20	0.10	0.00
Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	0.94	0.94	0.98	1.00	1.00	1.00	1.00	0.99	0.96	0.91	0.84	0.75	0.64	0.51	0.36	0.19	0.00
Y (R)	0.00	0.01	0.06	0.12	0.21	0.31	0.43	0.56	0.70	0.85	1.00	1.00	1.00	1.00	0.93	0.91	0.92	0.91	0.90	0.93	1.00	0.92	0.81	0.67	0.53	0.38	0.26	0.15	0.07	0.02	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XEMV(C1)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	53.00	56.00	59.00	62.00	65.00	68.00	71.00	74.00	77.00	80.00
YEMV1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	0.88	0.75	0.63	0.50	0.38	0.25	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.75	1.00	0.92	0.83	0.75	0.67	0.57	0.47	0.37	0.27	0.17	0.07	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
YEMV(C1)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	0.92	0.91	0.94	1.00	0.98	0.97	0.97	1.00	0.96	0.89	0.81	0.71	0.58	0.44	0.30	0.20	0.10	0.00
Area	0.00	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95	2.50	2.50	2.40	2.28	2.31	2.43	2.48	2.44	2.43	2.47	2.94	2.78	2.56	2.28	1.94	1.54	1.11	0.75	0.45	0.15
Xarea	0.00	0.78	2.48	4.38	6.48	8.78	11.28	13.98	16.88	19.98	23.28	65.63	71.88	74.92	76.96	83.72	94.04	102.12	106.60	112.24	120.21	151.15	151.24	146.91	137.64	122.87	102.08	77.15	54.38	33.98	11.78
XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
X(EMV)	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00	25.00	27.50	30.00	32.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	53.00	56.00	59.00	62.00	65.00	68.00	71.00	74.00	77.00	80.00
Y(EMV)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	0.92	0.91	0.94	1.00	0.98	0.97	0.97	1.00	0.96	0.89	0.81	0.71	0.58	0.44	0.30	0.20	0.10	0.00
Area	0.00	0.05	0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95	2.50	2.50	2.40	2.28	2.31	2.43	2.48	2.44	2.43	2.47	2.94	2.78	2.56	2.28	1.94	1.54	1.11	0.75	0.45	0.15
Xarea	0.00	0.78	2.48	4.38	6.48	8.78	11.28	13.98	16.88	19.98	23.28	65.63	71.88	74.92	76.96	83.72	94.04	102.12	106.60	112.24	120.21	151.15	151.24	146.91	137.64	122.87	102.08	77.15	54.38	33.98	11.78
X PREMC	0.30	0.40	0.52	0.66	0.82	1.00	1.20	1.43	1.67	1.95	2.25	2.99	3.89	4.94	6.17	7.59	9.22	11.05	13.12	15.43	18.00	20.04	22.22	24.53	26.98	29.58	32.31	35.20	38.24	41.44	44.80
YPREMC	0.00	0.00	0.01	0.04	0.08	0.16	0.26	0.39	0.56	0.77	1.00	1.00	1.00	0.92	0.84	0.85	0.92	0.89	0.87	0.90	1.00	0.88	0.72	0.55	0.37	0.22	0.11	0.05	0.01	0.00	0.00
Area	0.00	0.00	0.00	0.00	0.01	0.02	0.04	0.07	0.12	0.18	0.27	0.74	0.89	1.01	1.08	1.21	1.44	1.67	1.83	2.05	2.44	1.92	1.74	1.46	1.12	0.77	0.45	0.23	0.09	0.03	0.00
Xarea	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.10	0.18	0.33	0.56	1.95	3.07	4.47	6.02	8.30	12.11	16.88	22.06	29.30	40.82	36.51	36.75	34.20	28.95	21.66	14.04	7.73	3.37	1.04	0.14

1.2.2.1.2.2					X(I)	5.00	5.10	5.20	5.30	5.40	5.50	5.60	5.70	5.80	5.90	6.00	6.20	6.40	6.60	6.80	7.00	7.20	7.40	7.60	7.80	8.00	8.20	8.40	8.60	8.80	9.00	9.20	9.40	9.60	9.80	10.00
c1	6	7	8	10	Y1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.40	0.60	0.80	1.00	1.00	1.00	1.00	1.00	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
c2	5	6	6	9	Y2	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.93	0.87	0.80	0.73	0.67	0.60	0.53	0.47	0.40	0.33	0.27	0.20	0.13	0.07	0.00	0.00	0.00	0.00	0.00	0.00
c3	5	7	7	8	Y3	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.60	0.70	0.80	0.90	1.00	0.80	0.60	0.40	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C	5	6	8	10	X(P)	4.00	4.10	4.20	4.30	4.40	4.50	4.60	4.70	4.80	4.90	5.00	5.30	5.60	5.90	6.20	6.50	6.80	7.10	7.40	7.70	8.00	8.30	8.50	8.70	8.90	9.10	9.30	9.50	9.70	9.90	10.10
p1	4	5	5	6	Y1	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.70	0.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
p2	6	7	8	9	Y2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.50	0.80	1.00	1.00	1.00	1.00	0.70	0.50	0.30	0.10	0.00	0.00	0.00	0.00	0.00	0.00
p3	5	8	8	10	Y3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.85	0.75	0.65	0.55	0.45	0.35	0.25	0.15	0.05	0.00
P	4	5	8	10	X(R)	0.20	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.30	0.33	0.36	0.39	0.42	0.46	0.49	0.53	0.56	0.60	0.64	0.68	0.71	0.75	0.78	0.82	0.86	0.89	0.93	0.97	1.01
R	0.20	0.30	0.64	1.00	Y(I)	0.00	0.15	0.28	0.40	0.52	0.62	0.72	0.80	0.88	0.94	1.00	0.98	0.98	0.98	0.99	1.00	1.00	1.00	1.00	1.00	1.00	0.93	0.84	0.74	0.63	0.50	0.40	0.30	0.20	0.10	0.00
EMV1	50	60	60	90	Y(P)	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	0.73	0.52	0.37	0.52	0.75	0.92	1.00	1.00	1.00	1.00	0.96	0.88	0.76	0.60	0.45	0.35	0.25	0.15	0.05	0.00
EMV2	30	40	50	70	Y(R)	0.00	0.01	0.06	0.12	0.21	0.31	0.43	0.56	0.70	0.85	1.00	0.71	0.51	0.36	0.52	0.75	0.92	1.00	1.00	1.00	1.00	0.88	0.74	0.56	0.37	0.23	0.14	0.08	0.03	0.01	0.00
EMV3	30	35	45	60	Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.03	0.02	0.02	0.01	0.01	0.00	0.00	0.00	0.00
EMV(C1)	30	35	60	90	Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00	0.00
EMV1					XEMV(C1)	30.00	30.50	31.00	31.50	32.00	32.50	33.00	33.50	34.00	34.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	52.50	55.00	57.50	60.00	63.00	66.00	69.00	72.00	75.00	78.00	81.00	84.00	87.00	90.00
EMV2					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.75	1.00	0.90	0.80	0.70	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV3					YEMV2	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.75	1.00	1.00	1.00	1.00	1.00	0.88	0.75	0.63	0.50	0.35	0.20	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV(C2)	0	0	0	0	YEMV3	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.00	1.00	1.00	1.00	0.83	0.67	0.50	0.33	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV1					YEMV(C1)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.92	0.92	1.00	0.94	0.84	0.72	0.60	0.50	0.40	0.30	0.20	0.10	0.00
EMV2					Area	0.00	0.04	0.11	0.17	0.23	0.29	0.34	0.38	0.42	0.46	0.49	2.50	2.50	2.50	2.50	2.50	2.50	2.44	2.34	2.30	2.40	2.90	2.66	2.33	1.97	1.65	1.35	1.05	0.75	0.45	0.15
EMV3					Xarea	0.00	1.10	3.27	5.35	7.34	9.23	11.01	12.68	14.22	15.63	16.90	90.63	96.88	103.13	109.38	115.63	121.88	125.12	125.63	129.27	141.14	178.50	171.73	157.44	139.06	121.28	103.28	83.48	61.88	38.48	13.28
EMV(C3)	0	0	0	0	XEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EMV	30	35	60	90	YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PREMC	6.00	10.50	38.40	90.00	YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Area	36.0209				YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xarea	1181.9682				YEMV(C2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Defuzzified PREMC	32.8134				Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					XEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					YEMV(C3)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Area	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Xarea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					X(EMV)	30.00	30.50	31.00	31.50	32.00	32.50	33.00	33.50	34.00	34.50	35.00	37.50	40.00	42.50	45.00	47.50	50.00	52.50	55.00	57.50	60.00	63.00	66.00	69.00	72.00	75.00	78.00	81.00	84.00	87.00	90.00
					Y(EMV)	0.00	0.15	0.28	0.41	0.52	0.63	0.72	0.81	0.88	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95	0.92	0.92	1.00	0.94	0.84	0.72	0.60	0.50	0.40	0.30	0.20	0.10	0.00
					Area	0.00	0.04	0.11	0.17	0.23	0.29	0.34	0.38	0.42	0.46	0.49	2.50	2.50	2.50	2.50	2.50	2.50	2.44	2.34	2.30	2.40	2.90	2.66	2.33	1.97	1.65	1.35	1.05	0.75	0.45	0.15
					Xarea	0.00	1.10	3.27	5.35	7.34	9.23	11.01	12.68	14.22	15.63	16.90	90.63	96.88	103.13	109.38	115.63	121.88	125.12	125.63	129.27	141.14	178.50	171.73	157.44	139.06	121.28	103.28	83.48	61.88	38.48	13.28
					X PREMC	6.00	6.38	6.77	7.18	7.60	8.04	8.50	8.97	9.47	9.97	10.50	12.32	14.34	16.55	18.97	21.61	24.48	27.58	30.93	34.53	38.40	42.88	47.12	51.63	56.39	61.42	66.74	72.33	78.22	84.41	90.90
					YPREMC	0.00	0.00	0.02	0.05	0.11	0.20	0.31	0.45	0.62	0.80	1.00	0.71	0.51	0.36	0.52	0.75	0.92	0.95	0.92	0.92	1.00	0.83	0.62	0.40	0.22	0.11	0.06	0.02	0.01	0.00	0.00
					Area	0.00	0.00	0.00	0.01	0.03	0.07	0.12	0.18	0.26	0.36	0.47	1.56	1.23	0.96	1.07	1.67	2.39	2.91	3.13	3.31	3.71	4.09	3.07	2.29	1.48	0.85	0.45	0.22	0.08	0.02	0.00
					Xarea	0.00	0.00	0.02	0.09	0.25	0.52	0.96	1.58	2.43	3.52	4.86	17.83	16.40	14.90	18.96	33.95	55.18	75.66	91.59	108.40	135.46	166.27	138.04	113.01	80.18	49.86	28.68	15.27	6.32	1.63	0.14