A LIFE CYCLE RISK MANAGEMENT AND PREDICTION SYSTEM FOR CONSTRUCTION JOINT VENTURES

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การวิจัยนี้มีวัตถุประสงค์เพื่อพัฒนา ระบบบริหารและทำนายความเสี่ยงตามวงจรชีวิตสำหรับกิจกรรมร่วมค้างานก่อสร้าง (A Life Cycle Risk Management and Prediction System หรือ ระบบ LCRMP) ที่มุ่งเน้นการพิจารณาพฤติกรรมของปัจจัยเสี่ยงแบบพลวัตตามวงจรชีวิตของกิจกรรมร่วมค้างานก่อสร้าง (CJV Life Cycle) ทั้งนี้ระบบ LCRMP แบ่งออกเป็นสองระบบย่อยได้แก่ ระบบย่อยสำหรับการบริหารความเสี่ยงแบบหลายวัตถุประสงค์ (Multi-Objective Risk Management Subsystem หรือ ระบบย่อย M-ORM) และระบบย่อยสำหรับทำนายความเสี่ยงแบบเมทริกซ์หลายปัจจัย (Multi-Determinant Risk Prediction Subsystem หรือ ระบบย่อย M-DRP) สำหรับระบบย่อยแรกเป็นการพัฒนาขึ้นตามขั้นตอนการบริหารความเสี่ยงของ ISO โดยระบบสามารถระบุและวิเคราะห์ปัจจัยเสี่ยงของ CJV ทั้ง 30 ปัจจัย ขณะเดียวกันก็นำเสนอแนวทางการตอบสนองต่อความเสี่ยง (Risk Treatment Options) สำหรับปัจจัยเสี่ยงแต่ละตัว ส่วนระบบย่อยที่สองใช้การพิจารณาปัจจัยแวดล้อมของ CJV (Determinant) จำนวน 48 ปัจจัย เป็นพื้นฐานของระบบ ซึ่งภายหลังนำไปสู่การพัฒนาเมทริกซ์หลายปัจจัย (Multi Determinant Matrix) ทั้งนี้การวิเคราะห์ข้อมูลสำหรับเมทริกซ์เหล่านี้ได้นำวิธีวิเคราะห์เชิงลำดับชั้น (Analytic Hierarchy Process หรือ AHP) มาเป็นเครื่องมือหลัก

ผลลัพธ์ของการวิจัยแสดงให้เห็นว่า พฤติกรรมของปัจจัยเสี่ยงสำหรับแต่ละช่วงในวงจรชีวิตของกิจกรรมร่วมค้างานก่อสร้างมีรูปแบบที่เป็นพลวัตอย่างชัดเจน ทั้งในประเด็นเกี่ยวกับจำนวนของปัจจัยเสี่ยง ผลกระทบ (Consequence) และโอกาสในการเกิด (Likelihood) ทั้งนี้จากการใช้สถิติที่ไม่ใช้พารามิเตอร (Nonparametric Statistics) พบว่ามีปัจจัยเสี่ยงจำนวน 21 ตัว ที่ผลกระทบและโอกาสในการเกิด มีความสัมพันธ์กับรูปแบบโครงสร้างองค์กรของ CJV (CJV Organization Structure) ที่ประกอบด้วยโครงสร้างแบบทำงานร่วมกัน (Cooperative Governance Joint Venture หรือ CG-JV) และโครงสร้างแบบแยกงานกันทำงาน (Separate Governance Joint Venture หรือ SG-JV)

การวิจัยนี้ก่อให้เกิดประโยชน์แก่การบริหารความเสี่ยงของ CJV ในหลายๆ ด้าน กล่าวคือ สมาชิกของ CJV สามารถนำพฤติกรรมของปัจจัยเสี่ยงตามวงจรชีวิตของกิจกรรมร่วมค้างานก่อสร้างและแนวทางการตอบสนองต่อความเสี่ยงที่เหมาะสมในระบบย่อยสำหรับบริหารความเสี่ยงแบบหลายวัตถุประสงค์ ไปพัฒนาการบริหารความเสี่ยงที่ครอบคลุมสำหรับการบริหาร CJV ของสมาชิก ขณะที่ความสัมพันธ์ระหว่างโครงสร้างองค์กรของ CJV กับพฤติกรรมของปัจจัยเสี่ยง ก็สามารถนำมาใช้ประกอบการพิจารณาเลือกโครงสร้างองค์กรของ CJV ที่เหมาะสมแก่ผู้รับเหมาก่อสร้างแต่ละราย นอกจากนี้ผู้รับเหมาก่อสร้างยังสามารถประยุกต์ใช้ระบบย่อยสำหรับทำนายความเสี่ยงแบบเมทริกซ์หลายปัจจัย สำหรับทำนายค่าผลกระทบและโอกาสในการเกิดของปัจจัยเสี่ยง โดยอาศัยการพิจารณาปัจจัยแวดล้อมพื้นฐานของ CJV

ภาควิชา	วิศวกรรมโยธา	ลายมือชื่อนิสิต	....
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This research develops the life cycle risk management and prediction (LCRMP) system for construction joint ventures (CJVs). The system focuses on the dynamic of risk characteristics throughout the CJV life cycle. It consists of two subsystems: the multi-objective risk management (M-ORM) subsystem and the multi-determinant risk prediction (M-DRP) subsystem. The first subsystem was modified from the ISO risk management process. The 30 CJV risks were identified and analyzed, and the treatment options for each individual risk were investigated. The second subsystem was established by first deriving 48 CJV determinants, which were used as the framework of multi-determinant matrices. These matrices were then analyzed by the analytic hierarchy process (AHP). The inputs of both subsystems were derived from the results of relevant past research as well as the questionnaire surveys and the in-depth interviews with a large panel of CJV experts in Thailand. The Delphi method was also integrated into the data collection processes to increase the accuracy of the results.

The results indicated that the risk characteristics in each phase of CJV life cycle were quite dynamic in terms of the number of risks as well as their consequence and likelihood of occurrence. Based on nonparametric statistics, there were 21 risks, the consequence and likelihood of which were sensitive to the organization structures of CJVs, namely, the cooperative governance joint venture (CG-JV) and the separate governance joint venture (SG-JV).

This research contributes to CJV risk management in many ways. The CJV partners can use the characteristics of risks throughout the CJV life cycle and appropriate risk treatment options from the multi-objective risk management subsystem to develop a comprehensive risk management for their CJV administration. The relations between the CJV organization structures and their risk characteristics can be used to design an appropriate CJV organization for a certain contractor. The contractors can apply the multi-determinant risk prediction subsystem to predict the consequence and likelihood of risks based on the 48 underlying project determinants.

Department:	Civil Engineering	Student's Signature	....
Field of Study:	Civil Engineering	Advisor's Signature	....
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CHAPTER I

INTRODUCTION

1.1 Background

Joint venture (JV) is a cooperative strategy used by firms to create the project-based cooperation for accomplishing a specific project. This business pattern involves a cooperation of at least two firms which are willing to share their resources, including capital money, manpower, raw material, , techniques, and competitive ability, to build up a jointly-owned entity (Contractor and Lorange, 1988; Geringer, 1988). The firms that participate in a JV are called partners (Dibner, 1972; Hewitt, 2005). When at least one of the JV partners is a foreign firm, the mother company of which is located outside of the country where the JV is operating, this JV is considered an international joint venture (IJV) (Geringer and Hebert, 1989 & 1991). In recent decades, JV has become a cooperative strategy which has been widely adopted in several industries (Pearce and Robison 2003, 2005, 2009), especially the construction industry (Bing and Tiong, 1999).

In the construction industry, construction joint venture (CJV) is a form of cooperative strategy, which is adopted by contractors (partners) for executing large construction projects that requires a large amount of resource beyond the capability of a single contractor (Ho et al., 2009). The number of CJV projects have been increasing all over the world, particularly in developing countries (Lim and Liu, 2001). Due to limited experience, financial capital, and other resources of both local and foreign contractors, the international construction joint venture (CJV) is an alternative form of CJVs which is widely adopted (Mohamed, 2003). This is because local partners can attract capital and technology from foreign partners, whereas the foreign partners can access the local market and address critical factors of the local business with less difficulty.

The definitions and abbreviations concerning joint ventures are not internationally standardized (Julian, 2005; Hewitt, 2005). In this thesis, “JVs” represents the joint ventures in any industry (including the construction industry). Meanwhile, “CJVs” stands for construction joint ventures, the partners of which might be local or foreign firms, and “CJVs” represents international construction joint venture projects.

Although JVs are adopted globally for decades, about 37-70% of JVs were unsuccessful [e.g., Bing et al. (1999), Geringer and Hebert (1991), Kotelnikov (2010), and Spranger (2004)]. Bing and Tiong (1999) reported that more than 50% of JVs in developing countries were unsuccessful or disjointed before the specified time. Zhang and Zou (2007) indicated that most of the CJVs had poor performance. This results correspond to those of the CJVs in Thailand (Prasitsom, 2008), which indicated that around 78% of Thai JV partners were not satisfied with the benefits which their firms earned. Surprisingly, a JV is still one of the most popular strategies which many contractors want to use. This is because their benefits seem to surpass the risk which they have to take (Ling et al., 2009).

For unsuccessful CJVs, one or all partners miss the objectives that are associated with the management of the cooperation unit (Julian, 2005; Ozorhon et al., 2010). It should be noted that in some articles about JV, the word “failed” was used rather than “unsuccessful.” While a “failed JV” is referred to a JV which is unable to meet the financial obligations, an “unsuccessful JV” is referred to a JV that cannot accomplish the intended objectives (Adopted from Bacal, 1999; Grote, 2002). In this thesis, however, the term “unsuccessful” is used as the main word to cover the failures of CJVs in all aspects.

With the literature review throwback 20 years, there have been a large number of previous studies concerning JVs in various disciplines, including investment, management, accounting, trust, culture, and laws. These studies can be categorized into several groups based on several specific fields such as insurance, finance, production industry, research and development, and construction. Most of these studies aimed to avoid failure, eliminate problems, determine success factors, control risks, and enhance JV performance. However, JVs in different industries are quite unique (Ozorhon et al., 2008a). The construction industry is regarded as one of the unique businesses, whose the formats and factors influencing its operation are totally different from those of other industries (Chan and Suen, 2005). Thus, the managerial concepts of general JVs may not be applied to CJVs directly (Mohamed, 2003).

Recently, there have been several studies related to CJVs. Most of them focused on the success of CJVs, which can be divided into two levels: the macro level and the micro level. The macro level focused on system development, evaluation process, and relevant factors that make CJVs successful. The research topics included partner selection, CJV foundation, risk identification, and performance appraisal. Meanwhile, the micro level focused on detailed issues such as SWOT analysis, characteristics of partner, success factors, trust, and cultural issues. Even though these previous studies encompassed several important issues about how to manage CJVs successfully, many key issues have not been addressed.

For the first issue, more than 80 percent of previous studies focused on CJV management during the construction phase. However, in the reality, CJV management involves not only the tasks of construction works, but it also includes other important tasks in different time periods in which partners have to accomplish. For example, a negotiation between partners to set up the CJV body and reach an agreement at the beginning, the preparation of bidding documents before signing a construction contract with the owner, as well as warranty, accounting, and legal issues at the end of project. By focusing on the construction phase, it is not surprising that many CJVs in Thailand were often failed in the other phases.

Next issue, while many factors can contribute to unsuccessful CJVs, however, a factor that has been limitedly investigated in the previous research work is CJV organization structure. The CJV organization structure is extremely important for management because it is directly related to task allocation, coordination, and supervision, all of which clearly affect the success of CJVs in several aspects (Julian, 2005).

The final issue is that most of these research works cannot be applied to CJV by CJV. Because the characteristics of CJV would be vary, when the situation of CJV and CJV project, denoted by determinants, is changed (Ozorhon et al., 2008b). While the previous studies were developed from the data of CJVs that the determinants of which were controlled (such as nation of partners, type of construction project and etc.), most of their results were the static information which was hard to apply to other CJVs with different determinants.

With the above issues, there are three critical research gaps concerning CJVs. First, there is no comprehensive risk management system that can evaluate the risks throughout the series of phases which a CJV management passes from the beginning until the end, denoted by CJV life cycle. Although, some contractor may use the information from some previous studies, mostly for the formation and construction phase, to fulfill the risk management process through CJV life cycle. This integrated information is not perfect and does not fit to CJVs in Thailand. As a result, CJV life cycle can be divided into five phase: (1) the formation phase, (2) the bidding phase, (3) the construction phase, (4) the warranty phase, and (5) the termination phase. There are various operation objectives in these phases. So, the process to maximize the chances of these objectives being achieved for this study can be considered as the Multi-Objective Risk Management (MD-RM).

The second gap is about the impacts of CJV organization structure which is addressed explicitly in the risk management process. The CJV organization structure can be classified into the four types (Prasitsom and Likhitruangsilp, 2011 & 2013):

(1) Cooperative governance joint venture (CG-JV), in which every partner work together in every task

(2) Separate governance joint venture (SG-JV), in which each partner operates all tasks exclusively

(3) Mixed governance joint venture (MG-JV), in which partners operate some tasks exclusively (like the SG-JV) and work mutually with other partners in the other tasks (like the CG-JV)

(4) Single governance joint venture (SinG-JV), in which only one partner takes control for the whole project

Each type of the organization structure represents the relation among partners in various aspects such as work allocation, coordination process, supervision, and liability. It is therefore necessary to develop a comprehensive risk management system for evaluating the risks based on the effects by types of CJV organization structure.

Third, there is no risk assessment system that can evaluate the risks according to change of CJV or CJV project situation, denoted by determinants. For CJVs, not only construction determinants but also other determinants can affect the characteristics of CJV. These multi determinants should be used to predict the consequence and likelihood of risks for future CJVs.

1.2 Objectives

To develop the Life Cycle Risk Management and Prediction (LCRMP) system for CJVs is the main aim of this study. In addition, the LCRMP system consists of two subsystems which have different functions for CJV risk management process, as shown in Figure 1-1. The detail for each subsystem is:

(1) Multi-Objective Risk Management (M-ORM) subsystem

It can suggest the risk information used for CJV risk management process. This information was based on the opinions of experiencers on past CJVs in Thailand. The M-ORM subsystem includes with the different list of risks in all five phases of CJV life cycle, the risk parameters that are consequence and likelihood for those risks, the risk criterion and the risk treatment options.

(2) Multi-Determinant Risk Prediction (M-DRP) subsystem

It can predict the risk parameters, being consequence and likelihood, of risks in all phases of CJV life cycle for future CJVs. As well, these predictive outcomes would be harmony with the all situation of the future CJVs.

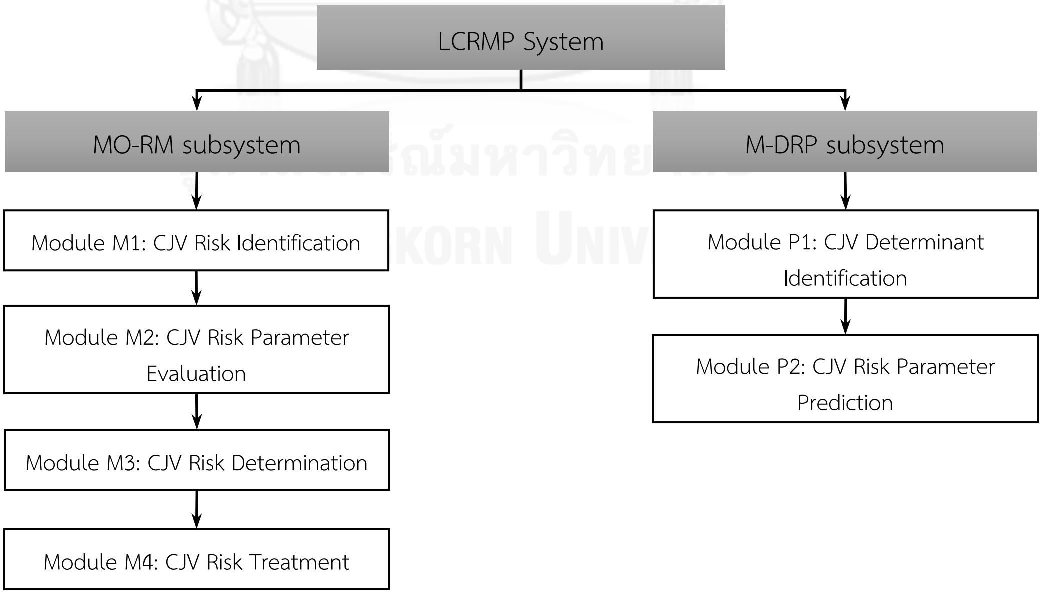


Figure 1-1 Structure of LCRMP System

1.3 Scope of Research

The scope of this research is as follows.

(1) The scales that were used to evaluate consequence and likelihood for risks were assessed by both subjective and objective approach.

(2) The respondents in this research were the group of top or middle staffs from construction firms who are experienced in CJVs operating in Thailand.

(3) The CJVs that were investigated in this research consisted of one local partner and one or more foreign partners.

(4) The impacts of risks to both objectives of CJV (for the formation and termination phases) and objectives of CJV project (for the bidding, construction and warranty phases) were determined.

1.4 Research Methodology

The concept of risk management was used as the fundamental framework in developing the proposed system. In addition, several techniques of data survey, statistics, and decision making were adopted in this research. Due to its capacity to manage and predict risks throughout CJV life cycle, the system was called “Life Cycle Risk Management and Prediction” (LCRMP).

There are two subsystems in namely the Multi-Objective Risk Management (M-ORM) subsystem which consists of four modules and the Multi-Determinant Risk Prediction (M-DRP) subsystem which consists of two modules. Both subsystems are separate but their data can be linked to increase the efficiency of risk management process. The research started with the development of four modules in M-ORM subsystem, first. Then, the information from this subsystem became the assumptions to develop M-DRP subsystem. Figure 1-2 shows the steps of research methodology for development all modules in both subsystems as well as other research steps. The details of each step are as follows.

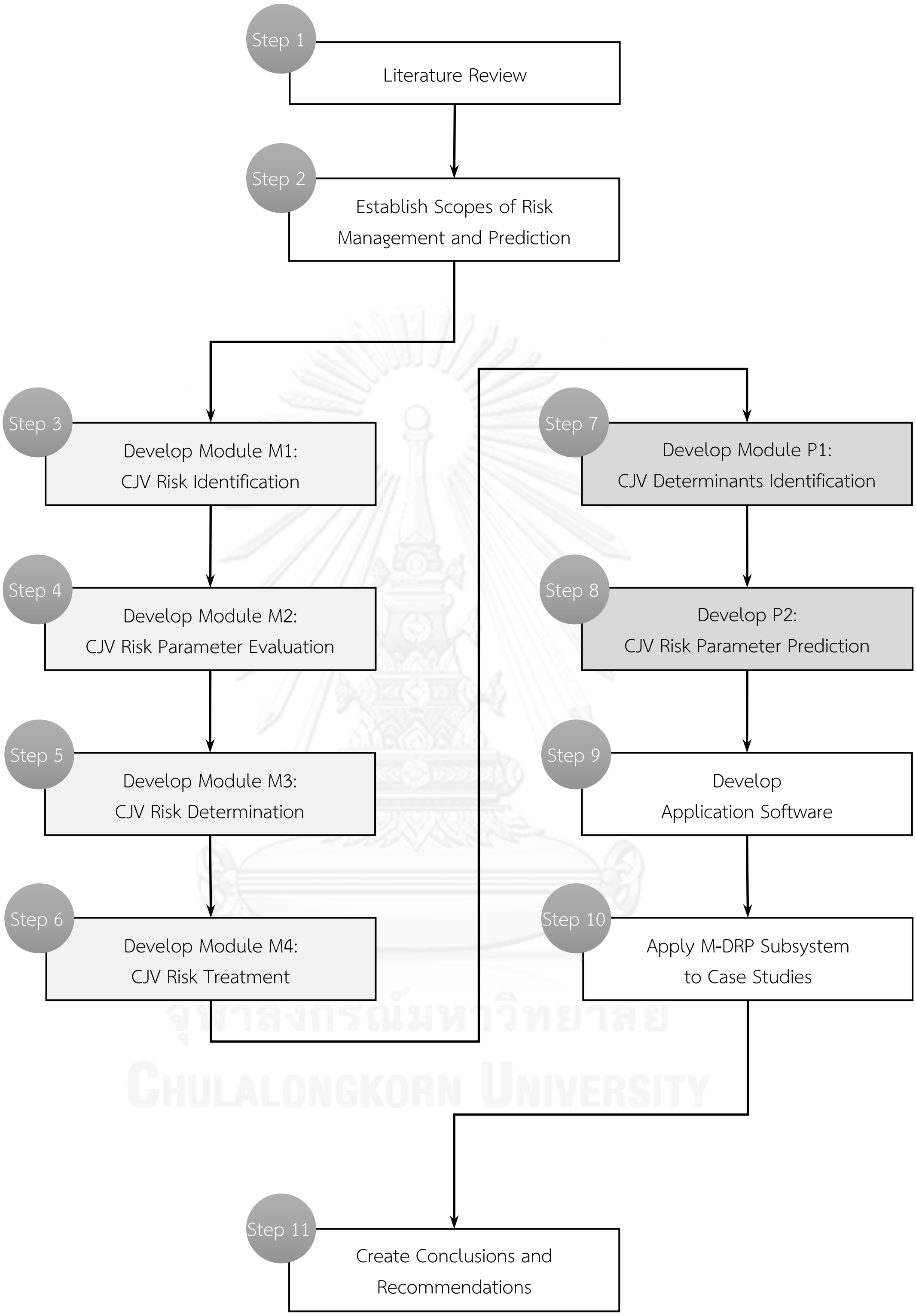


Figure 1-2 Research Methodology for the LCRMP System

(1) Literature Review

The relevant knowledge was collected from various textbooks, academic journals, and websites. It was then used as the fundamentals for developing the components of the LCRMP system. The literature review covered the following topics.

1) General concepts of CJV management such as advantages of CJV, critical success factors, risk assessment, project life cycle, organization structure, as well as CJV control and evaluation.

2) Basic concepts of risk management

3) Data survey methods and reliability of survey results

4) Basic concepts of Delphi technique, trend analysis, nonparametric statistics and analytic hierarchy process (AHP)

(2) Establish Scope of Risk Management and Prediction

In this step, the scopes of processes for CJV risk management and prediction throughout all five phases of CJV life cycle were defined. The detail for each phase was established including the definition, the objectives of CJV or CJV project operation and the sets of likert scale for evaluating consequence and likelihood. As well, the types of CJV organization structure were explored and analyzed to set the hypothesis for developing the system. The accuracy and suitability of data in this step was verified by interview with the pilot group.

(3) Develop Module M1: CJV Risk Identification

In this step, risks that contribute to the success of CJV or CJV project operations in each phase of its life cycle were identified. The previous research works of CJVs on the topics about cooperative success, critical success factors, performance indexes, and risks were analyzed. Then, all risks, being suitable for CJVs in Thailand, were identified and arranged, which were based on their characteristics, into three categories. These were the internal risk category, the project risk category and the external risk category. The reason to split factors into three categories was to help the analysis process in the further steps, as well as, using the LCRMP system in the future.

Again, the interview with the pilot group were used as the tool for testing the accuracy and suitability of data.

(4) Develop Module M2: CJV Risk Parameter Evaluation

In this step, the risk parameter, including consequence (CSQ) and likelihood (LLH, of risks in each phase of CJV life cycle were evaluated by the survey. It done by widely distributing the questionnaires to the professional group. They were asked to rate CSQ and LLH for risks in each phase based on their experience in previous CJVs. Moreover, the effects by types of CJV organization structure were also considered during the survey. In additional, the distribution consisted of five sets of questionnaire. Each set contained different set of questions which depended on the number of risks and different objectives of CJV or CJV project operation in each phase.

As well, Delphi technique was adopted to the survey, thus, the surveys conducted in three rounds to reduce bias of respondents and enhance reliability of the results. The results were adopted with the measures of central tendency and the nonparametric statistics for analyzing the data and answering the hypotheses.

(5) Develop Module M3: CJV Risk Determination

In this step, the guidelines, for making the decision what the risks in each phase should be considered as the critical risks, were created. The criterion in each guideline was developed by the opinions of the professional group with Delphi technique.

(6) Develop Module M4: CJV Risk Treatment

In this step, the guideline of risk treatment options, to minimize the impacts and/or chances of critical risks in each phase, were presented. The details of guideline, which are suitable with CJVs in Thailand, were the results from the literature review, as well as, the interviews with the professional group.

(7) Develop Module P1: CJV Determinant Identification

In this step, the determinants that are the representative of CJV and CJV project situation were identified. At the same time, the set of determinants, have the effect to increase or decrease risk parameter for each risk, were also developed. These identification processes were done through the in-depth interview with the expert group and the in-depth analysis in the results of previous studies.

(8) Develop Module P2: CJV Risk Prediction

In this step, the function, to predict risk parameter for future CJVs which correspond to the environments of CJV and CJV project, was developed. It started by a set of determinants for each risk to be created as the multi determinant matrix (MDM) by the concept of analytic hierarchy process (AHP). Then, the weights of determinants in each MDM were generated by process of the pairwise comparison via the brainstorm with the expert group. Finally, the CJV appraisal form to evaluate the status of determinants and the calculation process to predict the risk parameter were developed and presented.

(9) Develop Application Software

In this step, the capability to predict risk parameter for future CJVs in the M-DRP subsystem was created as the application software. With the features of Microsoft Excel, all processes including the data input, the data link, the calculation and the data presentation were done by capability of the application software. The main reason for developing the system into the form of the application software is the convenience of a partner, as a user, in order to reduce time and human errors. Moreover, a guideline to describe how to use the M-DRP subsystem and its application software was introduced. The details of the guideline are the process of partner selection and the process of CJV organization structure selection.

(10) Apply M-DRP Subsystem to Case Studies

In this step, three CJVs in Thailand, which were set up by the local and Japanese partners, were intended as the case studies for the processes of system verification and validation. The results were verified to check the accuracy of functions in the application software, as well as, were validated to summarize the suitability of the subsystem for the real practice.

(11) Create Conclusions and Recommendations

In this step, the details of LCRMP system in the overview were summarized. In addition, the conclusions, limitations and suggestions of the study were described.

1.5 Research Results

The Life Cycle Risk Management and Prediction (LCRMP) system with two subsystem, namely the Multi-Objective Risk Management (M-ORM) subsystem and the Multi-Determinant Risk Prediction (M-DRP) subsystem, is the results of the study.

The M-ORM subsystem includes with the important risk information for process of CJV risk management through CJV life cycle. They are the definition of risks, the characteristics of risk in each phases, the risk parameter (CSQ and LLH) for risks in all phases, the difference of risk parameter under the effects by types of CJV organization structure (CG-JV and SG-JV), the guidelines of risk criterion and the guideline of risk treatment options

The M-DRP subsystem is the set of functions and its application software for process of predicting risk parameter of risks in all phases for future CJVs. By the capability of functions, these predictive outcomes would be harmony with the all situation of the future CJVs.

1.6 Research Contributions

(1) Contractors, as partners of a CJV, can use the M-DRP subsystem to predict risk parameter, being CSQ and LLH, which would be harmony with the situation of their future CJV.

(2) Contractors can also execute the M-DRP subsystem for supporting the process of the partner selection and/or the CJV organization structure selection. The decision process would be based on the comparison of results by the M-DRP subsystem, as a result of the difference of input data.

(3) Contractors can use the M-ORM subsystem to realize the dynamic characteristics of risks under the effects of CJV organization structure for

each phase of CJV life cycle. The risk parameter, the risk criterion and the risk treatment options in the M-ORM subsystem, based on experiences in previous CJVs, can be the available information and guidelines for contractors to prepare the efficiency risk management plans which are suitable for CJVs in Thailand.

(4) Contractors can reduce time for assessing risks and planning the risk management plans for their CJV, especially during the pre-construction phase, by applying the LCRMP system.

CHAPTER II
LITERATURE REVIEW

The chapter reviewed knowledge, former studies and principles which relate to this research. It was divided into five sections. The first section was the details about types of current cooperative strategy in generally business and construction industry. The second and third sections were shown the general knowledge about Joint Venture (JV) and Construction Joint Venture (CJV) which should be tried to understand. The analysis and conclusion of review former articles about Construction Joint Venture (CJV) over past two decades were analyzed in section number four. Finally, the basic principles of the risk management, the Delphi technique and the Analytic Hierarchy Process (AHP), as the techniques for developing the Life Cycle Risk Management Model (LCRM Model), were explained in the fifth section.

2.1 Joint Venture

From revision of the literatures, the form of “Joint Venture” has been widely used since 20 years back but it came with different wording, (e.g. Combination of companies, Enterprise Commune, Co Adventure, Group, Pool, Joint Undertaking, and Joint Speculation (Brown, 1942)). However, at present, those words are not used anymore (Julian, 2005)).

Although, since the past up to now, JV has been a popular cooperative strategy, it has never been given the international definition (Julian, 2005). After the definitions of JV, which explained in many sources ranging from management journals, business laws, accounting, engineering and business terms dictionary, have analyzed, it is found that there are lot of differences between each of them. There is an obvious reason why JV’s definition has never been standardized internationally. As JV is considered as one type of business strategies which can be found in almost every industry and the laws controlling JV are also different in each country. So, it is difficult to cover all of those aspects into only one definition. However, it can be classified the important characteristics existed in JV’s operation which are (Prasitsom and Likhitruangsilp, 2008);

(1) It must be a cooperation of at least 2 partners.

(2) Partners can be both individual or business entity.

(3) Set up to work upon a specific project only.

(4) Cooperation may come in form of sharing, at least one or more of, resources like capital money, profit or loss and risk based on agreement.

(5) Agreement can be made by either verbal or written contract.

(6) Time duration of the cooperation must be specified clearly. It can be specific date or accomplishment of target objectives.

Although JV is a temporary cooperative business, it often gets the legal status approval from most of countries (Buchel et al., 1998; Fan, 1988; Julian, 2005). However, laws and regulations in each country have different details which may result in some changes of above characteristic but they would not be changed totally. For example, important characteristics of (b) in some countries, like China, may consider that all partners must be companies and so on.

It is usually found that many people view JV as a business form of Partnerships but JV is formed just to operate under 1 or 2 projects (Jacob 1999; Luo 1997). Although their administrative structures are quite similar, but in reality, they are quite different in many ways like constitution process, legal status, laws enforcement or tax policy. However, JV can be changed to be Partnership or company if additional requirements are fulfilled as regulations state.

2.1.1 Joint Venture in Construction Industry

Construction joint venture (CJV) is a business cooperation strategy which most of contractors prefer to use for operation in mega construction projects those have high complexity or tense competition through sharing resources among partners (e.g. capital, labor, technology, machine, skill, right, opportunity and so on) including risk management, responsibility and profit shared which all variables will be under control of relating contracts which are agreed by all partners (Likhitruangsilp and Prasitsom, 2008).

From past till today, construction business is classified as another industry which has always been applying CJV as its main strategy in operation (Chan and Suen, 2005). Since a CJV can help contractor's operation in many aspects like job auction, operation, organization improvement and market expansion and so on. Apart from that, state agency, who is normally the owner of mega and complex projects, normally allow contractors who are in form of CJV to take part in auction as it wants to promote competition that will lead to improvement of local contractor by allowing foreign firms to operate in the country legally or sometime to follow the instructions given by financial supporters outside the country.

When considered about the form of CJVs' members, it is found that most of CJVs tend to have at least one foreign firm as its partner which is normally called as International Construction Joint Venture (ICJV) (adapted from Geringer and Hebert, 1989). The main reason for domestic partners to use ICJV as their strategy is improving capabilities in capital, skill, technology and knowledge and these things can be found from foreign partners. At the same time, foreign partners also want to have legal rights and benefits, relationship with state agency or approach to available resources which can be gathered through local partners. CJVs with form of DJV (Domestic Construction Joint Venture; DCJV) (adapted from Yan and Gray, 1994) can also be found but in relatively small number when compared to ICJV. Most of CDJV is formed by cooperation of middle-sized and small-sized local contractors to enhance their construction capabilities in several aspects which will allow them to compete with large-sized domestic contractors (Prasitsom, 2008).

CJV is classified differently due to its unique characteristics which are different from other industries (Shen et al., 2001) in various factors like objectives, risks and success indicators which are generally accepted in its complexity and uniqueness. That's why applying JV management's principles from other industries into CJVs can't be done directly (Ozorhon et al., 2008). Content is this part will be an explanation of important basic ideas of CJVs which will be used as foundation in this research.

2.1.2 Joint Venture and Consortium

From reviews, there is a significant difference in the functioning and working of these two strategies. Consortium is usually an arrangement where firms come together for a project and has not the cooperative investment like JV (Richardson, 2010). Each participant remains independent. Prasitsom (2008) concluded the definition of Consortium in his research that "Consortium is the cooperative gathering for operating in a specific project to achieve a common goal. Each participant in Consortium has clearly its separate task and retains its separate legal status. It is impossible that participants will have cooperation in any task in the project. Participants also clearly separate their revenues, expense and liability for this project."

2.1.3 Partners of Joint Venture

JV, under each cooperation and industry, has its own JV structure which is different from others. It differs in the aspect of number of partners, legal status, operation pattern, business administration or agreement between partners and etc. Although there are many differences among them but they can always be divided into 2 groups (Buchel et al. 1998; Dibner, 1972), which are;

(1) Partners

They are any companies or individuals, specified in JVA as partners, involving in JV operation. They are sometimes called JV's members or member instead of partners. All those three words carry the same meaning. JV's partner may come from same or different industry depends on level of co-operation and benefits agreed between partners. Suitability and compatibility of every partner are the most important factors which influence JV's operation effectiveness.

(2) Sponsor or Leading Partner

In many texts or journals, the word "sponsor" may be substituted with leader or parent member and so on. Sponsor is a partner who is specified in JV agreement as the head of all partners or has the largest amount of investment ratio in that JV. Sponsor is usually responsible for liaison of all partners and also deals with business transaction with outsiders ranging from project owner to state agency in case that nobody is clearly appointed to this position in JV. For ICJV, a partner, who is a domestic firm in operating country, usually be the leading partner as required by relating laws in that country such as laws about foreigner who want to run a business in that country and so on. Domestic firm also has several advantages over foreign firm when it has to contact other domestic business or in the aspect of administrative management.

However, it does not always mean that sponsor is the one who contact all partners to establish the JV.

2.2 Construction Joint Venture Articles Review

This part of chapter will cover revision of research articles which contains relevant contents with CJV management in order to analyze studies and tools used in analysis from past till today. Within this process, the trend and format of research studies on JV in construction business which will become very important foundations to the directions of this research's development.

The collecting process starts from exploration of printed articles in Journal of Construction Engineering and Management and Journal of Management in Engineering from American Society of Civil Engineers (ASCE) which is considered as one of the most accepting journals about construction management (Hua, 2008).

Both journals are explored during period of 1990 to 2010 through online search engine with "Joint Venture" as a main keyword from categories of title, abstract and keyword. There are two main reasons for using this keyword which falls into these three categories instead of searching through only title and keyword. The first reason is the truth that printed articles before 2003 do not contain keyword part which makes searching through title only insufficient. Another important reason is that some journals and articles doesn't directly contain the term "Joint Venture" in their titles or keywords such as the issue about contractor's strategy management. Its content is linked with reasons behind decision of setting up Joint Venture between each contractor but the term "Joint Venture" is not emphasized clearly in title and keyword part but it will be mentioned in abstract part instead. As the main criteria for the exploration is covering as much contents as possible which requires searching through those three categories. From exploration, there are totally 34 articles which contain keyword in their tile, abstract and keyword part.

Next process will be analyzing content of each article. After analyzing, 4 out of 34 articles are cut out due to irrelevant contents and term "Joint Venture" is only rarely mentioned as the format of projects for research. For other 30 articles, they can be classified by direction of the study into 2 types, which are; (1) Macro Level which focus overall picture of CJV and (2) Micro Level which aim to study deeply into minor details.

By analyzing contents of all articles, based on study issues, the information gathered are as followed;

2.2.1 Formation and Policy Issue

Formation stage is a very important process for CJV as there are many operations exist between each partner within this stage, such as partner screening, contracting, structural formatting, personnel positioning and so on. However, in order to see whether what they have planned is right or wrong, they have to wait until operation or termination stage. Although some operations can be adjusted and improved later, most of them are still not. From study, it is necessary to study each process within operation stage of CJV as it will reflect in lowering risk and improving performance of future operation

Kelley (1991) has studied about the process of partner screening and job delegation in The FT. Drum Project which requires CJV operation due to large amount of investment, short operating period and unique weather condition. The result of the study indicates that, in the beginning, each partner within this CJV individually evaluate this project by themselves. After that, they meet together, compare what they have found and do brainstorming before categorized projects into several parts among each partners and subcontractors.

Although most of studies claim that administrative structure of CJV has a format of cooperation as partnership or so called integrated JV, Ping Ho et al. (2009) have studied about administrative structure of CJV in Taiwan and found out some aspects of operation which are different from conventional beliefs. They divide administrative structure format of CJV into two types. The first is Jointly managed JVs (JMJ) which its main characteristic is that CJV management team will be the one who make any decision related to CJV and all partners are also operating under this team’s order. Each partner will share profit/loss base on the proportion of their investment without concerning about number of jobs they are responsible for. Another type is separately managed JVs (SMJ) which each partner is separately responsible for decision making, profit and loss in accordance with the job they are responsible for. This article is also proposing concept in considering how to choose format of administrative structure by examining four aspects which are corporate cultural difference, trust, needs for procurement, autonomy and motivation for learning. Ping Ho and his team has gotten the result which goes in the same way with Prasitsom's study (2008) which focuses on CJV in Thailand and classifies administrative structure of CJV into four formats which (1) Collaborated-operation structure, (2) Separated-operation structure, (3) Mixed-operation structure, (4) Singled-operation structure.

2.2.2 Risk Management Issue

Risk management is a principle which uses analysis and evaluation to reflect opportunity and impact from variety of factors which may affect expected project's operation performance. If the company is willing to take those losses, company can just leave those risks there but if it can't, further improvement, consideration, strategies or policies will be needed in order to reduce chances and effect of those risks.

From studies which apply principles of risk management with CJV, it is found that the study of Kumaraswamy (1997) is the origin for risk study. His study focuses on appraisal and apportionment of risk related to project to all partners. It aims to find the balance between each partner which keeps partners working together. From this study, criteria, sub criteria and indicators of risk evaluation and allocation have been mentioned and studied. He proposes idea about risk allocation among partners. Even in this year, Seneviratne and Ranasinghe (1997) have also applied risk evaluation from financial aspect into practice on the involving factors leading to use CJV as strategy in mega transportation infrastructure construction project.

Two years after that, Bing and his team have also studied about risk of CJV by considering overall risk of the whole project. The study starts from identifying and evaluating each risk involved in CJV. Those risks are divided into three main groups, they are; Internal Risks, Project-Specific Risks and External Risks (Bing et al., 1999). A study after that emphasizes mainly on presenting idea about Risk Management Model for ICJV which can also be divided into three main parts which are identification, analysis and treatment. Three case studies are considered based on the structure of this model (Bing and Tiong, 1999). Risk evaluation by three groups of factor, done by

Bing and team, has become prototype which is mainly used for references in other studies about risk assessment of CJV which are done later.

Shen et al. (2001) is another group who study about identifying and evaluating risks of CJV but they divide risks into six groups which are financial risk, legal risk, management risk, market risk, policy and political risk and Technical risk. All of these six groups have different risks with different level of impact. Mohamed (2003) also studies about the relationship of risks that influences performance of ICJV through analysis done with SEM technique. Although the study doesn't dig down deep enough to evaluation of each risk, it is the only study that shows relationship between risks and performance factors.

In 2007, Zhang and Zou try to improve effectiveness for CJV's risks evaluation by applying fuzzy logic and analytical hierarchy process (AHP) technique with data collection in Likert scale to reduce defection done by judgment of people who answer questionnaires. This study is done by using information of Risks, done by Bing and team in 1999, as its foundation (Zhang and Zou, 2007).

2.2.3 Performance Management Issue

Performance management is any process (e.g. considering, evaluating, adjusting and tracing) required which help company to achieve its target goal. "The goal is accomplished" carries the same meaning with "Successful Company". Most of the time, they are mentioned as the same within several articles which do not focus directly on performance management or strategic management.

For those studies which have applied principles of performance management to evaluate CJV, Ozorhon and his team are considered as the leader in this field. Their articles regarding study of CJV's performance have been published in 4 journals from 2007 to2010.

Ozorhon and his team start their study by proposing model which can be used to predict CJV's performance (Ozorhon et al., 2007) by using technique which is called as analytical network process (ANP) to help in analyzing complex and linked relationship between factors and CJV's performance. This model mainly emphasize on relationship between CJV's performance and factors in four groups. They are JV Structural Factors, Interpartner Fit, Interpartner Relations, and External Factors. In last stage of study using this model, several important factors like Conflict resolution, Effectiveness of control, Cultural fit, Contract, Trust and Strategic fit have been mentioned as influencing factors. After applying this model to the real construction project, the result shows range of difference between evaluated performance from the model and actual performance at lowest 1.68% and highest at 23.30%.

Following year, Ozorhon and his team pick up issues about Interpartner Fit and Interpartner Relations which are two groups of factor mentioned in above model and study thoroughly. They try to find influences of Partner Fit over CJV Performance (Ozorhon et al., 2008a). They divide Partner Fit's consideration into three aspects which are Strategic Fit, Organizational Fit and Cultural Fit. In their study, in order to find relationship between each factor, the technique known as structural equation modeling (SEM) is used. The result proves that Strategic Fit has direct influence on Interpartner Relations while organizational Fit and Interpartner Relations also have direct influence on CJV Performance. It is surprising to learn that Cultural Fit has no direct influences to none. Moreover, this study is the beginning of adding new perspectives into CJV performance which are divided as "project performance" and "performance of IJV management."

As the result of study has shown abnormality of Cultural Fit, Ozorhon and his team, within following year, decide to study about each factor into more details. They pick Cultural Fit, which is one of three factors in Partner Fit, as the main target for analysis in order to find its relationship with project performance in clearer picture. They split issues regarding Cultural Fit into three main parts which National culture, Organizational Culture and Host Country Culture. Through SEM technique again, the result shows that Organizational Culture is the only factor which directly influence CJV Performance (Ozorhon et al., 2008b).

In year 2010, Ozorhon and his team reconsider about the model for CJV's performance evaluation (Ozorhon et al., 2010) by showing the result of the study to propose idea in separating aspects of CJV's performance evaluation into four aspects which are the performance of the project, the IJV partners, the IJV organization itself and the perceptions of the IJV partners. They also study about the relationship of these four aspects with all groups of factor through SEM analyzing technique again.

Apart from Ozorhon and his team's studies, Mohamed (2003) is also another one who studies about performance of CJV through learning relationship between CJV's risk, success factors and performance through SEM technique. He classifies relating factors into six groups which are Partner, Task, Formation, Government, Operation and Project. He finds that partner and task are two groups of factor which have direct influence over Formation while Formation has also direct influence on Operation.

Sillars and Kangari (2004) also propose study from different point. They focus on how successful each partner is from CJV's operation instead of seeing overall success of CJV. They use "Organization return" and "Market position change" as indicators for each partner's success. From result of study, smaller-sized partners tend to be more successful in both financial and growth aspect when compared to larger size partners. Moreover, the study also shows that culture compatibility is also supporting factors for partners' success.

2.2.4 Planning and Strategy Issue

Before running a business or project, a good company should evaluate, plan and make good decision about any possibility and suitability before investing into that project. It is same like using CJV as a strategy for construction project, evaluating and planning should be the first thing to do. It is the same way for everyone ranging from contractor (not called partner yet as JV hasn't been established yet), advisor up to project owner. The study topic about this issue is quite broad and depend on who, when and what they investigate. For articles published in both ASCE's 2 journals contain following topics,

(1) SWOT

Study about strengths, weaknesses, opportunities, and threats (SWOT) of the organization is the very first stage of strategic management that should be done to help company in directing its mission, vision and target objectives which will lead to choosing appropriate strategy. JV is also one of strategies used. It should be noted that studying about SWOT in other industries has been done quite a lot before (Ling et al., 2008).

Articles in construction business, however, do not concern about SWOT analysis of firm with using CJV that seriously. Most of them cover about finding objectives for joining as CJV. Until 2009, Ling and her team decide to study SWOT in architectural, engineering and construction firms in Vietnam (Ling et al., 2008) and consulting firms in Shenzhen, China (Ling and Gul, 2009). The result of those studies go in the same direction that lacking or under developing of knowledge in advanced design and construction technology, experience in complex projects, experience in international projects, general and project management ability up to financial ability of local firms are the main forces that drive the firms to work in form of CJV with foreign partners which will enhance all of partners' ability in investment. At the same time, Kazaz and Ulubeyli (2009) have also used SWOT to analyze Turkish construction companies to create a picture of overall usage of CJV as its strategy. It is found that CJV allows each partner to put what it is good at into project operation. At the same time, organization culture, strategic knowledge and politics are also major treats for firms using this strategy.

For concept of consideration for using partnering as a new strategy in construction industry, which is proposed by Cook and Hancher (1990), is a first step to see possibility for choosing CJV as an expansion strategy for construction business. Cook and Hancher suggest that using various forms of partnering to reduce cost and improve competitive capability. They also propose key elements which consist of commitment, trust, mutual advantage and opportunity to assist your consideration. In this study, Cook and Hancher has included JV as one of partnering by using format of contract as the indicating factors.

(2) Creating investment opportunity

For studying about alternative of launching business into international construction market of private sector, Chen and Messner (2009) propose ten basic strategies which contractors can apply in his study, they are strategic alliance, build-operate-transfer equity project, joint venture project, representative office, licensing, local agent, joint venture company, sole venture company, branch office/company and sole venture project. Chen and Messner specify that joint venture strategy is appropriate for operating under one specific project and state that JV has high flexibility. However, choosing the right partner is still the most important factor which will affect the performance of the strategy in this form.

At the same time, result of study from Ling et al. (2008) about entering construction market in SEA region of international architectural, engineering and construction firms indicate that using JV to merge with local partner is one of the most effective strategies for foreign contractors. Moreover, Zhang and Kumaraswamy (2001) have also analyzed alternatives of foreign investors for investing construction business in China. They suggest three ways which (1) Equity joint venture (EJV), (2) cooperative joint venture (CJV) and (3) wholly foreign-owned enterprise (WFOE). Choosing one of these alternatives is based mainly on financial factor, investment proportion and laws.

Yates (1997) conducts his study from another viewpoint. Yates studies about the perspective which SEA's companies have with engineers and constructors sent from America to cooperate with them in form of CJV or consultants. The result of this study is used by American companies in order to improve their personnel and increase their competitive capability in Asia market.

(3) Consideration from project owner's viewpoint

Study about using JV as strategy can also be done through the eyes of project owner which most of them come from government. When project owner set up criteria and allow contractors to operate in form of CJV to run the project. Like the result of study from Lo et al. (1998) which find that job delegation and contractor screening done by Department of Rapid Transit System for construction of mass electric transportation train system in Taipei. Taipei Mass Rapid Transit System claims that general construction parts which do not require high technology will be done by local contractor while experienced private and government-owned companies will be responsible for parts with higher complexity. JV or technical collaboration agreement will be responsible for parts which require high technology and are very complex. It goes in the same way with Khasnabis et al. (2010) have studied about possibility of different investment mechanisms which can help develop transportation infrastructure projects through cooperating between public agency and private enterprise (PPP infrastructure project). By using various techniques to evaluate IRR, the result projects that if JV is properly planned, all partners can be mutually beneficial. (In this study, PPP is regarded as one kind of JV)

Nelson and Chan (2002) study CJV beyond project owner's (Usually only one government sector) point of views but they look up to country's policy by developing a tool to forecast bankable demand and revenue of foreign investors. This tool is developed to promote investment between Chinese government and foreigners through form of CJV.

2.2.5 Abstraction Issue

For company or project management, apart from considering tangible factors like profit, company structure, contract and so on, intangible factors are also important. Although these factors do not affect company operation immediately but these intangible factors, if they are not taken care of in the early stage, may create serious impact toward company's efficiency operation and it will be very hard to fix. Some examples of intangible factors are company's culture, social norms, religious, relationship, trust, belief, motivation, experiences, agreement and solutions and so on.

Studies about CJVs in the past discuss quite a lot about these intangible factors. Most of them focus on trust and culture. There are some interesting issues which will be shown as following;

(1) Trust

In study about trust between each partner in CJV, Bing et al. (1999) have found that "distrust between partners" is classified as a significant risk for Internal Risks Group and they even conduct deeper analysis into cast studies. The result states that trust and relationship between each partner are the foundation for sharing resource management in CJV but the trust must not be too high which may lead to risk in doing contract among them. (Bing and Tiong, 1999). Same as Ozorhon et al. (2007) who identify trust as one sub factor of Interpartner Relations cluster which have great impact upon other relating factors. This method of CJV's evaluation is supported more by analysis result from SEM technique which shows a significant relationship between trust, CJV performance and strategic fit (Ozorhon et al. 2008a). In 2010, Girmscheid and Brockmann study about CJV's trust in details. They study both Interorganizational level formed by partners and Intraorganizational level faced by construction task. The result directs that trust keep changing from higher level when the CJV is established but move lower continuously as the operation progress. However, if the management and operation go well, the level of trust can be gained back too. On the other hand, if they are not managed well, the level of trust will keep moving lower until the point which it may affect the operation in the future. Research's result also proves that relationship is the key for long term cooperation and how well partners solve the conflict affect directly to gaining or losing trust (Girmscheid and Brockmann, 2010).

(2) Culture

In study about culture aspect, Bing et al. (1999) classify differences in social, culture and religious in group of external risks Group which affect risk in CJV's operation and also specify that study about differences of culture among each partner is something that need to be considered before the beginning stage of establishing CJV, so the measures to cope with these differences can be planned in advance to reduce risk in managing that CJV (Bing and Tiong, 1999).

Ozorhon et al. (2007) have also proposed one model to help in evaluation of CJV performance. They assign culture as one of factors in Interpartner Fit in their model. However, after Ozorhon et al. (2008a) analyzed it with SEM techniques, they find that culture fit has no influence on both Interpartner Relations and CJV performance which leads them to further study about culture. They change their perspective on culture to find any implications through SEM technique again. The result shows that national culture, like power distance, individualism, long-term orientation or masculinity, which most of them have been studied in culture fit issue, have negative relationship to CJV performance. On the opposite, organizational culture, like process-oriented versus results-oriented culture, open system versus closed system or the loose control versus tight control, has direct relationship with CJV's performance and overall satisfaction (Ozorhon et al., 2008b). The result from this study accords with the study of Sillars and Kangari (2004) which indicate that compatibility of organizational culture is an important factor that affect each partner's success in joining CJV which should be considered thoroughly since the first cooperating stage.

Not only there are a lot of studies about trust and culture, studies about intangible factors in CJV on other aspects have been done continuously too. Carrier (1992) has conducted a study about motive of employees when they work cooperatively in CJV. The result shows that, even they come from different partner, they can build up team spirit and realize the same goals which are very important things to have in order to guarantee CJV's success. Following that, there is a study about disputes and disputes resolution done by Chan and Suen (2005). They find that the cause for most of disputes are result from contractual, cultural and legal matters which most of them are in form of mediation and arbitration.

For other articles, some of them might discuss about these intangible factors but they are used just for backing up analysis without going into details, so information from those will not be discussed here.

2.2.6 Contract and Agreement Issue

From exploration, there is no article which aims to study about contract and agreement of CJV in the past 20 years even many studies indicate that it is one of factors which affect risk and performance of CJV management both in overall picture and individual partner's perspective.

This phenomenon can reflect that contract and agreement is a contract done by at least two parties which result in difficulty to obtain as only one party can't decide to disclose the contract. Researcher must get permission from all of parties involved in that contract before researcher can take a look at it. Most of researchers usually contact just one of the parties involves as contacting all parties involving in that CJV contract is very difficult. Granting permission from all of them to disclose the contract is very hard. Another reason is that some of details in the contract are CJV or particular partner's secret. Disclosing it may lead to stability of company or being sued from partner. This study provides same result with presentation of Rashid (2008) who studies JVA of CJV in Malaysia. It is presented that process required for disclosing contract done by CJV is extremely difficult. Most of documents are confidential which limit the scope of the study.

2.3 Risk Management

Risk is the effect of uncertainty on the objectives which are taken an interest (the International Organization for Standardization (ISO), 2009). Generally, the references of risk are the potentials of event (likelihood), the consequences of event (impact) and the combination of these two values, namely “level of risk”. However, level of risk is often represented as risk (The Institute of Risk Management (IRM), 2002). The consequence of an event can be either more favorable or less favorable than expected (Institution of Civil Engineers (ICE), 2005). This refers to “upside risk” or “positive risk” for more favorable objectives, such as taking less time than anticipated, and material cost much less than expected. As, less favorable refers to “downside risk” or “negative risk” , such as construction proves very difficult, taking too long, and concrete below soil prevents erection. Nevertheless, in the common implementation, risk is substituted for hazard, danger, and threat.

While “Risk management” is the technique with the correlated activities to direct, manage and control a firm with the respect to risk, “Risk management process”, a subpart of risk management, is systematic system of management to communicate the consultations, to establish the contexts, and to identify, analyze, evaluate, treat, monitor and review risk (ISO, 2009). The advantage of risk management process is that a firm can use it to evaluate, understand, and take the treatments on all its risk together with a view to increasing the probability of their successful performance (ICE, 2005).

The actions in risk management should be continued and developed. Moreover, they should run throughout the determination and the implementation of the firm’s strategies. All risk events of the firm should be identified systematically. This identification should cover over the operations in the former, present, particular, and future events (IRM, 2002; ISO, 2009).

2.3.1 Terms and Definitions

The term used in the field of risk management can be defined in a variety of ways. For this research, there are many words that should be cleared. They are (ICE, 2005; ISO, 2009):

(1) Objective means the various aspects such as financial, schedule, environment, health and safety for operating a project. They can be applied at different levels of operation and at different time period.

(2) Risk event means a possible occurrence which could affect (positively or negatively) the achievement of the objectives in many aspects. A risk event could have the several risks as the causes.

(3) Risk means a variable which can be varied and is associated with an increased risk event.

(4) Risk parameter means the values, including consequences and likelihood, for evaluating, categorizing, and prioritizing a risk.

(5) Consequence means the impact of the risk event on an aspect, which caused by the risks.

(6) Likelihood means the chance of a risk occurring within a defined time period.

(7) Source of risk or Determinant means the elements which have the potential to increase the values of the risk parameter.

(8) Level of risk means the magnitude of a risk which the combination of its risk parameter.

(9) Risk criteria means the terms of reference against which the significance of a risk.

Figure 2-1 is shown the relationship between objectives, risk events, risks and source of risk. As can be seen, a risk can rise from many source of risks, as well as, a risk event also can be caused by various risks. For the objective, it can possible to be affected by the occurrences from a risk event or more.

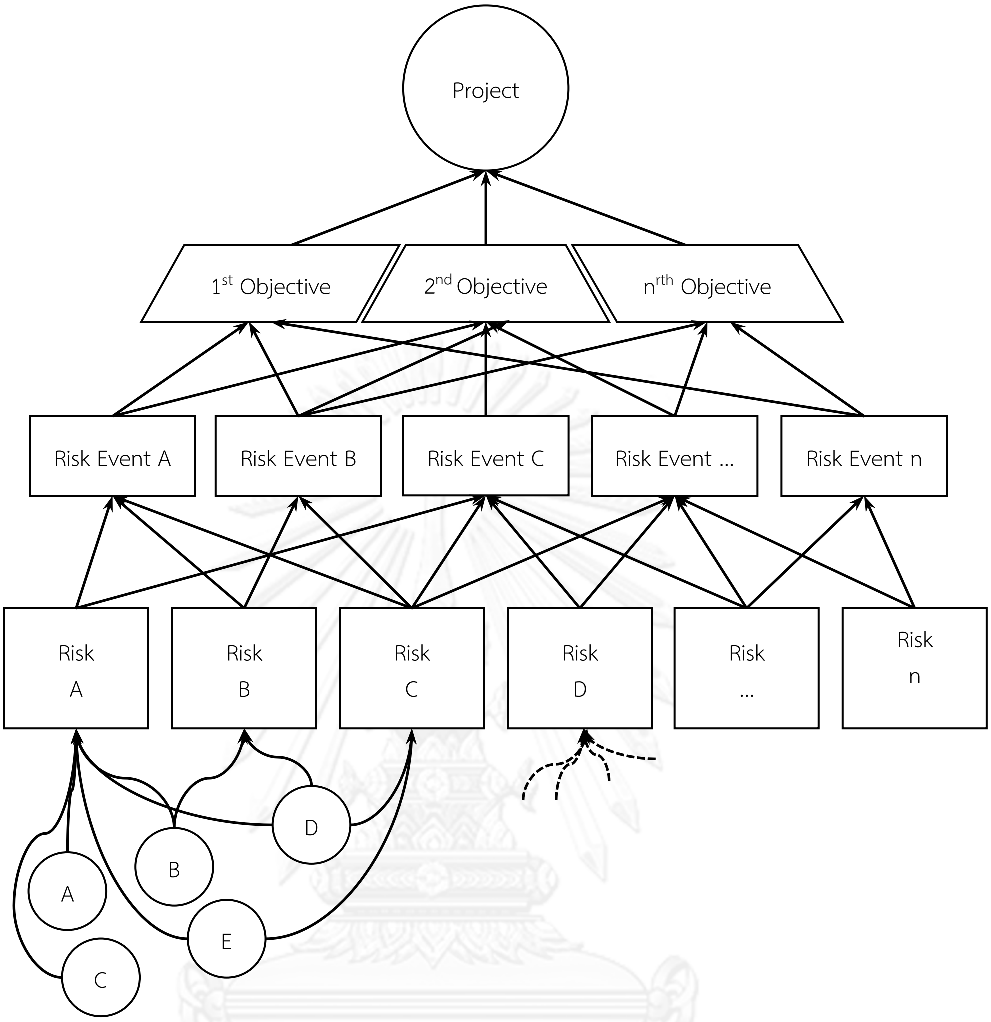


Figure 2-1 Association of Objectives, Risk Events, Risks and Determinant

2.3.2 Process of Risk Management

Risk management should be integrated as a part of firm's management. It also should be embedded in the firm's culture and practices. ISO (2009) splits risk management process into five main phases: (1) Communication and consultation, (2) Establishing the context, (3) Risk assessment, (4) Risk Treatment, and (5) Monitoring and review. Figure 2-2 is illustrated the detail and the relation of each phase in risk management process.

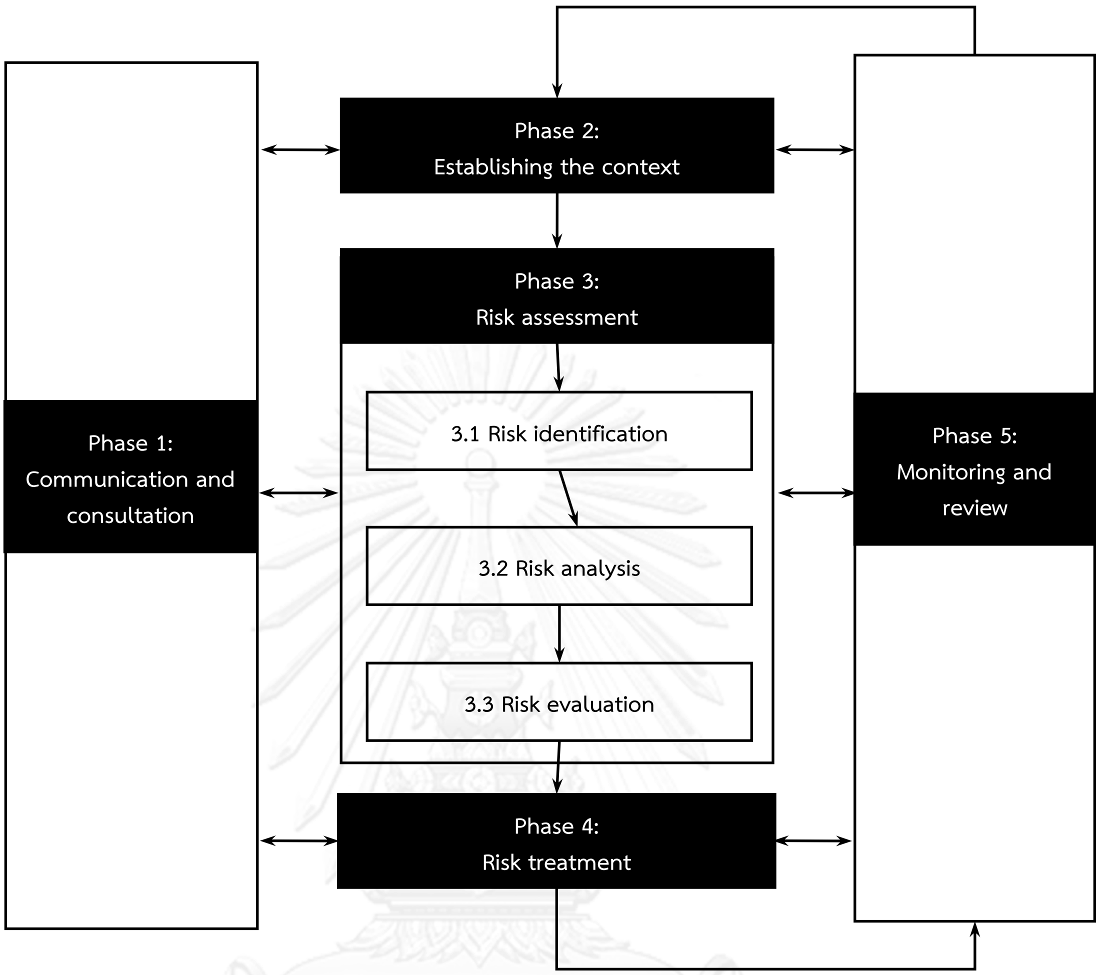


Figure 2-2 Risk Management Process

(1) Communication and consultation

The participants of the firm’s operation should communicate and consult with each other during all phases of risk management process. Therefore, the plan for both actions should be developed at beginning. In addition, this plans should mention the issues which relates to the risk itself, its causes, its consequences (if known), and the measures being taken to treat it. This phase takes place to ensure that any implementations in risk management processed can be accountable. The participants and stakeholders can understand the basis on which any decisions are arisen, and the reasons why particular actions are required.

(2) Establishing the context

In this process, the firm joins clearly its objectives, defines the external and internal parameters to be taken into account when managing risk, and sets the scope and risk criteria for the remaining process. While establishing the above context, the firm also needs to be considered in the greater detail and particularly how they relate to the scope of the particular risk management process.

(3) Risk assessment

There are three sub-processes in the risk assessment: the risk identification, the risk analysis, and the risk evaluation.

1) Risk identification

The sources, impact areas, events, causes, and potential consequences of each risk should be generated by the firm. The purposes of this step is to generate a comprehensive list of risks which is based on those events that might create, enhance, prevent, degrade, accelerate, or delay to achievement the firm's objectives. The identification process should include risks whether or not their source is under the control of the organization, even though the determinant or cause may not evident.

2) Risk analysis

Risk analysis process involves developing an understanding of the risk. The analysis provides an input to risk evaluation process and the decisions on whether risks need to be treated, and on the most appropriate risk treatment strategies and methods. Risk analysis can also provide an input into making decisions where choices must be made and the options involve different types and levels of risk.

Risk analysis involves consideration of the causes and sources of risk, their positive and negative consequences and the likelihood that those consequences can occur, Determinants that affect consequences and likelihood should be identified. The risks are analyzed by determining consequences and their likelihood, and other attributes of the risk. An event can have multiple consequences and can affect multiple objectives. Existing controls and their effectiveness and efficiency should also be taken into account.

3) Risk evaluation

The purpose of risk evaluation is to assist in making decisions, based on the outcomes of risk analysis, about which risks need treatment and the priority for treatment implementation. Risk evaluation involves comparing the level of risk found during the analysis process with risk criteria established when the context was considered. Based on this comparison, the need for treatment can be considered.

Decisions should take account of the wider context of the risk and include consideration of the tolerance of the risks borne by parties other than the firm those benefits from the risk. Decisions should be made in accordance with legal, regulatory and other requirements.

(4) Risk Treatment

Risk treatment is the actions to consider and select one or more options for modifying risks. Mostly, these actions will be focused on a risk parameter, level of risk of which has the significance until it could affect the firm's objectives. The risk treatment has various options, including avoiding, taking, removing, changing, sharing, and retaining. Each risk treatment options will be suitable with specific conditions.

(5) Monitoring and review

A final part of risk management process is the monitoring and review. Both actions are the important processes for regular checking and inspection during the firm's operation. These actions can be either periodic or particular. The person or team, who has the responsibilities for monitoring and review, has to clearly be defined since the commencement of the risk management process.

2.4 Methodology of the Delphi

The Delphi technique is the technique for the data collection process for to obtain the informed agreement and consensus among the panel of experts on the interested issue or topics. Delphi techniqueology has continued to evolve since its development in the 1950s by the RAND Corporation and in the 1963 by Dalkey and Helmer (Hsu, 2007). Then, the use of the Delphi technique in the data survey has increased in many diverse academic disciplines and fields of study such as health, education, technology and business.

There are many advantages for adapting the Delphi technique to the survey process (Kalaian and Kasim, 2012).

(1) It can provide the in-depth anonymous data and information about the issues under the consideration topics. This is also the most important reason for using the Delphi technique.

(2) It can avoid the conflict situation in the panel of experts because there is none face-to-face meetings and discussions.

(3) It can provide the more efficient solutions, judgments, and policies from the experts then the traditional method. With none face-to-face meetings, the experts have the courage to express their opinions.

Absolutely, the Delphi techniques also have the disadvantages. The critical disadvantage of the Delphi technique is that, during the multiple sequential rounds of collecting data, some experts may not available to for the further surveys. When they cannot return some of questionnaires, they are excluded from the panel of experts for further surveys.

2.4.1 Process of Delphi

Normally, the process of Delphi technique consists the series of survey rounds to a panel of experts by walk-in interview, mail or electronic mail. The number of rounds are not limit and should be continuous until the consensus of data is reached the target. However, in the real world, it is impossible to conduct the plentiful rounds of survey with the experts. For the well preparedness surveys adopted the concept of Delphi technique, the three rounds of the data collection are enough to meet the target consensus (Kalaian and Shah, 2006; Yang, 2003)

The following discussion is a brief introduction for conducting a survey for the data collection process in a research with the Delphi technique. Based on the structure of Delphi, the details are described in the form of rounds.

(1) The first round of survey

At the first round of the survey with Delphi technique, the open-ended questionnaire (the classic Delphi) or the close- ended questions (the modified Delphi) will be distributed to the panel of experts. The questions should be focused on the items which relate to the research topics. Moreover, each expert could freely suggest other alternatives as possible considerations or solutions to these items, as well as, the adding questions.

The main objective for this round is to create the collective information by reviewing and analyzing the data from the survey. The issues, found in the collective information, lead to the development of the closed-ended questionnaire used for the next round of survey.

(2) The second round of survey

For second time of survey, the same panel of experts receive the second questionnaire to review the issue of items gotten in the first rounds. The structure of this questionnaire is the closed-ended questions. However, the experts can still recommend and suggestion for adding or deleting the questions.

The main objective for this round is that each expert is requested to critic of the collective information from the first round. The information are presented in the form of the summary report including the frequency and statistic distributions. The results of this criticism will be in two areas, agreement and disagreement. In addition, all experts can confirm and/or modify their first round responses after they have received the collective information summarized from the panel of experts.

The survey data from the second round are reviewed and analyzed to identify a comprehensive description of agreement and disagreement and Consensus of the panel of experts. For the consensus for all items, they should be analyzed by the statistical methods. If the consensus value is not reached the targets, the third round of survey is needed. However, the next survey may not cover all items because some items should reach the expected consensus.

(3) The third round of survey

At the third time of survey, the same expert panel will get the revised closed-ended questionnaire including the items with their statistic distributions and consensus value. This is developed by a summary of the information from the second round. It should be noted that the questionnaire will be contained with only items which their consensus values were not reached the expected targets.

The purposes for this round, often the final round, is the same experts provided a final opportunity to revise their judgments and/or to specify their reasons for remaining outside the consensus (Pfeiffer, 1968).

After the process of data analysis for this round, the degree of consensus for remaining items is expected to increase or, in the worst case, to be certain (Weaver, 1971; Dalkey & Rourke, 1972; Anglin, 1991; Jacobs, 1996)

2.4.2 Consensus and Criteria

The main objective of the data analysis in the Delphi technique is to find the degree of consensus for items. The qualitative and quantitative analysis tools can be used for this finding. The qualitative tools are mostly used in the first round while the quantitative tools are mostly used for the second round or more.

For quantitative analysis, there are various methods to calculate the degree of consensus. The means, median, and mode are the popular statistic methods which are often used to measure the central tendency in order to present the degree of consensus for the collective information of experts (Hasson, Keeney, & McKenna, 2000).

Murray and Jarman (1987) mentioned that the median and mode are favored for the Delphi technique. However, the mean is also workable in some situations.

The establishment of the decision rule is another important topic. Before starting the second round of survey, the criteria of the decision rule have to be established to determine the consensus of the collective information by the panel of experts. However, the criteria is subject to interpretation. Basically, consensus on the item can be decided if a certain percentage of the votes falls within a prescribed range (Miller, 2006). The recommended range is that at least 70 to 80 percent of votes by panel of experts should have the same agreement on the issue of item (Green, 1982; Ulschak, 1983)

2.5 Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP), developed by T. Saaty (1995), is the multiple criteria decision making technique which allows users to assess the relative weight of multiple criteria against given “criteria” in an intuitive manner. After the literature review, it was found that the terms of “determinant” or “factor” may be used instead of criteria. Moreover, the best known and most widely applications of AHP can be seen from many previous studies in many topics which have been developed based on AHP. Because AHP helps to incorporate a group consensus, it has various advantages such as selecting the perfect alternative, evaluating the best answer, analyzing the benefit-cost, allocating strategies of resources, raking priority and forecasting the results.

The obvious feature of AHP is the process of “pairwise comparison” and the “hierarchy structure”. The users can recognize whether one criterion is more or less important than another by weights achieved from the results of the pairwise comparisons between all criterions. These criterion are arranged in the hierarchy structure which is associated with the goal and all alternatives. So, users can evaluate the answer by considering all criterions and their relations.

2.5.1 Principles of the Method

The AHP is constructed from two main principles: (1) structuring the hierarchy structure and (2) finding the priorities by pairwise comparison.

(1) Structuring the hierarchy

To create the hierarchy structure of AHP is to decompose the problem into its constituent parts. The top level is the goal or the objective of the problem. The second and/or third levels are prepared for the criteria and sub-criteria, respectively. The alternatives are always in the lowest level. During constructing the structure, the environment surrounding the problem and attributes of alternatives should be considered and identified.

Another benefit of arranging all the components in the hierarchy structure is the users can see the overall view of the complex relationships. In addition, they also assess whether the criteria in each level are of the same magnitude so that they can be compared accurately.

(2) Finding the priorities by pairwise comparison

After structure the hierarchy, a set of pairwise comparison matrixes are constructed. To make the comparison, the scale of numbers are used for indicating "how important is one criterion is over another criterion with the respect to the goal or the objective of the problem". In all previous studies, it was found that the processes was done by assigning a weight between 1 (equal importance) and 9 (extreme importance) which is suggested by Saaty (1990).

The weights from the finding process also have to be the homogeneous values. The significant errors may be introduced into the process of measurement (Saaty, 1990).

2.5.2 Basic Process of the Method

For general purpose, the basic processes for AHP are:

1) Define the problem and its possible alternatives
2) Identify the criteria and/or sub-criteria which relate to the alternatives.
3) Develop the problem in the decision hierarchy structure including, at least, the level of goal, the level of criteria and the level of alternative.
4) Compare each criteria and/or sub-criteria in the corresponding level by pairwise comparison and calibrate them on the numerical scale.
5) Perform calculations to find the weights for each criteria and/or sub-criteria.
6) Check the consistency by calculating the consistency index (CI), the consistency ratio (CR), and finding the random inconsistency index (RI).
7) Calculate the total weight and the priority for each alternatives.
8) Make the decision for the best alternative.

2.6 Summary

In construction industry, construction joint ventures (CJVs) is the temporary cooperation strategy established by partners who are mostly contractors to support working on a specific construction project. As well, for CJVs formed by local contractors and foreign contractors, the international construction joint ventures (ICJVs) is the term which is frequently adopted. CJVs are mostly preferred to use for the infrastructure construction projects those have high complexity or tense competition through sharing resources among partners (e.g. capital, labor, technology, machine, skill, right, opportunity and so on). The management, responsibility and profit among contractors will be shared under control of relating contracts or agreements which are agreed by all partners.

There have been a large number of studies and articles concerning JVs in various disciplines, including investment, management, accounting, trust, culture, and laws. There studies can also be divided into several groups based on several specific fields such as insurance, finance, production industry, research and development, and construction. By exploring journals during period of 1990 to 2010, there are totally 34 articles which contain keyword in their tile, abstract and keyword part about CJV. These can be classified by direction of the study into 2 types, which are; (1) Macro Level which focus overall picture of CJV (such as the partner selection, CJV foundation, risk identification, performance appraisal and etc.) (2) Micro Level which aim to study deeply into minor details (including SWOT analysis, characteristics of partner, success factors, trust, cultural issues and etc.).

With the literature review, it was found that the success rates of CJVs are not that high, although CJVs have been the popular used in various construction projects for few decades. That is why many of previous studies tried to develop ideas or tools to solve the problem. Risk management, one of famous tools being used for CJV management, is the processes of identification, assessment, and prioritization of risks. Moreover, it can minimize, monitor, and control the probability and/or impact of unfortunate events. With the framework by ISO (2009), there are five main phases of risk management process: (1) communication and consultation, (2) establishing the context, (3) risk assessment, (4) risk treatment, and (5) monitoring and review.

CHAPTER III
RESEARCH METHODOLOGY

This chapter presents twelve steps of the research methodology to develop the Life Cycle Risk Management and Prediction (LCRMP) system with two subsystem, namely the Multi-Objective Risk Management (M-ORM) subsystem and the Multi-Determinant Risk Prediction (M-DRP) subsystem. The chapter summarizes the research details of each step such as the main purpose, the research process, the type of respondents, and the adaptation of research techniques. Moreover, to provide the overview of methodology to develop LCRMP system, the examples of results for each step are shown, in addition.

3.1 Overview of Research Methodology

Before embarking on the details of each step in the research process for this study, it seem appropriate to present a brief overview of the methodology. Table 3-1 well indicates the desired sequence of ten research steps and their interesting details.

As shown in the table, while the first step and the last step of the methodology are the base for every research, the second step to the seventh step have the structure of LCRMP system behind them. The eighth step was set up to facilitate the working of the model by the application software and the ninth step is the process to test the accuracy of LCRMP system and its software. The Delphi technique was used as the main tool for the data collection process in many steps. However, the steps had the different groups of respondents and/or interviewees, as well as the different techniques for the data analysis.

Table 3-1 Summary of Research Methodology

Step	Description	Main Techniques	Source of Data	Respondents and/or Interviewees	Results
1	Literature Review	Three steps of literature review	1) Journals & Papers 2) Books	No	Chapter 2
2	Scope of Risk Management and Prediction	- Interview - Delphi technique	Literature review (step 1^{st})	Yes Pilot group	Chapter 4
3	Develop Module M1: CJV Risk Identification	- In-depth Interview - Delphi technique	- Literature review (step 1^{st}) - Scope of system (step 2^{nd})	Yes Pilot group	Chapter 5
4	Develop Module M2: CJV Risk Parameter Evaluation	- In-depth Interview - Questionnaire - Delphi technique	Categories of Risks (step 3^{rd})	Yes Professional group	Chapter 6
5	Develop Module M3: CJV Risk Determination	- In-depth Interview - Questionnaire - AHP - Delphi technique	- Literature review (step 1^{st}) - Risks (step 3^{rd} and 4^{th})	Yes Expert group	Chapter 7
6	Develop Module M4: CJV Risk Treatment	- In-depth Interview - Delphi technique	- Literature review	Yes Expert and Professional	Chapter 7
7	Develop P1: CJV Determinant Identification	- Interview - Delphi technique	- Literature review (step 1^{st}) - Results from step 2^{nd} to step 4^{th}	Yes Expert and Professional group	Chapter 8
8	Develop Module P2: CJV Risk Prediction	- Interview - Delphi technique - AHP	- Literature review (step 1^{st}) - Results from step 2^{nd} to step 4^{th}	Yes Professional group	Chapter 9
9	Develop Application Software	Formula, functions and items of Microsoft Excel	Results from step 2^{nd} to step 6^{th}	No	Chapter 10
10	Apply M-DRP Subsystem to Case Studies	Interview	M-DRP subsystem From step 9^{th}	Yes Participants	Chapter 11
11	Conclusions and Recommendations	-	Results from step 1^{st} to step 10^{th}	No	Chapter 12

3.2 Types of Respondents and Interviewees

To develop LCRMP system, many types of data were required through the steps of research methodology. Most of the data were the opinions and recommendations of respondents and/or interviewees, who are the civil engineers of the construction industry in Thailand. Due to the time constraints of those people and the complication of the research methodology of this study, they were decomposed according to their experience and their participation.

There are four groups of respondents and/or interviewees including: (1) the pilot group, (2) the professional group, (3) the expert group and (4) the participants. As shown in Table 3.1, most research steps of this study used the different groups of respondents and/or interviewees. To avoid the confusion, the detail of each groups presents as follow:

(1) The pilot group

Member : Engineers who have the work experiences as the project manager of three or more CJVs in Thailand.

Amount : 4 persons

(2) The professional group

Member : Engineers who have the work experiences in CJVs in Thailand.

Amount : 34 persons per phase

Total 45 persons for all phase

(3) The expert group

Member : Engineers who have the work experiences in three or more CJVs in Thailand.

Amount : 8 persons

(4) The participants

Member : Engineers who have the work experiences of CJVs in Thailand.

Amount : 5 persons

3.3 Details of the research methodology

Each step of research methodology in this study are quite unique. The main purposes, the types of respondents, the details of questionnaire, the period of data survey and the analysis techniques are diverse. However, the results from all ten steps are highly correlate and are used for the development of LCRMP system.

3.3.1 Literature Review

The goal of this step is to develop the extensive review of literatures focusing on CJVs. Then, the gaps of CJV management would be analyzed to evaluate the framework for developing the of LCRMP system

The in-depth literature review process covered the revision of previous studies which contains relevant contents with CJV management in order to analyze studies and tools used in analysis from past till today. Within this process, the trend and format of research studies on JV in construction business which will become very important foundations to evaluating the better management for CJVs.

To ensure the effective literature review, the process of literature review was conducted on three steps including (1) literature input, (2) literature processing and (3) literature output (Levy and Ellis, 2006). For the input steps, it is the process to find and select the quality and relevant literatures. Bloom et al (1956) provide the sequence for the literature processing including (1) know to demonstrate information from literatures, (2) comprehend to report the summarized knowledge, (3) apply by classifying the literatures into relevant categories, (4) analyze by identifying the importance of knowledge from literatures, (5) synthesis by assembling knowledge from literatures together, and (6) evaluate by concluding the distinguish opinions or knowledge among literatures. Final process, the literature output, is to write the results from the previous step into the academic paper form (Hart, 1998).

The collecting process is recognized the objective of this paper to focus on CJV's literatures. It started from exploration of printed articles in two journals. They are "the Journal of Construction Engineering and Management" and "the Journal of Management in Engineering" from American Society of Civil Engineers (ASCE) which is considered as one of the most accepting journals about management in construction industry (Hua, 2008). All journals were explored during period of 1990 to May 2013. From the exploration, there are totally 34 related articles for processing.

By analyzing contents of all articles, based on study issues, there are five main ideas of topics discussed including: (1) studying in the formation of CJVs, (2) studying in the risk management for CJVs, (3) studying in the performance management for CJVs, (4) studying in CJVs as investment strategy and (5) studying in abstraction of CJVs. The section 2.2 in Chapter 2 contains with the detailed contents of the literature review and research directions for CJVs.

3.3.2 Establish Scope of Risk Management and Prediction

The specification of framework and scopes for risk management and prediction in LCRMP system is the main purpose of this step. The finding of the literature Review in the previous step was used as the assumption.

Based on the previous results, the draft of framework was developed by dividing the objectives of CJV and/or CJV operation into five phases according to CJV life cycle and considering the effect of CJV organization structure on the risks. The draft of framework was reviewed by the in-depth interview with the pilot group in order to get the recommendations and opinions for the draft. Each respondent in the pilot group would be interviewed about two or three rounds. This action was based on the concept of Delphi technique.

The development the framework also lead to stipulate two hypotheses of the study. Their answers would be the assumption for developing LCRMP system.

In the meanwhile, the sets of the five point likert scale were developed in this step, as well. These sets of scale would be used for evaluating the values of the risk parameter, including consequence (CSQ) and likelihood (LLH). Because the ranges of the scale are associated with the goal in the each phase of CJV life cycle, it is appropriate, therefore, to develop at this step.

The Chapter 4 contains with all details of framework and scopes for CJV risk management and prediction by LCRMP system. The topics are:

1) Details of five phases in CJV life cycle such as the goals, the constraints, the risk events, timeline and etc.

2) Details of CJV organization structure such as the individual characteristics and etc.

3) Eleven sets of the five point likert scale for evaluating CSQ and LLH in each phase of CJV life cycle

3.3.3 Develop Module M1: CJV Risk Identification

The purpose of the first module for M-ORM subsystem is to identify the significance risks which would impact the CJV and CJV project operating objective in each phase of CJV life cycle. The group of risks, found in this step, would be used for evaluating the values of the risk parameter in the next steps.

The process started from reviewing the risks in the past, results from the first step of the research methodology, in order to identify all the possible risks. Then, those risks were considered that how they were consistent with the objective of each phase. However, most of previous studies were emphasizes on the risks in only one phase, being the construction phase. Therefore, for identifying risks in other phases, it would be applied from related articles. For example, during the formation, the factors would be identified from the articles emphasizing on setting up CJVs, the partner selection and etc.

The most outstanding sources of each risk were used as the criteria for this arrangement. The convenience for the further analysis process is the main reason for this research action.

To approve the accuracy and appropriateness of these risks and their category for CJVs in Thailand, they would be recommended and approved by the pilot group.

The process of requesting opinions for each expert in the pilot group would happen around two or three times. By starting from the second round and over, the expert would recognize the overall data, which was the conclusion from previous round, and could change or confirm his or her opinions. It can be said the process according to the principle of Delphi technique.

As results, there are 30 risks as the eventual result for the step including 12 risks for the internal risk category, 8 risks for the project risk category and 10 risks for the external risk category. The definitions of these risks were described in the Chapter 5. Table 3-2 indicates the example of risks in each category.

3.3.4 Develop Module M2: CJV Risk Parameter Evaluation

To study the characteristics of risks and in order to test two main hypotheses of the study, this module of M-ORM subsystem is focused on collecting data of the risk parameter (CSQ and LLH) for all risks in all phases of CJV life cycle.

The process began with the questionnaire survey and in-depth interview with the professional group. They would give the answers and opinions for CSQ and LLH by considered the work experience in the past. This step processes were separated into 3 parts including (1) the part of data survey, (2) the part of data analysis and (3) the part of hypothesis test, as shown in Figure 3-1.

Table 3-2 Example of Risks and Categories

Internal risk category (INT)	Project risk category (PRO)	External risk category (EXT)
– INT01 Cash flow problems in partners – INT02 Incompetent construction in partners – INT03 Changes in partners ...	– PRO01 Improper project planning and budgeting – PRO02 Problems in construction techniques – PRO03 Incompetent subcontractors and suppliers ...	– EXT01 Differences in social, culture and religions – EXT02 Language barrier – EXT03 Natural disasters and unpredictable weather ...

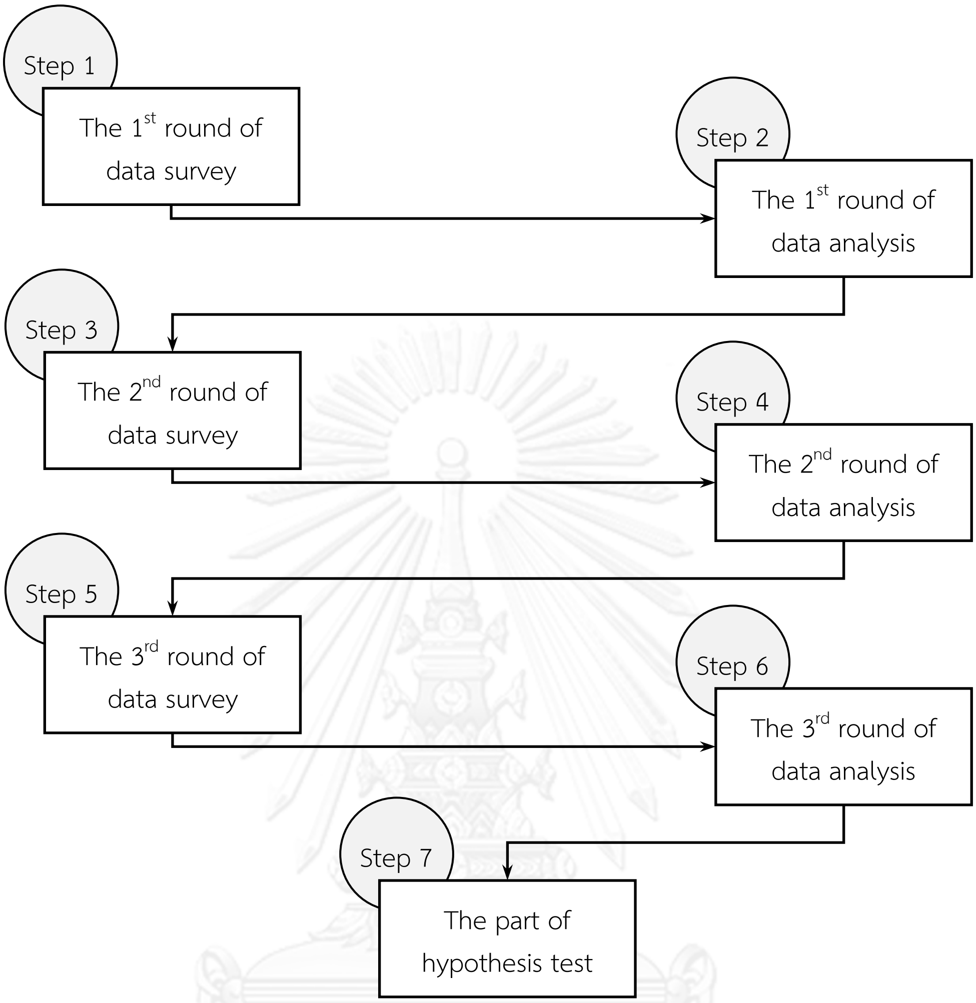


Figure 3-1 Process of Risk Parameters Evaluation

As can be seen from the figure, the process ran three rounds between the part of data survey and the part of data analysis, according to the concepts of the Delphi technique. Then, it went to the part of hypothesis test.

The details of research methodology of each part were as follows:

(1) Part of data survey

The data collection process for each engineer in the professional group would be happened more than 1 time but not more than three times. Each round had the different purposed and the different questionnaire.

The first round

The first questionnaire of risk was created for letting the engineers to evaluate CSQ and LLHs with the sets of scale developed in the Step 3. With the objective of study for assessing risks in five phases of CJV life cycle, there are five sets of questionnaire. Each questionnaire had the objective as follows:

1) To collect CSQ and LLHs of risks in the formation phase, the questionnaire in Appendix A-1 was created.
2) To collect CSQ and LLHs of risks in the bidding phase, the questionnaire in Appendix A-2 was created.
3) To collect CSQ and LLHs of risks in the construction phase, the questionnaire in Appendix A-3 was created.
4) To collect CSQ and LLHs of risks in the warranty phase, the questionnaire in Appendix A-4 was created.
5) To collect CSQ and LLHs of risks in the termination phase, the questionnaire in Appendix A-5 was created.

For the process of questionnaire distribution, each engineer in the professional group might not have equal set of questionnaire. In other words

1) An engineer, with work experience in every phase, would receive five sets of questionnaire.
2) An engineer, with experience not complete in every phase, would receive the same sets of questionnaire with his/her experienced phases.

Moreover, before the distribution, there was the mini interview with each engineer to specify that:

1) What kind of CJV organization structure he/she used to have the work experience in?

   The choices were (1) only in the cooperative governance joint venture (CG-JV), (2) only in the separate governance joint venture (SG-JV) and (3) both CG-JV and SG-JV.

2) How many phases of CJV life cycle he/she used to have the work experience in?

   The choices were the ranges of choices were from one phase to five phases.

The answers from above questions were the rules for the questionnaire distribution. These were:

1) In the case that an engineer only had the work experience in one format of CJV organization structure, he/she would get the set of questionnaire equal to the number of phases which he/she used to have experience.

2) In the case that an engineer only had the work experience in both formats of CJV organization structure, there are two sub-situations:

   If the engineer willing to answer the questionnaires for only structure, he/she would answer the questionnaires based on CJV organization structure which he/she had the most experience.

   If the engineer willing to answer the questionnaires for both structures, he/she would answer the questionnaires for the each structure with the different period of time in order to prevent confusion.

The format of distributing questionnaires and interviews was direct discussion with each engineer in the professional group. However, the schedule of each meeting could be divided into two formats: discussion all the data once or discussion data from set to set.

As the results, there were 45 engineers in the professional group as the respondents of all questionnaires, however, each phase had only 34 engineers. In additional, there are only seven engineers who provided the answers for both structures. Table B-1 in Appendix B was shown the details of the summary schedule for answering questionnaires of each engineer.

The second round

For collecting the data in this round, there are two contents for the second questionnaire of risk, as follows:

1) The content to propose the overview results from the first round of data collection. So, the engineers could consider the overall picture and propose comments

2) The content to ask further opinions or to confirm the data from the first round. The questions would focus on the only data which the engineers had different opinions from the overall results.

Each engineer received the one set of the second questionnaire of risk but each questionnaire had the different details. That was the first content in all questionnaires was same but the details in the second content would depend on the answer of each engineer from the first round.

The method to questionnaire distribution 2 used the sending by email, leaving documents at the company or making the appointment. It would depend on suitable situation of each engineer.

The third round

As for the data collection in the third round, the third questionnaire of risk had the contents and the method to distribution like as the second round. However, the amount of questionnaires in the second content were decreased a lot.

(2) Part of data analysis

Because there were three rounds of the part of data collection, there had to be three rounds for the part of data analysis, as well. The analysis of results for each round separated the calculation process into 2 parts as follows:

1) Finding of the measures of central tendency, including mean, median and mode, to analyze the averages of data

   In this study, mean, median and mode of CSQ and LLH for a risk in a phase would be calculated three times with the different populations. They were the whole population, the CG-JV population and the SG-JV population.

2) Finding of the consensus values to analyze the data consistency

   The calculation started from consideration of the frequency of each scale on how many percent of the total population and then choose the frequency with the most percentage as consensus value.

   The criteria to be used in considering that the data were consistent, the consensus values must be more than or equal to 70 percent after result analysis in the third round.

   If a risk still had the consensus value for the risk parameter, CSQ or LLH, less than 70%, it was considered that the risk must find the reason to support that why could not it find the consistency with information.

(3) Part of hypothesis test

After all data of risk parameter for all risks in all phase were stable, the statistical hypothesis test was formulated to answer the interesting question. For this study, it was that the risk parameter, CSQ and LLH, of a risks show differences or not when CJVs is operated under different organization structure.

The process for the statistical hypothesis test in this study was as follows: (Lehmann and Romano, 2005)

1) State the null hypothesis (H_o) which is a simplified version of the question.

   There were two null hypothesizes developed from the questions.

   $(H_o)_1$: There is no difference in the CSQ of a risk for a phase between CG-JV and SG-JV.

   $(H_o)_2$: There is no difference in the LLH of a risk for a phase between CG-JV and SG-JV.

2) Consider the statistical assumptions for samples.

They are:

a) The CG-JV population and the SG-JV population were the independent samples.

b) The data of the risk parameter granted in this study were not the normal distribution. It was caused by the process to reduce bias of respondents with the Delphi technique (Kalaian and Kasim, 2012).

3) Select the type of the statistical test

Based on the assumptions, the non-parametric statistic was appropriate. From various tests of this kind of statistic, this study decided to “the Mann–Whitney U test” and “the Median test” for the processes of hypothesis test. The reason for using two tests was the need to compare the testing results between the complex and the simple method.

4) Choose the significance level ($\propto$) for the statistical hypothesis test.

The significance level was chosen to be 0.10. (Easton and McColl, 1997)

5) Compute the value of each statistical test

For the Mann–Whitney U test, the U values were calculated, as well as it was the values of chi-square for the Median test. The equations and the calculating example for each test were fully described in Chapter 6.

6) Interpret the value of the test statistic to either “accept H_o” or "reject H_o "with statistically significant for each risk parameter of a risk for a phase. This decision was done based on the criteria of each test.

The example value of the measures of central tendency and results of the hypothesis tests are shown in Table 3-3 and Table 3-4, respectively.

The detailed contents of value of the measures of central tendency for 30 risks and the results of hypothesis tests are described in the Chapter 6.

Table 3-3 Example of Mean, Mode and Median for Risk

<table>
<tr><th rowspan="3">Code</th><th rowspan="3">Risk</th><th colspan="9">Type of population</th></tr>
<tr><th colspan="3">Whole population</th><th colspan="3">CG-JV population</th><th colspan="3">SG-JV population</th></tr>
<tr><th>Mean</th><th>Mode</th><th>Median</th><th>Mean</th><th>Mode</th><th>Median</th><th>Mean</th><th>Mode</th><th>Median</th></tr>
<tr><td>INT10</td><td>Distrust between partners</td><td>1.68</td><td>2.00</td><td>2.00</td><td>1.65</td><td>2.00</td><td>2.00</td><td>1.71</td><td>2.00</td><td>2.00</td></tr>
<tr><td>INT11</td><td>Lack of communication between partners</td><td>3.56</td><td>3.00</td><td>3.50</td><td>3.12</td><td>3.00</td><td>3.00</td><td>4.00</td><td>4.00</td><td>4.00</td></tr>
</table>

Table 3-4 Example of Hypothesis test Results

<table>
<tr><th rowspan="3">Code</th><th rowspan="3">Risk</th><th colspan="3">Mann–Whitney U test</th><th colspan="3">Median test</th></tr>
<tr><th colspan="2">the U value</th><th rowspan="2">Test result</th><th colspan="2">Chi-Square values</th><th rowspan="2">Test result</th></tr>
<tr><th>Critical</th><th>Computed</th><th>Critical</th><th>Computed</th></tr>
<tr><td>INT10</td><td>Distrust between partners</td><td>136</td><td>96</td><td>Accepted Ho</td><td>2.71</td><td>0.01</td><td>Accepted Ho</td></tr>
<tr><td>INT11</td><td>Lack of communication between partners</td><td>32</td><td>96</td><td>Rejected Ho</td><td>2.71</td><td>16.94</td><td>Rejected Ho</td></tr>
</table>

After considering the results of hypothesis test and other information, the process to find the values of the risk parameter in LCRMP system was made the decision. The finding of the LLHs was selected to forecast by sets of the determinants which its process would be developed in the next step of the research methodology. For the CSQs, they were decided to use the constant values. So, the mean CSQs gotten from this step were used as the database for LCRMP system.

3.3.5 Develop Module M3: CJV Risk Determination

Although M-ORM subsystem is based on the concept of risk management by ISO, the process was added many unique features. So, the finding of the values of CSQ, LLH and the level of risk (LOR), which is the combination of CSQ and LLH, in the model had the order of acquiring data in a way that was extraordinarily complicated. It was necessary to develop the guideline in order to recommend the method of LCRMP system. As well, the guideline of risk criterion for M-ORM subsystem is also created. The criterion would be used for judging what the risks should be considered as the critical risks and gotten the risk response.

To approve the accuracy of the guidelines, the in-depth interview with the professional group were collected through the interview. So, Delphi technique was also used. All the detail of the both guidelines describe in Section 7.1 of the Chapter 7.

3.3.6 Develop Module M4: CJV Risk Treatment

For response the critical risks, the M-ORM subsystem of LCRMP system need the guideline purposing the possible risk treatment options for 30 risks. To get this guideline, the research process is:

1) The data about the risk treatment, in the real practices, would be collected during the fourth step of this research methodology. The engineers in the professional groups would be asked orally or would be write the comments in the part of the questionnaire.

2) With others treatment options, gotten from the literature review, the risk treatment options for 30 risks of LCRMP system would be gathered, analyzed and concluded.

   The concept of the Delphi technique would be used in the process because the risk treatment needs all possible options which may be appropriate to CJVs with different conditions and environments.

The Section 7.2 of the Chapter 7 describes the detailed contents of the risk treatment options for 30 risks.

3.3.7 Develop Module P1: CJV Determinant Identification

The aim of this step is to identify the CJV determinants, which are the situation of CJV and CJV project, of M-DRP subsystem.

The process started from reviewing the situation of CJV and CJV project in the past, results from the first step of the research methodology and in-depth interview with the professional and expert groups, in order to identify all the possible determinants. Then, those determinants were considered that how they were effect the value of risk parameter. To approve the accuracy and appropriateness of these risks and their category for CJVs in Thailand, they would be recommended and approved by the expert group. As the results, the definitions and details of 48 CJV determinants risks are described by Chapter 8.

3.3.8 Develop Module P2: CJV Risk Prediction

The structure to predict the values of risk parameter for a future CJV which are consistent with the situation of the CJV, denoted "determinant". However, with the conclusion from the previous step, the structure would be focused only to forecast the LLHs. The structure would be called "the multi determinants matrix (MDM).

The process to develop the MDM consisted of the following steps:

1) Identify the possible determinants for each risk by reviewing the articles and the results from interviewing in the third and fourth steps.

2) Verify and revise the suitable details of determinants, gotten from previous step, by interviewing with the expert group.

3) Create the MDM for each risk. Each structure would be contained only with the associated determinants of the factor. Although LCRMP system have 31 risks, there are 34 sets of the MDM.

   The development was done by applying the concept of the hierarchy structure of the Analytic Hierarchy Process (AHP). It have to be noted that the concept was only used partially.

4) Develop the pairwise questionnaire in order to find the weights of determinants in each MDM. This process would be followed with the pairwise comparison of AHP as well.

5) Make the questionnaire surveys and the interview with the expert group to make the comparison. The nine point scale, suggested by Saaty (1990), was used.

   Because the each scale for each determinant had to be the homogeneous value between all experts. The survey would be based on the concept of the Delphi technique.

6) Perform calculations to find the weights for each determinant, as well as, check the consistency index (CI), the consistency ratio (CR), and the random inconsistency index (RI).

7) Conclude the weights in MDM for each risk.

Figure 3-2 indicates the example of the pairwise comparison process for "PRO03: Incompetent subcontractors and suppliers risk". Table 3-5 was shown the example of the weight of each determinant for same risk which were the result of the pairwise comparison process.

The details of MDM development according to the concept of AHP for 30 risks were described by Chapter 9.

Factor	EIA & EHIA status	Public attitudes towards project	Previous landowners of project sites	Environment of project sites	Level of project preparation
EIA & EHIA status	1.00	3.00	2.00	2.00	0.50
Public attitudes towards project	0.33	1.00	0.50	0.50	0.33
Previous landowners of project sites	0.50	2.00	1.00	2.00	1.00
Environment of project sites	0.50	3.00	0.50	1.00	1.00
Level of project preparation	2.00	3.00	1.00	1.00	1.00
Total	4.33	12.00	5.00	6.50	3.83

Level of Consistency	
Accep	
CI	0.09
RI	1.12
C. Ratio	0.08

Factor	EIA & EHIA status	Public attitudes towards project	Previous landowners of project sites	Environment of project sites	Level of project preparation	Total	Average	Consistency Measure
EIA & EHIA status	0.23	0.25	0.40	0.31	0.13	1.32	0.26	5.40
Public attitudes towards project	0.08	0.08	0.10	0.08	0.09	0.42	0.08	5.35
Previous landowners of project sites	0.12	0.17	0.20	0.31	0.26	1.05	0.21	5.37
Environment of project sites	0.12	0.25	0.10	0.15	0.26	0.88	0.18	5.30
Level of project preparation	0.46	0.25	0.20	0.15	0.26	1.33	0.27	5.40
Total	1.00	1.00	1.00	1.00	1.00		1.00	

Figure 3-2 Example of Pairwise Comparison Process

Table 3-6 Example of Weight of Determinants for the Risk

Determinants	Weight
Performance of subcontractor	0.21
Performance of suppliers	0.11
Type of subcontractor	0.30
Type of technology	0.08
Your construction site experiences	0.16
Local experiences of partners	0.14
Total (Approx.)	1.00

In addition, this step also developed the CJV appraisal form which is the sets of question and prepared answers for evaluating the status of 48 determinants. This process were as follow;

1) Collect all possible statuses for each determinant through discussion and interview with the expert group.

2) Identify the level of impact for each status would be analyzed and put in order to see which has the highest impact until the one with the least impact.

3) Stipulate the impact scale for each status.

   As status for each determinant comes in form of the qualitative data, they are required to be converted into the quantitative data before they can be used for risk evaluation during further process. For this study, the five Likert scale is used to help in conversion of value. The situation with the most likelihood value for risk to occur will be given 5 and the one with least likelihood value will be given 1.

   Moreover, although likert scale allow user to input only five values, the status for each determinant in actual practice may be more or less than five status. In short, it does not usually put in five values all the time. In some situations, they may be put under the same level under the likert scale while for those with less than five status, some level of Likert scale may be left blank.

4) Create the question for helping the user to rate the status of each determinant.

3.3.9 Develop Application Software of M-DRP Subsystem

The aim of this step is the development of the application software to easily evaluate the determinants of the project and to easily acquire the CSQ and LLHs for the various risks in each phase of CJV life cycle. The software should provide the convenience of people, who want to use M-DRP subsystem or shortly "user", to make the understanding of the model, to short the time for running the model and to reduce the opportunity of the human errors.

The study had selected "Microsoft excel" as the program to develop the application software for M-DRP subsystem. There are three sections of the application software should be developed in the spreadsheet to fulfill the requirement of the processes of the determinant and the risk parameter prediction in M-DRP subsystem. They are:

(1) The user interface section

It is the group of worksheets for communication with the user to receive the data of determinants and display the results of the model.

(2) The database section

It is the group of worksheets for collecting various information and the data received from the user.

(3) The processing section which

It is the group of worksheets for calculating the risk parameter for each risk.

The spreadsheet would be developed by the series of formula, functions and items of Microsoft Excel as the main tool to perform the mathematical calculations, to connect data, to find values, to create the box for filling out data, to graph data and etc. As the results, there are totally 45 worksheets in the spreadsheet as the application software for M-DRP subsystem. The example of first worksheet of the application software shows in Figure 3-3.

The Chapter 10 contains the details of the development of the application including the overview of the spreadsheet and the details of all the worksheets that had been developed.

3.3.10 Apply M-DRP subsystem to Case Studies

In order to test that the predicting results from M-DRP subsystem being close to the actual impacts and frequencies in the real world situations, the research is required this step. M-DRP subsystem needs to be through the processes of verification and validation by applying the model with the three case studies, shortly "case", through the data collection with the participants. The details of model verification and validation each case was described in Chapter 11. The methodology for each process is:

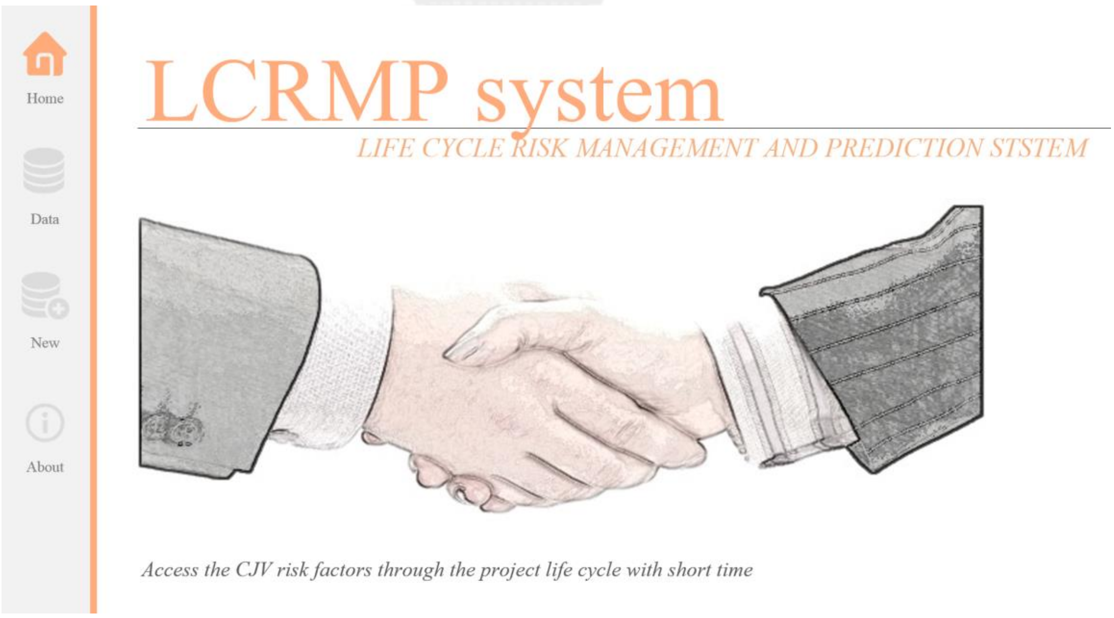


Figure 3-3 Example Frist Worksheet of M-DRP subsystem

(1) Process of model verification

It was the methodology in order to test that the risk assessment of M-DRP subsystem through the application software could create the correct results as specified.

The process of verification for this study was as follows:

1) The participants of each CASE would answer the set of questions in "the CJV Appraisal Sheet" which is shown in the appendix B. To answer the questions, they had to consider the determinants, which are the internal and external environment of the CJV project as it really happened during the pre-construction phase.

2) The risk parameters of all risks for the five phases of the ICVJ life cycle would be evaluated by using the answer from step 1) with two different methods. They are:

   a) Calculate by the ability of the application software as the functions have been designed and written in the step 8. So, the process in this step was only pressing the prepared button in the software.

   b) Calculate by hands according to the same processes which are in the application software. The calculator and Microsoft excel were used as tools in the calculation as suitable.

3) The values of risk parameter of the same risk at the same phase, which were received from method (a) and (b) in step 2), would be compared. For a CJV project, there are 220 values of the risk parameters which have to be compared.

The expectation of model verification is that the comparison result in the third step must not find any difference between the results received from calculating by M-DRP subsystem and by hands. If the results received was as said, it can be concluded that the model could be performed correctly.

(2) Process of model validation

It was the methodology for considering the accuracy of the risk parameter, including CSQ and LLH, received from M-DRP subsystem when they are compared with the actual results.

In this study, the process of system validation by Ozorhon et al. (2007) was applied to the study. The process was as follows:

1) The participants of each case would answer the set of questions in “the CJV Appraisal Form”.

2) The participants of each case would answer the set of in order to evaluate, under the actual situations of each risk for the case, how frequent it happened and how it would impact the objective of the phase.

   Finally, the result would be the list of the actual impact (Ai) and the actual frequency (Af) for risks in each phase.

3) The CSQ and LLH for each risk in all phases of the CJV life would be calculated by ability of the application software.

4) The values of from step 2) and step 3) of the same risk at the same phase would be compared and computed the ERROR. As the assumption, the CSQ is equivalent to the Ai value and the LLG value is equivalent to the Af value.

5) The ERROR value for each factor would be determined with the criteria.

   The expectation of the ERROR value should be different as least as possible. If it had no difference, it would be the best answer because it would mean that the model could forecast the value of the risk parameter consistent with the truth.

The Chapter 11 indicates the details of processes and results of the subsystem verification and validation.

3.3.11 Create Conclusions and Recommendations

The last step of the methodology was to present the summary in order to discuss the holistic results and to present the conclusion of LCRMP system which was based on the information received from the study. In additional, the restriction of this study and the recommendation for the other studies in the future would be also be presented in this part. The fully details of summary, conclusion and recommendation for this study were described in Chapter 11.

3.4 Summary

To accomplish the objective of study to create the LCRMP system, there are ten steps of the research methodology including

(1) Literature Review that focused on collecting relevant knowledge from various textbooks, academic journals, and websites.

(2) Establish Scope of Risk Management and Prediction that focused on establishing the system scopes including definition, objectives of CJV or CJV project operation and the sets of likert scale for evaluating consequence and likelihood.

(3) Develop Module M1: CJV Risk Identification that focused on identifying risks that contribute to the success of CJV or CJV project operations in each phase of its life cycle,

(4) Develop Module M2: CJV Risk Parameter Evaluation that focused on evaluating risk parameter (consequence (CSQ) and likelihood (LLH)) of risks in each phase of CJV life cycle, as well as, testing the two hypotheses by the nonparametric statistics.

(5) Develop Module M3: CJV Risk Determination that focused on introducing the guidelines of risk criterion for making the decision what the risks in each phase should be considered as the critical risks.

(6) Develop Module M4: CJV Risk Treatment that focused on presenting the guideline of risk treatment options, to minimize the impacts and/or chances of critical risks in each phase.

(7) Develop Module P1: CJV Determinant Identification that focused on the process of identifying determinants being the representative of CJV and CJV project situation.

(8) Develop Module P2: CJV Risk Prediction that focused on creating the multi determinant matrix (MDM) by the concept of analytic hierarchy process (AHP) for predicting risk parameters for future CJVs.

(9) Develop Application Software that focused on creating the application software for M-DRP with the features of Microsoft Excel.

(10) Apply M-DRP Subsystem to Case Studies that focused on verifying and validating subsystem to summarize the suitability of the subsystem for the real practice.

(11) Create Conclusions and Recommendations that focused on summarizing the conclusions, limitations and suggestions of the study.

These development processes are based on the principles of risk management. As well the relevant data for system, both qualitative and quantitative types, were gathered by various tools and methods such as the Delphi technique, and the nonparametric statistics.

CHAPTER V
CJV RISK IDENTIFICATION MODULE

This chapter presents the development of the module M1 which is the first module of the Multi-Objective Risk Management (M-ORM) subsystem. Moreover, the risks identified in this chapter would be used in other modules of the proposed life cycle risk management and prediction (LCRMP) system for construction joint ventures (CJVs). The 30 risks in the five phases of the CJV life cycle were identified and analyzed in detail. The chapter summarizes the definitions, characteristics, and important features of each risk.

5.1 Risk Identification

5.1.1 Development of Risks

Identifying risks for the LCRM system was mainly based on the previous research studies related to the risk assessment, the critical success factors, the performance management and the cooperative success of CJVs.

The five journal papers which were selected as a guideline for identifying risks were:

(1) Appropriate appraisal and apportionment of megaproject Risks by Kumaraswamy (1997)

(2) Risk management in international construction joint ventures by Bing et al. (1999)

(3) Risk assessment for construction joint ventures in China by Shen et al. (2001)

(4) Fuzzy analytical hierarchy process risk assessment approach for joint venture construction projects in China by Zhang and Zou (2007)

(5) Identifying the critical risks in underground rail international construction joint ventures: case study of Singapore by Zhao et al. (2012)

There are more than 60 risks in the first draft of risk identification. However, with the interview process with the pilot group and the thorough analysis (discussed in Section 3.3.3), only 30 risks were considered for all phases of CJV life cycle.

Table 5-1 compares the 30 risks proposed by the journal papers, the opinions from the pilot group and the result from Prasitsom (2007). Detailed discussion can be found in Section 3.3.3.

Table 5-1 Summary of Risk Identification

Risk	Sources									
	Previous studies					Prasit-som (2007)	Pilot group			
	Kumaras-wamy, 1997	Bing et al., 1999	Shen et al. 2001	Zhang and Zou, 2007	Zhao et al., 2012		1st Person	2nd Person	3rd Person	4th Person
Cash flow problems in partners	X	X	-	X	X	X	X	X	X	X
Incompetent construction in partners	-	X	X	X	X	X	X	X	X	X
Changes in partners	-	X	X	X	X	X	X	X	X	-
Lack of local experience in partners	X	-	X	-	-	X	X	-	X	X
Lack of JV experience in partners	-	X	X	X	-	X	X	X	X	X
Difference on accounting of profit & losses between partners	X	X	X	X	X	X	X	X	X	X
Difference on resource allocation between partners	X	-	X	X	-	X	X	X	X	X
Improper intervention by partners	X	X	-	X	X	X	X	X	X	X
Difference on organizational structure and culture between partners	X	-	-	X	X	X	X	X	X	X

Table 5-1 Summary of Risk Identification (Cont.)

Risk	Sources									
	Previous studies					Prasit-som (2007)	Pilot group			
	Kumaras-wamy, 1997	Bing et al., 1999	Shen et al. 2001	Zhang and Zou, 2007	Zhao et al., 2012		1st Person	2nd Person	3rd Person	4th Person
Distrust between partners	-	X	-	X	X	-	X	X	X	-
Lack of communication between partners			X	-	-	X	X	X	X	X
Incomplete in venture agreements	X	-	X	-	-	X	X	X	-	X
Improper project planning and budgeting		-	X	X	X	X	X	X	X	X
Problems in construction techniques		-	-	X	X	X	X	X	X	X
Incompetent subcontractors and suppliers	-	X	X	X	X	-	X	X	X	X
Problems in contract drawings and specifications	X	-	X	-	-	X	X	X	X	X
Problems in construction contracts	X	X	X	X	X	X	X	X	X	X
Improper project profit and risk sharing	X	-	-	-	-	-	X	X	X	X
Excessive demands and variation orders	-	X	X	X	X	-	X	X	X	X
Intervention and delay by owner or its representatives	X	-	X	X	-	X	X	X	X	X
Differences in social, culture and religions	-	X	X	X	X	X	X	X	X	X
Language barrier	-	X		X	X	X	X	X	X	X
Natural disasters and unpredictable weather	-	X	X	X	X	-	X	X	X	-
Pollution	X	X	X	X	X	-	-	X	-	X

Table 5-1 Summary of Risk Identification (Cont.)

Risk	Sources									
	Previous studies					Prasit-som (2007)	Pilot group			
	Kumaras-wamy, 1997	Bing et al., 1999	Shen et al. 2001	Zhang and Zou, 2007	Zhao et al., 2012		1st Person	2nd Person	3rd Person	4th Person
Resistance from society	-	-	X	X	-	-	X	X	X	-
Security problems and social disorder	-	X	-	X	X	-	-	-	X	X
Inconsistency in government policies	X	X	X	X	X	X	X	X	X	-
Investment restriction	-	X	X	X	X	-	X	X	-	X
Corruption and bribery	-		X	X	-	X	X	X	X	X
Fluctuation in economic and inflation	X	X	X	X	X	-	X	-	X	-

As shown in Table 5-1, to approve the risks being accurate in the details and appropriate for CJVs in Thailand, the study used the criteria that each factor should have the 50 percent or more of the consensus value by the pilot group. Because there are only four members in the group, so, a risk would be approved when two members or more have to agree on the factor. Moreover, most of names, used to call the risks, were a new rewrite from the previous studies because the different definitions and/or the different word selection.

5.1.2 Categories of Risks

To facilitate the further analysis, the 31 risks were grouped into three categories:

(1) The internal risk category (INT)

(2) The project risk category (PRO)

(3) The external risk category (EXT)

Among a total of 30 risks, twelve risks were classified in the internal risk category, eight risks were in the project risk category, and eleven risks were in the external risk category. Table 5-2 lists the risks for each category.

Table 5-2 List of Risks in Each Risk Category

Risk category	Risk	
	Code	Description
Internal risk category (INT)	INT01	Cash flow problems in partners
	INT02	Incompetent construction in partners
	INT03	Changes in partners
	INT04	Lack of local experience in partners
	INT05	Lack of JV experience in partners
	INT06	Difference on accounting of profit & losses between partners
	INT07	Difference on resource allocation between partners
	INT08	Improper intervention by partners
	INT09	Difference on organizational structure and culture between partners
	INT10	Distrust between partners
	INT11	Lack of communication between partners
	INT12	Incomplete in venture agreements
Project risk category (PRO)	PRO01	Improper project planning and budgeting
	PRO02	Problems in construction techniques
	PRO03	Incompetent subcontractors and suppliers
	PRO04	Problems in contract drawings and specifications
	PRO05	Problems in construction contracts
	PRO06	Improper project profit and risk sharing
	PRO07	Excessive demands and variation orders
	PRO08	Intervention and delay by owner or its representatives
External risk category (EXT)	EXT01	Differences in social, culture and religions
	EXT02	Language barrier
	EXT03	Natural disasters and unpredictable weather
	EXT04	Pollution
	EXT05	Resistance from society
	EXT06	Security problems and social disorder
	EXT07	Inconsistency in government policies
	EXT08	Investment restriction
	EXT09	Corruption and bribery
	EXT10	Fluctuation in economic and inflation

5.1.3 Risks throughout CJV Life Cycle

From the in-depth interviews with the pilot group, the risks in each phase of the CJV life cycle can be identified. It was found that some risks were associated with only one phase, whereas some risks were associated with several phases. The number of risks in each phase can be summarized as follows.

(1) The formation phase: 20 risks

(2) The bidding phase: 21 risks

(3) The construction phase: 29 risks

(4) The warranty phase: 25 risks

(5) The termination phase: 19 risks

Because each phase entails different operation objectives, the characteristics of risks would be different. Table 5-3 shows the list of risks in each phase of CJV life cycle.

Table 5-3 List of Risk in Each Phase of CJV Life Cycle

Risk		CJV life cycle				
Code	Description	Formation phase	Bidding phase	Construction phase	Warranty phase	Termination phase
INT01	Cash flow problems in partners	X	X	X	X	X
INT02	Incompetent construction in partners	X	X	X	X	X
INT03	Changes in partners	X	X	X	X	X
INT04	Lack of local experience in partners	X	X	X	X	X
INT05	Lack of JV experience in partners	X	X	X	X	X

Table 5-3 List of Risk in Each Phase of CJV Life Cycle (Cont.)

Risk		CJV life cycle				
Code	Description	Formation phase	Bidding phase	Construction phase	Warranty phase	Termination phase
INT06	Difference on accounting of profit & losses between partners	X	X	X	X	X
INT07	Difference on resource allocation between partners	X	X	X	X	X
INT08	Improper intervention by partners	X	X	X	X	X
INT09	Difference on organizational structure and culture between partners	X	X	X	X	X
INT10	Distrust between partners	X	X	X	X	X
INT11	Lack of communication between partners	X	X	X	X	X
INT12	Incomplete in venture agreements	-	X	X	X	X
PRO01	Improper project planning and budgeting	-	-	X	X	-
PRO02	Problems in construction techniques	-	-	X	X	-
PRO03	Incompetent subcontractors and suppliers	-	-	X	X	-
PRO04	Problems in contract drawings and specifications	-	X	X	-	-
PRO05	Problems in construction contracts	-	-	X	X	x
PRO06	Improper project profit and risk sharing	X	-	-	-	-

Table 5-3 List of Risk in Each Phase of CJV Life Cycle (Cont.)

Risk		CJV life cycle				
Code	Description	Formation phase	Bidding phase	Construction phase	Warranty phase	Termination phase
PRO07	Excessive demands and variation orders	-	X	X	-	-
PRO08	Intervention and delay by owner or its representatives	X	X	X	X	X
EXT01	Differences in social, culture and religions	X	X	X	X	X
EXT02	Language barrier	X	X	X	X	X
EXT03	Natural disasters and unpredictable weather	-	-	X	X	-
EXT04	Pollution	-	-	X	-	-
EXT05	Resistance from society	X	X	X	X	-
EXT06	Security problems and social disorder	X	X	X	X	-
EXT07	Inconsistency in government policies	X	X	X	X	X
EXT08	Investment restriction	X	-	X	-	X
EXT09	Corruption and bribery	X	X	X	X	X
EXT10	Fluctuation in exchange rates	-	-	X	X	X
EXT11	Fluctuation in economic and inflation	-	-	X	X	-

5.2 Definitions of Risks

To understand in the definitions and interesting characteristic of 31 risks, their details were described in this sections. It is very important to understand the means of all risks before starting the data analysis of risks for the study in the next chapters. As well, the risk assessment for a CJV by using LCRM system would be successful when the user know the meaning of all risks, as the main component of the model. These contents were the conclusion from the fourth step of the research methodology with the further information from the first and third of research steps.

The details start with the definitions of 12 risks of the internal risk category (INT) in the section 5.2.1. Next section is the details for 8 risks of the project risk category (PRO). The 11 factors of the external risk category (EXT) describe at the section 5.2.3.

5.2.1 Internal Risk Category

This category is the group of risks which their source of risk relate to the internal environment of CJVs. The internal environment of each CJV is always different depending on the characteristics of each partner and the details of cooperation between partners. The partner could control the source of risks in this category by the process of partner selection and the negotiation.

In most of the previous studies, during the process of risk assessment, the characteristics of the user are often considered as that they are perfect and are not a source of any risks. However, in reality, it would not like that. For the study, the term of "partner" means every partner in the CJV including the user who is assessing the risk.

The definitions and interesting issues for 12 risks in this category are as follow:

(1) INT01: Cash flow problems in partners

This certain risk relates with cash flow problem within each partner's head office. Please do keep in mind that cash flow problem is not a key indicator used to tell that partner is going bankrupt but it is a result from poor income and expense management which does not go according to plan. It leads to cash shortage for ongoing operation. Moreover, there are only a few companies who never encounter cash flow problem. It is likely, for every company, to face with cash flow problem as long as they are still operating.

Each partner may face with cash flow problems at any time. From the past studies, some partners face it only during starting phrase in JV life cycle while others faced it in the middle or in the final phrase of JV life cycle. The construction business is a type of business that expenses occurs every day while income is not. Normally, contractors tend to get paid on fixed schedule, which the fastest is monthly although it rarely is this fast. The timing of income and expense, during the project, are also not balanced as project tends to be inspected first, which delays income, while expense has to be paid on time.

The effects from cash flow problems in partners can be divided into several levels. It ranges from lowering resource gathering capability to even zero resource which also delays or even halt construction progress. The partners may choose to seek cash, via several tools, from financial institutes but it will inevitably increase the cost of operation due to interest charged. This risk also affects relationship, in term of trust and decision making, among partners both in short and long term.

(2) INT02: Incompetent construction in partners

The construction competence of partners is very important. Although it can vary among partner but each should be on acceptable level. However, if some partners have too low construction competency, it will lead to many problems in CJVs such as the construction delay, the overrun cost and etc.

The evaluation of each partner's construction competency should be done since partner secretion process. However, it was found that the experience in the past construction projects did not usually reflect their current construction competency. Following that, the past studies showed that many CJVs in Thailand, the partners had to choose the contractor with almost no competency due to the political reasons.

(3) INT03: Changes in partners

The main operation of CJVs is depended on the resource sharing among partners. This is an ongoing process until it reaches the final phase of CJV life cycle. Normally, the operation duration from the first to the final phase of CJVs for the infrastructure projects take three to six years. With this time span, the policy toward the CJV of the partner's head office may change from positive to negative. This would conflict with the CJV operation and management.

The little or moderate changes in policy may not have much influence toward CJVs. It usually results in delayed decision making or unsatisfactory among partners as each of them tries to avoid violating signed contract. However, it is possible that business policy may change greatly due to changes changing stakeholders or even economic situation. These situations often changes the direction of co-operation immediately which the worst case of risk impact is disbanding the CJV.

(4) INT04: Lack of local experience in partners

This risk is about how familiar or acknowledgment of construction site's local environment each partner is. The local environment means the geographical data, the weather data, the labor pool, the materials markets, the product agents, laws, the government officers, relationship with local, the attitude of local and etc. These are the results from past experiences of each partner. Although the information for local environment can be studied in advance, it cannot be compared with actual experience which usually lead to more learning and understanding unexpected things.

Normally, the lack of local experience in partners usually occur with the foreign partners who have no work experience in Thailand, the partners who worked for a few times, the partners who used to work long time ago or the partners who worked in different local environment. This is similar to the Thai partners, they sometimes face with this risk too. It is because the environment JV is operating in is different from environment they used to work before.

The impacts of this risk are varied. For example, they are the disputes with local, the disputes with personnel and workforce, the problems with security, the problems with finding materials and workforce, the legal issues, the taxation, the government officer-related issues and etc. All of those problems affect cost and schedule of the CJV projects. The severity of the factor depends on how well each partner in CJVs prepare.

(5) INT05: Lack of JV experience in partners

The past experiences of the CJV projects are the main topic for this risk. If partners have had the past experience in CJVs either in Thailand or in other counties, they will be familiar with several key processes of the CJV management. So, the partners should be able to prepare the CJV documents, to understand the processes of CJV operation, to gather labor and other resources, to reduce unnecessary risks and problems in the cooperate unit, to solve the unexpected problems and etc. On the contrary, if partners have no experiences at all, they will lack experience in those mentioned above and will reduce efficiency in the CJV management. As the results, it will increase time and cost for management.

In order to consider the CJV experience in partners, it is necessary to divide the experience into two levels which are the organization level and the staff level. Both levels are very important but they provide different impact to CJVs. It can be said that, for organization level, it affects the efficiency of the CJV management such as decision making, negotiation and etc. When it is the staff level, it affects the general operation of CJVs such as information sharing, updating project status and etc.

From interviews, the partners usually cannot achieve their objectives in joining JV because their staff rarely understand the concept of the CJV management. Apart from that, it is frequently found that the partners who are experienced in the CJV projects tends to employ staff who do not have any experience to work in the CJV instead.

(6) INT06: Difference on accounting of profit & losses between partners

The risk is focused on the requirement of each partner in term of the financial and the resource investment which co-relates with workload and benefits in the CJV. As well, the liability towards owner and 3rd parties, which usually lead to higher cost or even loss, is also one of things partners concern about too.

It is normal for each partner to require their needs in several aspects as they expect to gain as much as they can from their investment but they also want to take as less responsibility and risk as they can which follow the business principle of capitalism. However, when they are agree to make the partnership together in the CJV, each partner cannot focus only on their own benefit, all the time. That is when the negotiation process comes in to compromise everyone’s requests and come up with the term which satisfies everyone as well as possible.

The result of the negotiation may be varied but it can be categorized into 3 types. These are:

1) The negotiation goes well (everyone is happy).

2) The negotiation is just fair (some are happy while some are not)

3) The negotiation fails (everyone is not happy and there is no solution).

It is found that the more diversity there is among the partners in investment, benefits and liabilities, the more time they need for negotiation. It can be reduced if the partners used to work together before and have good relationship or they have great negotiation skill.

In case of negotiation's failure, there are several levels of impact;

1) The new negotiation schedule is set up but it will delay work schedule and create unhappiness among partners

2) Take it as what it is which will result in investment which does not go according to plan.

3) Canceling or termination of the CJV before finishing the project.

Sometimes even they can get the solution from the negotiation but the result is the same as it has failed because not everyone is happy with the solution. So, they tend to offer new negotiation which benefit them more than the previous solution.

(7) INT07: Difference on resource allocation between partners

This risk is about requirement of each partner in term of delegating or transferring staff, equipment and etc. under their control into several positions within the CJV. This is an important factor, especially for staff, because the staff who work in key positions will have authority to direct, control and follow the CJV's operation in order to fulfill need of a specific partner. Apart from that, as the partners have to share responsibility, profit and loss, each of them want to have their own people in management position within JV to avoid being exploited by other partners.

When each partner wants his/her own staffs in the same position (could be someone from the head office or an outsourced), it creates conflict within the CJV. It is resulted in delayed planning as the partners need to negotiate among each other to find acceptable choice and makes operation slower if the partners cannot find acceptable solution. Nevertheless, this problem does not normally lead to disbanding of the CJV as it often ends by one partner decide to withdraw although it takes a while. The real issue about this risk is that it creates dissatisfaction among partners.

(8) INT08: Improper intervention by partners

This risk relates to the behavior of partners which is considered as intervention within CJVs in both construction and management aspect which cross the boundary of their own responsibility agreed among partners in advance.

The intervention by partners can be put into two characteristics, they are intentionally and unintentionally intervention. The first characteristic is usually happen when the partners have their own secret objectives which they cannot tell anyone. So, they tend to do intervene in any operation to make sure they get what they want. The partners who fall into this type usually want to learn technology, know more supplier, expand market, increase profitability, build fame and etc.

For the partners who unintentionally intervene, which fall into the second characteristic, usually want make sure the JV operates at its best performance. So, they want others to work accordingly to them. It is the problem from unclear communication or misunderstanding during the formation phase.

Although the intervention has different levels of severity but it surely create unhappiness among the partners which accumulates and affects their relationship in long term. In the meantime, it also has immediately impact. The most obvious impact is when partners cannot take the intervention from others and end up with argument which leads to no-progress work. It delays work process and increase unnecessary expenses.

(9) INT09: Difference on organizational structure and culture between partners

The main point of this risk is differences among partners upon how to direct the task allocation, the coordination and the supervision within their head office's organization (donated as the organization structure) and differences on staff's behavior (donated as the organization culture)

The differences mentioned above are causes of uniqueness for each partner and its staff on how they work. For different organization structure, it will affect how fast or slow decision making is, quality of work, expected cost and organization development. While for different culture, it is reflected through how staff work in term of attitude, communication, worker placement, how they deal with customer, how they deal with boss, how they deal with other parties and etc.

The organizational structure and culture are both mixed into staff through daily work until it has become their habits. When these staff have to work with others, they tend to bring their own organization structure and culture with them without noticing that other parties may have their own organization structure and culture too. When each of them holds on to their own structure and culture, there will create conflict within workplace. The operation does not go smoothly and the staff cannot work together as they tend to resist each other. Finally, it creates fracture within cooperate team and create extremely disadvantageous situation on the CJV management and relationship among partners in long term.

(10) INT10: Distrust between partners

The risk is focused on the relationship among partners within the CJV. Although, the naturally and business alliances should have solid trust among partners as a foundation of co-operation unit. In the reality, they are still distrust each other. The issue occurs because they come from similar type of industry which makes them competitors during the normal situation. Moreover, as partners have to share investment benefits and liabilities, they are worried that they may be exploited by other partners.

One thing which makes distrust among partner different from other risks is that distrust among partner changes all the time. It can be said that the partners may start the CJV with a level of distrust, which comes from past experience, but whether it will keep changing in better or worse way depends on interaction among others during operation.

The impact of distrust among partner does not show immediately. Although they can be clearly seen through action of partners. The slower operation, stressful work environment, resistance from staff are examples of the situation created by distrust among members. It will keep going on and the consequences will be worse and worse until the operation is stopped or none of them want to work with each other anymore.

(11) INT11: Lack of communication between partners

The risk is focused on the communication process in the CJV's body which is focuses on the communication among partners. It is an important part of the process in order to become successful CJV. The word of "Communication", in this study, means the processes of exchanging information and data in all aspects, such as technical, administration, financial and etc. between staff in every level. It can be in the form of discussion, meeting, paper work, sign or etc. The problem about communication in the CJV usually comes from problem during communication process. In some organizations, there is no process of communication at all while some organizations have very strong process but information exchanging does not occur as much as it should. There are many reasons for such issue. For example, the staff from one partner may not trust the staff from other partners and try to conceal the information from each other. Another famous case is when staff have no experience in the CJV and do not know how important effective communication is within the CJV. So, they tend to ignore meeting among the staffs from different partners.

Impact from lack of communication can be deadly for JV. It affects in several aspects of operation. In term of management, it may directs JV operation into the wrong objectives, misunderstanding, delay in operation and etc. All of things mentions create unpleasant feeling among members and may even lead to disbanding of JV. In term of construction management, it affects both cost and schedule. To say it simply, technical data in construction process tends to change all the time. What you can use yesterday may be unusable today. If operating staffs don't get information on time, it may lead to mistake in preparation, unusable materials or even razing of structure which shouldn't become unnecessary expenses.

(12) INT12: Incomplete in venture agreements

The key for this risk is defectiveness in details within contract agreed between partners. It can cover from the contract within the joint venture agreement (JVAX or other agreement contracts. It can br divided this kind of defectiveness into three types, which are;

1) Laxing in agreement

   It creates mistake during the CJV operation when the partners cannot enforce the agreement in contract or some partners may get disadvantages in financial term.

2) Over-strict agreement

   It results in the situation when partners try to fix problem but they found that it contradict with the agreement or it leads to complicated and slow work process.

3) Agreement which puts any partners at disadvantage from the beginning

   It usually comes in form of overloaded work, responsibility to deal with external problem alone, lack of right to vote and etc. It increases cost of operation for disadvantageous partners. In most cases, the responsibility and risk taken may not worth investing.

The main cause of defectiveness within the venture agreement is, generally, from lacking of experience in CJVs. The partners may not know what they should put in the contract to prevent problems or even become problem itself in the future. The carelessness is also another key issue. Some partners just pick conditions they like from sample contracts for the JVA or the old JVA projects and put in the contract. Most of the time, the conditions they put in are not suitable for current project or become defectiveness in the contract themselves. One of thing to keep in mind is that each partner has his/her own ability, experience and personal objectives. Moreover, even working with the same partners from last project, the same contract may not work well anymore. When time and project change, the partners may also change their working habit and personal objectives.

5.2.2 Project Risk Category

The risks in this category relate to the characteristics of construction project which the CJV have to manage. The source of risk for factors in the category mostly relate to the details in the construction contract documents and the capability of the owner and its representatives. The partner could rarely control the source of risks in this category. The possible actions is the negotiation with the owner of the project. However, it does not guarantee that the results will be as desired.

For the study, there are eight risks in this category. The definition and issue for each factor is:

(1) PRO01: Improper project planning and budgeting

This risk relates to the situation when the partners plan the operation schedule and/or estimate the cost of management, construction and the overhead cost improperly. The problems usually occurs when the actual operation require more resources or longer period of time than expected. The completeness of information toward project, the proper time needed estimation and experiences of partners are the key factors directly related to success or failure in operation and cost estimation.

The impact from the improper project planning and budgeting tends to create unnecessary cost to the partners. In the meantime, the construction project may require more activities which will extend working period. Although, due to the principal of construction management, partners usually spare times and cost of unexpected issue but it is usually enough for just small changes. So, when the project requires the higher cost or the longer duration, it strongly affects profit for each partners and company’s reputation.

(2) PRO02: Problems in construction techniques

This risk is about the incapability to continue construction or the incapability to finish construction in acceptable standard due to technical problems. For example, the applied technique does not provide the expected result. The chosen technique is not suit with the project requirement. The partners do not know which technique to apply with the project tasks.

This problem can be the technic in any function such as electric, mechanical, computer, chemical, environmental and civil. It can be any specific technique or many of them combined. This risk tends to have the serious and immediate impact toward CJVs. It halts the construction process until the solution for the mistakes within construction technique can be found. Most of times, the solution is changing the technique which leads to much higher cost when compared to the cost of previous technique.

The partners may face problems in the construction technique due to several reasons such as the inexperience of partners which have never used the technique before, the ignorance of partner during bidding process which makes the overlook technical problem, the misunderstanding of engineer who does not know that the technique cannot be used or apply with the project or environment. Moreover, the new technology usually leads to this risk too. In many projects, the partners try to apply the newest technique without enough knowledge and forget to consider how difficult it is in finding required resources.

(3) PRO03: Incompetent subcontractors and suppliers

This risk is about the competency of operation of the suppliers and the subcontractors. CJVs usually operate in the mega project. It is normal that many subcontractors will be hired in several parts. These contractors who become subcontractors of the CJV may be someone who used to work with each other in the past, totally new contractors, or even mother company of contractors themselves. While the buying materials from contacted suppliers is normal for the construction project. As the CJV projects need large number and various materials which some of them may be unique, buying them from suppliers tend to be the most suitable channel based on cost, placement and delivery.

Generally, if the suppliers cannot deliver the materials, the partners do not have to pay anything while the subcontractors are paid with the lump sum contract, so the partners are not responsible even though the cost of subcontractors rise tremendously. However, if the subcontractors and the suppliers do not work effectively, there will be certain levels of effect back toward CJVs and the partners.

In case of the incompetent suppliers, CJVs will lack materials which be needed for the construction. In additional, the partners need to contact with the new suppliers which take more time and delay of work. Moreover, some materials cannot be order in short time. There are some materials which require assembly and need to be order at least a year in advance while some materials cannot be found elsewhere. When materials are ordered in a rush, it comes with higher unnecessary cost too.

In case of the incompetent subcontractors, they may not be able to finish their work, finish slower than expect or even finish in under standard quality which the CJV cannot avoid to take the responsibility for these issues finally when it has to submit the project to the owner. When the CJV cannot submit their part of the project on time, there are a lot of consequences which may follow such as paying fine, rising cost, even poor reputation and etc.

(4) PRO04: Problems in contract drawings and specifications

This risk is about the contract drawings and specifications which is counted as part of the construction contract. It is an agreement upon operation and responsibility between owner and the CJV. If there is failure, ambiguous or missing in key details. These problem is the result of ineffective operation by owner and/or its representatives due to several reasons such as lacking of experience, rushing in preparing documents, fail in communication, fraud, shirking responsibility and etc.

Even the partners may not be a direct cause or have any control over failure in this risk, they should be able to reduce its impact since the bidding phase. In short, if the partners find any mistake, they should inform the owner or its representatives for a solution before problematic documents are included as a part of construction contract officially. However, the possibility for the partners to notice the mistake is very slim due to limited document preparing time during the bidding phase with overloading documents work during the period.

The impact for failure in preparing documents, which will be used as references for estimating workload, planning and appraising, will be a great disadvantageous toward the partners. The result from erroneous documents are increasing in work, increasing in materials required or changing to more expensive materials which all of them lead to higher cost for each partner and more time needed for work.

(5) PRO05: Problems in construction contracts

This risk concerns about the situation when the key details within the construction contract which covers all agreements between the owner and the CJV are ambiguous, erroneous or missed out. But within this study, this risk will not cover the drawings and specifications contract as it will be mentioned specifically as another risk.

Although the construction contracts is the most important set of document within the CJV project in the view of owner or the contractor as it directs the CJV's operation and the benefits but the ambiguity and errors always present. The more or less errors depend on how well the project prepares.

These mistakes come from several reasons such as lack of experience, rush in document preparation, fraud and etc. The partners usually do not aware of the problems until they are doing the actual operation and many of agreements are not even needed.

Under circumstances when the agreements within the contracts are needed to settle some issues within CJVs, ambiguity and error in the construction contracts may create conflict between the owner and the CJV. It can be both advantages and disadvantages toward the CJV. When it becomes disadvantages, it affects the CJV in many levels, they are; unsatisfied with owner, complicated work process, higher expenses, paying fine, losing expected income and etc. When the level of unsatisfactory is high enough, it may lead to legal process on court which will forever affect relationship between all partners and owner. Following that, from this study, this factor also creates conflict among members.

(6) PRO06: Improper project profit and risk sharing

The main point of this risk is consideration of the proportion of value worth by using the CJV management which returns are usually in form of cash and perks when compared with the chance that the CJV will be in loss due to unexpected expenses from operation and from uncontrollable factors. On the other hand, these proportion values related directly to wages payment from the owner and risk taking during the CJV operation or it can be called sharing project profit and risk among each other. This risk in this study will focus on consideration of sharing between project (owner) and the CJV (all partners) only while consideration among partners will be done in another factor separately.

The above proportion between the owner and the CJV is not a fixed number. The negotiation usually succeed when every party feel that the they get more value than possibility of loss and when the partners of a CJV decide to bid for a specific project, it means everyone has already accepted proportion of project profit and risk sharing beforehand.

However, the perspectives of the owner and the CJV toward the proportion are contradicted which lead to frequent negotiation during bidding phase to adjust those differences until both parties are happy although it does not turn out to be successful every time. There are several bidders who decide to resign during bidding period within many projects.

(7) PRO07: Excessive demands and variation orders

This risk relates to the demand of the owner to change the operational details within the CJV project. It can occur since the bidding phase, which relates to bidding and documents preparation process or during the construction phase, which relates to detail of materials and warranty phrase which relate to redressing of structure. The reasons of changes may come from changes in the use of structure, errors or missing details since the beginning or even owner's personal need. It is certain that when there are changes from previous operation, it affects both cost and duration of operation.

Although it is responsibility of the partners as contractors who must follow changes in work details but they can also ask for more payment and operation time when there are unreasonable or too many changes occur. When it occurs, both sides may have different perspective toward the issue. Most of the times, the owner tries to exploit weaknesses in the contract to avoid being responsible for excessive demands and variation.

Apart from consideration of cost and time directly related to demands and variations orders, the partners also need to see overall picture of the project. Generally, the demands and variation orders toward a specific aspect of work tends to affect other parts of the project too as most of the work are co-related with each other. When there is any changes occur to any specific part, others also need to change. The partners usually plan things in advance and each of them relate to each other. So, the changes will create unexpected expenses and time needed.

(8) PRO08: Intervention and delay by owner or its representatives

The risk is focused on two related issues. First, it is the issue when owner or its representatives intervene in operation of the partners in both construction and management aspect which is not their direct responsibility based on agreement within the construction contract. Any action which is not normally done in based on normally accepted practice and agreement is considered to be the intervention. Here are some examples of intervention, they are; trying to direct details of JV operation or structure, exchanging of staff within JV, persuading project to be faster or slower, directing plan of work, unnecessary request and etc. To be optimistic, the owner and its representatives may be trying to get the best out of the project but in worst case, owner and its representatives may try to exploit or keep their own benefits.

The result from intervention of owner and its representatives can be varied from partner's lacking in decision power, unsatisfactory among partners and owner or its representatives which none of them is beneficial toward the CJV in term of cost and schedule and even lead to changes in quality of the project itself.

The second issue is circumstance when the owner and its representatives do not try to put their responsibility toward project. It is normally happen when owner and its representatives are lack of experience, lack of personnel, complicated structure, unclear policy, changes in organization and etc. However, the worst case is when the owner and its representatives do not want to be responsible for anything within the project.

Along construction period from the formation until termination phase of CJV life cycle, it does not just relate to only the operation of partners only, the owner or its representatives also have to operate closely to the project all the time as many of the processes require their attention such as review and approval of construction documents, accepting or rejecting request, inspection, payroll and etc. The several operation of the CJV cannot progress forward without support from the owner and its representatives. If the owner or its representatives work slowly, schedule and cost of contractors will be directly affected.

5.2.3 External Risk Category

The risks in this category are focused on the impacts from the external parameters of CJVs including the social, law, economic, environment and etc. Not like as the two previous categories, the partners could not control the source of these risks. Only way, they should prepare the plans for responding the risks.

The category contain with the 11 risks which their definitions and interesting issues are as follow:

(1) EXT01: Differences in social, culture and religions

This risk is about context for each group of staff within the CJV, who usually represent each partner. The social, culture and religions, are tied with staff personally than organization as they lived within that believed and were taught since young which makes it extremely difficult to change. As, it is related to how they were raised, even people from the same nation still have different contexts. It is not surprising at all for general construction project or even organization management to frequently mention issues about social, culture and religions.

For CJVs which consists of partners from several countries. They cannot avoid this risk and have to work under environment which is more complicated and varied than general project. Nowadays, the employing staff have become more open. The local and foreign staff are hired to work together. For example, the CJV who consists of Thai and Japanese partners may not hire only Thais and Japanese. The staff may come from Singapore, Malaysia, Taiwan or even European. This phenomenon lead to the CJV's differences in social, culture and religions being more complicated.

As people who have different social, culture and religions, it leads to differences in ideas, attitudes, beliefs and daily lifestyles. It should be concerned as it would surely influence the CJV operation. When staff work under differences, they tend to be unsatisfied and uncomforted. Moreover, when the feeling get accumulated without a remedy, some of staffs may be unhappy and lead to conflict, resistance or even violence in workplace. At the end, overall staff's efficacy will drop tremendously to even zero point.

(2) EXT02: Language barrier

The risk is focused on different communication skill among staff in the CJV. Although English is a famous medium language for communication, not all staffs in construction industry can speak English well especially for local contractors in Thailand or even contractors from abroad which English is not their standard language. In construction industry, the skills for listening, speaking, reading and writing are required. The staff in each level of work may need different level of these skill. In short, for staff at the lowest level, they may need only skills for listening and reading with a bit of speaking while the high level requires all skills in moderate level at least. The staff being able to use English fluently is appreciated.

The impact from the language barrier among staff can be varied. First, there is too few communication occurs as staff try to avoid communication among each other as they are afraid that they may not communicate well. Next, the communication may take long time. For example, when a staff wants to write something to another staff, he/she tends to spend time trying to find words which can express what they mean while the receiver may interpret the message in another direction (especially paper work). Last but not least, when staff understand things differently from the same document, it affects the CJV in term of legal, financial, technical support and etc. which may lead to the CJV's failure or partners breaking up.

(3) EXT03: Natural disasters and unpredictable weather

This risk relate to the natural disasters and the unpredictable weather within the construction site of the CIJV. For Thailand, most of the natural disasters are related to flood which occur every year. The tsunami and earthquake also occur but it affects only limited area and chances of their occurrences are much less than flood. The cause of flood usually relates to heavy rain. The drought is not as bad in Thailand as in many other countries. It can be considered lucky that most of natural disasters in Thailand are not so severe that they can break down structure immediately (except for tsunami) but the projects tends to be on halt for long time and some structure may be damaged. Based on the good principle of construction planning, contractors should have done research about the natural disaster in the area of the project site but in reality, the natural disasters and the unpredictable weather are factors which are difficult to forecast. That is why they are ignored in most of construction project but when they happen, they affect more than it should be.

(4) EXT04: Pollution

The main point of this risk is unsatisfied environment or situation which can lead to danger or damage, such as dust, smell, noise, vibration, subsidence and etc., which all of them are effects from the CJV construction project. They affects people and environment which are surrounding the construction sites which can be both short term and long term to health issue, life-threatening danger or nature degenerative. However, they are not the real effects towards the CJV, those which will really affect the CJV comes afterward which are protest, site blocked, being sued, forcing to take day off, and paying fine and, in worst case, shutting down project.

The reason why the pollution is counted as the risk even though it is caused by project is that when pollution spreads outside of construction site it means contractors cannot control or manage it anymore and it will reflect back to the project itself. Moreover, the impact is directed back to the project itself not specific person. Whether what happen afterwards, it is out of the CJV's control.

(5) EXT05: Resistance from society

The risk is focused on the resistance from people who live nearby the construction site and the previous owner of the land which will be used for the construction. It also includes people who live outside the area but oppose the idea of construction. Opposition from people arises from several reasons such as the lack of public relation, the impact to daily lives, the effect toward environment, the political situation, the pollution from site, the lacking EIA and etc. All of those are related to development and preparation procedure of the owner which is not efficient while opposition comes from people who are not related to the project. That is why resistance from society is categorized within the external risk category.

The impact from the resistance from society towards the CJV tends to be delay in operation which may have to be on halt until the problem is fixed. The project can be on hold from one to three weeks up to several years. The longer the project is on hold, the more impact it has on the cost and schedule of the partners and relationship among the CJV and the owner, especially during the construction phase. Nowadays, many of the construction projects assign the contractors to response impact from this risk instead of the owner or sharing like in the past. When the project cannot operate due to protest by locals, site blocked or expropriated resistance, the contractors are responsible for negotiating with protestors themselves and have to pay fine if the project cannot be delivered on time. Above this rule, it makes this risk more impactful and more severe.

(6) EXT06: Security problems and social disorder

This risk is about the safety from criminal and riot in area surrounding the construction site. The crime usually happens to the IC JV directly which most cases are stealing of materials from the project. The riot tends to occur outside construction site but can expand into the site which leads to insecurity like stealing, damaging properties or setting fire.

The impact from crime to the CJV, apart from increasing expenses to cover the loss, it will also delay the operation at the same time. Some materials cannot be substituted easily, they require time for arrangement and takes time before it is ready to continue working. In case of social disorder, if lucky, the CJV may just slow down construction or stop for a short time but it does not increase too much cost but, in worst case, when the structure is damaged, the partners have to spend time and resources building things up again.

In Thailand, the crime rate has been increasing due to changing economic and social situation while the social disorder also occur continuously and become more violent in the past few years due to differences in the political idea.

(7) EXT07: Inconsistency in government policies

This factor relates to the government or political party’s policy which makes the partners gain or lose the benefit from operating the CJV project. It is well known that almost every the CJV in Thailand work with projects which has government as the owner. It can be on any level from the government itself, co-operative project between government and private company, state enterprise and etc. When the decision has to be made by the owner upon some issues, such as the financial approval which affects every parts of the project, support from higher authority is always a must. In short, if it is get supported by political party, the approval tend to be fast and easy.

When there are changes in the political power, or even the same party, a person in power usually change the government policies which affects the CJV project. However, these changes are manageable by contractors if the contract is well made to support unexpected changes since the beginning. Most of contractors work without expecting political party's support anyway.

(8) EXT08: Investment restriction

The main point of this risk is laws which limit the proportion of foreign members. For Thailand, normally, the foreigners cannot have the proportion more than 49% of the total investment. Even this is an official laws commonly used, it should not be considered as risk but there is still uncertainty based on action and preparedness of partners. In some the CJV project, the partners may ignore this regulation due to lack of experience, haste to establishing or even do it intentionally which omit this part during the negotiation and tend to ignore this limitation. It would later become a problem while doing document work with the government's offices. It creates unnecessary work and takes time for a new negotiation among the CJV's partners.

The impact of the investment limitation puts the burden of taking higher investment on the shoulder of the Thai partners which means higher investment cost. On the other hand, the foreign partners find it less attractive to invest in Thailand as the proportion of the profit is not as high as they expect. Even this laws has been officially used for a while, this factor has become more flexible as some certain construction projects may have a special laws which remove this limitation due to the need to attract more foreign members to participate more.

(9) EXT09: Corruption and bribery

This risk is about the illegal exploitation for self or others. Although the corruption and bribery in the construction could be beneficial to the partners, such as winning the bid, reducing operating cost, but in long term, it becomes disadvantages in several aspects. For example, during the construction phase, the effectiveness and quality of work will be reduced or lower than standard as the actual cost for the project is less than it should be due to bribery. After finishing projects, some CJVs are sued and lose reputation as the quality of projects is not as good as they should be or they are not constructed based on the design.

Moreover, if it can be considered its impact on the industry and the national's interest, the corruption and bribery has many terrible disadvantages. For example, the good and honest contractors have no chance to win the bid. The quality of material and construction does not reach the standard. The projects are left unfinished. The safety of people is not guaranteed. In short, it slows down the country's infrastructure development and does not worth amount of tax money which have to be paid.

(10) EXT10: Fluctuation in economic and inflation

This risk is about the economic changes and the inflation rate within the country that the CJV is operating in. These contexts are result from combination of several local and foreign factors such as the consumption rate, the cash flow in the system, the lack of material, the oil price, the unemployment rate, the interest rate and etc. Those are factors which partners cannot control or avoid but become very strong and influential factors. The most obvious and immediate effect is rising in price of material and labor which will increase the operating cost of the CJV project. Another impact is about higher interest rate. It will affect the partners who seek financial support via financial institute for investment. There are many others side effects which hide below the surface. For an example, normally, contractors for any construction project would have calculated the cost which covers cost rising due to risks but it usually be small number as proposed price may be too high for them to win the auction. So, when there is drastic fluctuation in the economic and the inflation rate, the cost of construction tends to be higher than expected number.

5.3 Summary

There are 30 risks which can contribute to unsuccessful CJV operation throughout the five phases of CJV life cycle. However, there are different number of risks for each phase. They are 20 risks for the formation phase, 21 risks for the bidding phase, 30 risks for the construction phase, 26 risks for the warranty phase, and 20 risks for the termination phase. These are the results that each phase has the difference of operating objectives. As well, these risks are also categorized into 3 categories according to their characteristics.

First, it is the internal risk category (INT). It is the group of risks which their source of risk relate to the internal environment of CJVs. So, the partners could control the source of risks in this category by the process of partner selection and the negotiation. There are 12 risks in this category. For examples, they are *"INT01: Cash flow problems in partners", "INT05: Lack of JV experience in partners", "INT11: Lack of communication between partners"* and etc.

The second group is the project risk category which consist of 8 risks such as *"PRO02: Problems in construction techniques", "PRO07: Excessive demands and variation orders", "PRO08: Intervention and delay by owner or its representatives"* and etc. The risks in this category mostly relate to the details in the construction contract documents and the capability of the owner and its representatives which CJV partner can rarely control their sources.

For the final category, it is the external risk category which related to the external parameters of CJVs including the social, law, economic, environment and etc. The partners could not control the source of these risks. The category contain with the 11 risks including *"EXT01: Differences in social, culture and religions", "EXT02: Language barrier", "EXT09: Corruption and bribery"* and etc.

The results of CJV risk identification not only use for the M-ORM subsystem but also use for another part of LCRMP system, namely the Multi-Determinant Risk Prediction (M-DRP) subsystem.

CHAPTER VI
CJV RISK PARAMETER EVALUATION MODULE

This chapter is the development of the module M2 of the Multi-Objective Risk Management (M-ORM) subsystem. It discusses a test of two important hypotheses of this study. That is, whether or not the consequence (CSQ) and the likelihood (LLH) of risks in construction joint ventures (CJVs) are different for (1) different phases of CJV life cycle and for (2) CJV organization structures. The in-depth interviews and the questionnaire surveys with the professional group were used to evaluate both risk parameters (CSQ and LLH) for each risk in all five phases of CJV life cycle. The results were then analyzed by trend analysis and a nonparametric method to prove both hypotheses.

6.1 Data Survey

In this research, the risk parameters (CSQ and LLH) were evaluated by the selected contractors in Thailand who have had experience in construction joint ventures (CJVs), called the professional group. In the statistical viewpoint, these representatives can be called "the sample," which are the observations drawn from the population of contractors. Detailed discussion about this issue was presented in Section 3.2.

In addition, the Delphi technique were another important tool used while gathering data. As a result, the in-depth interviews and surveys with each engineer in the professional group were conducted in two or three rounds to reduce the bias of respondents and enhance the reliability of results. Because there are five sets of risks according to five phases of CJV life cycle, the questionnaires were divided into five sets as well. Each set had a different set of questions and a different type of the five-point Likert scale for evaluating CSQ or CSQ. Section 3.3.4 presents the details of the data survey using the concept of the Delphi technique used for this research. More details about the various sets of the five-point Likert scale can be found in Section 4.2.

6.2 Characteristics of Sample

In this research, five sets of samples were used to evaluate risk parameters in accordance with the five phase of CJV life cycle. The details of risk parameter evaluation are as follows.

The risk parameter evaluation was based on the opinions of 45 experienced respondents called the professional group. Since each of them was not involved in every phase of the CJV project, only respondents who were familiar with a certain phase were chosen to participate in the evaluation of such phase.

The samples for each phase was further divided into two groups: the cooperative governance joint venture (CG-JV) group and the separate governance joint venture group (SG-JV) group. Each group entails 17 samples. Figure 6-1 illustrates the characteristics of samples in this research.

6.3 Computation of Risk Parameters

For each set of samples, there were 34 values of CSQ and LLH, which were evaluated by each respondent in the profession group. In statistics, the measures of central tendency (e.g., mean, median and mode) are the common tool for analyzing the average of data. The average values were chosen to represent these CSQ and LLH values.

According to the standard of the International Organization for Standardization (ISO) on risk management (ISO 31000:2009), the level of risk (LOR) for a certain risk is the product of CSQ and LLH, which are represented by the mean scores assigned by respondents. Equations 6.1 to 6.3 (Zhao et al., 2012) were used to calculate the risk parameters in this research.

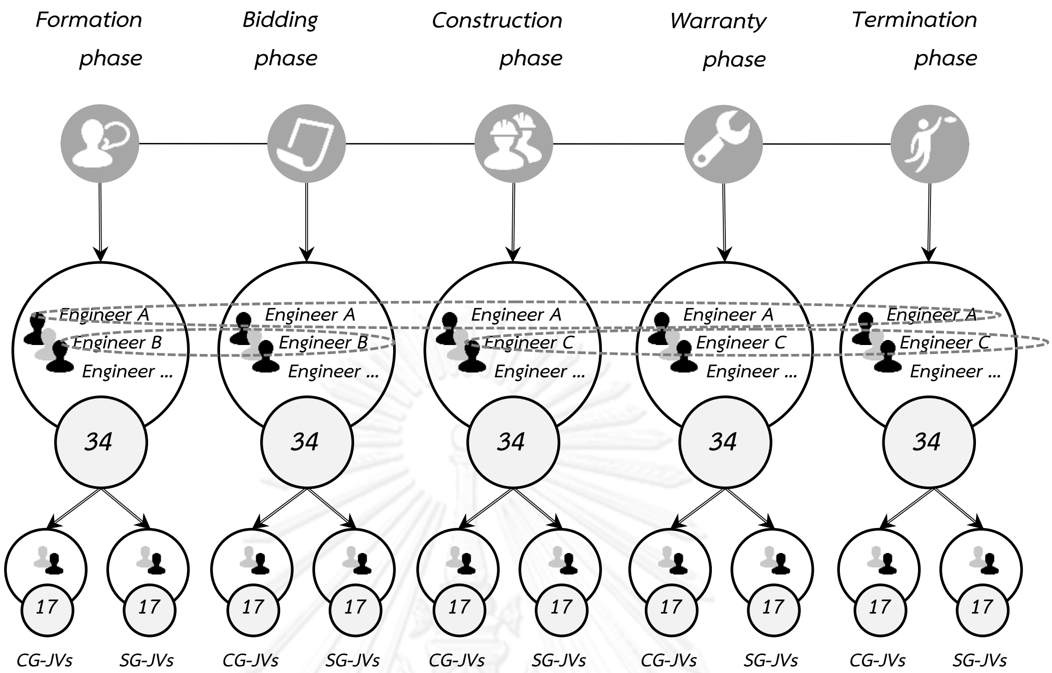


Figure 6-1 Characteristic of Samples.

$$CSQ^{i} = \frac{1}{n}\sum_{j=1}^{n} CSQ_{j}^{i} \quad (6.1)$$

$$LLH^{i} = \frac{1}{n}\sum_{j=1}^{n} LLH_{j}^{i} \quad (6.2)$$

$$LOR^{i} = CSQ^{i} \times LLH^{i} \quad (6.3)$$

Where n = the size of sample,

CSQ^i = the mean score of consequence of risk i

LLH^i = the mean score of likelihood of risk i

CSQ_j^i = the consequence of risk i by respondent

LLH_j^i = the likelihood of risk i by respondent j

LOR^i = the level of risk of risk i

For a risk in each phase of CJV life cycle, there are three sets of CSQ, LLH and LOR values. They are the set for the total sample size, for the CG-JV group and for the SG-JV group.

The examples of computing for CSQ, LLH and LOR for the risk by considering three sets samples are presented in Appendix D-1.

6.4 Nonparametric Hypothesis Tests

As discussed in Chapter 4, it is necessary to test Hypothesis 2, which states that the CSQ and CSQ values of a risk in a certain phase are different for different CJV organization structures. Thus, such values of the risks in five phases of CJV Life cycle must be tested by an appropriate method. There are many possible methods to test the hypothesis of a study from simple approaches with low reliability to complex approaches with high reliability. In this research, a statistical hypothesis test was chosen as the main tool for testing Hypothesis 2 due to its high reliability.

There are also many possible statistic hypothesis testing methods. In general, these methods are divided into two diffenct theories: the parametric statistic test and the nonparametric statistic test. The first theory entails more reliable statistic methods with difficult calculation processes. It also requires complete and restricted information about the population such as the size and the type of distribution. When the population or sample are not perfect due to the limit of population size or the shape of distributed data, the hypothesis should be tested by nonparametric statistic testing methods. The calculation process of this theory is simpler than that of parametric statistic tests, but its reliability is less. The nonparametric methods are a more popular tool because it is usually challenging to set perfect assumptions for the population or sample for the studies.

6.4.1 Reasons to Apply Nonparametric Tests

To select the right statistic test, it is very important to understand the important characteristics of samples and the data gotten from the survey. For this study, they are:

(1) Size of sample

- There are 34 cases for the total sample per each phase of CJV life cycle.
- There are 17 cases in each group of the sample, being the CG-JV group and the SG-JV group.
- The assumption for the CG-JV group and the SG-JV group is both independent for each other.

In statistical viewpoint, this amount is considered as the small-medium sample size. Moreover, the samples was not random according to the statistic theory.

(2) Types of data

- All data in all phases are in the format of the ordinal scale.
- Each of CSQ and CSQ for each phase were evaluated by the exclusive set of the five-point likert scale.

(3) Distribution of data

- All data in five phases are not the normal distribution.

  Although, the sample size for each phase is 37 cases which can be applied with the central limit theorem which infer to the normal distribution among samples (Bartz, 1998). However, the data granted in this research were not distributed normally anymore via the process to reduce bias of respondents with the Delphi technique (Kalaian and Kasim, 2012).

With the characteristics of sample and their data mentioned above, the hypothesis No.2 of this study cannot be tested by the method of parametric statistic. The main reason for this decision is that the data of the study are not the normal distribution. Therefore, this study decided to use the methods of the nonparametric statistic. Form existing methods in this type of statistic test, with the format groups of sample, the sample size and type of data, “the Mann–Whitney U test” and “the median test” was selected.

Normally, the one method of the nonparametric statistic test should be enough for testing the hypothesis for any study. However, this study need to make the comparison between the Mann–Whitney U test, which is the efficiency tool being close as the t-test on nonparametric statistic (Boundless, 2013), and the median test, which is the most simple method in the group of nonparametric statistic but has less efficient.

6.4.2 Process of the Mann–Whitney U test

The Mann–Whitney U test is the method to compare whether the data distributions of the independent groups of the sample would be differ. Because the concepts of the Mann–Whitney U are close as the t-test or ANOVA in the parametric statistic test, many researchers mentioned that the efficiency of this test are higher than many method of the nonparametric statistics. However, for data in the format of the ordinal scale, its efficiency is dropped. The basic hypotheses the Mann–Whitney U test are:

H_0 : The distribution of data in all groups of the sample are same.

H_1 : The distribution of data in all groups of the sample are different.

So, the applied hypotheses of the Mann–Whitney U test for this study are:

H_0 : The data distribution for the CG-JV group and the SG-JV group are same.

H_1 : The data distribution for the CG-JV group and the SG-JV group are different.

The process for the Mann–Whitney U test are as follow:

(1) Rearrange the data from all groups of sample form the lowest score to the highest score. However, the process have to still keep the track of group’s data.

(2) Assign the rank to each data. It would be started with the rank "1" for the lowest score and be increased by one for the next score. In the case which there are two or more data being tie, all data will get the average rank between them. The next score also would get the next rank. For example, please see the example shown in Appendix D-2

(3) Calculate the total of the ranks for all groups of sample, denoted as "T".

(4) Consider the value of T from step 3 and call the maximum T as T_x.

(5) Consider the group size for each group, denoted as "N".

(6) Calculate the U by the equation 6.4, as follow:

$$\mathrm{U} = N_1 \cdot N_2 + N_x \cdot \frac{N_x+1}{2} - T_x \tag{6.4}$$

Where N_1 = the number of size for the group No. 1

N_2 = the number of size for the group No. 2

N_x = the number of size for the group which have maximum T

T_x = the value of the maximum T between all groups.

(7) Find the critical U from Appendix C-1 by considering N_1, N_2 and the level of significance was set as 10%.

(8) Compare the critical U (from Step 7) and the computed U (from Step 6).

a) If the computed U is more than the critical U, the H_0 would be accepted.

b) If the computed U is equal or less than the critical U, the H_0 would be rejected.

(9) Report the result of hypothesis test for this set of sample.

The calculation examples the Mann–Whitney U test by using the data of this study describe in Appendix D-3. The risk named "INT 08: Improper intervention by partners" is selected as the example.

Moreover, because there are huge data for testing by computation processes of the Mann–Whitney U, they were done by the Microsoft Excel with the functions which are developed specifically for this study.

6.4.3 Process of Median Test

The median test is the test for comparing whether the medians between all independent groups in the sample differ. The test is suitable with the data measured by at least the ordinal scale and the independent sample. Although, its efficiency is lower than other methods of the nonparametric hypothesis, it is good for the small sample size and the heavy-tailed distribution sample. The basic hypotheses for the median test are:

H_0 : the median for all groups of the sample are not different.

H_1 : the median for all groups of the sample are different.

So, the applied hypotheses of the median test for this study are:

H_0 : The median for the CG-JV group and the SG-JV group are not different.

H_1 : The median for the CG-JV group and the SG-JV group are different.

The process for the median test are as follow:

(1) Calculate the overall median for the total sample.

(2) For each group, divide the data into two sub-groups with the overall median as the basis. They are the sub-group which the value of data are greater the overall median and the sub-group which the value of data are equal or less than the overall median.

(3) Count the amount of data in each sub-group form Step 2.

(4) Put the count results from Step 3 into the k x k contingency table, when k is the number of sub-groups, Table 6-1 shows the example of table for two sub-groups.

Table 6-1 Example of 2 x 2 Contingency Table

Score	Group No. 1	Group No. 2	Total
> overall median	A	B	A+B
≤ overall median	C	D	C+D
Total	A+C	B+D	A+B+C+D

Where A = the number of cases in of the group No. 1 which the value of data are greater than the overall median

B = the number of cases in of the group No. 2 which the value of data are greater than the overall median

C = the number of cases in of the group No. 1 which the value of data are equal or lower than the overall median

D = the number of cases in of the group No. 2 which the value of data are equal or lower than the overall median

(5) Determine the chi-square test by using information from the table in Step 4. Because the overall population of this study is more than 20, the equation for the chi-square test is:

$$\chi^2 = \frac{N(|AD-BC|-N/2)^2}{(A+B)(C+D)(A+C)(B+D)} \tag{6.5}$$

Where X^2 = the chi-square

N = the total sample size

= $A + B + C + D$

For *A, B, C* and *D* please see Table 6-1

(6) Calculate the degrees of freedom (*df*), while the level of significance was set as 10%. The equation for *df* is:

$$\mathrm{df} = (col - 1)(row - 1) \tag{6.6}$$

Where *df* = the degrees of freedom for sample

col = the number for columns in Table 6-1

row = the number for rows in Table 6-1

(7) Find the critical chi-square from Appendix C-2 by considering the level of significance and *df*.

(8) Compare the critical chi-square (from Step 7) and the computed chi-square (from Step 5).

a) If the computed chi-square is more than the critical chi-square, the H_0 would be rejected.

b) If the computed chi-square is equal or less than the critical chi-square, the H_0 would be accepted.

(9) Report the result of hypothesis test for this set of sample.

The calculation examples the median test by using the data of this study describe in Appendix D-4. Again, the risk named "INT 08: Improper intervention by partners" is selected as the example. As well, the study also develop specific feature in the Microsoft Excel for the computation process of the median test.

6.5 Data Analysis Results

The aim of this section is analyzing, interpreting and reporting of the study results for risk parameters of risks in all phases of CJV life cycle. The concepts of risk management and the nonparametric statistics, described in the section 6.3 and 6.4, were used as the main tools through this description.

The conclusion gotten from this section would be used as the main assumption for developing the Multi Determinants Matrix (MDM), which is the heart module of LCRM system, in the next chapter.

6.5.1 Overall Results

After the analyzing the results and identifying the conflicting viewpoints between the engineers in the professional group through three time of surveys following processes of Delphi technique, were done, the overall results of CSQ and LLH, as well as, their standard deviation for:

(1) The 20 risks in the formation phase, shown in Table 6-2

(2) The 21 risks in the bidding phase, shown in Table 6-3

(3) The 29 risks in the construction phase, shown in Table 6-4 and Table 6-5

(4) The 25 risks in the warranty phase, shown in Table 6-6

(5) The 19 risks in the termination phase, shown in Table 6-7

Comparing with the overall results in previous studies, it is found that that the value of CSQ, LLH or LOR for some risks are quite different.

Table 6-2 Overall Results of Risk Parameters for the Formation Phase

No	Risk		Consequence (CSQ)				Likelihood (LLH)			
	Code	Description	CG-JV		SG-JV		CG-JV		SG-JV	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	INT01	Cash flow problems in partners	3.7	0.5	3.7	0.5	2.5	0.5	1.8	0.4
2	INT02	Incompetent construction in partners	3.8	0.5	4.1	0.6	2.8	0.7	2.9	0.9
3	INT03	Changes in partners	4.0	0.4	4.1	0.6	1.3	0.5	1.2	0.4
4	INT04	Lack of local experience in partners	3.4	0.5	3.6	0.3	3.1	0.8	3.2	0.9
5	INT05	Lack of JV experience in partners	2.9	0.4	3.8	0.4	2.8	0.6	2.8	0.7
6	INT06	Difference on accounting of profit & losses between partners	4.3	0.5	4.2	0.4	3.2	0.7	3.2	0.5
7	INT07	Difference on resource allocation between partners	4.2	0.4	4.3	0.5	2.8	0.7	3.5	0.7
8	INT08	Improper intervention by partners	3.3	0.5	3.9	0.2	1.2	0.4	1.2	0.4
9	INT09	Difference on organizational structure and culture between partners	1.9	0.2	2.1	0.2	2.6	0.5	2.7	0.7
10	INT10	Distrust between partners	3.6	0.5	3.7	0.5	1.4	0.5	1.5	0.5
11	INT11	Lack of communication between partners	3.2	0.4	3.9	0.6	1.9	0.6	2.7	0.7
12	PRO06	Improper project profit and risk sharing	4.3	0.5	4.2	0.4	4.1	0.7	4.1	0.7
13	PRO08	Intervention and delay by owner or its representatives	3.6	0.5	3.8	0.4	2.5	0.7	2.6	0.5
14	EXT01	Differences in social, culture and religions	1.7	0.5	1.8	0.4	2.8	0.7	2.8	0.8
15	EXT02	Language barrier	2.8	0.4	2.6	0.5	2.8	0.8	2.4	0.5
16	EXT05	Resistance from society	2.8	0.4	2.9	0.2	1.8	0.6	1.9	0.7
17	EXT06	Security problems and social disorder	1.2	0.4	1.1	0.3	1.8	0.4	1.7	0.5
18	EXT07	Inconsistency in government policies	2.2	0.4	2.3	0.5	2.7	0.8	2.6	0.6
19	EXT08	Investment restriction	2.6	0.5	2.8	0.4	2.6	0.7	2.6	0.9
20	EXT09	Corruption and bribery	1.7	0.5	1.9	0.5	4.5	0.5	4.6	0.5

Note the sample size for each sample is 17.

Table 6-3 Overall Results of Risk Parameters for the Bidding Phase

No	Risk		Consequence (CSQ)				Likelihood (LLH)			
	Code	Description	CG-JV		SG-JV		CG-JV		SG-JV	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	INT01	Cash flow problems in partners	2.0	0.0	2.3	0.5	2.6	0.5	2.8	0.4
2	INT02	Incompetent construction in partners	3.3	0.5	3.9	0.4	2.9	0.7	2.8	0.8
3	INT03	Changes in partners	3.7	0.5	4.0	0.4	1.3	0.5	1.2	0.4
4	INT04	Lack of local experience in partners	3.2	0.4	3.3	0.5	3.0	0.8	3.1	0.8
5	INT05	Lack of JV experience in partners	3.6	0.5	3.9	0.3	2.6	0.7	2.7	0.9
6	INT06	Difference on accounting of profit & losses between partners	2.2	0.4	2.2	0.4	2.8	0.6	2.9	0.7
7	INT07	Difference on resource allocation between partners	2.7	0.5	2.3	0.5	3.0	0.6	2.1	0.6
8	INT08	Improper intervention by partners	2.7	0.5	2.9	0.2	2.6	0.5	1.6	0.5
9	INT09	Difference on organizational structure and culture between partners	3.3	0.5	2.6	0.5	2.9	0.6	2.8	0.6
10	INT10	Distrust between partners	3.4	0.5	3.3	0.5	1.6	0.5	1.6	0.5
11	INT11	Lack of communication between partners	3.6	0.5	3.6	0.5	2.0	0.6	2.8	0.7
12	INT12	Incomplete in venture agreements	2.2	0.4	3.1	0.7	2.5	0.5	2.7	0.7
13	PRO04	Problems in contract drawings and specifications	4.0	0.4	4.2	0.4	3.2	0.8	3.3	0.7
14	PRO07	Excessive demands and variation orders	3.4	0.5	3.2	0.4	3.1	0.9	3.0	0.9
15	PRO08	Intervention and delay by owner or its representatives	2.6	0.5	2.6	0.5	2.6	0.5	2.8	0.4
16	EXT01	Differences in social, culture and religions	2.1	0.2	2.2	0.4	3.4	0.5	3.1	0.3
17	EXT02	Language barrier	3.4	0.5	2.6	0.5	3.1	0.6	3.2	0.6
18	EXT05	Resistance from society	1.4	0.5	1.4	0.5	2.1	0.2	1.9	0.4
19	EXT06	Security problems and social disorder	1.1	0.3	1.1	0.3	1.8	0.4	1.7	0.7
20	EXT07	Inconsistency in government policies	2.2	0.4	2.4	0.5	2.8	0.8	2.6	0.6
21	EXT09	Corruption and bribery	2.2	0.4	2.3	0.5	4.6	0.5	4.6	0.5

Note the sample size for each sample is 17.

Table 6-4 Overall Results of Risk Parameters for the Construction Phase (Cost)

No	Risk		Consequence (CSQ)				Likelihood (LLH)			
	Code	Description	CG-JV		SG-JV		CG-JV		SG-JV	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	INT01	Cash flow problems in partners	3.2	0.6	4.0	0.6	3.1	0.7	3.1	0.5
2	INT02	Incompetent construction in partners	4.1	0.4	4.2	0.4	3.2	0.5	3.1	0.8
3	INT03	Changes in partners	3.3	0.5	3.4	0.5	3.0	0.6	3.3	0.7
4	INT04	Lack of local experience in partners	2.8	0.4	2.1	0.3	3.2	0.5	3.1	0.5
5	INT05	Lack of JV experience in partners	2.6	0.5	2.4	0.5	2.8	0.6	2.9	0.8
6	INT06	Difference on accounting of profit & losses between partners	3.3	0.5	3.1	0.5	3.1	0.7	2.9	0.7
7	INT07	Difference on resource allocation between partners	2.9	0.6	1.7	0.5	3.5	0.5	2.6	0.5
8	INT08	Improper intervention by partners	3.4	0.5	2.7	0.5	3.3	0.6	2.5	0.6
9	INT09	Difference on organizational structure and culture between partners	2.9	0.4	2.1	0.3	3.2	0.7	3.4	0.5
10	INT10	Distrust between partners	1.6	0.5	1.7	0.5	2.6	0.7	2.5	0.5
11	INT11	Lack of communication between partners	3.1	0.3	4.0	0.5	3.0	0.8	3.6	0.5
12	INT12	Incomplete in venture agreements	3.4	0.5	3.6	0.3	3.1	0.4	3.0	0.5
13	PRO01	Improper project planning and budgeting	3.1	0.5	4.1	0.3	2.0	0.7	2.1	0.7
14	PRO02	Problems in construction techniques	4.1	0.2	4.9	0.3	1.9	0.7	2.3	0.6
15	PRO03	Incompetent subcontractors and suppliers	3.3	0.5	4.2	0.4	2.5	0.9	2.5	0.9
16	PRO04	Problems in contract drawings and specifications	3.7	0.5	4.4	0.5	3.4	0.6	3.4	0.6
17	PRO05	Problems in construction contracts	2.9	0.2	3.1	0.2	2.6	0.7	2.5	0.7
18	PRO07	Excessive demands and variation orders	3.3	0.5	3.9	0.2	3.5	0.5	3.7	0.5
19	PRO08	Intervention and delay by owner or its representatives	2.5	0.5	2.5	0.6	3.0	0.7	3.1	0.7
20	EXT01	Differences in social, culture and religions	2.4	0.5	2.3	0.5	3.6	0.5	2.9	0.3
21	EXT02	Language barrier	2.2	0.4	2.0	0.0	3.6	0.6	2.8	0.4
22	EXT03	Natural disasters and unpredictable weather	1.6	0.5	2.4	0.5	1.8	0.4	1.9	0.3
23	EXT04	Pollution	2.2	0.4	3.0	0.5	2.5	0.5	2.4	0.5
24	EXT05	Resistance from society	3.2	0.4	3.5	0.5	2.6	0.7	2.6	0.5
25	EXT06	Security problems and social disorder	2.2	0.4	2.4	0.5	1.7	0.5	1.8	0.6
26	EXT07	Inconsistency in government policies	1.6	0.5	1.6	0.5	3.0	0.7	2.9	0.6
27	EXT08	Investment restriction	2.0	0.4	1.3	0.5	2.7	0.8	2.8	0.9
28	EXT09	Corruption and bribery	4.7	0.5	4.6	0.5	4.6	0.5	4.5	0.5
29	EXT10	Fluctuation in economic and inflation	3.2	0.6	4.0	0.6	3.1	0.7	3.1	0.5

Note the sample size for each sample is 17.

Table 6-5 Overall Results of Risk Parameters for the Construction Phase (Schedule)

No	Risk		Consequence (CSQ)				Likelihood (LLH)			
	Code	Description	CG-JV		SG-JV		CG-JV		SG-JV	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	INT01	Cash flow problems in partners	2.3	0.5	3.2	0.5	3.1	0.7	3.1	0.5
2	INT02	Incompetent construction in partners	3.6	0.5	4.4	0.5	3.2	0.5	3.1	0.8
3	INT03	Changes in partners	4.1	0.4	4.2	0.4	3.0	0.6	3.3	0.7
4	INT04	Lack of local experience in partners	2.9	0.2	3.6	0.5	3.2	0.5	3.1	0.5
5	INT05	Lack of JV experience in partners	3.5	0.5	2.7	0.5	2.8	0.6	2.9	0.8
6	INT06	Difference on accounting of profit & losses between partners	2.0	0.5	1.9	0.4	3.1	0.7	2.9	0.7
7	INT07	Difference on resource allocation between partners	2.3	0.5	2.5	0.5	3.5	0.5	2.6	0.5
8	INT08	Improper intervention by partners	2.6	0.5	2.9	0.2	3.3	0.6	2.5	0.6
9	INT09	Difference on organizational structure and culture between partners	3.4	0.5	2.8	0.4	3.2	0.7	3.4	0.5
10	INT10	Distrust between partners	3.3	0.5	3.1	0.3	2.6	0.7	2.5	0.5
11	INT11	Lack of communication between partners	3.4	0.5	4.2	0.4	3.0	0.8	3.6	0.5
12	INT12	Incomplete in venture agreements	2.2	0.4	2.1	0.3	3.1	0.4	3.0	0.5
13	PRO01	Improper project planning and budgeting	2.3	0.5	2.2	0.4	2.0	0.7	2.1	0.7
14	PRO02	Problems in construction techniques	4.2	0.4	4.4	0.5	1.9	0.7	2.3	0.6
15	PRO03	Incompetent subcontractors and suppliers	4.1	0.3	4.2	0.4	2.5	0.9	2.5	0.9
16	PRO04	Problems in contract drawings and specifications	3.3	0.5	3.4	0.5	3.4	0.6	3.4	0.6
17	PRO05	Problems in construction contracts	2.3	0.5	2.4	0.5	2.6	0.7	2.5	0.7
18	PRO07	Excessive demands and variation orders	3.4	0.5	3.6	0.5	3.5	0.5	3.7	0.5
19	PRO08	Intervention and delay by owner or its representatives	2.2	0.4	2.4	0.5	3.0	0.7	3.1	0.7
20	EXT01	Differences in social, culture and religions	3.4	0.5	2.7	0.5	3.6	0.5	2.9	0.3
21	EXT02	Language barrier	3.4	0.5	2.3	0.5	3.6	0.6	2.8	0.4
22	EXT03	Natural disasters and unpredictable weather	3.8	0.4	3.8	0.4	1.8	0.4	1.9	0.3
23	EXT04	Pollution	2.1	0.3	2.3	0.5	2.5	0.5	2.4	0.5
24	EXT05	Resistance from society	4.6	0.5	4.5	0.5	2.6	0.7	2.6	0.5
25	EXT06	Security problems and social disorder	1.7	0.5	1.8	0.4	1.7	0.5	1.8	0.6
26	EXT07	Inconsistency in government policies	2.1	0.2	2.1	0.3	3.0	0.7	2.9	0.6
27	EXT08	Investment restriction	2.6	0.5	2.4	0.4	2.7	0.8	2.8	0.9
28	EXT09	Corruption and bribery	3.4	0.5	3.3	0.5	4.6	0.5	4.5	0.5
29	EXT10	Fluctuation in economic and inflation	2.3	0.5	3.2	0.5	3.1	0.7	3.1	0.5

Note the sample size for each sample is 17.

Table 6-6 Overall Results of Risk Parameters for the Warranty Phase

No	Risk		Consequence (CSQ)				Likelihood (LLH)			
	Code	Description	CG-JV		SG-JV		CG-JV		SG-JV	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	INT01	Cash flow problems in partners	2.2	0.4	3.3	0.5	2.9	0.6	3.0	0.5
2	INT02	Incompetent construction in partners	2.2	0.4	2.2	0.4	3.1	0.7	3.0	0.6
3	INT03	Changes in partners	2.9	0.3	2.9	0.2	3.2	0.4	3.5	0.5
4	INT04	Lack of local experience in partners	2.2	0.4	3.3	0.5	3.2	0.5	3.1	0.6
5	INT05	Lack of JV experience in partners	3.4	0.5	3.4	0.5	2.6	0.6	2.8	0.7
6	INT06	Difference on accounting of profit & losses between partners	3.3	0.5	3.7	0.5	2.9	0.6	2.8	0.4
7	INT07	Difference on resource allocation between partners	2.4	0.5	3.4	0.5	3.1	0.6	2.4	0.6
8	INT08	Improper intervention by partners	2.4	0.5	3.1	0.6	3.1	0.6	2.2	0.7
9	INT09	Difference on organizational structure and culture between partners	2.2	0.4	2.1	0.3	3.1	0.7	3.0	0.8
10	INT10	Distrust between partners	2.1	0.2	2.1	0.3	3.1	0.3	3.3	0.5
11	INT11	Lack of communication between partners	2.1	0.3	2.9	0.5	2.9	0.8	3.5	0.5
12	INT12	Incomplete in venture agreements	3.6	0.5	4.0	0.4	2.9	0.7	2.9	0.7
13	PRO01	Improper project planning and budgeting	3.3	0.5	3.4	0.5	2.3	0.5	2.5	0.5
14	PRO02	Problems in construction techniques	2.8	0.4	3.2	0.4	1.4	0.5	1.5	0.5
15	PRO03	Incompetent subcontractors and suppliers	2.5	0.5	2.9	0.4	2.2	0.7	2.4	0.6
16	PRO05	Problems in construction contracts	3.0	0.0	3.3	0.5	2.5	0.5	2.4	0.5
17	PRO08	Intervention and delay by owner or its representatives	3.1	0.5	3.2	0.4	3.4	0.6	3.5	0.5
18	EXT01	Differences in social, culture and religions	2.4	0.5	3.3	0.5	2.4	0.5	2.4	0.5
19	EXT02	Language barrier	2.1	0.3	2.1	0.3	2.4	0.5	2.6	0.5
20	EXT03	Natural disasters and unpredictable weather	1.7	0.5	1.9	0.5	1.8	0.5	1.8	0.5
21	EXT04	Pollution	1.2	0.4	1.4	0.5	1.0	0.0	1.1	0.3
22	EXT06	Security problems and social disorder	1.7	0.5	1.8	0.4	1.8	0.4	1.8	0.6
23	EXT07	Inconsistency in government policies	2.8	0.5	3.0	0.5	2.9	0.8	2.8	0.8
24	EXT09	Corruption and bribery	1.7	0.5	1.8	0.4	4.5	0.5	4.6	0.5
25	EXT10	Fluctuation in economic and inflation	2.1	0.3	2.8	0.4	3.1	0.6	3.2	0.5

Note the sample size for each sample is 17.

Table 6-7 Overall Results of Risk Parameters for the Termination Phase

No	Risk		Consequence (CSQ)				Likelihood (LLH)			
	Code	Description	CG-JV		SG-JV		CG-JV		SG-JV	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	INT01	Cash flow problems in partners	1.3	0.5	1.4	0.5	2.6	0.5	2.6	0.5
2	INT02	Incompetent construction in partners	1.4	0.5	1.6	0.5	3.1	0.6	3.0	0.5
3	INT03	Changes in partners	4.0	0.4	4.0	0.4	3.2	0.4	3.4	0.5
4	INT04	Lack of local experience in partners	3.4	0.5	4.5	0.5	3.3	0.5	3.2	0.6
5	INT05	Lack of JV experience in partners	4.6	0.5	4.6	0.5	2.8	0.6	2.8	0.6
6	INT06	Difference on accounting of profit & losses between partners	4.2	0.4	3.4	0.5	3.4	0.5	3.2	0.4
7	INT07	Difference on resource allocation between partners	2.6	0.5	1.8	0.4	3.1	0.7	2.2	0.6
8	INT08	Improper intervention by partners	3.4	0.5	3.6	0.5	3.4	0.5	2.4	0.5
9	INT09	Difference on organizational structure and culture between partners	2.8	0.5	3.6	0.5	3.3	0.8	3.4	0.5
10	INT10	Distrust between partners	3.8	0.4	3.9	0.5	3.2	0.7	3.4	0.7
11	INT11	Lack of communication between partners	3.1	0.4	4.2	0.4	2.6	0.7	3.4	0.5
12	INT12	Incomplete in venture agreements	2.8	0.4	2.9	0.3	2.6	0.8	2.8	0.8
13	PRO05	Problems in construction contracts	2.4	0.5	2.4	0.5	2.5	0.5	2.4	0.5
14	PRO08	Intervention and delay by owner or its representatives	3.2	0.4	3.4	0.5	2.0	0.6	2.5	0.8
15	EXT01	Differences in social, culture and religions	2.4	0.5	2.1	0.3	2.3	0.5	2.4	0.5
16	EXT02	Language barrier	2.6	0.5	3.6	0.5	1.8	0.4	2.2	0.8
17	EXT07	Inconsistency in government policies	3.6	0.5	3.8	0.4	2.7	0.5	2.6	0.5
18	EXT08	Investment restriction	1.8	0.4	1.6	0.5	2.5	0.5	2.5	0.5
19	EXT09	Corruption and bribery	3.1	0.3	3.0	0.0	4.5	0.5	4.5	0.5

Note the sample size for each sample is 17.

As shown in these five tables, the scores for CSQ or CSQ can be found from "1" to "5", while it is almost impossible to find in the 5 score in most previous studies. These situations were occurred from two reasons. First, with the concept of the Delphi, the data of each round was seen and reviewed by the engineers in the professional group. So, they had the courage to choose the higher scores than the score at the middle for some factors after the first round. Second, the sets of the five-point likert scale using in the questioners have the scope of impact or frequency for the risk is smaller than the normal.

6.5.2 Trends of Risk Parameter through CJV Life Cycle

The trend analysis, being the process of considering the data and attempting to spot a pattern of the data, was used as the tool for test hypothesis 1. With the consideration throughout five phases of CJV life cycle and the each type of CJV organization structures (CG-JV and the SG-JV), the results of analysis for CSQ and LLH are shown in Table 6-8 to and Table 6-11, respectively.

As can be seen in these tables, the trends of CSQ and LLH through the first phase to the last phase of CJV life cycle would be considered. The possible pattern may be

a) The values clearly increase at some phase of CJV life cycle.

b) The values clearly decrease at some phase of CJV life cycle.

c) The values are equal through CJV life cycle.

d) The values are vary through life cycle.

These patterns of CSQ and LLH would be used as the assumption for the CJV risk parameter prediction process in another part of LCRMP system, namely the Multi-Determinant Risk Prediction (M-DRP) subsystem.

Table 6-8 Patterns of CSQ in All Phases for CG-JV

No	Risks	Consequence (CSQ)						Trend of Values
		For. P.	Bid. P.	Con. P.		War. P.	Ter. P.	
				Cost	Schedule			
1	INT01	3.70	1.70	3.20	2.30	2.20	1.30	
2	INT02	3.80	3.30	4.10	3.60	2.20	1.40	
3	INT03	4.00	3.70	3.30	4.10	2.90	4.00	
4	INT04	3.30	3.20	2.80	2.90	2.20	3.40	
5	INT05	2.90	3.60	2.60	3.50	3.40	4.60	
6	INT06	4.30	2.20	3.30	2.00	3.30	4.20	
7	INT07	4.20	2.70	2.90	2.40	2.40	2.60	
8	INT08	3.30	2.70	3.40	2.60	2.40	3.20	
9	INT09	1.90	3.30	2.90	3.40	2.20	2.80	
10	INT10	3.10	3.40	1.60	3.30	2.10	3.80	
11	INT11	3.20	3.60	3.10	3.40	2.10	3.10	
12	INT12	0.00	2.20	3.30	2.20	3.60	2.80	
13	PRO01	0.00	0.00	3.10	2.30	2.90	0.00	
14	PRO02	0.00	0.00	4.10	4.20	2.80	0.00	
15	PRO03	0.00	0.00	3.30	4.10	2.40	0.00	
16	PRO04	0.00	4.00	3.70	3.30	0.00	0.00	
17	PRO05	0.00	0.00	2.90	2.30	2.80	2.40	
18	PRO06	4.30	0.00	0.00	0.00	0.00	0.00	
19	PRO07	0.00	3.40	3.30	3.40	0.00	0.00	
20	PRO08	3.30	2.60	2.50	2.20	3.10	3.20	
21	EXT01	1.70	2.10	2.40	3.40	2.40	2.40	
22	EXT02	2.80	3.40	2.20	3.40	2.10	2.60	
23	EXT03	0.00	0.00	1.60	3.80	1.70	0.00	
24	EXT04	0.00	0.00	2.20	2.10	1.20	0.00	
25	EXT05	2.80	1.40	3.20	4.60	0.00	0.00	
26	EXT06	1.20	1.10	2.20	1.70	1.70	0.00	
27	EXT07	2.20	2.20	1.60	2.10	2.80	3.60	
28	EXT08	2.30	0.00	2.00	2.70	0.00	1.80	
29	EXT09	1.70	2.20	4.70	3.40	1.70	3.10	
30	EXT10	0.00	0.00	2.60	1.30	2.10	0.00	

Note the sample size for each phase is 34.

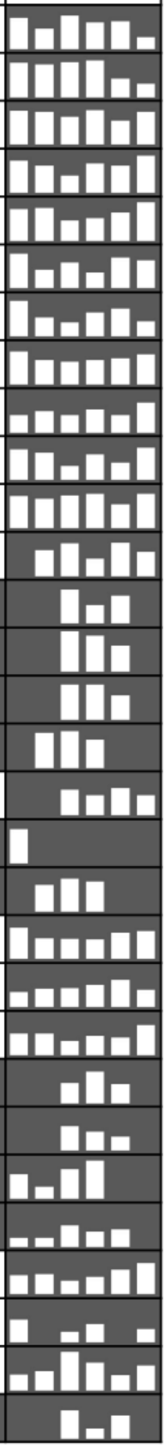
Table 6-9 Patterns of LLH in All Phases for CG-JV

No	Risks	Likelihood (LLH)					Trend of Values
		For. P.	Bid. P.	Con. P.	War. P.	Ter. P.	
1	INT01	2.50	2.60	3.10	2.90	2.60	
2	INT02	2.80	2.90	3.20	3.10	3.10	
3	INT03	1.30	1.30	3.00	3.20	3.20	
4	INT04	3.10	3.00	3.20	3.20	3.30	
5	INT05	2.80	2.60	2.80	2.60	2.80	
6	INT06	3.20	2.80	3.10	2.90	3.40	
7	INT07	2.80	3.00	3.50	3.10	3.10	
8	INT08	1.20	2.60	3.30	3.10	3.40	
9	INT09	2.60	2.90	3.20	3.10	3.30	
10	INT10	1.40	1.60	2.60	3.10	3.20	
11	INT11	1.90	2.00	3.00	2.90	2.60	
12	INT12	0.00	2.50	3.10	2.90	2.60	
13	PRO01	0.00	0.00	2.00	2.30	0.00	
14	PRO02	0.00	0.00	1.90	1.40	0.00	
15	PRO03	0.00	0.00	2.50	2.20	0.00	
16	PRO04	0.00	3.20	3.40	0.00	0.00	
17	PRO05	0.00	0.00	2.60	2.50	2.50	
18	PRO06	4.10	0.00	0.00	0.00	0.00	
19	PRO07	0.00	3.10	3.50	0.00	0.00	
20	PRO08	2.50	2.60	3.00	3.40	2.00	
21	EXT01	2.80	3.40	3.60	2.40	2.30	
22	EXT02	2.80	3.10	3.60	2.40	1.80	
23	EXT03	0.00	0.00	1.80	1.80	0.00	
24	EXT04	0.00	0.00	2.50	1.00	0.00	
25	EXT05	1.80	2.10	2.60	0.00	0.00	
26	EXT06	1.80	1.80	1.70	1.80	0.00	
27	EXT07	2.70	2.80	3.00	2.90	2.70	
28	EXT08	2.60	0.00	2.70	0.00	2.50	
29	EXT09	4.50	4.60	4.60	4.50	4.50	
30	EXT10	0.00	0.00	2.80	3.10	0.00	

Note the sample size for each phase is 34.

Table 6-10 Patterns of CSQ in All Phases for SG-JV

No	Risks	Consequence (CSQ)						Trend of Values
		For. P.	Bid. P.	Con. P.		War. P.	Ter. P.	
				Cost	Schedule			
1	INT01	3.70	2.40	4.00	3.20	3.30	1.40	
2	INT02	4.10	3.90	4.20	4.40	2.20	1.60	
3	INT03	4.10	4.00	3.40	4.20	2.90	4.00	
4	INT04	3.90	3.30	2.10	3.60	3.30	4.50	
5	INT05	3.80	3.90	2.40	2.70	3.40	4.60	
6	INT06	4.20	2.20	3.10	1.90	3.70	3.40	
7	INT07	4.30	2.30	1.70	2.90	3.40	1.80	
8	INT08	3.90	2.90	2.70	2.90	3.10	3.60	
9	INT09	2.10	2.60	2.10	2.80	2.10	3.60	
10	INT10	3.70	3.30	1.70	3.10	2.10	3.90	
11	INT11	3.90	3.60	4.00	4.20	2.90	4.20	
12	INT12	0.00	3.10	3.90	2.10	4.00	2.90	
13	PRO01	0.00	0.00	4.10	2.20	3.40	0.00	
14	PRO02	0.00	0.00	4.90	4.40	3.20	0.00	
15	PRO03	0.00	0.00	4.20	4.20	2.90	0.00	
16	PRO04	0.00	4.20	4.40	3.40	0.00	0.00	
17	PRO05	0.00	0.00	3.10	2.40	3.30	2.40	
18	PRO06	4.20	0.00	0.00	0.00	0.00	0.00	
19	PRO07	0.00	3.20	3.90	3.60	0.00	0.00	
20	PRO08	3.80	2.60	2.50	2.40	3.20	3.40	
21	EXT01	1.80	2.20	2.30	2.70	3.30	2.10	
22	EXT02	2.60	2.60	1.70	2.30	2.10	3.60	
23	EXT03	0.00	0.00	2.40	3.80	2.30	0.00	
24	EXT04	0.00	0.00	3.00	2.30	1.70	0.00	
25	EXT05	2.90	1.40	3.50	4.50	0.00	0.00	
26	EXT06	1.10	1.10	2.60	1.80	2.10	0.00	
27	EXT07	2.30	2.40	1.60	2.10	3.00	3.80	
28	EXT08	2.80	0.00	1.30	2.20	0.00	1.60	
29	EXT09	1.90	2.30	4.60	3.30	1.80	3.00	
30	EXT10	0.00	0.00	3.40	1.20	2.80	0.00	



Note the sample size for each phase is 34.

Table 6-11 Patterns of LLH in All Phases for SG-JV

No	Risks	Likelihood (LLH)					Trend of Values
		For. P.	Bid. P.	Con. P.	War. P.	Ter. P.	
1	INT01	1.80	2.80	3.10	3.00	2.60	
2	INT02	2.90	2.80	3.10	3.00	3.00	
3	INT03	1.20	1.20	3.30	3.50	3.40	
4	INT04	3.20	3.10	3.10	3.10	3.20	
5	INT05	2.80	2.70	2.90	2.80	2.80	
6	INT06	3.20	2.90	2.90	2.80	3.20	
7	INT07	3.50	2.10	2.60	2.40	2.20	
8	INT08	1.20	1.60	2.50	2.20	2.40	
9	INT09	2.70	2.80	3.40	3.00	3.40	
10	INT10	1.50	1.60	2.50	3.30	3.40	
11	INT11	2.70	2.80	3.60	3.50	3.40	
12	INT12	0.00	2.70	3.00	2.90	2.80	
13	PRO01	0.00	0.00	2.10	2.50	0.00	
14	PRO02	0.00	0.00	2.30	1.50	0.00	
15	PRO03	0.00	0.00	2.50	2.40	0.00	
16	PRO04	0.00	3.30	3.40	0.00	0.00	
17	PRO05	0.00	0.00	2.50	2.40	2.40	
18	PRO06	4.10	0.00	0.00	0.00	0.00	
19	PRO07	0.00	3.00	3.70	0.00	0.00	
20	PRO08	2.60	2.80	3.10	3.50	2.50	
21	EXT01	2.80	2.80	2.90	2.40	2.40	
22	EXT02	2.40	2.50	2.80	2.60	2.20	
23	EXT03	0.00	0.00	1.90	1.80	0.00	
24	EXT04	0.00	0.00	2.40	1.10	0.00	
25	EXT05	1.90	1.90	2.60	0.00	0.00	
26	EXT06	1.70	1.70	1.80	1.80	0.00	
27	EXT07	2.60	2.60	2.90	2.80	2.60	
28	EXT08	2.60	0.00	2.80	0.00	2.50	
29	EXT09	4.60	4.60	4.50	4.60	4.50	
30	EXT10	0.00	0.00	2.90	3.20	0.00	

Note	the sample size for each phase is 34.

6.5.3 Difference of Risk Parameter between CJV Organization Structure

For the hypothesis 2 test by the Mann–Whitney U test and the median test, the results for the CSQ and LLH for:

(1) The formation phase, shown in Table 6-12

(2) The bidding phase, shown in Table 6-13

(3) The construction phase, shown in Table 6-14

(4) The warranty phase, shown in Table 6-15

(5) The termination phase, shown in Table 6-16

As can be seen in the hypothesis testing results in these tables, there are no difference in the results between the Mann–Whitney U test and the median test. So, it may be concluded that:

For the data of the study which is not the normal distribution and has the small sample size, it can be concluded the median test has enough efficiency to use for testing the hypothesis. The results by this method are not different from the more efficient methods. The results of the analysis for 30 risks throughout five phase of CJV life cycle and the two types of CJV organization structure are conclude in the form of the infographic which can be easy communicate for the future implementations.

With the consideration on the hypothesis test results for all risks, the hypothesis 2 was proved that it is correct but it is only true for the certain risks in the certain phases. The conclusion of the results of hypothesis 2 for each risk are as follow:

Table 6-12 Results of Hypothesis test for Risks in Formation Phase

No	Risk	Testing Results of CSQ Between CG-JV and SG-JV				Testing Results of LLH Between CG-JV and SG-JV			
		Mann–Whitney U test		Median Test		Mann–Whitney U test		Median Test	
		Cal. U	Ho	Cal. X^2	Ho	Mean	SD	Mean	SD
1	INT01	144.5	A	0.13	A	52	R	4.29	R
2	INT02	115.5	A	0.12	A	135.5	A	0.00	A
3	INT03	136.5	A	0.00	A	136	A	0.00	A
4	INT04	102	A	2.42	A	141.5	A	0.12	A
5	INT05	38.5	R	4.84	R	142.5	A	0.13	A
6	INT06	136	A	0.00	A	135	A	0.12	A
7	INT07	136	A	0.00	A	70.5	R	2.95	R
8	INT08	51	R	3.54	R	144.5	A	0.12	A
9	INT09	128	A	0.00	A	134.5	A	0.00	A
10	INT10	136	A	2.15	A	136	A	0.14	A
11	INT11	48	R	11.76	R	60.5	R	3.04	R
12	PRO06	127.5	A	0.00	A	144	A	0.12	A
13	PRO08	127.5	A	1.47	A	138.5	A	0.14	A
14	EXT01	127.5	A	0.00	A	136	A	0.00	A
15	EXT02	119	A	0.00	A	101.5	A	0.14	A
16	EXT05	127.5	A	0.00	A	131	A	0.00	A
17	EXT06	136	A	0.00	A	136	A	0.13	A
18	EXT07	136	A	0.00	A	142.5	A	0.00	A
19	EXT08	127.5	A	1.47	A	141.5	A	0.00	A
20	EXT09	121.5	A	0.00	A	127.5	A	0.00	A

Note (1) The sample size for each sample is 17.

(2) Level of significance is 10%.

Table 6-17 Results of Hypothesis test for Risks in Bidding Phase

No	Risk	Testing Results of CSQ Between CG-JV and SG-JV				Testing Results of LLH Between CG-JV and SG-JV			
		Mann–Whitney U test		Median Test		Mann–Whitney U test		Median Test	
		Cal. U	Ho	Cal. X^2	Ho	Mean	SD	Mean	SD
1	INT01	102	A	1.88	A	119	A	0.13	A
2	INT02	57	R	3.54	R	136.5	A	0.12	A
3	INT03	104.5	A	0.12	A	136	A	0.00	A
4	INT04	136	A	0.00	A	142	A	0.12	A
5	INT05	110.5	A	0.13	A	140	A	0.14	A
6	INT06	136	A	0.12	A	131	A	0.00	A
7	INT07	85	R	4.24	R	43.5	R	11.76	R
8	INT08	110.5	A	0.12	A	35	R	5.78	R
9	INT09	60	R	2.95	R	130.5	A	0.00	A
10	INT10	136	A	0.13	A	136	A	0.14	A
11	INT11	136	A	0.14	A	64.5	R	3.22	R
12	INT12	45	R	11.76	R	127	A	0.14	A
13	PRO04	112.5	A	0.12	A	139.5	A	0.00	A
14	PRO07	127.5	A	0.00	A	139	A	0.00	A
15	PRO08	144.5	A	0.14	A	127.5	A	0.00	A
16	EXT01	127.5	A	0.00	A	110.5	A	1.88	A
17	EXT02	60.5	R	2.95	R	129.5	A	1.99	A
18	EXT05	144.5	A	0.13	A	128.5	A	0.00	A
19	EXT06	144.5	A	0.12	A	132	A	0.13	A
20	EXT07	127.5	A	0.00	A	134.5	A	0.00	A
21	EXT09	136	A	0.00	A	136	A	0.14	A

Note (1) The sample size for each sample is 17.

(2) Level of significance is 10%.

Table 6-18 Results of Hypothesis test for Risks in Construction Phase

No	Risk	Testing Results of CSQ (Cost) Between CG-JV and SG-JV				Testing Results of CSQ (Schedule) Between CG-JV and SG-JV				Testing Results of LLH Between CG-JV and SG-JV			
		Mann–Whitney U test		Median Test		Mann–Whitney U test		Median Test		Mann–Whitney U test		Median Test	
		Cal. U	Ho	Cal. X^2	Ho	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	INT01	59	R	3.54	R	41	R	6.31	R	138.5	A	0.12	A
2	INT02	129	A	0.00	A	60.5	R	2.95	R	141	A	0.00	A
3	INT03	136	A	0.13	A	129	A	0.00	A	109.5	A	0.48	A
4	INT04	51	R	3.54	R	48	R	3.22	R	136.5	A	0.00	A
5	INT05	110.5	A	0.14	A	54	R	2.95	R	140	A	0.12	A
6	INT06	121.5	A	0.12	A	137	A	0.12	A	124.5	A	0.00	A
7	INT07	24	R	7.97	R	110.5	A	1.28	A	40	R	5.78	R
8	INT08	60	R	2.95	R	102	A	0.50	A	55	R	4.29	R
9	INT09	33	R	16.94	R	65	R	2.95	R	133.5	A	0.00	A
10	INT10	136	A	0.00	A	119	A	0.12	A	135.5	A	0.00	A
11	INT11	32	R	16.94	R	49	R	4.48	R	78.5	R	3.22	R
12	INT12	102	A	2.42	A	136	A	0.00	A	137	A	0.00	A
13	PRO01	22.5	R	6.94	R	136	A	0.00	A	138	A	0.00	A
14	PRO02	25.5	R	5.44	R	127.5	A	0.00	A	104	A	0.48	A
15	PRO03	32.5	R	6.31	R	127.5	A	0.00	A	144.5	A	0.13	A
16	PRO04	60	R	2.95	R	136	A	0.13	A	136.5	A	0.00	A
17	PRO05	128	A	0.00	A	136	A	0.13	A	129.5	A	0.00	A
18	PRO07	51	R	3.54	R	119	A	0.47	A	119	A	0.14	A
19	PRO08	140.5	A	0.00	A	127.5	A	0.00	A	131.5	A	0.00	A
20	EXT01	136	A	0.13	A	60	R	2.95	R	52.5	R	3.04	R
21	EXT02	110.5	A	1.06	A	27.5	R	7.97	R	47.5	R	4.29	R
22	EXT03	60.5	R	2.95	R	136	A	0.00	A	127.5	A	0.00	A
23	EXT04	47	R	3.54	R	119	A	0.12	A	136	A	0.14	A
24	EXT05	102	A	0.54	A	127.5	A	0.00	A	143	A	0.14	A
25	EXT06	127.5	A	0.54	A	136	A	0.13	A	138.5	A	0.13	A
26	EXT07	136	A	0.14	A	136	A	0.12	A	138	A	0.12	A
27	EXT08	48.5	R	3.54	R	102	A	1.28	A	140.5	A	0.14	A
28	EXT09	136	A	0.00	A	136	A	0.13	A	127.5	A	0.00	A
29	EXT10	60.5	R	2.95	R	136	A	0.00	A	137.5	A	0.12	A

Note (1) The sample size for each sample is 17.

(2) Level of significance is 10%.

Table 6-19 Results of Hypothesis test for Risks in Warranty Phase

No	Risk	Testing Results of CSQ Between CG-JV and SG-JV				Testing Results of LLH Between CG-JV and SG-JV			
		Mann–Whitney U test		Median Test		Mann–Whitney U test		Median Test	
		Cal. U	Ho	Cal. X^2	Ho	Mean	SD	Mean	SD
1	INT01	24	R	7.97	R	129.5	A	0.00	A
2	INT02	136	A	0.12	A	137.5	A	0.00	A
3	INT03	136	A	0.00	A	110.5	A	0.13	A
4	INT04	24	R	7.97	R	130	A	0.00	A
5	INT05	144.5	A	0.13	A	131.5	A	0.00	A
6	INT06	85	R	4.24	R	139	A	0.12	A
7	INT07	33	R	5.95	R	61.5	R	3.22	R
8	INT08	66	R	3.22	R	54	R	3.22	R
9	INT09	136	A	0.00	A	132.5	A	0.00	A
10	INT10	136	A	0.12	A	119	A	0.12	A
11	INT11	41.5	R	3.54	R	78	R	3.04	R
12	INT12	96.5	A	0.50	A	138.5	A	0.00	A
13	PRO01	136	A	1.06	A	119	A	0.00	A
14	PRO02	98	A	0.47	A	136	A	0.14	A
15	PRO03	102	A	2.15	A	124	A	0.13	A
16	PRO05	102	A	1.06	A	127.5	A	0.00	A
17	PRO08	129.5	A	0.00	A	131.5	A	0.00	A
18	EXT01	36	R	5.95	R	136	A	0.00	A
19	EXT02	144.5	A	0.12	A	110.5	A	0.14	A
20	EXT03	121.5	A	1.88	A	144.5	A	0.12	A
21	EXT04	127.5	A	1.28	A	127.5	A	0.00	A
22	EXT06	127.5	A	0.48	A	142.5	A	0.13	A
23	EXT07	122	A	0.00	A	138	A	0.12	A
24	EXT09	136	A	0.13	A	136	A	0.00	A
25	EXT10	51	R	3.54	R	130	A	0.00	A

Note (1) The sample size for each sample is 17.
(2) Level of significance is 10%.

Table 6-20 Results of Hypothesis test for Risks in Termination Phase

No	Risk	Testing Results of CSQ Between CG-JV and SG-JV				Testing Results of LLH Between CG-JV and SG-JV			
		Mann–Whitney U test		Median Test		Mann–Whitney U test		Median Test	
		Cal. U	Ho	Cal. X^2	Ho	Mean	SD	Mean	SD
1	INT01	136	A	0.13	A	144.5	A	0.14	A
2	INT02	119	A	0.47	A	137	A	0.00	A
3	INT03	144.5	A	0.12	A	119	A	0.13	A
4	INT04	27	R	7.64	R	138.5	A	0.00	A
5	INT05	144.5	A	0.14	A	138.5	A	0.00	A
6	INT06	39	R	4.48	R	127.5	A	0.00	A
7	INT07	39	R	5.95	R	52.5	R	4.84	R
8	INT08	102	A	1.28	A	38.5	R	5.95	R
9	INT09	54	R	3.04	R	138	A	0.00	A
10	INT10	129.5	A	0.00	A	129.5	A	0.00	A
11	INT11	13	R	8.60	R	57	R	4.24	R
12	INT12	127.5	A	0.00	A	136	A	0.13	A
13	PRO05	144.5	A	0.13	A	127.5	A	0.00	A
14	PRO08	127.5	A	0.00	A	99.5	A	0.48	A
15	EXT01	110.5	A	0.12	A	136	A	0.13	A
16	EXT02	33	R	7.64	R	104	A	0.47	A
17	EXT07	119	A	0.00	A	136	A	0.00	A
18	EXT08	127.5	A	0.00	A	136	A	0.00	A
19	EXT09	127.5	A	0.00	A	144.5	A	0.16	A

Note (1) The sample size for each sample is 17.

(2) Level of significance is 10%.

(1) INT01: Cash flow problems in partners

The analysis of the value was shown in Figure 6.2. For the conclusion of the diffenct between the CJV organization structure is:

a) Consequence (CSQ)

There were difference in CSQ values between CG-JV and SG-JV which relate to three from six objectives in the different two phases of the

CJV life cycle. This results led to the conclusion that the impact of "cash flow problems in partners" for the cost and schedule objectives in the construction phase and the objectives in the warranty are affected by characteristics of CG-JV and SG-JV. For objectives in other phases, they are not impacted by the structures because their null hypotheses were accepted at the 95% level of confidence.

b) Likelihood (LLH)

The population mean and median of five LLH values in all phase of the CJV lifecycle are not different at the 95% level of confidence. It mean that the chance of "cash flow problems in partners" to happen are not affect by types of CJV organization structure.

(2) INT02: Incompetent construction in partners

The summary of the risk parameter through the CJV life cycle was shown in Figure 6.3. The analysis of the diffenct between structures is:

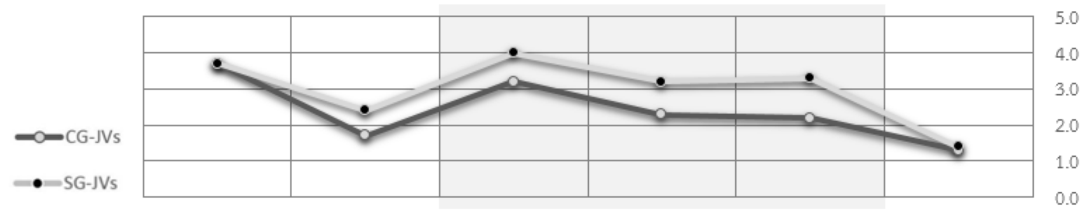
a) Consequence (CSQ)

From six null hypotheses, two of them were rejected at the 95% level of confidence. It can be summarized that the CJV organization structure are the cause for the different impact of "incompetent construction in partners" only for the objective in the bidding phase and the objective (schedule) in the construction phase. For other objectives in four phase of the CJV life cycle, the structures does not cause the difference.

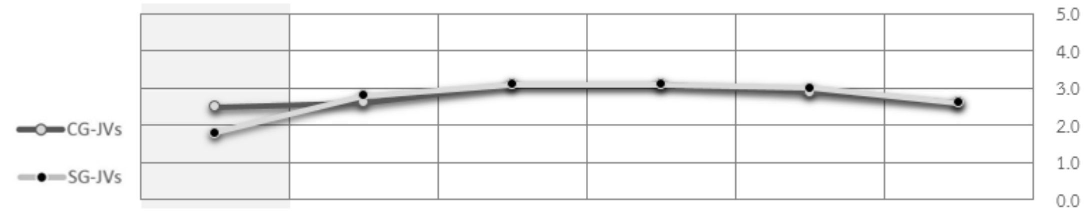
b) Likelihood (LLH)

The CG-JV and SG-JV do not relate to the occurrence of "incompetent construction in partners" because the null hypothesis for LLH values in all phase of the CJV lifecycle is accepted at the 95% level of confidence.

INT01	Cash flow problems in partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	3.7	1.7	3.2	2.3	2.2	1.3
SG-JVs	3.7	2.4	4.0	3.2	3.3	1.4
Ho Test	*Nodiff*	*Nodiff*	*Diff*	*Diff*	*Diff*	*Nodiff*



Likelihood (LLH)						
CG-JVs	2.5	2.6	3.1	3.1	2.9	2.6
SG-JVs	1.8	2.8	3.1	3.1	3.0	2.6
Ho Test	*Diff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)						
CG-JVs	9.3	4.4	9.9	7.1	6.4	3.4
SG-JVs	6.7	6.7	12.4	9.9	9.9	3.6

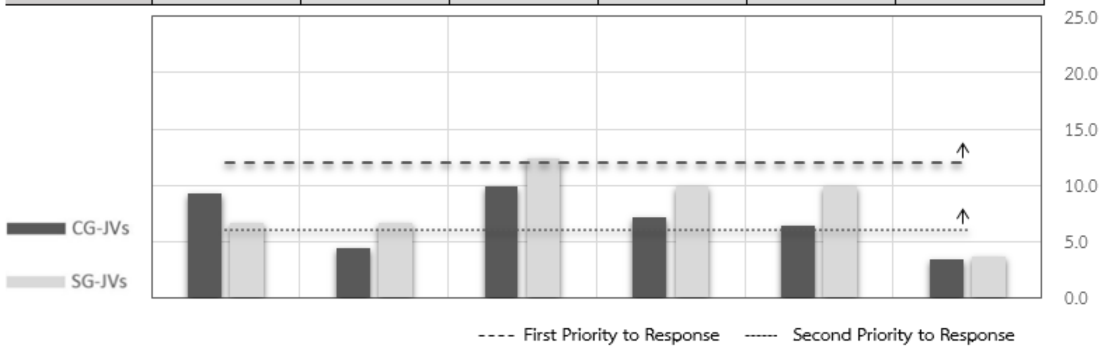
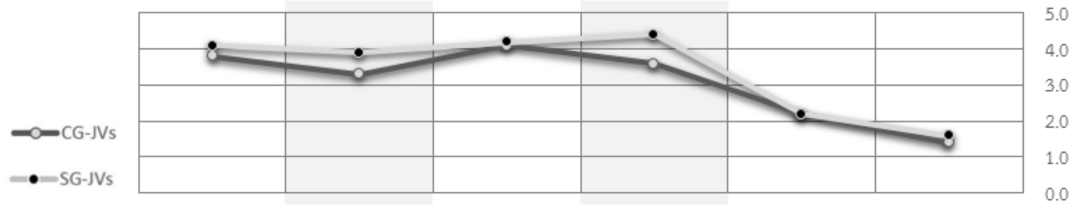


Figure 6-2 Infographic for INT01: Cash Flow Problems in Partners

INT02	Incompetent construction in partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

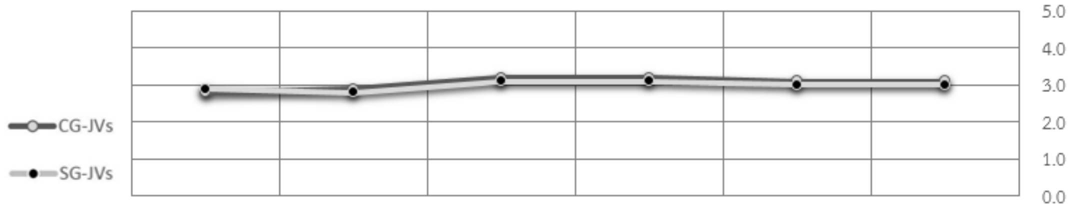
Consequence (CSQ)

CG-JVs	3.8	3.3	4.1	3.6	2.2	1.4
SG-JVs	4.1	3.9	4.2	4.4	2.2	1.6
Ho Test	*Nodiff*	*Diff*	*Nodiff*	*Diff*	*Nodiff*	*Nodiff*



Likelihood (LLH)

CG-JVs	2.8	2.9	3.2	3.2	3.1	3.1
SG-JVs	2.9	2.8	3.1	3.1	3.0	3.0
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)

CG-JVs	10.6	9.6	13.1	11.5	6.8	4.3
SG-JVs	11.9	10.9	13.0	13.6	6.6	4.8

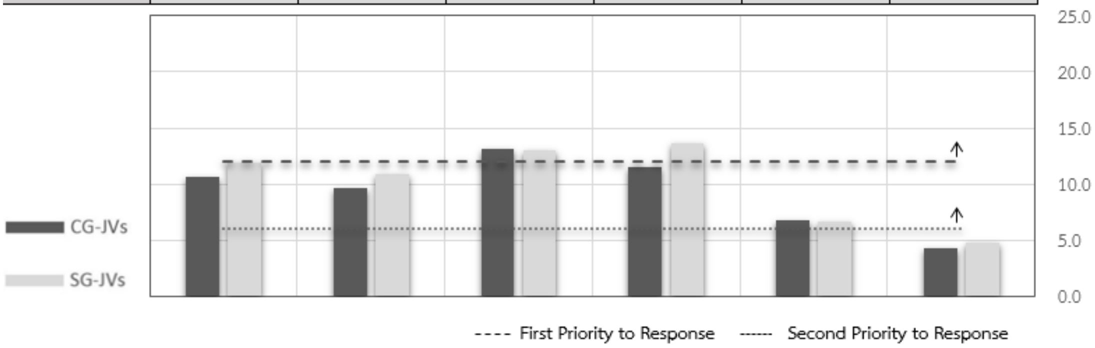


Figure 6-3 Infographic for INT02: Incompetent Construction in Partners

(3) **INT03: Changes in partners**

The analysis for the risk was shown in Figure 6.4. For the conclusion of the difference value between the CJV organization structures, it is:

a) **Consequence (CSQ)**

After the test of the null hypotheses for six CSQ values from all phases of CJV life cycle, it was found that they were accepted at the 95% level of confidence. So, it can be summarized that the CJV organization structures are not the cause for the impact of "changes in partners" for all phases.

b) **Likelihood (LLH)**

After the process of the hypothesis test, it was found that all LLH values in five phase of the CJV lifecycle are not different at the 95% level of confidence. That led to the conclusion that the chance to happen for "changes in partners" are not affect by types of CJV organization structure.

(4) **INT04: Lack of local experience in partners**

Figure 6.5 shows the summary for the risk. The analysis of the difference value between the CJV organization structures is:

a) **Consequence (CSQ)**

Because three null hypotheses for CSQ values in the construction and warranty phases were rejected at the 95% level of confidence, it means that the consequence of "lack of local experience in partners" for the objectives (cost and schedule) in the construction phase and the objectives in the warranty are affected by characteristics of CG-JV and SG-JV. However, other three null hypotheses in three phases, including the formation, bidding and termination phase, were accepted at the 95% level of confidence. It means those CSQ values are not be impacted by characteristics of structures.

b) **Likelihood (LLH)**

Because the null hypothesis for LLH values in five phase of the CJV lifecycle were accepted, there are no difference in the LLH values between CG-JV and SG-JV through the CJV lifecycle. So, the types of CJV organization structure are not the cause for the occurrence of "lack of local experience in partners"

(5) INT05: Lack of JV experience in partners

The conclusion for the risk parameter was shown in Figure 6.6. The conclusion about the difference between the CG-JV and the SG-JV is:

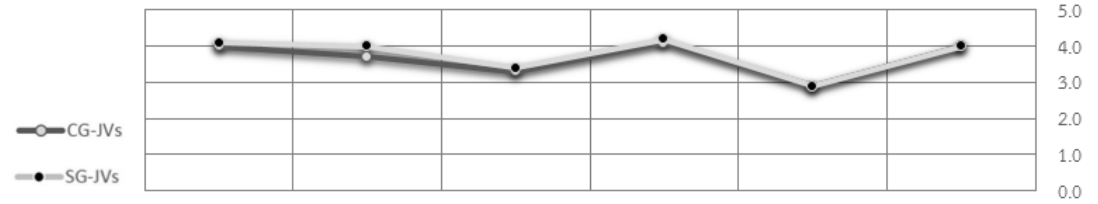
a) **Consequence (CSQ)**

Four CSQ values form the construction to termination phase of the CJV life cycle were different between CG-JV and SG-JV because their null hypotheses were rejected at the 95% level of confidence. These results make the conclusion that the CSQ values for four objectives in those phases are affected by types of CJV organization structure. For the formation and biding phase, their objectives were judged that do not relate to chrematistics of structures because their null hypotheses were accepted.

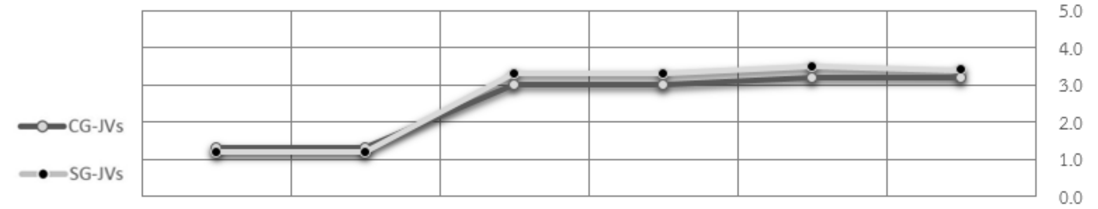
b) **Likelihood (LLH)**

With the results of the null hypothesis test which were accepted for all phases in the CJV lifecycle, it can conclude that the chance to happen for "lack of JV experience in partners" are not be impacted by types of CJV organization structure.

INT03	Changes in partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	4.0	3.7	3.3	4.1	2.9	4.0
SG-JVs	4.1	4.0	3.4	4.2	2.9	4.0
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Likelihood (LLH)						
CG-JVs	1.3	1.3	3.0	3.0	3.2	3.2
SG-JVs	1.2	1.2	3.3	3.3	3.5	3.4
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)						
CG-JVs	5.2	4.8	9.9	12.3	9.3	12.8
SG-JVs	4.9	4.8	11.2	13.9	10.2	13.6

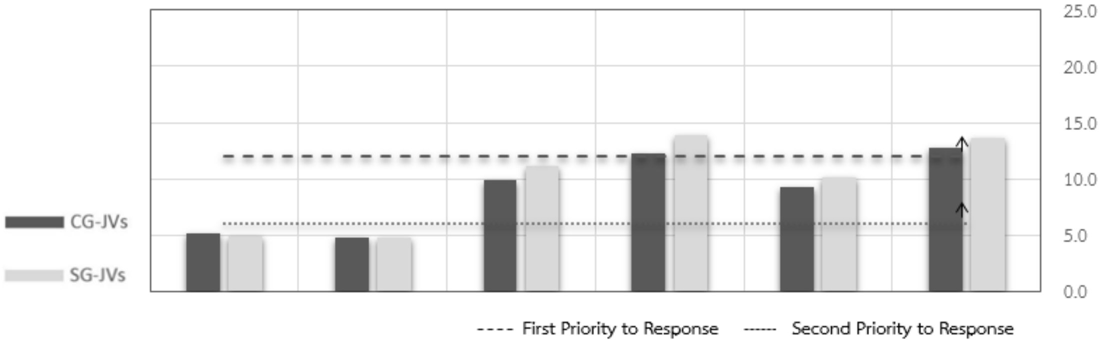
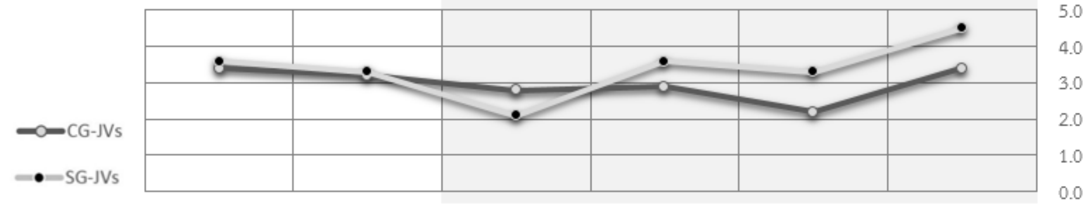


Figure 6-4 Infographic for INT03: Changes in Partners

INT04	Lack of local experience in partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

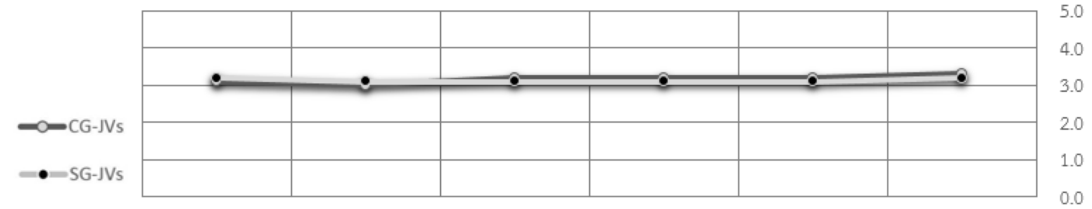
Consequence (CSQ)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	3.4	3.2	2.8	2.9	2.2	3.4
SG-JVs	3.6	3.3	2.1	3.6	3.3	4.5
Ho Test	*Nodiff*	*Nodiff*	*Diff*	*Diff*	*Diff*	*Diff*



Likelihood (LLH)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	3.1	3.0	3.2	3.2	3.2	3.3
SG-JVs	3.2	3.1	3.1	3.1	3.1	3.2
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	10.5	9.6	9.0	9.3	7.0	11.2
SG-JVs	11.5	10.2	6.5	11.2	10.2	14.4

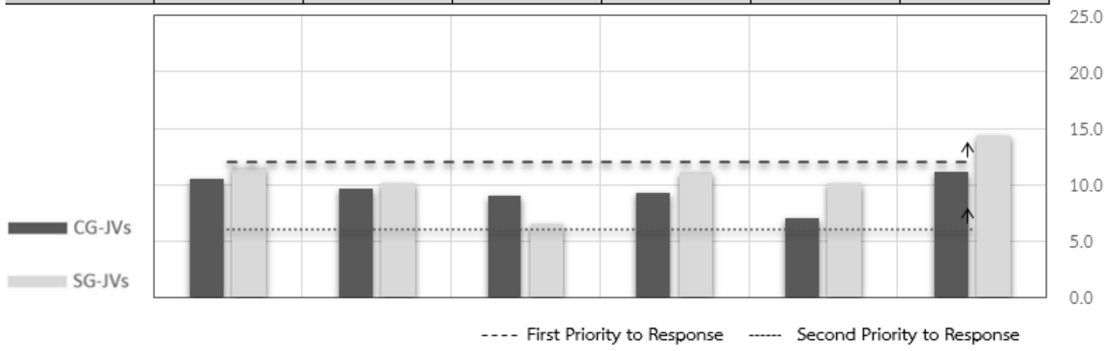
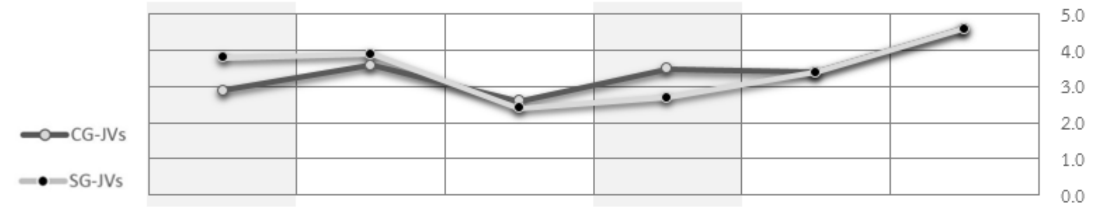
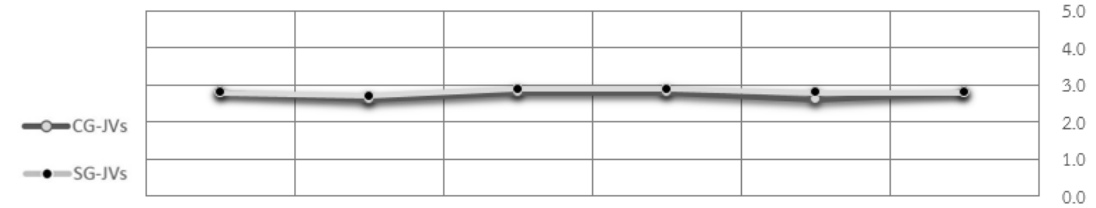


Figure 6-5 Infographic for INT04: Lack of Local Experience in Partners

INT05	Lack of JV experience in partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	2.9	3.6	2.6	3.5	3.4	4.6
SG-JVs	3.8	3.9	2.4	2.7	3.4	4.6
Ho Test	*Diff*	*Nodiff*	*Nodiff*	*Diff*	*Nodiff*	*Nodiff*



Likelihood (LLH)	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	2.8	2.6	2.8	2.8	2.6	2.8
SG-JVs	2.8	2.7	2.9	2.9	2.8	2.8
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	8.1	9.4	7.3	9.8	8.8	12.9
SG-JVs	10.6	10.5	7.0	7.8	9.5	12.9

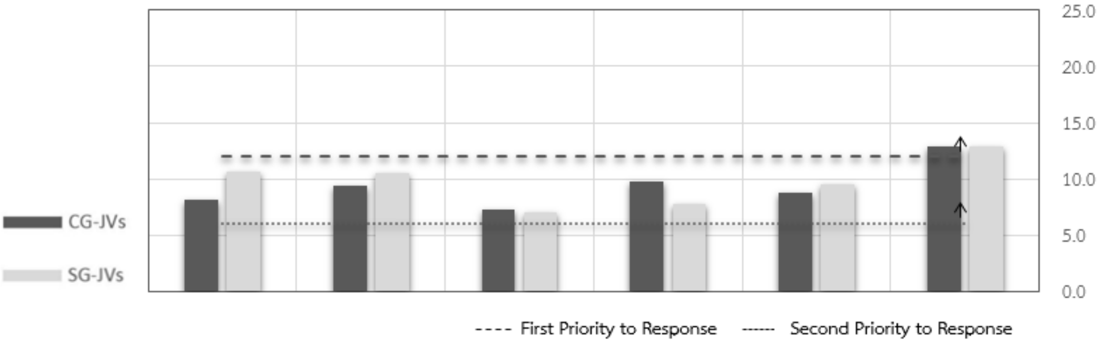


Figure 6-6 Infographic for INT05: Lack of JV Experience in Partners

(6) INT06: Difference on accounting of profit & losses between partners

Figure 6.7 shows the summary for the risk parameter for the factor. The analysis of the difference value between the CJV organization structures is:

a) Consequence (CSQ)

From six null hypotheses, there are only two of them that rejected at the 95% level of confidence. It means that the level of impact for "difference on accounting of investment, benefits and liabilities between partners" affected by characteristics of CG-JV and SG-JV for the objective in the warranty and termination phase. For four objectives in the first three phases, their CSQ values, the CJV organization structures does not cause the difference in the impact for this risk.

b) Likelihood (LLH)

It was found that there were none difference in LLH values for all five phases of the CJV lifecycle at the 95% level of confidence. It can be summarized that CG-JV and SG-JV are not the cause for change in likelihood of "difference on accounting of investment, benefits and liabilities between partners" for all phases.

(7) INT07: Difference on resource allocation between partners

The analysis for the risk was shown in Figure 6.8. For the conclusion of the difference value between the CJV organization structures, it is:

a) Consequence (CSQ)

With the process of the null hypothesis test, the four from six null hypotheses were rejected at the 95% level of confidence. The exception were the null hypothesis for the formation and construction (schedule) phase. It led to the summary that characteristics of CG-JV and SG-JV are the cause for the variance in the impact of "difference on staff allocation among partners" in the bidding, construction (cost), warranty and termination phase while that for the formation and construction (schedule) phase are not be affected.

b) Likelihood (LLH)

The population mean and median of five LLH values in all phase of the CJV lifecycle are different at the 95% level of confidence. It mean that the chance of “difference on staff allocation among partners” to happen are affect by types of CJV organization structure, CG-JV and SG-JV. The LLH values for CG-JV in five phases were higher than those for SG-JV with significance.

(8) INT08: Improper intervention by partners

Figure 6.9 shows the summary for the risk. The analysis of the difference value between the CJV organization structures is:

a) Consequence (CSQ)

After the test of six null hypotheses for CSQ values from all CJV life cycle phases, it was found that three of them were rejected and others were accepted at the 95% level of confidence. So, the CJV organization structures cause the difference in the impact of “improper intervention by partners” for only the objectives in the formation, construction (cost) and warranty phase.

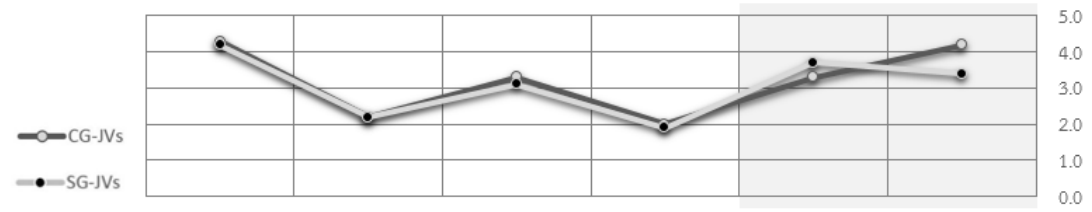
b) Likelihood (LLH)

The CG-JV and SG-JV relate to the occurrence of “incompetent construction in partners” for four phases of the CJV lifecycle because the null hypothesis for those LLH values is rejected at the 95% level of confidence. The LLH values for CG-JV from the bidding phase to the termination phase were higher than those for SG-JV with significance.

INT06	Difference on accounting of profit & losses between partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

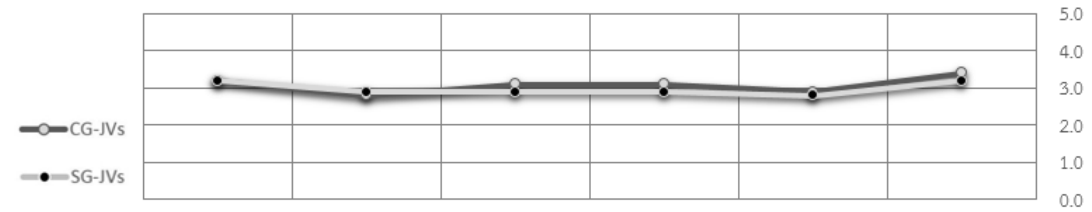
Consequence (CSQ)

CG-JVs	4.3	2.2	3.3	2.0	3.3	4.2
SG-JVs	4.2	2.2	3.1	1.9	3.7	3.4
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Diff*	*Diff*



Likelihood (LLH)

CG-JVs	3.2	2.8	3.1	3.1	2.9	3.4
SG-JVs	3.2	2.9	2.9	2.9	2.8	3.2
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)

CG-JVs	13.8	6.2	10.2	6.2	9.6	14.3
SG-JVs	13.4	6.4	9.0	5.5	10.4	10.9

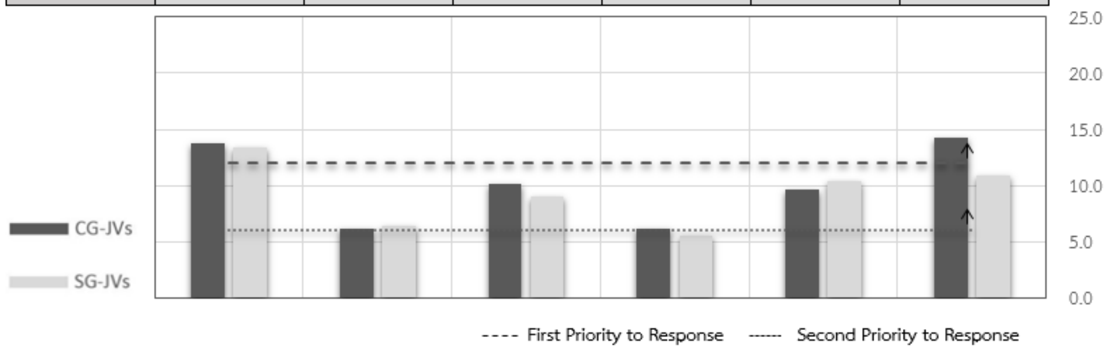
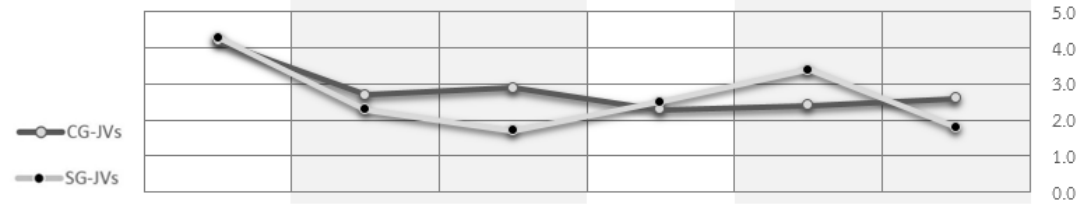


Figure 6-7 Infographic for INT06: Difference on Accounting of Profit & Losses between Partners

INT07	Difference on resource allocation between partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

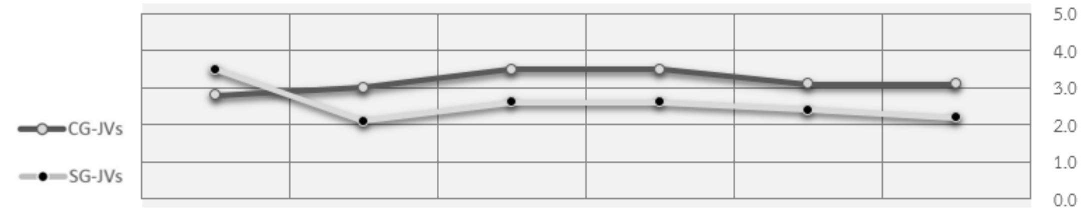
Consequence (CSQ)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	4.2	2.7	2.9	2.3	2.4	2.6
SG-JVs	4.3	2.3	1.7	2.5	3.4	1.8
Ho Test	*Nodiff*	*Diff*	*Diff*	*Nodiff*	*Diff*	*Diff*



Likelihood (LLH)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	2.8	3.0	3.5	3.5	3.1	3.1
SG-JVs	3.5	2.1	2.6	2.6	2.4	2.2
Ho Test	*Diff*	*Diff*	*Diff*	*Diff*	*Diff*	*Diff*



Level of Risk (LOR)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	11.8	8.1	10.2	8.1	7.4	8.1
SG-JVs	15.1	4.8	4.4	6.5	8.2	4.0

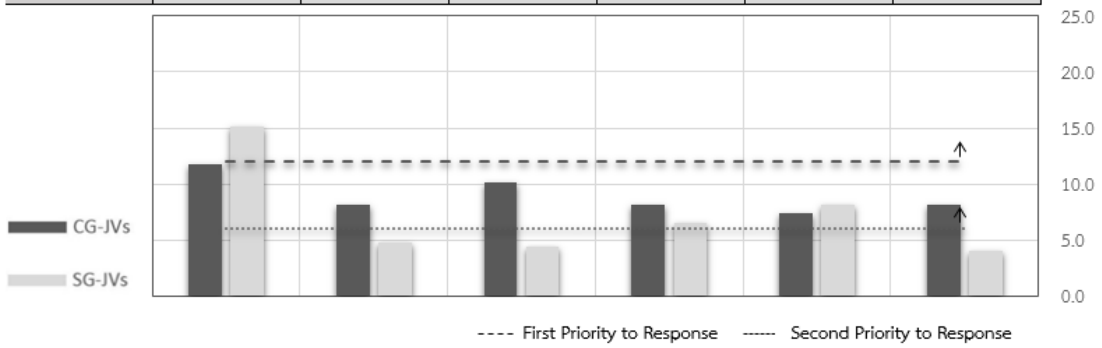
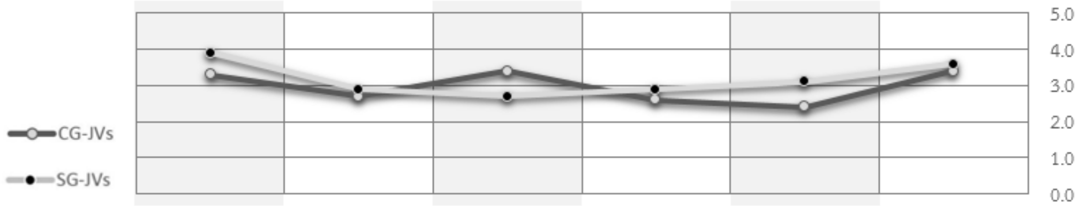
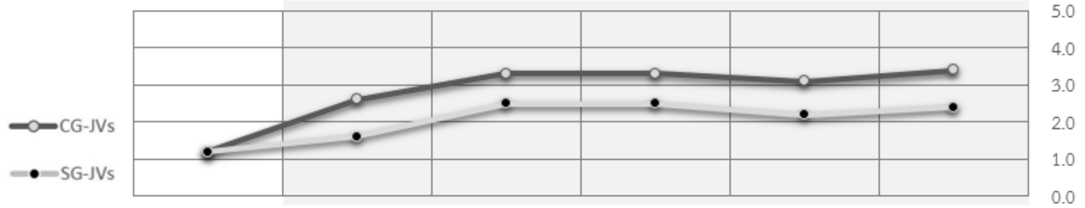


Figure 6-8 Infographic for INT07: Difference on Resource Allocation between Partners

INT08	Improper intervention by partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	3.3	2.7	3.4	2.6	2.4	3.4
SG-JVs	3.9	2.9	2.7	2.9	3.1	3.6
Ho Test	*Diff*	*Nodiff*	*Diff*	*Nodiff*	*Diff*	*Nodiff*



Likelihood (LLH)						
CG-JVs	1.2	2.6	3.3	3.3	3.1	3.4
SG-JVs	1.2	1.6	2.5	2.5	2.2	2.4
Ho Test	*Nodiff*	*Diff*	*Diff*	*Diff*	*Diff*	*Diff*



Level of Risk (LOR)						
CG-JVs	4.0	7.0	11.2	8.6	7.4	11.6
SG-JVs	4.7	4.6	6.8	7.3	6.8	8.6

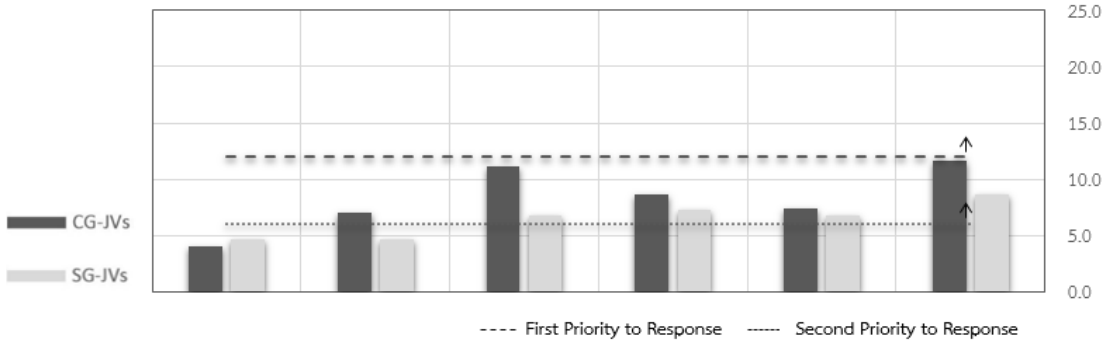


Figure 6-9 Infographic for INT08: Improper Intervention by Partners

(9) **INT09: Difference on organizational structure and culture between partners**

The analysis for the risk was shown in Figure 6.10. For the conclusion of the difference value between the CJV organization structures, it is:

a) **Consequence (CSQ)**

The null hypotheses for CSQ values in three phases of the CJV life cycle were rejected at the 95% level of confidence. These hypotheses are in the bidding, construction and termination phase. So, it can be summarized that the CJV organization structure are the cause for the different impact of “difference on organizational structure and culture between partners” for four objectives in those phases. Moreover, CSQ values in the other phase are judged that there is no difference in the consequence causing by structures.

b) **Likelihood (LLH)**

After the process of the hypothesis test, it was found that all LLH values in five phase of the CJV lifecycle were not different at the 95% level of confidence. That led to the conclusion that the chance to happen for “difference on organizational structure and culture between partners” are not affected by types of CJV organization structure.

(10) INT10: Distrust between partners

The summary of the risk parameter through the CJV life cycle was shown in Figure 6.11. The analysis of the diffenct between structures is:

a) **Consequence (CSQ)**

The CJV organization structures does not cause the difference in the impact for “distrust between partners” for all objectives in five phases of the CJV life cycle because six null hypotheses for CSQ values were accepted at the 95% level of confidence.

b) Likelihood (LLH)

Because the null hypothesis for LLH values in five phases of the CJV lifecycle were accepted, there are no difference in the LLH values between CG-JV and SG-JV. So, the types of CJV organization structure are not the cause for the occurrence of “distrust between partners”

(11) INT11: Lack of communication between partners

The conclusion for the risk parameter was shown in Figure 6.12. The conclusion about the difference between the CG-JV and the SG-JV is:

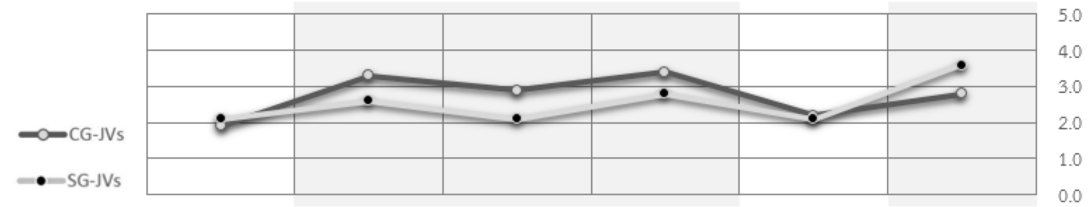
a) Consequence (CSQ)

After the process of the null hypothesis test, there is only one from six hypotheses were accepted at the 95% level of confidence. This is the CSQ value in the bidding phase. It means that the consequence of “lack of communication” of the objectives for CJV life cycle phases, excepting for the bidding phase, are affected by characteristics of CG-JV and SG-JV.

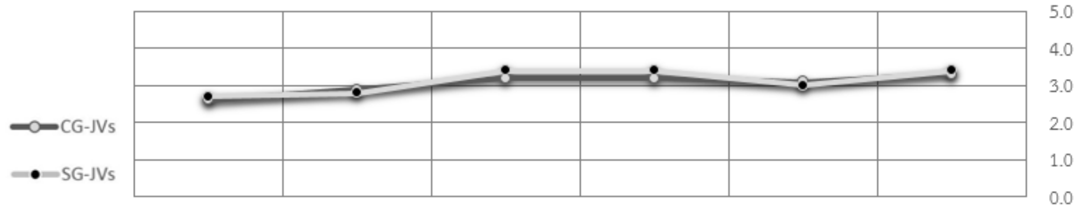
b) Likelihood (LLH)

With the results of the null hypothesis test which were rejected in three phases including the bidding, construction and warranty phase, it can be concluded that the chance to happen for “lack of communication” in those phases are impacted by types of CJV organization structure. It was found that LLH values of SG-JV in all three phases were significant higher than those for CG-JV.

INT09	Difference on organizational structure and culture between partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	1.9	3.3	2.9	3.4	2.2	2.8
SG-JVs	2.1	2.6	2.1	2.8	2.1	3.6
Ho Test	*Nodiff*	*Diff*	*Diff*	*Diff*	*Nodiff*	*Diff*



Likelihood (LLH)	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	2.6	2.9	3.2	3.2	3.1	3.3
SG-JVs	2.7	2.8	3.4	3.4	3.0	3.4
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	4.9	9.6	9.3	10.9	6.8	9.2
SG-JVs	5.7	7.3	7.1	9.5	6.3	12.2

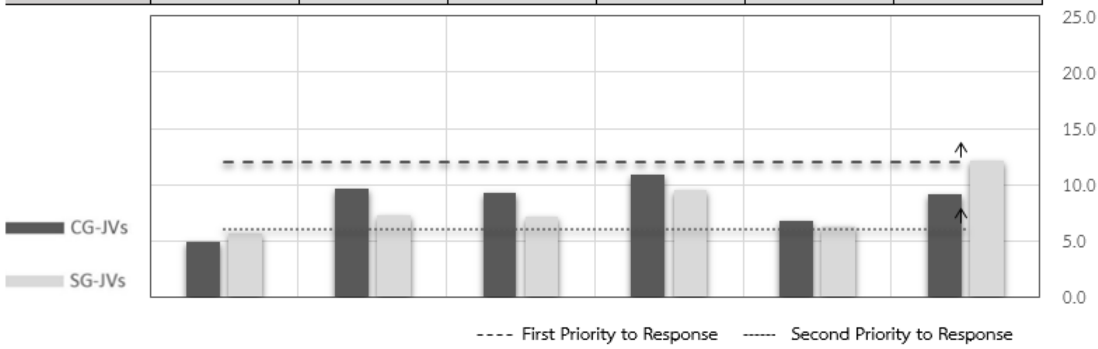
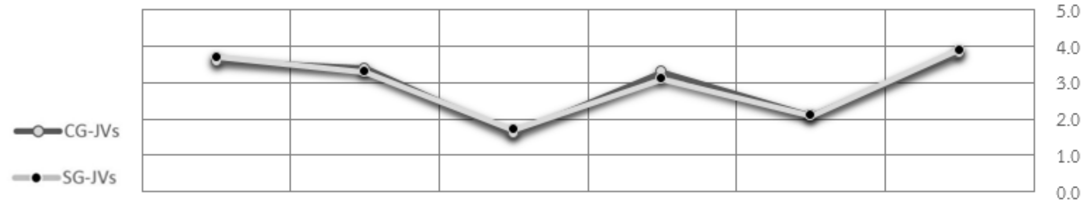
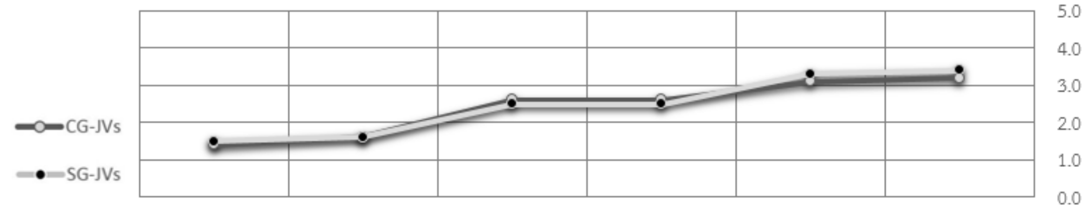


Figure 6-10 Infographic for INT09: Difference on Organizational Structure and Culture between Partners

INT10	Distrust between partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	3.6	3.4	1.6	3.3	2.1	3.8
SG-JVs	3.7	3.3	1.7	3.1	2.1	3.9
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Likelihood (LLH)						
CG-JVs	1.4	1.6	2.6	2.6	3.1	3.2
SG-JVs	1.5	1.6	2.5	2.5	3.3	3.4
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)						
CG-JVs	5.0	5.4	4.2	8.6	6.5	12.2
SG-JVs	5.6	5.3	4.3	7.8	6.9	13.3

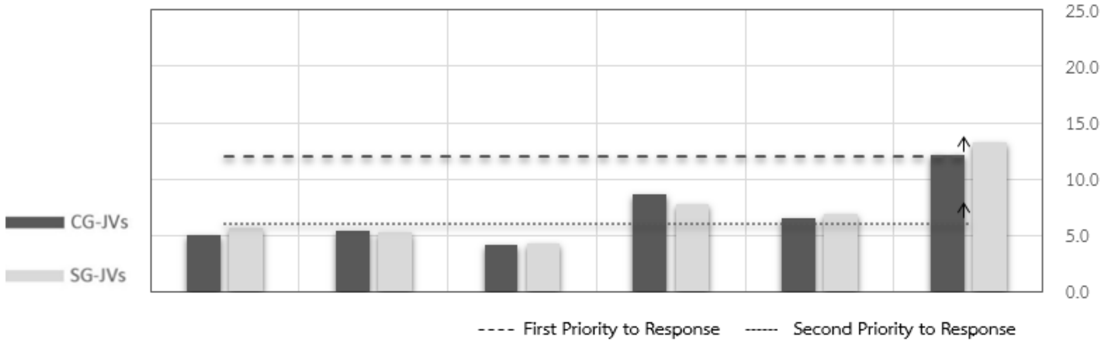
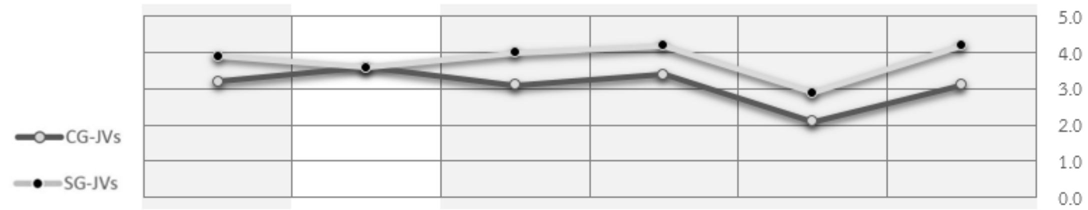
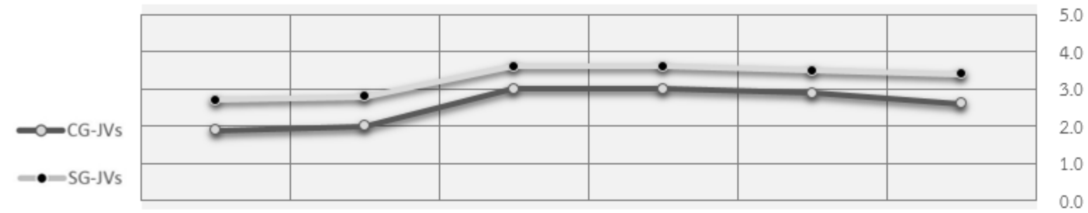


Figure 6-11 Infographic for INT10: Distrust between Partners

INT11	Lack of communication between partners					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	3.2	3.6	3.1	3.4	2.1	3.1
SG-JVs	3.9	3.6	4.0	4.2	2.9	4.2
Ho Test	*Diff*	*Nodiff*	*Diff*	*Diff*	*Diff*	*Diff*



Likelihood (LLH)						
CG-JVs	1.9	2.0	3.0	3.0	2.9	2.6
SG-JVs	2.7	2.8	3.6	3.6	3.5	3.4
Ho Test	*Diff*	*Diff*	*Diff*	*Diff*	*Diff*	*Diff*



Level of Risk (LOR)						
CG-JVs	6.1	7.2	9.3	10.2	6.1	8.1
SG-JVs	10.5	10.1	14.4	15.1	10.2	14.3

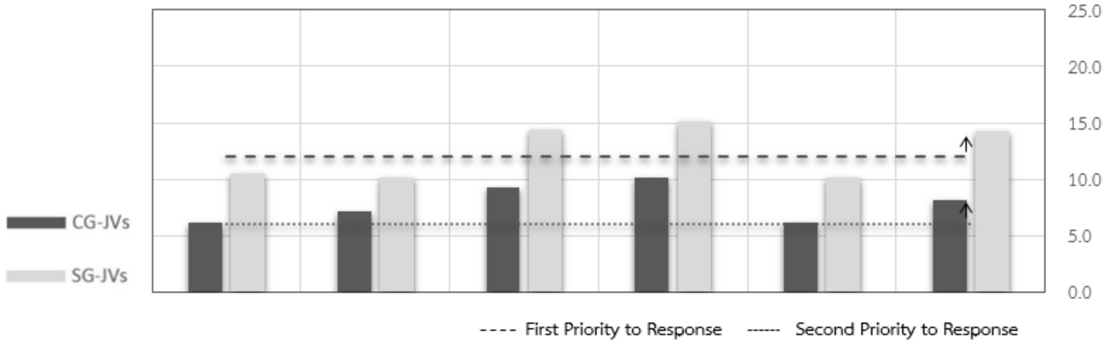


Figure 6-12 Infographic for INT11: Lack of Communication between Partners

(12) INT12: Incomplete in venture agreements

Figure 6.13 shows the summary for the risk. The analysis of the difference value between the CJV organization structures is:

a) **Consequence (CSQ)**

Because the null hypothesis for CSQ value in the bidding phase were rejected at the 95% level of confidence, it mean that the consequence of "incomplete in venture agreements" are affected by types of CJV organization structure only for the objective in the bidding phase. However, other four null hypotheses in three phases, including the construction, warranty and termination phase, were accepted at the 95% level of confidence.

b) **Likelihood (LLH)**

It was found that there were none difference in LLH values for four phases of the CJV lifecycle at the 95% level of confidence. It can be summarized that CG-JV and SG-JV are not the cause for change in likelihood of "incomplete in venture agreements" for four phases.

(13) PRO01: Improper project planning and budgeting

The trend analysis for the risk was shown in Figure 6.14. For the conclusion of the difference value between the CJV organization structures, it is:

a) **Consequence (CSQ)**

The null hypothesis for CSQ value in the construction phase were rejected while another were accepted at the 95% level of confidence. Moreover, the null hypothesis in the warranty phase also were accepted. So, the CJV organization structure are the cause of the variance in the consequence of "improper project planning and budgeting" only for objective (cost) in the construction phase.

b) Likelihood (LLH)

The mean and median of population for two LLH values in two phases of the CJV lifecycle are not different at the 95% level of confidence. It mean that the chance of “improper project planning and budgeting” to happen are not affect by organization structure of CG-JV and SG-JV.

(14) PRO02: Problems in construction techniques

The summary of the risk parameter through the CJV life cycle was shown in Figure 6.15. The analysis of the diffenct between structures is:

a) Consequence (CSQ)

There were difference in CSQ values between CG-JV and SG-JV for the objective (cost) in the construction phase while other two CSQ values were not different. This results led to the conclusion that types of CJV organization structure affect the level of CSQ value for “problems in construction techniques” only for that objective in the construction phase.

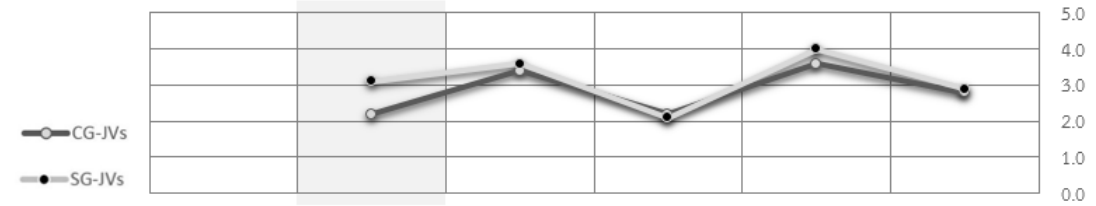
b) Likelihood (LLH)

The CG-JV and SG-JV do not relate to the occurrence of “incompetent construction in partners” because the null hypothesis for LLH values in the construction and warranty phase is accepted at the 95% level of confidence.

INT12	Incomplete in venture agreements					
Phase ->	Formation	Bidding	Construction		Warranty	Termination
			(Cost)	(Schedule)		

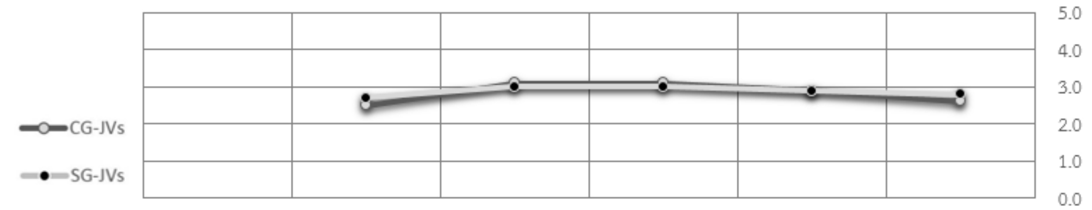
Consequence (CSQ)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs		2.2	3.4	2.2	3.6	2.8
SG-JVs		3.1	3.6	2.1	4.0	2.9
Ho Test		*Diff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Likelihood (LLH)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs		2.5	3.1	3.1	2.9	2.6
SG-JVs		2.7	3.0	3.0	2.9	2.8
Ho Test		*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs		5.5	10.5	6.8	10.4	7.3
SG-JVs		8.4	10.8	6.3	11.6	8.1

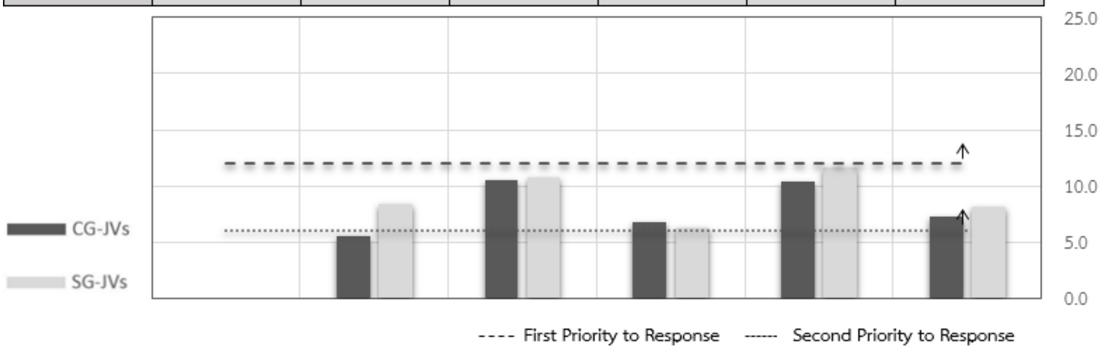
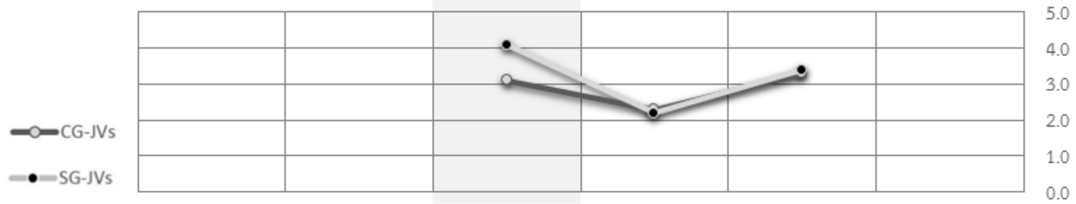


Figure 6-13 Infographic for INT12: Incomplete in Venture Agreements

PRO01	Improper project planning and budgeting					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

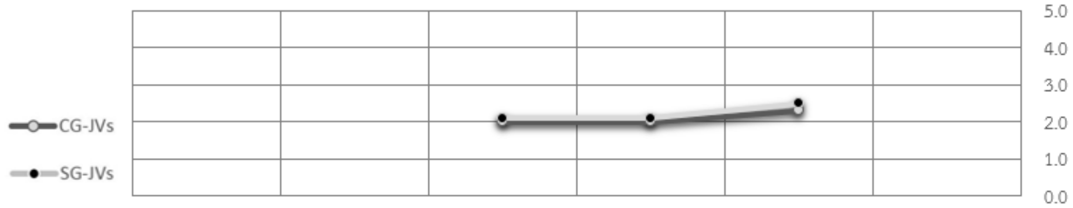
Consequence (CSQ)

CG-JVs			3.1	2.3	3.3	
SG-JVs			4.1	2.2	3.4	
Ho Test			*Diff*	*Nodiff*	*Nodiff*	



Likelihood (LLH)

CG-JVs			2.0	2.0	2.3	
SG-JVs			2.1	2.1	2.5	
Ho Test			*Nodiff*	*Nodiff*	*Nodiff*	



Level of Risk (LOR)

CG-JVs	0.0	0.0	6.2	4.6	7.6	0.0
SG-JVs	0.0	0.0	8.6	4.6	8.5	0.0

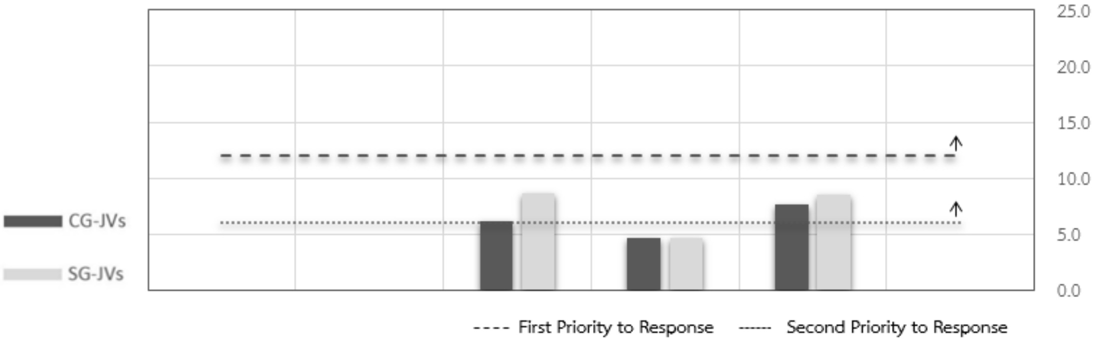
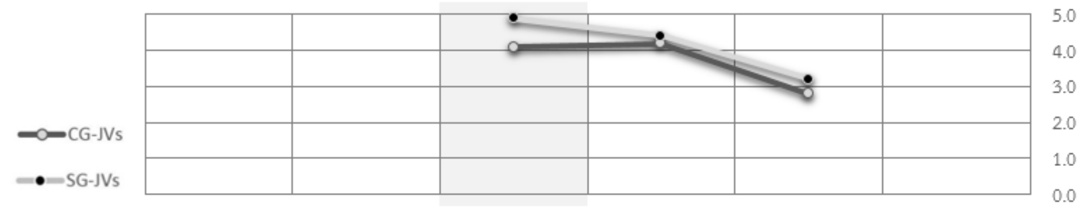


Figure 6-14 Infographic for PRO01: Improper Project Planning and Budgeting

PRO02	Problems in construction techniques					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

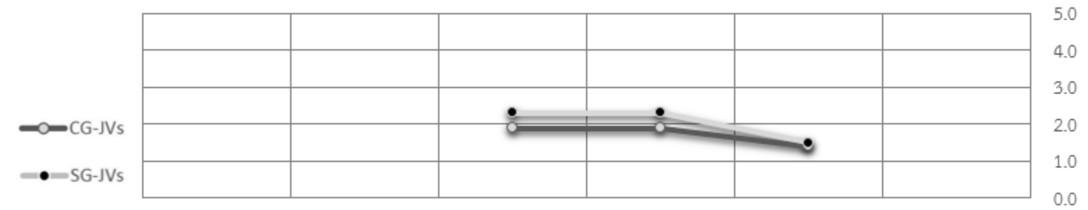
Consequence (CSQ)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs			4.1	4.2	2.8	
SG-JVs			4.9	4.4	3.2	
Ho Test			*Diff*	*Nodiff*	*Nodiff*	



Likelihood (LLH)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs			1.9	1.9	1.4	
SG-JVs			2.3	2.3	1.5	
Ho Test			*Nodiff*	*Nodiff*	*Nodiff*	



Level of Risk (LOR)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	0.0	0.0	7.8	8.0	3.9	0.0
SG-JVs	0.0	0.0	11.3	10.1	4.8	0.0

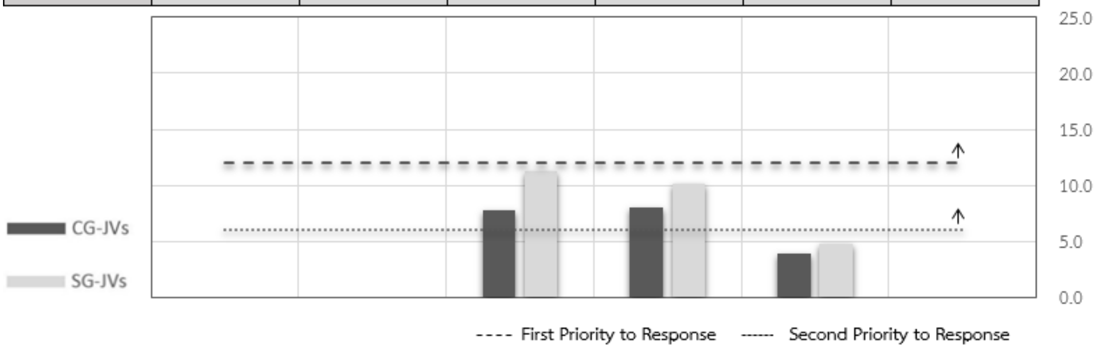


Figure 6-15 Infographic for PRO02: Problems in Construction Techniques

(15) PRO03: Incompetent subcontractors and suppliers

The conclusion for the risk parameter was shown in Figure 6.16. The conclusion about the difference between the CG-JV and the SG-JV is:

a) **Consequence (CSQ)**

After the test of the null hypotheses for three CSQ values from two phases of CJV life cycle, it was found that one of them were rejected and others were accepted at the 95% level of confidence. So, the CJV organization structures cause the difference in the impact of "incompetent subcontractors and suppliers" only for the objective (cost) in the construction phase while they does not impact the consequence of the objective (schedule) in the construction phase and the objective in the warranty phase.

b) **Likelihood (LLH)**

Because the null hypothesis for LLH values in the construction and warranty phase were accepted, there are no difference in the LLH values between CG-JV and SG-JV. So, the types of CJV organization structure are not the cause for the occurrence of "incompetent subcontractors and suppliers

(16) PRO04: Problems in contract drawings and specifications

Figure 6.17 shows the summary for the risk. The analysis of the difference value between the CJV organization structures is:

a) **Consequence (CSQ)**

Although two null hypotheses in the bidding and construction phase were accepted at the 95% level of confidence, there was another null hypothesis in the construction phase which were rejected. It can be concluded that the consequence of "problems in contract drawings and specifications" for the objective (cost) in the construction phase is affected by characteristics of CG-JV and SG-JV.

b) **Likelihood (LLH)**

After the process of the hypothesis test, it was found that all LLH values in both phases of the CJV lifecycle were not different at the 95% level of confidence. That led to the conclusion that the chance to happen for “problems in contract drawings and specifications” in the bidding and construction phase are not affected by types of CJV organization structure.

(17) PRO05: Problems in construction contracts

The analysis for the risk was shown in Figure 6.18. For the conclusion of the difference value between the CJV organization structures, it is:

a) **Consequence (CSQ)**

There were none difference in CSQ values for objectives from the construction phase to the termination phase between CG-JV and SG-JV at the 95% level of confidence. So, the CJV organization structure are not the cause for the different consequence of “problems in construction contracts” in those phases.

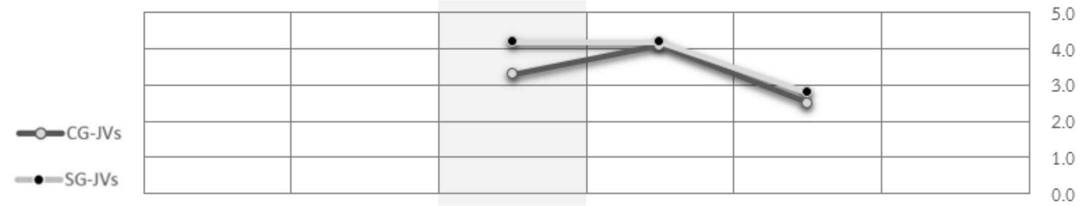
b) **Likelihood (LLH)**

Because the null hypothesis for LLH values in three phases of the CJV lifecycle were accepted, there are no difference in the LLH values between CG-JV and SG-JV. So, the types of CJV organization structure are not the cause for the occurrence of “problems in construction contracts” in the construction, warranty and termination phase.

PRO03	Incompetent subcontractors and suppliers					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

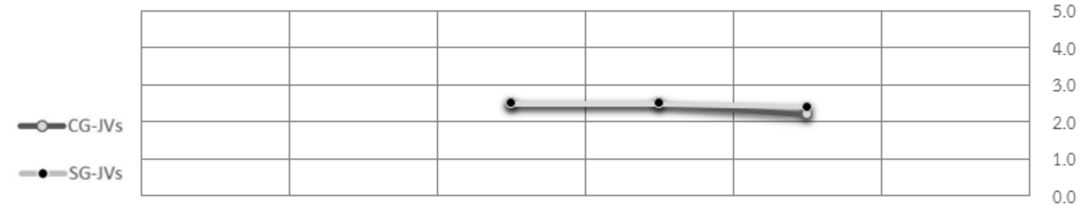
Consequence (CSQ)

CG-JVs			3.3	4.1	2.5	
SG-JVs			4.2	4.2	2.8	
Ho Test			*Diff*	*Nodiff*	*Nodiff*	



Likelihood (LLH)

CG-JVs			2.5	2.5	2.2	
SG-JVs			2.5	2.5	2.4	
Ho Test			*Nodiff*	*Nodiff*	*Nodiff*	



Level of Risk (LOR)

CG-JVs	0.0	0.0	8.3	10.3	5.5	0.0
SG-JVs	0.0	0.0	10.5	10.5	6.7	0.0

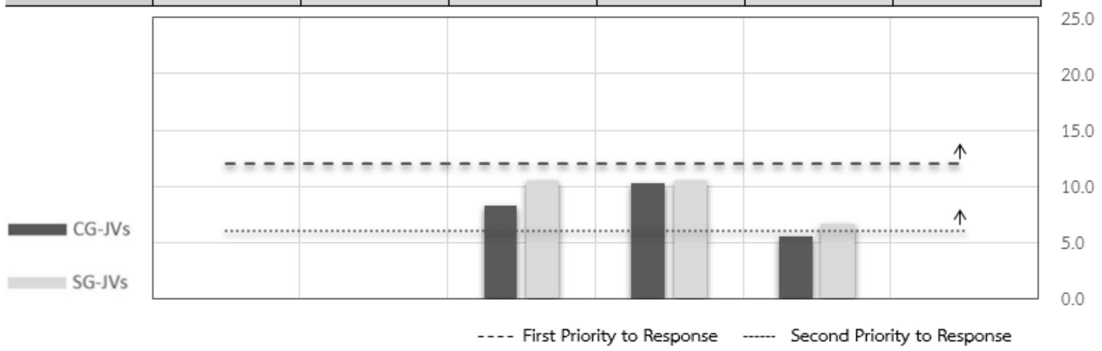
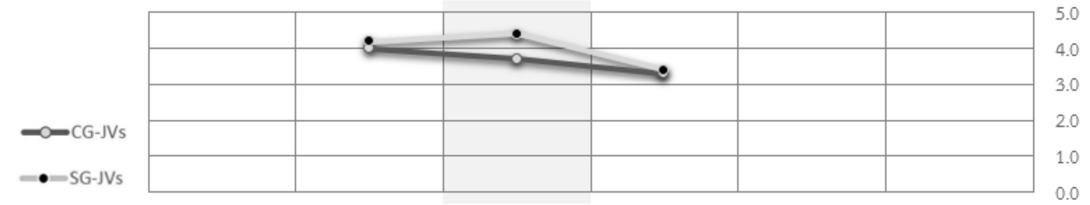


Figure 6-16 Infographic for PRO03: Incompetent Subcontractors and Suppliers

PRO04	Problems in contract drawings and specifications					
Phase ->	Formation	Bidding	Construction		Warranty	Termination
			(Cost)	(Schedule)		

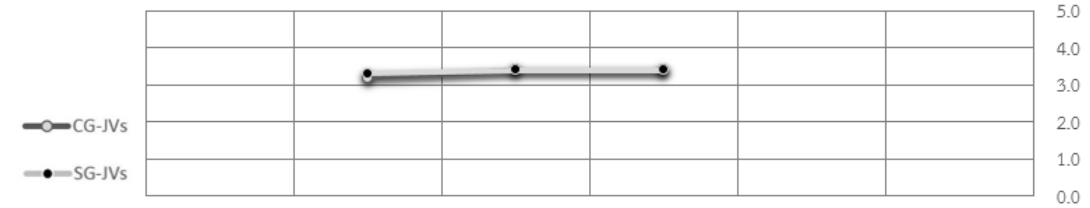
Consequence (CSQ)

CG-JVs		4.0	3.7	3.3		
SG-JVs		4.2	4.4	3.4		
Ho Test		*Nodiff*	*Diff*	*Nodiff*		



Likelihood (LLH)

CG-JVs		3.2	3.4	3.4		
SG-JVs		3.3	3.4	3.4		
Ho Test		*Nodiff*	*Nodiff*	*Nodiff*		



Level of Risk (LOR)

CG-JVs	0.0	12.8	12.6	11.2	0.0	0.0
SG-JVs	0.0	13.9	15.0	11.6	0.0	0.0

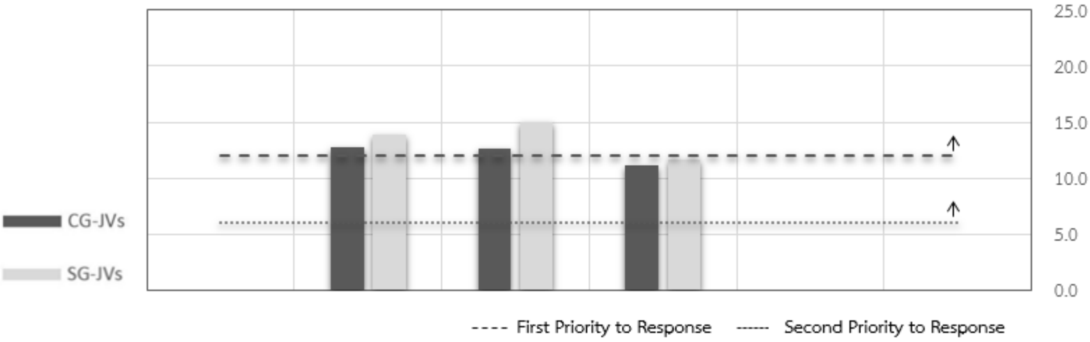
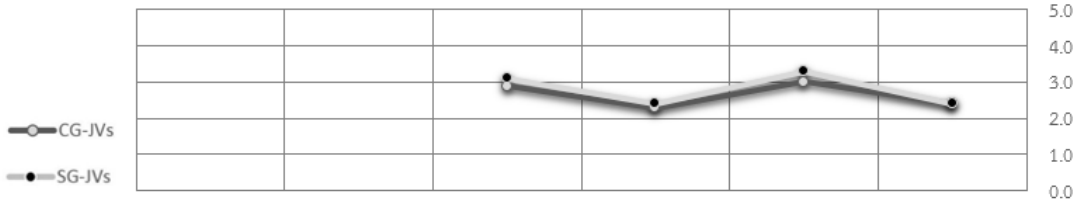


Figure 6-17 Infographic for PRO04: Problems in Contract Drawings and Specifications

PRO05	Problems in construction contracts					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

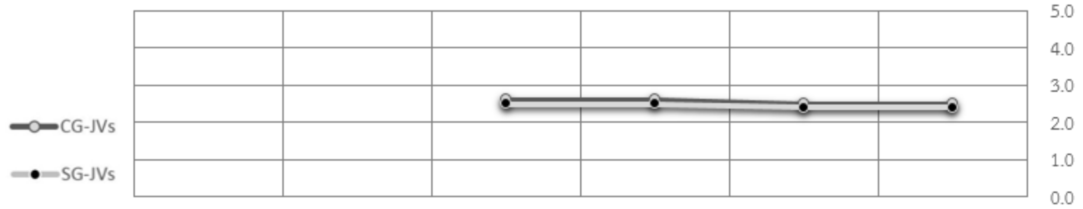
Consequence (CSQ)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs			2.9	2.3	3.0	2.4
SG-JVs			3.1	2.4	3.3	2.4
Ho Test			*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Likelihood (LLH)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs			2.6	2.6	2.5	2.5
SG-JVs			2.5	2.5	2.4	2.4
Ho Test			*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	0.0	0.0	7.5	6.0	7.5	6.0
SG-JVs	0.0	0.0	7.8	6.0	7.9	5.8

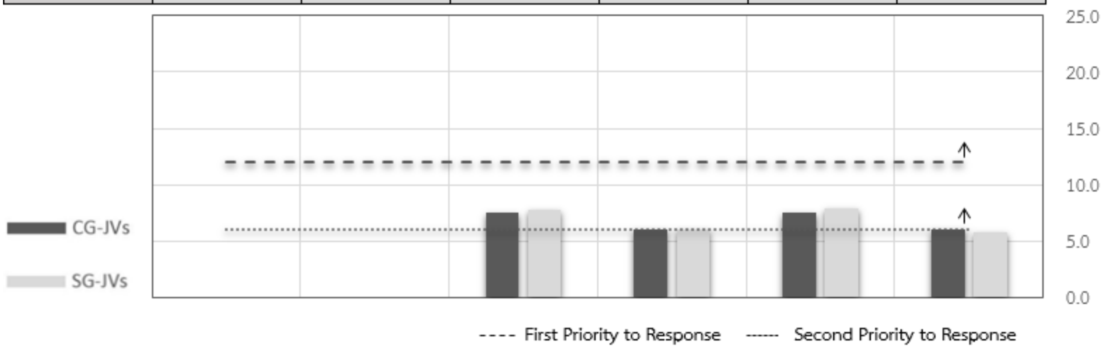


Figure 6-18 Infographic for PRO05: Problems in Construction Contracts

(18) PRO06: Improper project profit and risk sharing

The summary of the risk parameter through the CJV life cycle was shown in Figure 6.19. The analysis of the diffenct between structures is:

a) Consequence (CSQ)

With the result of the null hypothesis test which was accepted for the first phases in the CJV life cycle, it means that the consequence of "improper project profit and risk sharing" for the objective in the formation phase are not be affected by types of CJV organization structure.

b) Likelihood (LLH)

With the results of the null hypothesis test which were accepted for the formation phases, it can conclude that the chance to happen for "improper project profit and risk sharing" are not be impacted by types of CJV organization structure.

(19) PRO07: Excessive demands and variation orders

The conclusion for the risk parameter was shown in Figure 6.20. The conclusion about the difference between the CG-JV and the SG-JV is:

a) Consequence (CSQ)

There were difference in CSQ values between CG-JV and SG-JV in the construction phase. This results led to the conclusion that the consequence of "excessive demands and variation orders" for the objective (cost) in the construction are affected by types of CJV organization structure. For objectives in the bidding phase and the objective (schedule) in the construction phase, it was found that there were no difference in CSQ values between both structures. So they are not impacted by the structures.

b) **Likelihood (LLH)**

It was found that there were none difference in LLH values for the bidding, construction and warranty phase at the 95% level of confidence. It can be summarized that CG-JV and SG-JV are not the cause for change in likelihood of "excessive demands and variation orders" for above three phases.

(20) PRO08: Intervention and delay by owner or its representatives

Figure 6.21 shows the summary for the risk. The analysis of the difference value between the CJV organization structures is:

a) **Consequence (CSQ)**

After the tests of the null hypotheses for the CSQ values from five phases of CJV life cycle, it was found that those six hypotheses were accepted at the 95% level of confidence. That results led to the conclusion that the level of impact for "intervention and delay by owner or its representatives" are not affected by types of CJV organization structure.

b) **Likelihood (LLH)**

The population mean and median of five LLH values in all phase of the CJV lifecycle are not different at the 95% level of confidence. It mean that the chance of "intervention and delay by owner or its representatives" to happen are not affect by types of CJV organization structure.

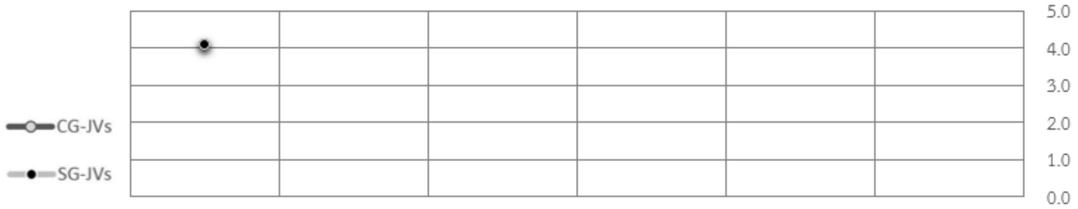
PRO06	Improper project profit and risk sharing					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

Consequence (CSQ)

CG-JVs	4.3					
SG-JVs	4.2					
Ho Test	*Nodiff*					

Likelihood (LLH)

CG-JVs	4.1					
SG-JVs	4.1					
Ho Test	*Nodiff*					



Level of Risk (LOR)

CG-JVs	17.6	0.0	0.0	0.0	0.0	0.0
SG-JVs	17.2	0.0	0.0	0.0	0.0	0.0

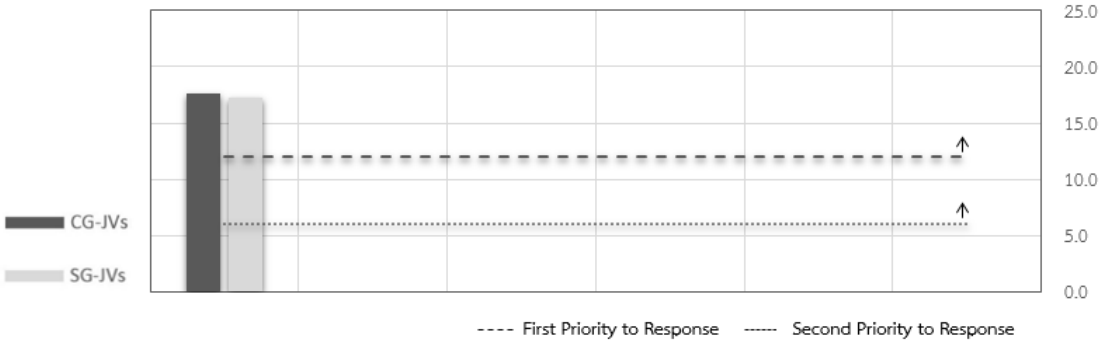
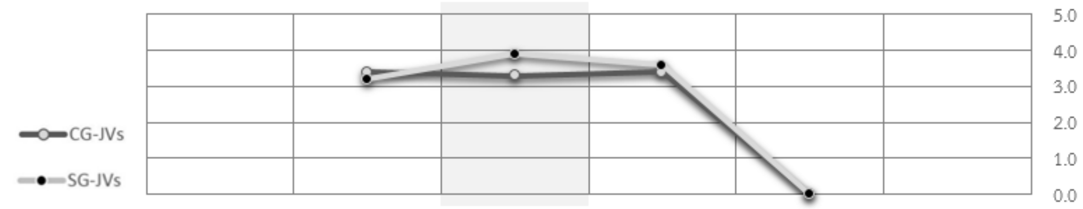


Figure 6-19 Infographic for PRO06: Improper Project Profit and Risk Sharing

PRO07	Excessive demands and variation orders					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

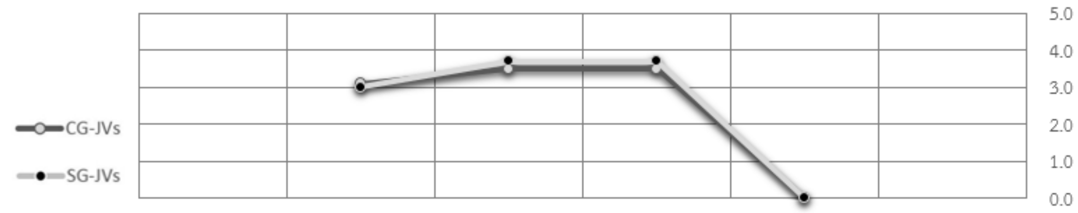
Consequence (CSQ)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs		3.4	3.3	3.4	0.0	
SG-JVs		3.2	3.9	3.6	0.0	
Ho Test		*Nodiff*	*Diff*	*Nodiff*	-	



Likelihood (LLH)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs		3.1	3.5	3.5	0.0	
SG-JVs		3.0	3.7	3.7	0.0	
Ho Test		*Nodiff*	*Nodiff*	*Nodiff*	-	



Level of Risk (LOR)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	0.0	10.5	11.6	11.9	0.0	0.0
SG-JVs	0.0	9.6	14.4	13.3	0.0	0.0

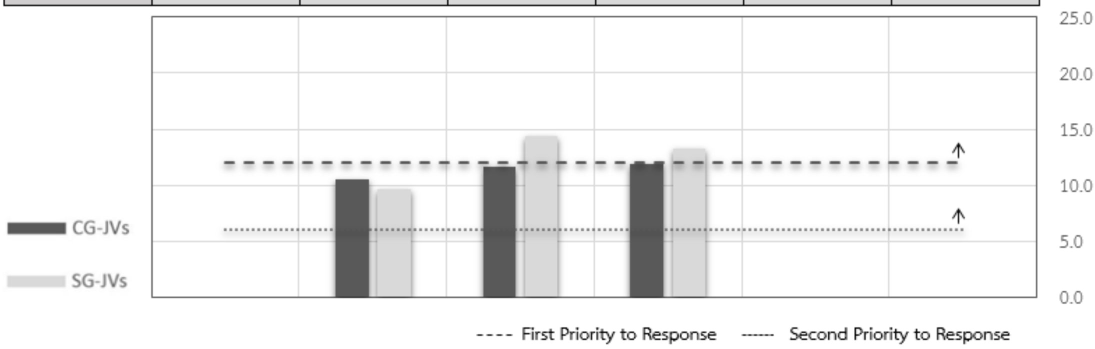
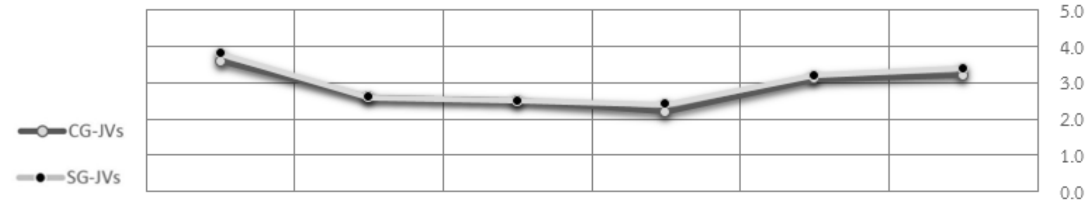


Figure 6-20 Infographic for PRO07: Excessive Demands and Variation Orders

PRO08	Intervention and delay by owner or its representatives					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

Consequence (CSQ)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	3.6	2.6	2.5	2.2	3.1	3.2
SG-JVs	3.8	2.6	2.5	2.4	3.2	3.4
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Likelihood (LLH)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	2.5	2.6	3.0	3.0	3.4	2.0
SG-JVs	2.6	2.8	3.1	3.1	3.5	2.5
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*

Level of Risk (LOR)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	9.0	6.8	7.5	6.6	10.5	6.4
SG-JVs	9.9	7.3	7.8	7.4	11.2	8.5

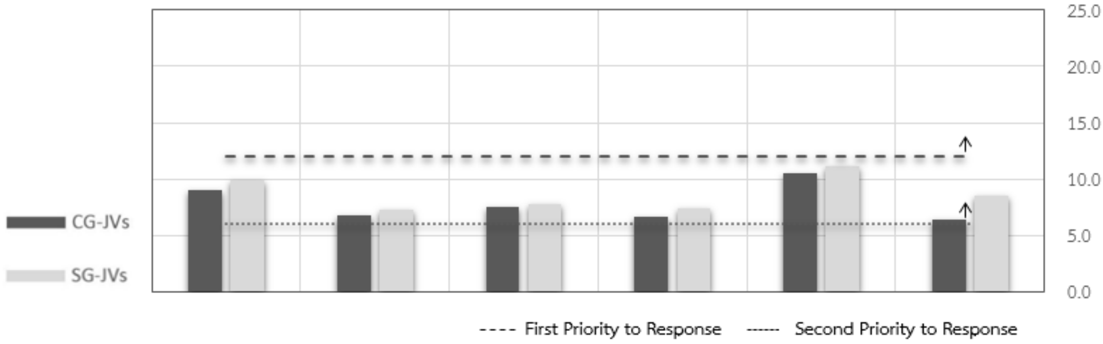


Figure 6-21 Infographic for PRO08: Intervention and Delay by Owner or Its Representatives

(22) EXT02: Language barrier

The summary of the risk parameter through the CJV life cycle was shown in Figure 6.22. The analysis of the diffenct between structures is:

a) Consequence (CSQ)

Because three null hypotheses for CSQ value were rejected at the 95% level of confidence, it mean that the consequence of “language barrier” for the objectives the bidding, construction (schedule) and termination phase are affected by characteristics of CG-JV and SG-JV.

b) Likelihood (LLH)

With the results of the null hypothesis test which were rejected for the construction phase, it can conclude that the chance to happen for “language barrier” are impacted by types of CJV organization structure for only the construction phase.

(23) EXT03: Natural disasters and unpredictable weather

Figure 6.23 shows the summary for the risk. The analysis of the difference value between the CJV organization structures is:

a) Consequence (CSQ)

From three null hypotheses, there are only one which were rejected at the 95% level of confidence. This result led to the conclusion that the level of impact for “natural disasters and unpredictable weather” are impacted by types of CJV organization structure only for the objective (cost) in the construction phase.

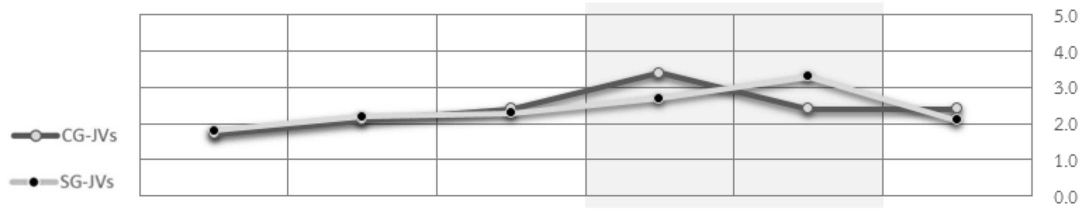
b) Likelihood (LLH)

The CG-JV and SG-JV do not relate to the occurrence of “natural disasters and unpredictable weather” because the null hypothesis for LLH values in the construction and warranty phase is accepted at the 95% level of confidence.

EXT01	Differences in social, culture and religions					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

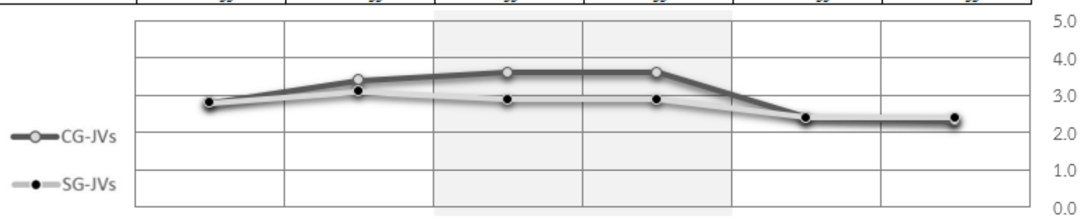
Consequence (CSQ)

CG-JVs	1.7	2.1	2.4	3.4	2.4	2.4
SG-JVs	1.8	2.2	2.3	2.7	3.3	2.1
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Diff*	*Diff*	*Nodiff*



Likelihood (LLH)

CG-JVs	2.8	3.4	3.6	3.6	2.4	2.3
SG-JVs	2.8	3.1	2.9	2.9	2.4	2.4
Ho Test	*Nodiff*	*Nodiff*	*Diff*	*Diff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)

CG-JVs	4.8	7.1	8.6	12.2	5.8	5.5
SG-JVs	5.0	6.8	6.7	7.8	7.9	5.0

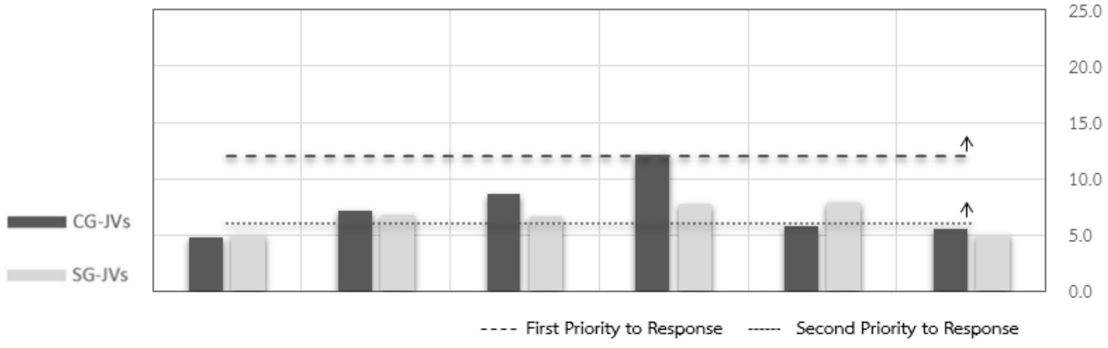
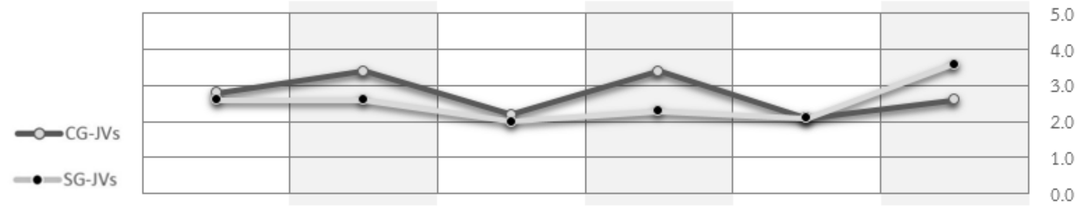
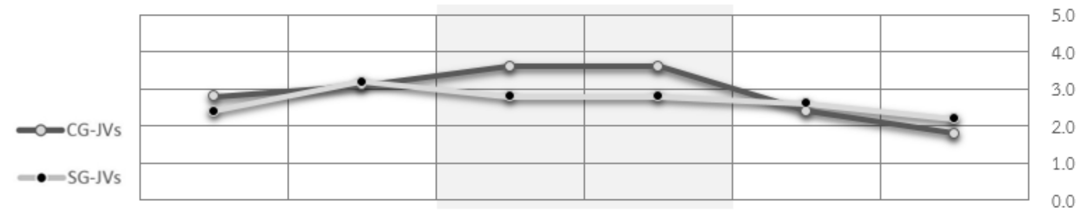


Figure 6-22 Infographic for EXT01: Differences in Social, Culture and Religions

EXT02	Language barrier					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	2.8	3.4	2.2	3.4	2.1	2.6
SG-JVs	2.6	2.6	2.0	2.3	2.1	3.6
Ho Test	*Nodiff*	*Diff*	*Nodiff*	*Diff*	*Nodiff*	*Diff*



Likelihood (LLH)						
CG-JVs	2.8	3.1	3.6	3.6	2.4	1.8
SG-JVs	2.4	3.2	2.8	2.8	2.6	2.2
Ho Test	*Nodiff*	*Nodiff*	*Diff*	*Diff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)						
CG-JVs	7.8	10.5	7.9	12.2	5.0	4.7
SG-JVs	6.2	8.3	5.6	6.4	5.5	7.9

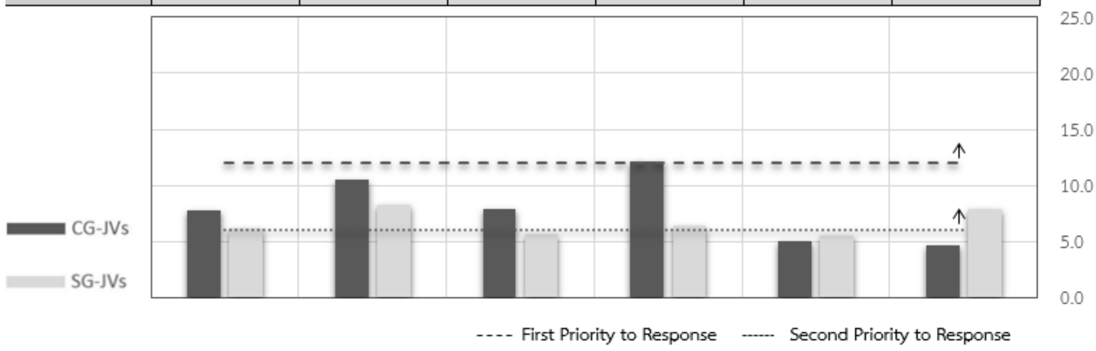


Figure 6-23 Infographic for EXT02: Language Barrier

(24) EXT04: Pollution

The summary of the risk parameter through the CJV life cycle was shown in Figure 6.24. The analysis of the diffenct between structures is:

a) Consequence (CSQ)

The null hypothesis for CSQ value (cost) in the construction phase were rejected while the other null hypotheses in the construction and the warranty phase were accepted at the 95% level of confidence. It can be concluded that the consequence of "pollution" for the objective (cost) in the construction phase are affected by characteristics of CG-JV and SG-JV.

b) Likelihood (LLH)

After the process of the hypothesis test, it was found that all LLH values in two phases of the CJV lifecycle were not different at the 95% level of confidence. That led to the conclusion that the chance to happen for "pollution" for the construction and warranty phase are not affected by types of CJV organization structure.

(25) EXT05: Resistance from society

The analysis for the risk was shown in Figure 6.25. For the conclusion of the difference value between the CJV organization structures, it is:

a) Consequence (CSQ)

After the test of the null hypotheses for four CSQ values from three phases of CJV life cycle, it was found that they were accepted at the 95% level of confidence. It can be summarized that the CJV organization structure are not the cause for the impact of "resistance from society" for the objectives in the formation, bidding and construction phases.

b) **Likelihood (LLH)**

Because the null hypothesis for LLH values in the first three phases of the CJV lifecycle were accepted, there are no difference in the LLH values between CG-JV and SG-JV. So, the structures of CG-JV and SG-JV are not the cause for the occurrence of "resistance from society" in the formation, bidding and construction phase.

(26) EXT06: Security problems and social disorder

The summary of the risk parameter through the CJV life cycle was shown in Figure 6.26. The analysis of the diffenct between structures is:

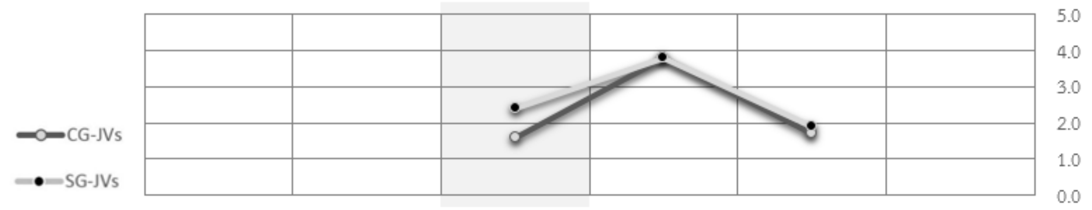
a) **Consequence (CSQ)**

With the results of five null hypotheses test which was accepted for four phases in the CJV life cycle, it means that the consequence of "security problems and social disorder" for the five objectives from the formation phase to the warranty phase are not be affected by CJV organization structures.

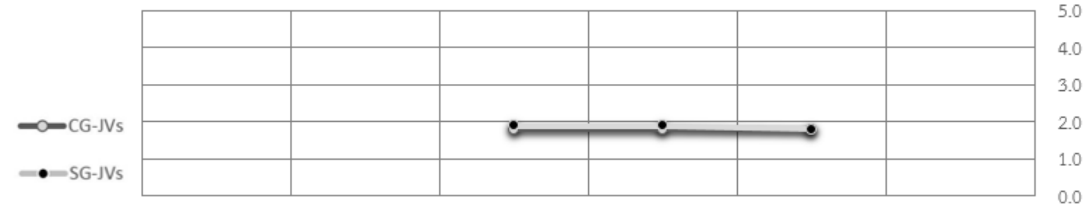
b) **Likelihood (LLH)**

With the results of the null hypothesis test which were accepted for the formation, bidding, constriction and warranty phase, it can conclude that the chance to happen for "security problems and social disorder" are not be impacted by types of CJV organization structure.

EXT03	Natural disasters and unpredictable weather					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs			1.6	3.8	1.7	
SG-JVs			2.4	3.8	1.9	
Ho Test			*Diff*	*Nodiff*	*Nodiff*	



Likelihood (LLH)						
CG-JVs			1.8	1.8	1.8	
SG-JVs			1.9	1.9	1.8	
Ho Test			*Nodiff*	*Nodiff*	*Nodiff*	



Level of Risk (LOR)						
CG-JVs	0.0	0.0	2.9	6.8	3.1	0.0
SG-JVs	0.0	0.0	4.6	7.2	3.4	0.0

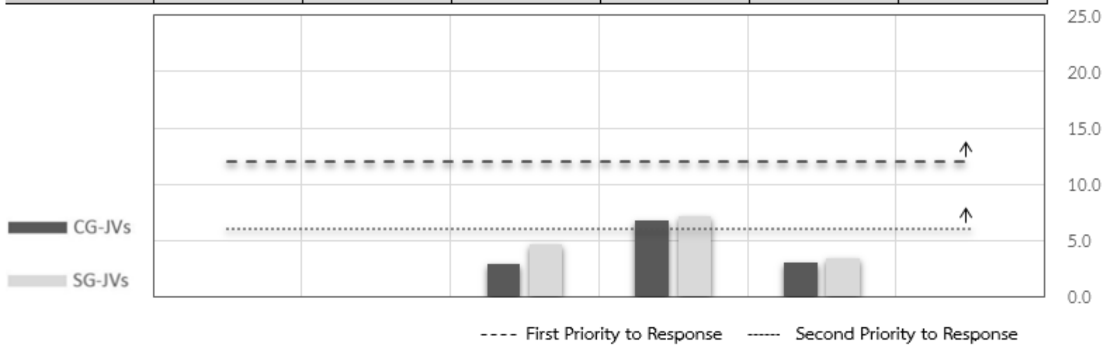
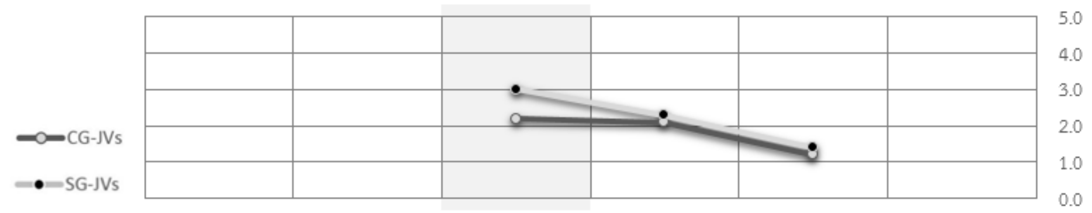


Figure 6-24 Infographic for EXT03: Natural Disasters and Unpredictable Weather

EXT04	Pollution					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

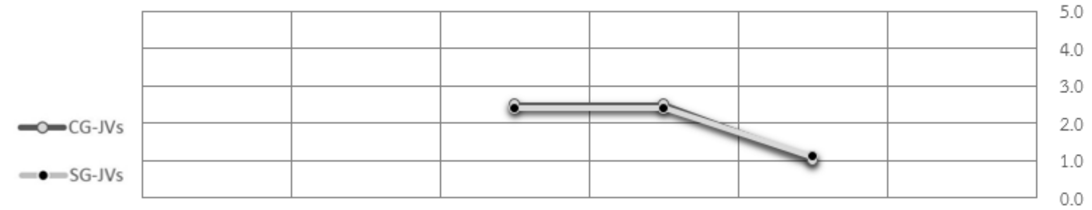
Consequence (CSQ)

CG-JVs			2.2	2.1	1.2	
SG-JVs			3.0	2.3	1.4	
Ho Test			*Diff*	*Nodiff*	*Nodiff*	



Likelihood (LLH)

CG-JVs			2.5	2.5	1.0	
SG-JVs			2.4	2.4	1.1	
Ho Test			*Nodiff*	*Nodiff*	*Nodiff*	



Level of Risk (LOR)

CG-JVs	0.0	0.0	5.5	5.3	1.2	0.0
SG-JVs	0.0	0.0	7.2	5.5	1.5	0.0

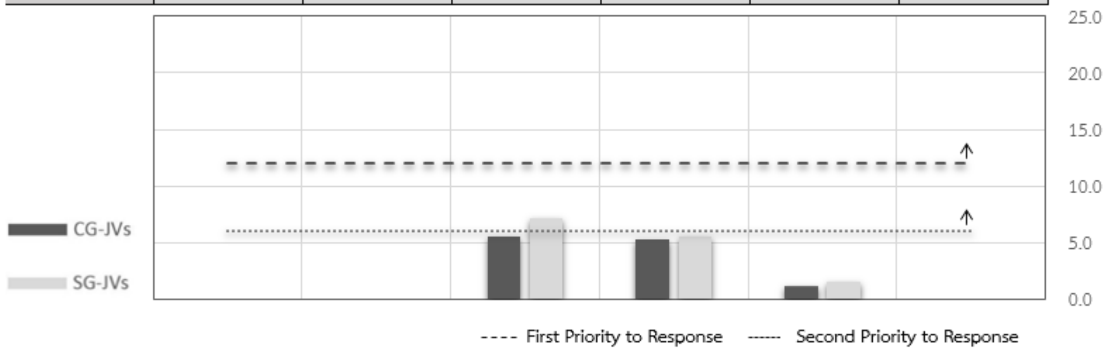
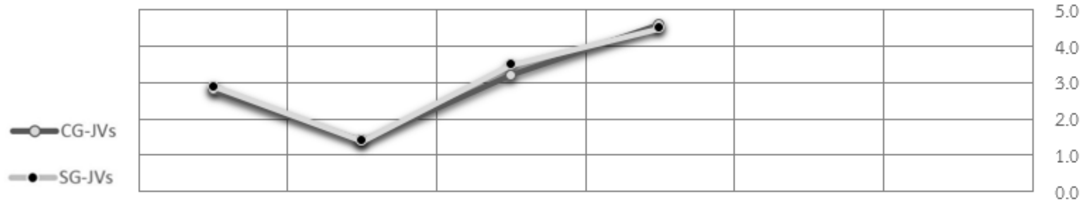
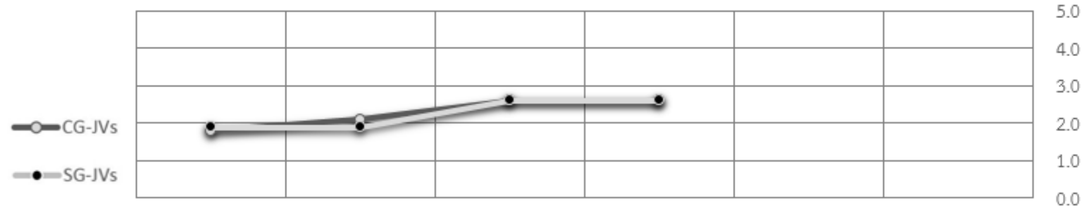


Figure 6-25 Infographic for EXT04: Pollution

EXT05	Resistance from society					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	2.8	1.4	3.2	4.6		
SG-JVs	2.9	1.4	3.5	4.5		
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*		



Likelihood (LLH)						
CG-JVs	1.8	2.1	2.6	2.6		
SG-JVs	1.9	1.9	2.6	2.6		
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*		



Level of Risk (LOR)						
CG-JVs	5.0	2.9	8.3	12.0	0.0	0.0
SG-JVs	5.5	2.7	9.1	11.7	0.0	0.0

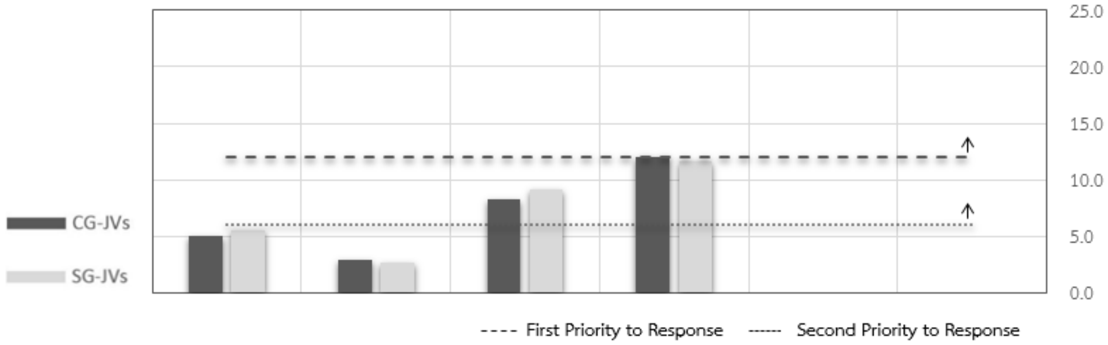


Figure 6-26 Infographic for EXT05: Resistance from Society

(26) EXT06: Security problems and social disorder

The summary of the risk parameter through the CJV life cycle was shown in Figure 6.27. The analysis of the diffenct between structures is:

a) **Consequence (CSQ)**

With the results of five null hypotheses test which was accepted for four phases in the CJV life cycle, it means that the consequence of "security problems and social disorder" for the five objectives from the formation phase to the warranty phase are not be affected by CJV organization structures.

b) **Likelihood (LLH)**

With the results of the null hypothesis test which were accepted for the formation, bidding, constriction and warranty phase, it can conclude that the chance to happen for "security problems and social disorder" are not be impacted by types of CJV organization structure.

(27) EXT07: Inconsistency in government policies

Figure 6.28 show the summary for the risk. The analysis of the difference value between the CJV organization structures is:

a) **Consequence (CSQ)**

There were none difference in CSQ values between CG-JV and SG-JV for all five phases of the CJV life cycle at the 95% level of confidence. It can be summarized that the CJV organization structure are not the cause for the impact of "inconsistency in government policies" for the objectives in all phases.

b) **Likelihood (LLH)**

It was found that there were none difference in LLH values for all five phases of the CJV lifecycle at the 95% level of confidence. It can be summarized that CG-JV and SG-JV are not the cause for change in likelihood of “inconsistency in government policies” form the first phase to the final phase of CJV lifecycle

(28) EXT08: Investment restriction

The summary of the risk parameter through the CJV life cycle was shown in Figure 6.29. The analysis of the diffenct between structures is:

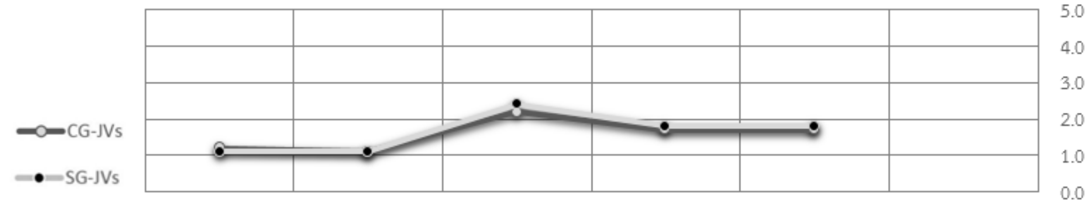
a) **Consequence (CSQ)**

Because the null hypothesis for CSQ value in the construction phases were rejected at the 95% level of confidence, it mean that the consequence of “investment restriction” are affected by types of CJV organization structure only for the objective (cost) in the construction phase. However, other three null hypotheses in three phases, including the formation, construction and termination phase, were accepted at the 95% level of confidence.

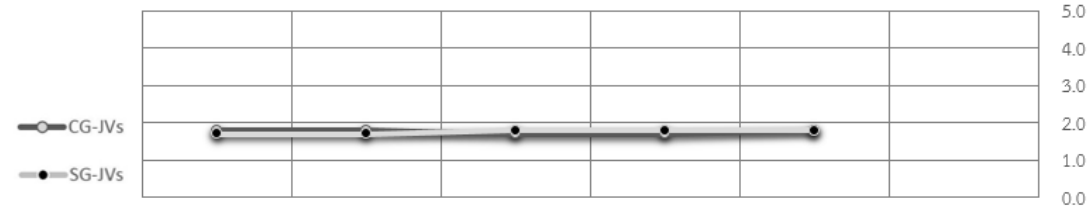
b) **Likelihood (LLH)**

The population mean and median of three LLH values in the formation, construction and termination phases are not different at the 95% level of confidence. It mean that the chance of “investment restriction” to happen are not affect by types of CJV organization structure.

EXT06	Security problems and social disorder					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	1.2	1.1	2.2	1.7	1.7	
SG-JVs	1.1	1.1	2.4	1.8	1.8	
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	



Likelihood (LLH)						
CG-JVs	1.8	1.8	1.7	1.7	1.8	
SG-JVs	1.7	1.7	1.8	1.8	1.8	
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	



Level of Risk (LOR)						
CG-JVs	2.2	2.0	3.7	2.9	3.1	0.0
SG-JVs	1.9	1.9	4.3	3.2	3.2	0.0

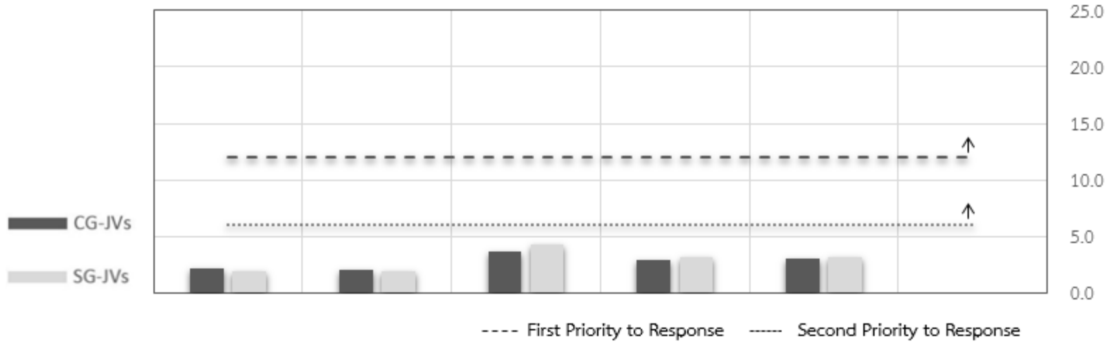
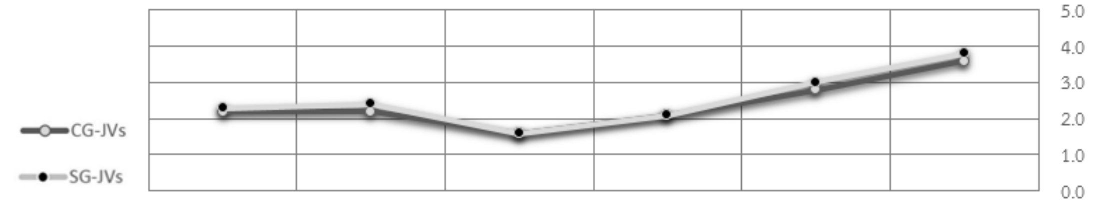
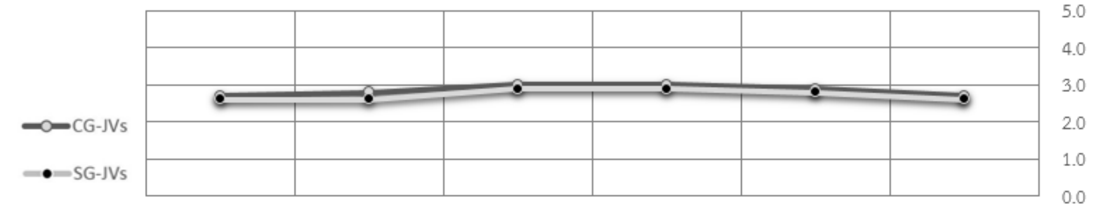


Figure 6-27 Infographic for EXT06: Security Problems and Social Disorder

EXT07	Inconsistency in government policies					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	2.2	2.2	1.6	2.1	2.8	3.6
SG-JVs	2.3	2.4	1.6	2.1	3.0	3.8
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Likelihood (LLH)	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	2.7	2.8	3.0	3.0	2.9	2.7
SG-JVs	2.6	2.6	2.9	2.9	2.8	2.6
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	5.9	6.2	4.8	6.3	8.1	9.7
SG-JVs	6.0	6.2	4.6	6.1	8.4	9.9

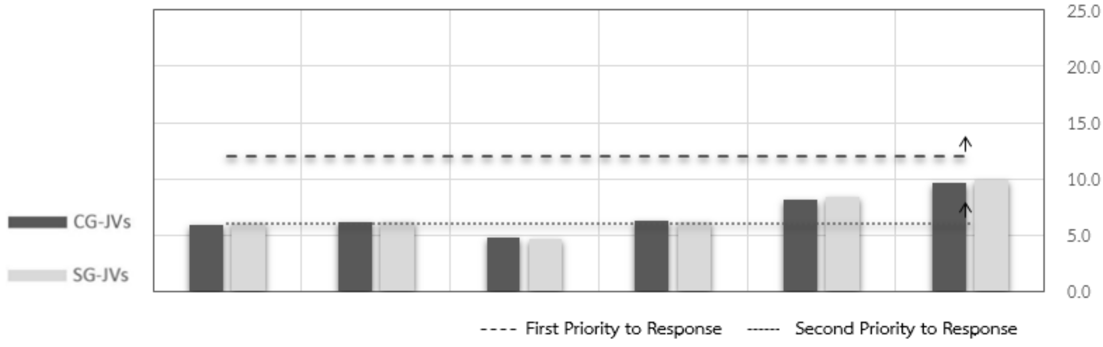
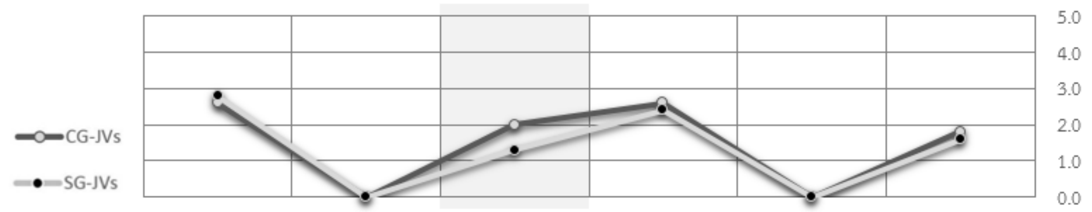


Figure 6-28 Infographic for EXT07: Inconsistency in Government Policies

EXT08	Investment restriction					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

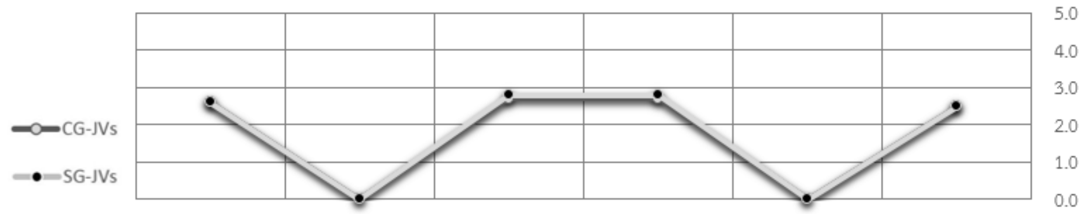
Consequence (CSQ)

CG-JVs	2.6	0.0	2.0	2.6	0.0	1.8
SG-JVs	2.8	0.0	1.3	2.4	0.0	1.6
Ho Test	*Nodiff*	-	*Diff*	*Nodiff*	-	*Nodiff*



Likelihood (LLH)

CG-JVs	2.6	0.0	2.7	2.7	0.0	2.5
SG-JVs	2.6	0.0	2.8	2.8	0.0	2.5
Ho Test	*Nodiff*	-	*Nodiff*	*Nodiff*	-	*Nodiff*



Level of Risk (LOR)

CG-JVs	6.8	0.0	5.4	7.0	0.0	4.5
SG-JVs	7.3	0.0	3.6	6.7	0.0	4.0

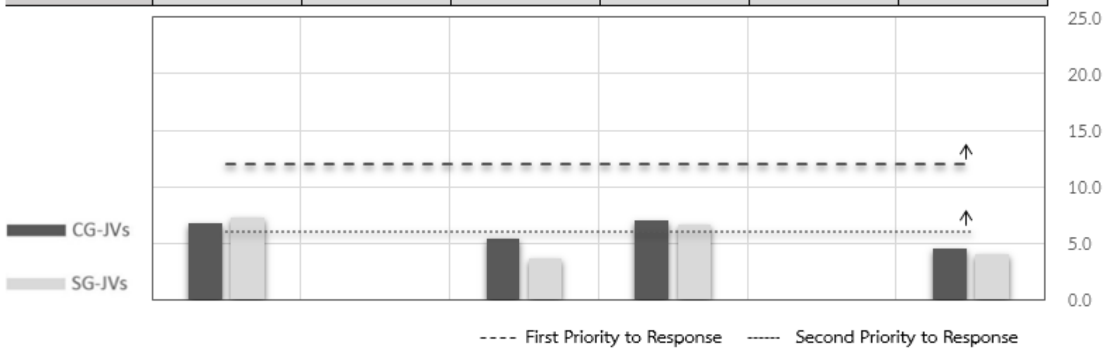


Figure 6-29 Infographic for EXT08: Investment Restriction

(29) EXT09: Corruption and bribery

The conclusion for the risk parameter was shown in Figure 6.30. The conclusion about the difference between the CG-JV and the SG-JV is:

a) Consequence (CSQ)

There is no difference in the level of consequence for “corruption and bribery” causing by the types of CJV organization structure for the objectives through the CJV life cycle because the six null hypotheses for CSQ values were accepted at the 95% level of confidence.

b) Likelihood (LLH)

The CG-JV and SG-JV do not relate to the occurrence of “incompetent construction in partners” because the null hypothesis for LLH values in all five phases of the CJV lifecycle is accepted at the 95% level of confidence.

(30) EXT10: Fluctuation in economic and inflation

The analysis for the risk was shown in Figure 6.31. For the conclusion of the difference value between the CJV organization structures, it is:

a) Consequence (CSQ)

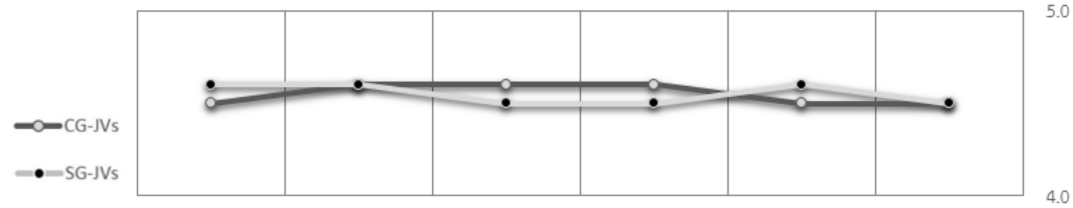
After the test of the null hypotheses for five CSQ values from four phases of CJV life cycle, it was found that there were two null hypotheses were rejected at the 95% level of confidence. It can be summarized that the CJV organization structure are the cause for the different impact of “fluctuation in economic and inflation” of the objectives in the construction phase (cost) and the warranty phase.

b) Likelihood (LLH)

It was found that there were none difference in LLH values for four phases of the CJV lifecycle at the 95% level of confidence. It can be summarized that CG-JV and SG-JV are not the cause for change in likelihood of “fluctuation in economic and inflation” for the formation, bidding, construction and warranty phase.

EXT09	Corruption and bribery					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
Consequence (CSQ)						
CG-JVs	1.7	2.2	4.7	3.4	1.7	3.1
SG-JVs	1.9	2.3	4.6	3.3	1.8	3.0
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*

Likelihood (LLH)						
CG-JVs	4.5	4.6	4.6	4.6	4.5	4.5
SG-JVs	4.6	4.6	4.5	4.5	4.6	4.5
Ho Test	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*	*Nodiff*



Level of Risk (LOR)						
CG-JVs	7.7	10.1	21.6	15.6	7.7	14.0
SG-JVs	8.7	10.6	20.7	14.9	8.3	13.5

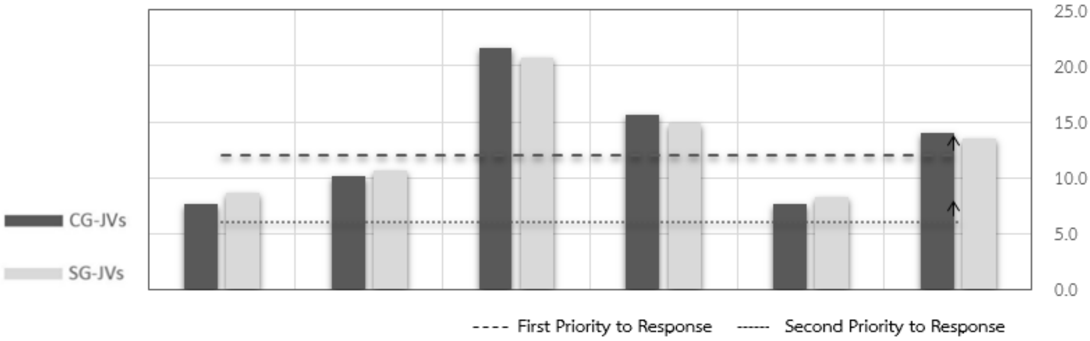
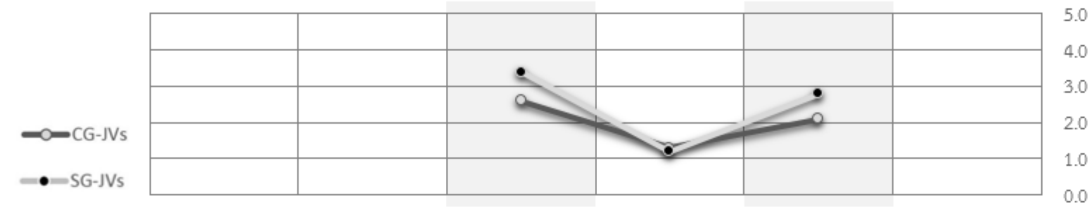


Figure 6-30 Infographic for EXT09: Corruption and Bribery

EXT11	Fluctuation in economic and inflation					
Phase ->	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination

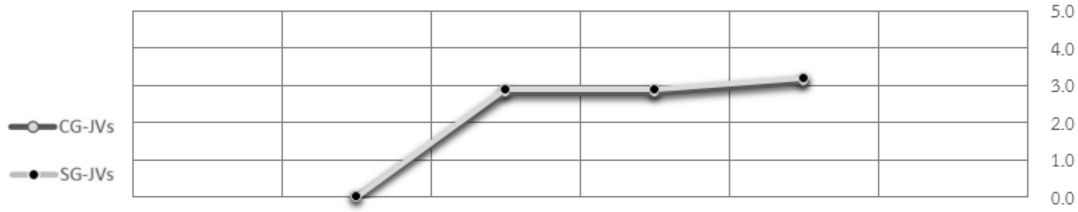
Consequence (CSQ)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs			2.6	1.3	2.1	
SG-JVs			3.4	1.2	2.8	
Ho Test			*Diff*	*Nodiff*	*Diff*	



Likelihood (LLH)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs		0.0	2.8	2.8	3.1	
SG-JVs		0.0	2.9	2.9	3.2	
Ho Test		-	*Nodiff*	*Nodiff*	*Nodiff*	



Level of Risk (LOR)

	Formation	Bidding	Construction (Cost)	Construction (Schedule)	Warranty	Termination
CG-JVs	0.0	0.0	7.3	3.6	6.5	0.0
SG-JVs	0.0	0.0	9.9	3.5	9.0	0.0

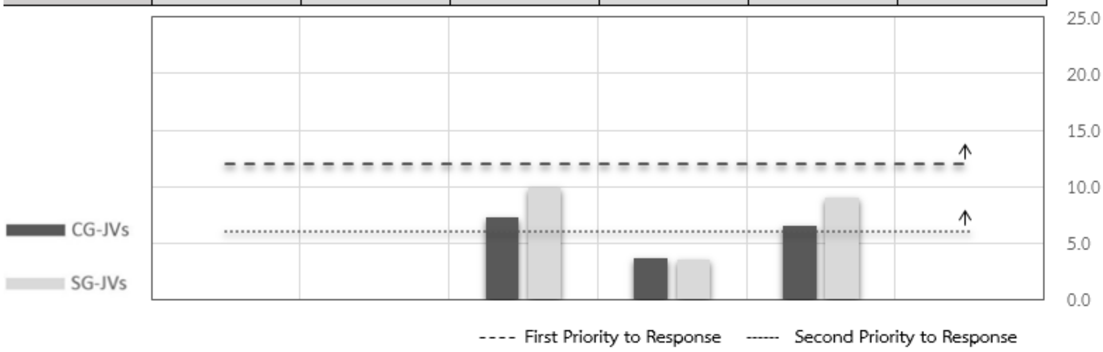


Figure 6-31 Infographic for EXT10: Fluctuation in Economic and Inflation

6.6 Summary

The objective of this chapter is to test the two hypotheses of this study. Their results would be the main assumption for the LCRM model to evaluate the risk parameter for the future interesting CJVs.

The data were done by widely distributing the questionnaires to the 34 respondents in the professional group to check their attitude, based on CJV organization structure being the CG-JV or the SG-JV, toward the risk parameters of those risks. In additional, Delphi technique were adopted as the main technique for the data collection, thus, the surveys conducted in three rounds to reduce bias of respondents and enhance reliability of the results. The analysis processes were done with many tools and techniques including the measures of central tendency, the Mann–Whitney U test and the median test

The results can be concluded as follow:

For the hypothesis 1, it is stated that “for a risk, its values of CSQ and LLH should be changes, when it is evaluated under the difference phase of CJV life cycle.”

With the trend analysis review for each risk, this hypothesis is proved that it is correct by the trend. The values of CSQ and LLH for a risk differ between phases. The values may be more or less when CJV is managed through each phase of CJV life cycle. The possible pattern may be (1) values clearly increasing at some phase of CJV life cycle, (2) values clearly decreasing at some phase of CJV life cycle, (3) values being equal through CJV life cycle and (4) values being vary through life cycle. these patterns of CSQ and LLH would be used as the assumption for the CJV risk parameter prediction process in another part of LCRMP system, namely the Multi-Determinant Risk Prediction (M-DRP) subsystem.

The detail of the hypothesis 2 is that “for a risk, its values of CSQ and LLH may be different, when it is evaluated under the difference of CJV organization structures.”

Because the data of the study are not the normal distribution, this study decided to use the methods of the nonparametric statistic including the Mann–Whitney U test and the median test. As the results, the hypothesis 2 was proved that it is correct but it is only true for the certain risks in the certain phases.

CHAPTER VII
CJV RISK DETERMINATION AND TREATMENT MODULES

This chapter presents the development of the module M3 and M4 of the Multi-Objective Risk Management (M-ORM) subsystem. The guidelines of risk criterion and risk treatment options by in-depth interviews were developed and summarized. The contractor, as the partner of construction joint ventures (CJVs) can use these guidelines to support the processes of risk management for the life cycle risk management and prediction (LCRMP) system. Moreover, the risk parameters of risks by the module M2, based on previous experience or by the module P2 of Multi-Determinant Risk Prediction (M-DRP) subsystem can be determined and treated with the guidelines.

7.1 Guidelines of Risk Criterion

There are many risk criterions to judge that what risks are the critical risks that should be responded. It can be found in many standard or textbooks. However, a contractor, as the partner of CJV, should develop their own risk criterion which is suitable for the situation of a CJV and a head firm. For this study, the guideline of risk criterion, which was developed from the in-depth interview with the professional and expert group (discussed in Section 3.3.5 and Section 3.3.6), is presented in this section.

As the results, there are two proposed guidelines of risk criterion being the risk matrix form and the score form.

7.1.1 Matrix Risk Criterion

The risk matrix which is the matrix used to present the levels of risk parameter, including consequence (CSQ) and likelihood (LLH). This is a simple structure to increase visibility of risks and assist management decision making.

Figure 7-1 illustrates the guideline of risk matrix for LCRM system. This is the result from summary of comment from the professional and expert group. It should be noted that the matrix is just the guide, so CJV partners in the future can change the criterion according to their situations.

As can be seen in the matrix, there are three priorities of risks to response.

1) The 1st priority group

The risks have the level or risk (LOR) which is plotted in the six dark grey cells as shown Figure 7-1. CJV partners have to apply immediately the risk treatment option for these factors.

Likelihood (LLH)

5	3rd Priority	2nd Priority	1st Priority	1st Priority	1st Priority
4	3rd Priority	2nd Priority	2nd Priority	1st Priority	1st Priority
3	3rd Priority	2nd Priority	2nd Priority	2nd Priority	1st Priority
2	3rd Priority	3rd Priority	3rd Priority	2nd Priority	2nd Priority
1	3rd Priority	3rd Priority	3rd Priority	3rd Priority	3rd Priority
	1	2	3	4	5

Consequnce (CSQ)

Figure 8-1 Risk Matrix for Critical Risk Judgment

2) The 2nd priority group

The risks have the level or risk (LOR) which is plotted in the eight light grey cells as shown Figure 8-1. CJV partners have to apply the risk treatment option for these factors.

3) The 3rd priority group

The risks have the level or risk (LOR) which is plotted in the eleven white cells as shown Figure 8-1. CJV partners may apply the risk treatment option for these factors. However, in the general, CJV partners ignore to do the options for these risks.

7.1.2 Score Matrix Risk Criterion

The score of LOR for risks is be considered to determine the critical risks. This format was developed because some contractors argued that three types of cells in the risk matrix have the inequality. The level of score for LOR is applied to criterion. As well, there are three priorities of risks to response.

1) The 1st priority group

The risks which have the LOR is equal or higher than 12 points. CJV partners have to apply immediately the risk treatment option for these factors.

2) The 2nd priority group

The risks which have the LOR is equal or higher than 6 points but not more than 12 points. CJV partners have to apply the risk treatment option for these factors.

3) The 3rd priority group

The risks which have the LOR is less than 6 points. CJV partners may apply the risk treatment option for these factors. However, in the general, CJV partners ignore to do the options for these risks.

The risk criterion in the format of score was adopted to the results of analyzing risk parameters in Chapter 6. The results are shown in the infographic of each risk in Figure 6-2 to Figure 6-31.

7.2 Risk Treatment Options

Risk treatment options is the one or more response actions to reduce the consequence and likelihood of the interesting risks which are mostly the critical factors. In additional, these options can be applied together at the same to increase the efficiency of risk response.

To implement these options, CJV partners have to consider many factors of the interesting CJV. To make it easier, when CJV partners decide to choose one of risk treatment options, they have to answer these questions: They are (ISO, 2009):

(1) The benefits from the options

(2) The extra resources from the options

(3) The time and schedule from the options

(4) The increase cost from the options

(5) The effects to main management of CJV

If CJV partners can accept the all answers all above questions, the risk treatment option could be applied to the CJV. For the good CJV management, all risk treatment options should be integrated with the normal management processes of CJVs. Then, they will get the attention from the staff, as well as, are treated continuously through phases of CJV life cycle. However, after adding the risk treatment options to the CJVs, the managers and/or the staff should monitor the outcomes. There is the change that the options may create new risks.

The action plans of each risk treatment option are vary. As can notice from the list of above questions. The characteristics and others constraints of each CJV directly affect to the detail of plans.

For this study, the guideline of risk treatment options for 30 risks throughout five phases of CJV life cycle presents in this section. This guideline was the results from the in-depth interview with the professional group and the expert group. The format of the guideline is presented in the format of conclusion table. The possible option for each risk are in the first column. The next five columns are the short summary of the option performance when it is applied to the phase of CJV life cycle. Figure 8-2 show the example of this short summary.

(1) Phase of CJV life cycle

It means the phase which the risk treatment option is applied to.

(a) "For." stands for the formation phase.

(b) "Bid." stands for the bidding phase.

(c) "Con." stands for the construction phase.

(d) "War." stands for the warranty phase.

(e) "Ter." stands for the termination phase.

(2) Efficiency of option

It means the level of effectiveness for reducing consequence and/or the likelihood of risk after applying the risk treatment option. This is a summary of comment from the professional and expert group. So, it can be changed in each project.

(a) "LE" stands for the low efficiency.

(b) "E" stands for the moderate efficiency.

(c) "HE" stands for the high efficiency.

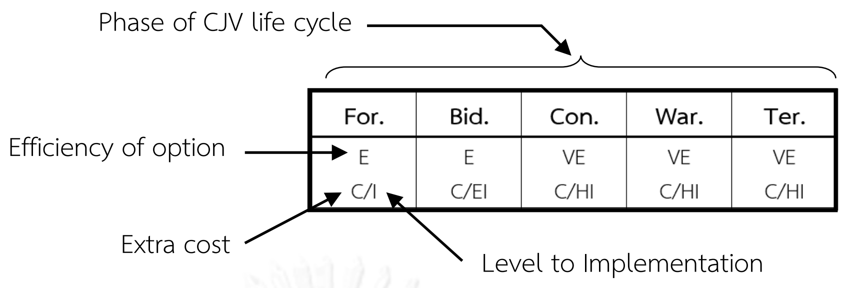


Figure 8-2 Details of Short Summary Box in the Guideline

(3) Extra cost

It means the level of cost and resource which is required after applying the risk treatment option.

(a) “LC” stands for the requiring the low cost and resource.

(b) “C” stands for the requiring the moderate cost and resource.

(c) “HC” stands for the requiring the high cost and resource.

(4) Level of implementation

It means the level of applying the risk treatment option to the CJV.

(a) “LI” stands for the option that can be implemented easily.

(b) “I” stands for the option that can be implemented moderately.

(c) “HI” stands for the option that can be implemented hardly.

As well, both “extra cost” and “level of implementation” were a summary of comment from the professional and expert group. So, it can be changed in each project.

Table 7-1 to Table 7-30 indicates the risk treatment options for each risk, sorted by the risk code and the category.

Table 7-1 Risk Treatment Options for INT01: Cash Flow Problems in Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Set the central cash pool for CJV	E C/I	E C/EI	VE C/HI	VE C/HI	VE C/HI
Extra cash from financial institutions	LE HC/I	LE HC/I	VE HC/I	VE HC/HI	E HC/HI
Extra cash from the head office	E C/I	E C/I	E C/HI	E C/HI	E C/HI

Table 7-2 Risk Treatment Options for INT02: Incompetent Construction in Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Select partners with good profile	E C/HI	-	-	-	-
Select partner which worked well together before	E LC/I	-	-	-	-
Provide the advice or assistance, as possible	E HC/HI	E HC/HI	E HC/HI	E HC/HI	E HC/HI
Prepare the special plans to support the partner	LE C/HI	LE C/HI	LE C/HI	LE C/HI	LE C/HI
Hire the project manager with high ability	E HC/I	E HC/I	LE HC/I	LE HC/I	LE HC/I
Hire staff with high ability	E C/I	E C/I	LE C/I	LE C/I	LE C/I
Hire the third parties to take the responsibility	-	-	VE HC/I	LE HC/I	-

Table 7-3 Risk Treatment Options for INT03: Changes in Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	**Bid.**	**Con.**	**War.**	**Ter.**
Select partners with good profile	E LC/HI	-	-	-	-
Inform clear requirements	E LC/I	LE LC/EI	LE LC/I	LE LC/I	LE LC/I
Set clear role and responsibility between partners	LE LC/EI	LE LC/HI	E LC/HI	E LC/HI	LE LC/HI
Report all details of the operation transparently	LE LC/EI	E C/I	E C/I	E C/I	E C/I

Table 7-4 Risk Treatment Options for INT04: Lack of Local Experience in Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	**Bid.**	**Con.**	**War.**	**Ter.**
Select partner which have the experience	VE C/I	-	-	-	-
Provide the advice or assistance, as possible	VE C/I	VE C/I	VE C/I	VE C/I	VE C/I
Prepare the plans to support the partner	LE C/I	LE C/I	LE C/I	LE C/HI	LE HC/I
Alert both the official and unofficial notices, continuously	E LC/EI	E LC/EI	E LC/EI	E LC/EI	E LC/EI

Table 7-5 Risk Treatment Options for INT05: Lack of JV Experience in Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	**Bid.**	**Con.**	**War.**	**Ter.**
Select partner which have the experience	VE C/I	-	-	-	-
Provide the advice or assistance, as possible	VE C/I	VE C/I	VE C/I	E C/I	E C/I
Prepare the plans to support the partner	LE C/I	LE C/I	LE C/I	LE C/HI	LE HC/I
Alert both the official and unofficial notices, continuously	E LC/EI	E LC/EI	LE LC/EI	LE LC/EI	LE LC/EI
Hire the project manager with high ability	E HC/EI	E HC/EI	LE HC/EI	E HC/EI	E HC/EI

Table 7-6 Risk Treatment Options for INT06: Difference on Accounting of Profit & Losses between Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Inform clear requirements	E LC/I	LE LC/I	LE LC/HI	LE LC/HI	LE LC/HI
Set clear role and responsibility between partners	LE LC/HI	E LC/HI	E LC/HI	E LC/HI	E LC/HI

Table 7-7 Risk Treatment Options for INT07: Difference on Resource Allocation between Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Inform clear requirements	E LC/I	E LC/I	E LC/HI	E LC/HI	LE LC/HI
Set clear role and responsibility between partners	LE LC/HI	E LC/HI	VE LC/HI	VE LC/HI	VE LC/HI
Track the efficiency of resource allocation	LE LC/I	E C/I	E C/I	E C/I	E C/I
Hire the project manager with high ability	LE HC/EI	E HC/EI	E HC/EI	E HC/EI	LE HC/EI

Table 7-8 Risk Treatment Options for INT08: Improper Intervention by Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Inform clear requirements	E LC/HI	E LC/HI	E LC/HI	E LC/HI	E LC/HI
Report all details of the operation transparently	E C/I	E C/I	VE C/I	VE C/I	VE C/I
Alert both the official and unofficial notices, continuously	LE LC/EI	LE LC/EI	E LC/EI	E LC/EI	E LC/EI
Select partner which worked well together before	E C/I	-	-	-	-
Set clear rules between partners	VE C/I	VE C/I	E C/I	E C/I	E C/I
Hire the project manager with high ability	E HC/EI	E HC/EI	E HC/EI	E HC/EI	E HC/EI

Table 7-9 Risk Treatment Options for INT09: Difference on Organizational Structure and Culture between Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Train staff to understand the process of CJV	LE LC/I	VE LCHI	VE LC/I	VE LC/I	E LC/I
Train staff to understand the process of other partners	E LC/HI	VE LCHI	VE LC/I	VE LC/I	E LC/I
Create the activities to make the relationships between employees	LE LC/I	LE LC/I	E LC/I	E LC/I	LE LC/I
Track and resolve the problems	E C/HI	E C/I	E C/I	E C/HI	LE C/HI
Employ staff with the experience	LE HC/EI	LE HC/EI	LE HC/EI	LE HC/EI	LE HC/EI

Table 7-10 Risk Treatment Options for INT10: Distrust between Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Train staff to understand the process of CJV	LE LC/I	E LC/I	E LC/I	E LC/I	LE LC/I
Create the activities to make the relationships between employees	-	LE C/I	LE C/I	LE C/I	LE HC/I
Set teams to support	LE C/I	LE C/I	E C/I	E C/I	LE C/I
Track and resolve the grievances of staff	VE LC/HI	VE LC/HI	VE LC/HI	VE LC/HI	VE LC/HI
Operate CJV openly and sincerely	VE C/HI	VE C/HI	VE C/HI	E C/HI	E C/HI
Employ staff with the experience	LE HC/EI	LE HC/EI	LE HC/EI	LE HC/EI	LE HC/EI
Reduce the disparity between staff of each partners	VE LC/HI	VE LC/HI	VE C/HI	VE C/HI	VE LC/HI

Table 7-11 Risk Treatment Options for INT11: Lack of Communication between Partners

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Create the activities to make the relationships between employees	-	LE LC/I	LE LC/I	LE LC/I	LE LC/I
Train staff to understand the process of CJV	LE LC/EI	LE LC/EI	E LC/EI	E LC/EI	LE LC/EI
Set teams to support the communication	VE C/I	E LC/I	E LC/I	E LC/I	E LC/I
Set the communication channel between staff	E C/I	E C/HI	VE C/HI	VE C/I	E C/I
Set the schedule meeting	VE C/EI	E LC/EI	E LC/EI	E LC/EI	E LC/EI
Employ staff with the experience	VE HC/EI	E HC/EI	LE HC/EI	LE HC/EI	LE HC/EI

Table 7-12 Risk Treatment Options for INT12: Incomplete in Venture Agreements

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Apply the agreements form other project		LE LC/EI	LE LC/EI	LE LC/EI	LE LC/EI
Review the detail in agreements		VE LC/HI	LE LC/HI	LE LC/HI	LE LC/HI
Provide the staff to operate the events		E C/I	E C/I	E C/I	E C/I
Accept the damage		LE HC/EI	LE HC/EI	LE HC/EI	LE HC/EI
Negotiate for the settlement		E C/HI	VE C/HI	E C/HI	VE C/HI
Do contractual and legal measures		E HC/I	E HC/I	E HC/I	E HC/I

Table 7-13 Risk Treatment Options for PRO01: Improper Project Planning and Budgeting

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Review the plan and the budget			VE LC/HI	VE LC/HI	
Hire the expertise staff			LE HC/I	LE HC/I	

Table 7-14 Risk Treatment Options for PRO02: Problems in Construction Techniques

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Review the techniques job requirements			VE LC/HI	VE LC/HI	
Set the special plans for the tasks			LE LC/EI	LE LC/EI	
Test the technique process before the real operation			VE HC/I	VE HC/I	
Hire the expertise staff			E HC/I	LE HC/I	
Hire the third parties to operate the tasks			E C/I	E HC/I	
Negotiate to change the techniques in tasks			E LC/HI	E LC/HI	

Table 7-15 Risk Treatment Options for PRO03: Incompetent Subcontractors and Suppliers

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Hire only parties with good experience			LE LC/I	LE LC/I	
Set fines and damages			LE LC/EI	LE LC/EI	
Prepare other parties for the emergency backup			VE C/HI	VE LC/I	
Give the advice and monitor, closely			E C/I	E C/I	

Table 7-16 Risk Treatment Options for PRO04: Problems in Contract Drawings and Specifications

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Check the integrity of the contents		VE LC/HI	E LC/I		
Provide the staff to operate the events		E LC/I	E C/I		
Alert both the official and unofficial notices, continuously		E LC/EI	LE LC/EI		
Do contractual and legal measures		E LC/HI	E C/I		
Negotiate for the settlement		-	E C/HI		

Table 7-17 Risk Treatment Options for PRO05: Problems in Construction Contracts

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Check the integrity of the contents			VE LC/HI	VE LC/HI	-
Provide the staff to operate the events			E LC/I	E LC/I	E C/I
Alert both the official and unofficial notices, continuously			LE LC/EI	LE LC/EI	LE LC/EI
Do contractual and legal measures			E C/I	E C/HI	VE HC/HI
Negotiate for the settlement			VE LC/HI	VE LC/HI	VE C/I

Table 7-18 Risk Treatment Options for PRO06: Improper Project Profit and Risk Sharing

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Decide not to join the project	VE LC/I				
Reduce costs elsewhere in order to replace the lost income.	LE C/HI				
Transfer responsibility to other parties	E HC/I				
Recognize the less profits with normal operations	LE HC/I				

Table 7-19 Risk Treatment Options for PRO07: Excessive Demands and Variation Orders

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Alert both the official and unofficial notices, continuously		VE LC/EI	LE LC/EI		
Set the mark up cost in the proportion to compensation from this damage		E LC/HI	VE LC/HI		
Provide the staff to operate the events		E LC/I	E C/I		
Change the plans to accommodate the extra tasks		LE LC/EI	LE HC/EI		
Do contractual and legal measures		-	LE C/HI		

Table 7-20 Risk Treatment Options for PRO08: Intervention and Delay by Owner or Its Representatives

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Alert both the official and unofficial notices, continuously	LE LC/EI	LE LC/I	E LC/I	LE LC/I	LE LC/I
Provide the advice or assistance, as possible	LE LC/I	LE LC/I	E LC/I	E LC/I	E LC/I
Select the owner who has a history of good project management	VE C/HI	-	-	-	-
Prepare the plans which accommodate the delays	LE LC/I	LE HC/HI	E HC/HI	E C/I	LE C/I
Provide the staff to operate the events	LE LC/EI	LE LC/EI	E LC/EI	LE LC/EI	LE LC/EI
Do contractual and legal measures	VE C/I	VE C/I	VE C/HI	E C/HI	E HC/HI

Table 7-21 Risk Treatment Options for EXT01: Differences in Social, Culture and Religions

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Create the activities to make the relationships between employees	-	LE LC/EI	VE LC/EI	E LC/EI	LE LC/EI
Employ staff with the experience with different cultures	VE HC/I	VE HC/I	VE HC/I	LE HC/I	LE HC/I
Support the communication between staff	E LC/HI	E LC/HI	VE LC/I	VE LC/I	E LC/I
Train staff to understand the difference	LE LC/EI	LE LC/EI	LE LC/EI	LE LC/EI	LE LC/EI

Table 7-22 Risk Treatment Options for EXT02: Language Barrier

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	**Bid.**	**Con.**	**War.**	**Ter.**
Train the language skill to staff	-	E C/EI	E C/EI	LE C/EI	LE C/EI
Create the activities to make the relationships between employees	-	E C/I	VE C/I	E C/I	LE C/I
Supply the translators	VE HC/I	VE HC/I	VE HC/I	E HC/I	E HC/I
Employ staff with the language skills	VE HC/HI	VE HC/HI	VE HC/I	E HC/I	E HC/I

Table 7-23 Risk Treatment Options for EXT03: Natural Disasters and Unpredictable Weather

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	**Bid.**	**Con.**	**War.**	**Ter.**
Build the temporary structure to protect the impact			E HC/HI	E C/I	
Set the mark up cost in the proportion to compensation from this damage			E LC/HI	E LC/HI	
Insure the insurance for the natural disasters			E HC/I	LE C/I	

Table 7-24 Risk Treatment Options for EXT04: Pollution

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	**Bid.**	**Con.**	**War.**	**Ter.**
Build the temporary structure to protect the impact			VE HC/I	VE C/I	
Monitor the impact			VE C/HI	E LC/I	
Communicate with society			E C/I	-	

Table 7-25 Risk Treatment Options for EXT05: Resistance from Society

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Communicate with society	E C/HI	E C/HI	VE C/HI		
Let the owner to solve the problems	VE LC/EI	VE LC/EI	E LC/EI		
Select the construction project with clear details and legally	VE LC/I	-	-		
Decide not to participate the construction project	VE LC/HI	-	-		

Table 7-26 Risk Treatment Options for EXT06: Security Problems and Social Disorder

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Build the defensive structures	-	-	LE C/I	E C/I	
Provide personnel and equipment safety	-	-	E C/EI	VE C/EI	
Budget the provision for the losses	LE HC/I	-	LE HC/I	LE HC/I	
Decide not to participate the construction project	VE LC/HI	-	-	-	

Table 7-27 Risk Treatment Options for EXT07: Inconsistency in Government Policies

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Reduce reliance on support from politicians	E LC/HI	E LC/HI	E LC/HI	E LC/HI	E LC/HI
Implement transparent procedures	VE LC/I	VE LC/I	E LC/HI	E LC/HI	E LC/HI
Select the construction project with clear details and legally	VE LC/I	-	-	-	-

Table 7-28 Risk Treatment Options for EXT08: Investment Restriction

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Find additional sources of funding from financial institutions.	E HC/I		E HC/I		-
Employ sub-contractors which is itself a partner of the CJV	-		VE C/I		-
Plan funding in accordance with the law	VE LC/I		LE HC/HI		E C/I

Table 7-29 Risk Treatment Options for EXT09: Corruption and Bribery

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Decide not to join the project	VE LC/EI	VE LC/I	-	-	-
Reduce costs elsewhere in order to replace the lost income.	-	-	LE C/HI	LE C/I	LE C/I
Transfer responsibility to other parties	-	-	E C/I	E C/I	-
Recognize the less profits with normal operations	-	-	E C/HI	E C/HI	E C/HI

Table 7-30 Risk Treatment Options for EXT10: Fluctuation in Economic and Inflation

Risk Treatment Options	Efficiency Cost / Implementation				
	For.	Bid.	Con.	War.	Ter.
Set the mark up cost in the proportion to compensation from this damage			VE LC/HI	E LC/HI	
Advance purchase of materials or equipment			E C/I	LE HC/I	
Stock materials and machine in the storage			VE HC/HI	E HC/HI	
Insure the insurance for the price risk			VE C/EI	LE C/EI	

7.3 Summary

The aims of this chapter are to provide the guideline for risk criterions to judge what the risks in each phase should be considered as the critical risks, as well as, the guideline of risk treatment options for all risks in LCRM system. To archive these aims, the results from the in-depth interviews with the professional and expert group were analyzed. For the risk criterions, there are two proposed guidelines of risk criterion being the risk matrix form and the score form.

For the matrix risk criterion guideline, it is the matrix which group risks into three priorities of risks to response. The 1st priority group is the risks which partners have to apply immediately the risk treatment option for these factors. The 2nd priority group is the risks which partners apply the risk treatment option for these factors. Finally, the 3rd priority group is the risks which partners may ignore to do the options for these risks.

For the score risk criterion guideline, it is the score of LOR for risks that be considered to determine the critical risks. The level of score for LOR is applied to criterion. As well, there are three priorities of risks to response. The 1st priority group is risks having LOR higher than 12 points. When the LOR is equal or higher than 6 points but not more than 12 points, risks are in the 2nd priority group. With LOR being less than 6 points, the 3rd priority group is denoted.

The both guidelines are the introduction information for contractors. However, a contractor, as the partner of CJV, should develop their own risk criterion which is suitable for the situation of a CJV and a head firm.

The part of the risk treatment options for 30 risks throughout five phases of CJV life cycle presents in this section. This guideline was the results from the in-depth interview with the professional group and the expert group. The format of the guideline is presented in the format of conclusion table. Each option is presented with the information about (1) phase which risk treatment option can be applied, (2) efficiency which is the effectiveness for reducing consequence and/or the likelihood applying the option, (3) cost which is the amount of resource required after applying option and (4) implementation which is level of applying the option to the CJV.

CHAPTER VIII
CJV DETERMINANT IDENTIFCATION MODULE

This chapter presents the development of the module P1 of Multi-Determinant Risk Prediction (M-DRP) subsystem as the part of the purposed life cycle risk management and prediction (LCRMP) system. The function of M-DRP subsystem is to predict the risk parameter, including consequence (CSQ) and likelihood (LLH), for all risks in all phases according to the situation of the future construction joint ventures (CJVs). The predictive process is based on the consideration of impacts and relationship by future situation, denoted by determinant. For this chapter, the assumptions of M-DRP subsystem were presented at the first part. Then, the 48 determinants were identified and analyzed in detail. The chapter also analyzed the sets of determinants, have the effect to increase or decrease risk parameter for each risk in the last part of the chapter.

8.1 Concepts of risk prediction process

The risk parameters, CSQ and LLH, for the risks which is evaluated in the chapter 6, as the part of the Multi-Objective Risk Management (M-ORM) subsystem, are the information aggregated from the opinions of professional group. These are the constant risk parameter that does not vary according to changing situations of the future CJVs.

For the part of this study, M-DRP subsystem have to predict risk parameter of risks for each phase in CJV life cycle under the effect of the CJV organization structure and the current situations of the future CJVs. To achieve this objective, it need the complex tools which can predict the value of risk parameter with the acceptable accuracy. However, due to the time constraint of the study and the limitation of the expert for participating the development process, the study have to make the decision the parts of predication. They are the part of CSQ predication and the part of LLH predication.

(1) Part of CSQ predication

With the study results analyzed in the chapter 6, it was found that the values of CSQ for all risk in five phases and for both the CG-JV and the SG-JV have the standard deviation less than 0.5. Moreover, all consensus values for these CSQ in the process of survey with the concept of the Delphi technique are totally higher than 70%. So, due to the constraints of research process, the study decided to make the assumption that when the characteristics of the CJVs are controlled with the same conditions, the CSQ are rarely change.

It mean that M-DRP subsystem would not predict the new CSQ according to changing situations of future CJVs. The CSQ for all risks in all phases, which were gotten from the study, would be used as the database form the M-ORM subsystem.

(2) Part of LLH predication

The possibility of occurrence or likelihood for the same risk in each CJVs tends to be different. This phenomenon was the result of each CJV would be always under the different determinants such as the abilities of partners, the types of civil structures, the owners, the social and the environment around the project sites. These situations can vary along the time according to their related factors. It can be said that these determinants are the variables which may increase or decrease the LLH for each risk.

Considering the results of LLH for all risk in five phases and for both the CG-JV and the SG-JV in the chapter 6, it was found that some LLH have the standard deviation more than 0.5. In additional, mostly consensus values of the Delphi method for these LLH are lower than 70%. It can be conclude that the LLH still vary, although the characteristics of the CJVs for the survey process were controlled. So, the study decide to focus on the predication of the LLH for all risks according to changing situations of each CJV project. The tool for this aim is the consideration of the relationship between desired determinants to predict the LLH. This process is called that the LLH predication by multi determinant matrix (MDM).

8.2 Identification of determinants

The contents within this section is focused on identifying of the determinants for 31 risks in LCRM system. After the in-depth interview with the expert group (discussed in Section 3.3.7), it is found that there are only 48 determinants which have enough significant implication to change the LLH for 30 risks. These determinants are categorized into ten groups based on their characteristics and how they relate to the situations of the CJVs. The list of groups are in Table 8-1

The definitions for each determinant and its group are as follow:

8.2.1 Determinants of the contractor

It is a group of determinants which relate to preparedness of contractor, as partner of CJV, from the view of the model's user as the subsystem is designed to be used with single partner. The group consists of a total of seven determinants which are as following;

Table 8-1 Groups of Determinants

Groups	Number of determinants
Determinants of the contractor	9
Determinants of the partners	10
Determinants of the cooperation	7
Determinants of the sub-parties	3
Determinants of the project policies	1
Determinants of the project characteristics	7
Determinants of the environment	4
Determinants of the owner	2
Determinants of the political factor	2
Special determinants	3
Total	48

(1) Contractor policies for JV

It is the contractor's policy for cooperation within the CJV which will affect format of cooperation and preparedness of the CJV for both organization and personnel level. Although decision making in the CJV is done by agreement from partners, it does not mean that all partners are willing to cooperate fully. With their own benefit and interest in mind, partners tend to limit level of their cooperation. The result of study shows that supporting policy tend to benefit the CJV or reduce chances of conflict. On the other hand, if the policy tends to limit cooperation, it increases the chance for other risks to occur.

(2) Contractor cash flow

It relates to readiness of evaluator's cash flow for the CJV management based on the proportion of his/her own responsibility. The cash flow within the CJV management varies among time. If the cash flow is strong, the chance that the objective has to be changed within management of risk is lower. If the ash flow is not strong, possibility of risks occurrence is higher.

(3) Contractor CJV experiences

It is experiences from working within the CJV in the past project of evaluator. The real personal experience is better for organization than knowing theories or hiring experienced personnel to arrange things. However, having real experience does not guarantee that the CJV will not have any problem at all as it is affected by several determinants. Nevertheless, the more experience Evaluator has from working in the CJV, the less likely that risks will occur.

(4) Contractor experiences in international projects

It is related to experience in the international construction projects which can be in from of working locally with foreign partners, in any position such as contractor, inspector, controller, advisor and etc. and working aboard which foreign partner is a part of project. The experiences from working with foreign partner make evaluator feels familiar with culture, attitude, and languages of people from different countries which help a great deal in adapting to work environment. From study, the more experience you have with foreign partners, the fast contractor can cooperate well with them within the CJV. It leads to reduction of impact risks.

(5) Contractor's staff with language capabilities

This topic concerns about staff's ability to communicate in foreign language within evaluator's organization. Normally it means English, which covers all skills from speaking, writing, listening and reading, which is necessary for managing CJV. When staff can communicate within foreign language well, chance for related risks to occur is reduced. If they can communicate just adequately, it increases the chance of occurrence for risk by a number. Moreover, from study, language skill for staff tends to be better along the time they work together within CJV.

(6) Contractor's staff with CJV experiences

It covers past working experience of the contractor's staffs, who will be working within evaluator's organization, within the CJV. In this study, it is focused on staff in middle and low level which separates from "Contractor Experiences" which is tied to management level. In reality, main group of people who really operate the CJV during daily operation are staff in middle and lower level. If staffs within these two levels lack experiences in the CJV, it increases the chance and impact of risks.

(7) Contractor workload

It means quantity of work in other projects which evaluators organization is responsible for. The proportion of workload is varied based on availability of resources in term of manpower, machine, and capital for CJV. It is normally found that organization with heavy workload tend to increase chance for risks to occur within CJV.

(8) Contractor construction site experiences

It relates to experiences on the area around the project sites. These experiences affect the user in term of the finding labor, supplier contact, knowledge on legal and official process, understanding local culture and norm and etc. For the CJVs with the foreigner partners, the local partner is always required to have the high level for this experience.

(9) Contractor construction experiences

It covers the capability of evaluator in term of construction and other engineering aspects when compared with work requirement set within contract. CJV usually need contractor with high capability. The more skillful evaluator is, the more likely he/she can work effectively or, in other word, chance of risks occurrence is lower.

8.2.2 Determinants of the partners

It is a group of determinants which relates to preparedness of other partners within the CJV excluding evaluator, who is using model, himself. However, the group is related to partner's organization, so there are several determinants which are similar to the previous group. The only difference between them is that this group does not include evaluator himself. This determinant group consist of a total of ten, they are;

(1) Cash flow of partners

It contains same details with "Contractor Cash Flow" for the user group but it changes from evaluation of evaluator's organization to consideration of other partner's cash flow. It is difficult to get the exact data but hints can be found on their financial documents.

(2) Policies of partners

The main details are the same with "Contractor Policies" for the user group but it changes from evaluation of evaluator to evaluation of other partner's policy which, in practical term, is quite hard to get the accurate data. However, the evaluation should have overview policies or the expectation of how other partners would lay down their policies. There are possible errors but it is the risk which has to be taken. It is almost impossible for several partners to work together without any idea of other's partner policy toward managing the CJV.

(3) Legal status of partners

It concerns legal status for doing business abroad for other partners. In Thailand, foreign companies can enter and operate in CJV within several forms such as having Branch Company in Thailand already, opening new company in Thailand or direct investment from aboard and etc. Each form differently affects project operation for Thai member and risks. From study, chance of risks occurrence is higher when foreign partner's legal status is not stable such as low registered capital, direct investment and etc.

(4) Financial status of partners

It refers to financial status of other members which directly affect stability of Mother Company. This status is very significant and should be researched from several sources since the process of picking up partners for the CJV. This data is not hard to gain especially when the mother company of other partners is a public company. To be safe, the documents you get should be proved by financial expert again to prevent fraud data. Although instability in the partner's financial status affects only a few risks but all of them have severe affect toward the CJV.

(5) Past performance of partners

It means past performance which similar to current the CJV from other partners. It is one of the factors which the user has to evaluate since the partner selection process. This data must be collected although it is not 100% accurate as the partners may try to cover or edit some information to look better than reality. From study, the pairing members within the CJV usually occur among partners with poor past performance but the user has no choice because they need alliance due to political and business aspect. It increases chances of risk occurrence and greatly affects the CJV's management.

(6) Local experiences of partner

It relates to local experiences for other partners which directly affect efficiency of construction operation in many aspect such as finding labor, supplier contact, knowledge on legal and official process, understanding local culture and norm and etc. Although they have good work history within other countries, it does not guarantee that they can surely operate well within the local environment because the several factors are different within each country. They need hand-on experiences to be able to understand. It is certain that the more experience partner has on working locally, the less chance of risk to occur which is beneficial to the CJV.

(7) Workload of partners

Its detail is similar to "Contractor workload" in the user group but it changes from considering evaluator's organization to considering other partners' organization. The information can be found via several documents and should be done since picking up partners in CJV. However, some partners may try to hide some information from you.

(8) CJV experiences of partners

It has same details with "Contractor JV Experiences" in the user group but it changes from consideration of evaluator's organization to consideration of other partners' experience in the CJV. It is not a difficult task to get this data and it should be done since the process of picking partners.

(9) Language capabilities in staff of partners

It covers same detail with "Contractor staff with language capabilities" in the user group but it change from considering evaluator own organization to consider other partner's instead. It is an easy task and must be done during qualification screen process while picking up partners.

(10) CJV experiences in staff of partners

It has similar details with "Contractor staff with JV experiences" in the contractor group but change from considering own organization to considering other's partner instead. It looks easy but data tends to have some discrepancy because evaluator rarely knows the staffs which partners send to work in the CJV.

8.2.3 Determinants of the cooperation

It is a group of determinants which relates to status of the partner cooperation within the CJV. Each CJV has its own characteristic based on its elements which are developed by the partners by that time. From study, there are seven sources within this source group, which are;

(1) Specializations among partners

It refers to specializations among partners within the CJV whether they are specialized in the same function or not. From study, if the partners are specialized in the same aspect of work, their requirement of work within CJV can be overlapped. For example, if all partners are specialized in contractors, they may want to work on the same operation. When it happens, it leads to higher chance of risk occurrence related to conflict. On the opposite, if partners are specialized in different functions such as contractor with supplier, machine installer, financial institutes, research company, advisor and etc. The chance of risk to occur from overlapped work will be lowered or disappear as specialization in partner allow them to work well in their own function.

(2) Diversity in JV

It refers to diversity in nationality of personnel who work together within the CJV. The more diversity they are, the complicated operation it is. In other words, chance of risk, related to language and culture, to occur is high. Nowadays, this issue has become even more complicated as hiring people has been more open. For example, the CJV which consists of Thais and Japanese partners does not employ just Thais and Japanese, there are people from China, Taiwan, Singapore, British, Laotian and etc. working under the same project.

(3) Partnership between partners

This topic is about relationship among the partners from the past till today. From study, the better relationship and trust partners have among each other, the easier and faster it is when they have to negotiate on any problem which, in the end, helps reduce chances of risk.

(4) Relationship with owner

It refers to relationship between all partners and owner. It need to look on relationship of every partner toward member because if there is even one partner who has bad relationship, other partners tend to share disadvantages as all of them are under the same CJV. The better relationship partners have with owner, the easier and faster negotiation for any issues can be settled. It helps reduce the possibility for risk, regarding to owner operation, to occur.

(5) Relationship with owner representatives

It concerns about every partner's relationship toward the project owner and its representative. Each of them has to be examined separately as if there is even one of partner who have poor relationship with the owner and/or its representative, it usually bring problems to other members too as they are operating within the same CJV.

Normally, the CJV tends to be mega project and consists of several owner representatives. Most of operations are required to get approval from these representatives. Even though the partners have a very strong relationship with the owner, it can still be bad if their relationship with any of owner's representative is not good. It will increase the chance of risk to occur.

(6) Relationship with government

It is about relationship of all partners with government which can be government officer, representative of government sector or even politician. Although the CJV operation, especially construction contract, is done between the partners and the owner, when the owner is government, it is still under controlled by higher government body. Many of decisions are required to be approved by higher up officers. If they do not have strong relationship with government, it also increases the risk to face with related risk.

(7) CJV experiences in staff at management-level

It means capability of the personnel who work in management level of the CJV which bring together the partners and other key function within the CJV which most of them are complicated and requires lot of work. If people who work here have no experience from the CJV, they tend to create a lot of mistakes and errors.

8.2.4 Determinants of the sub-parties

It is a group of determinants which relates to the sub-parties of the CJVs which the partners cannot fully control but they are still significant or management of the CJV. It mainly consists of the subcontractors and the suppliers. For the CJVs, there are a large number of those sub-parties as quantity of work usually contradict with time available. There are three determinants within this group, they are;

(1) Performance of subcontractor

It relates to performance of subcontractors of the CJV in term of capability to work, quality of work, punctuality. Although the subcontractors come from one of partners or the familiar with other partners, it does not guarantee that subcontractors will have great performance like they used to do in the past. They can be overloaded with work, lack of knowledge on technology used or even working with the CJV which has different management system than the one they used to work with. That is why subcontractor should be inspected in term of finance, experience, resources on hand and etc. which all of them have direct impact toward possibility of risk's occurrence.

(2) Performance of suppliers

It concerns about past performance of the suppliers in term of finding required materials in time. Like as the subcontractors, the partners should pick supplier who are familiar with them. However, as the CJV always requires large amount of materials, which some of them may be unique, they sometimes have to work with new supplier who does not have any past work experience and lead to higher chance of risk occurring.

(3) Type of subcontractor

It concerns about who the subcontractors are and whether they have worked with the CJV before. From study, the subcontractors within some the CJV are the partners themselves. If the subcontractors come from the partner within the CJV, the risk from these subcontractors is lower but if they hire the subcontractors from outside, the partners need to consider whether they have past work experience. If they used to work together, they have more reliability but if they do not, the chance of risks to occur is higher.

8.2.5 Determinants of the project policies

It is a group of determinants related to policy and management plan within the CJV which usually be set up by agreement from every partners. Normally, they policies and management plans are usually set up during process of the signing of the joint venture agreement (JVA). This group consists of only one determinant which is as following;

(1) Policies for environment and pollution

It relates to how the project plans to manage environment and pollution toward the nearby areas. If the effective plan is prepared, the chance of risk occurrence related to the environment may be lowered. On the opposite, if there is no solid plan set in advance, the risks may occur a lot.

8.2.6 Determinants of the project characteristics

It is a group of determinants which relate to internal status within the construction project which the CJV is operating in. All determinants are the result from the owner's operation which the partners can rarely change anything but have to take burden from them. This group consists of a total of seven determinants, they are;

(1) Characteristic of project cash flow

It concerns about the quantity of work and the predicted cash flow within the project which each project has its own characteristic. For the project which has a large gap between income and expenses, the pay out more than take in, the partners need to reserve more cash on hand to make sure that the project can continue without interruption. The consideration of project's cash flow during the start of construction and the real operation are always different. That is why the user has to consider in advance how much different it can be from the expected plan.

(2) Level of project preparation

It means the readiness of information on several aspects within the construction project such as the possible work scope, the specification model, the construction site, the expropriation, the public awareness and etc. All of those information comes from the preparation and operation of the owner. The better project prepares with necessary data, the less chance it has for error and opposition. As a result, the chance of risk's occurrence can be reduced.

(3) Type of structures

It relates to how challenging the structure within project is. There are many times that structure is not designed with the problem during construction in mind. When the structure is designed in unique shape, the partners may find it become a very serious problems during the construction phase. It is the essential that the partners need to evaluate how easy or difficult the project is in order to figure out related the risks which may occur.

(4) Type of technology

It is about the types of technology used within the project and how advance it is. If the technology is so advance that the partners or the designers are not familiar with, implementing that technology during the construction phase may lead to the unexpected problems and increase possibility of the risks occurring. However, if the technology is too old, it can lead to several problems too.

(5) EIA & EHIA status

This source concerns about laws relating to impact toward the environment from the construction project. Most of the CJV tends to be the mega project which cannot avoid the affecting social and environment. If the project can pass the EIA &EHIA status, the chance of risks occurrence during the construction phase should be lower or none at all. However, there are several times that projects, which passed the EIA & EHIA, are opposed due to the problems during the project's study period or they are not accepted by the related parties.

(6) Level of health and environment effects

For this source, it considers about how much the impact construction project may have on the environment during the construction phase. There are several of possible impact such as noise, dust, vibration, hygiene, area blockage, area access and etc. The more impact it has toward the environment, the more related risks to occur especially when it is certain that these impacts are unavoidable and continuous.

(7) Sensitivity of project to disaster

It concerns about considering how much the damage structures within project can take if there is any natural disaster occur, although within this study, it is focused mainly on flooding. The different types of structure have different kind of damage. In short, the underground structure tends to take most damage while the structure higher up tends to be damaged less.

8.2.7 Determinants of the environment

It is a group of determinants which relates to the environment surrounding the construction sites and the public attitude towards the project itself. Although they are not directly related to the CJV management, they lead to other problems which may result in holding the project. From study, there are a total of four determinants, they are;

(1) Environment of project sites

This determinant refers to considering of the environment around the project sites which are nearby buildings, roads, rivers, landscape or other natural areas. If there are a lot of these things around the construction sites, possibility of relating risk occurrence is also higher and it is likely to have impact on the project.

(2) Disaster of project sites

This determinant covers about past record of the flooding or other natural disaster for the construction sites. If there are disasters occurred in the past, how serious and how often it is. The data from here can be used to consider the chances of related risks occurrence. This kind of information is easy to gather but it is hard to accurately forecast as it may or may not happen again.

(3) Previous landowners of project sites

It concerns about the owner of the land which the project will be operated on. If it belongs to the owner completely, the construction tends to progress smoothly but if it is still belong to other parties or even trespassing, the construction may be delayed due to the problems about the expropriation or the rejection to move out.

(4) Public attitudes towards project

This topic refers to the public attitudes towards the project. If the project gain acceptance or support, operation can progress smoothly without interruption. On the other hand, if there are opposing parties, the project may have to be on halt in the several processes due to the impact from the opposing parties.

8.2.8 Determinants of the owner

It is a group of determinants which relates to readiness of the owner which have very strong impact toward the operation of the CJVs. From study, there are two determinants, which are;

(1) CJV experiences in owner

It refers to the past experiences of the owner for working with the CJV. From study, it is found that the owner who has no experience with hiring the contractors in form of the CJV tends to make several mistakes. The risks relating to the CJV operation can come in form of documents, contracts, payment or even operation.

(2) Performance of owner & representatives

It refers to ability to function among several parts within the project which requires operation from the owner and its representatives such as the approving documents, the considering documents, the co-operation. If the owner and its representatives do not help much, the chance for the risks to occur is also higher.

8.2.9 Determinants of the political

It is a group of determinants which relates to the political situation and the stability which indirectly affects the operation of the CJVs. From study, there are two determinants, which are;

(1) Status of government

It refers to stability of the government which affects changing in person in charge of the important political position or the policies. Instability in the government results in changes in the owner's legal, the efficiency among governmental sector which can be both good and bad toward the CJV.

(2) Political issues

It means consideration of political conflict between the parties with opposing opinion. If the conflict is in serious situation, it is likely to create political changes or social crisis which affects the CJV management.

8.2.10 Special determinants

For this group, it is different from other group because their characteristic in the MDM are unique. Three special determinants are;

(1) Type of CJV organization structure

Not like other determinants, the relationship of this determinant with risks would be based on the results of the hypothesis No.2 in Chapter 6.

(2) Corruption and bribery

It is the difficult determinant to predict. It can happen immediately or disappear by uncontrolled factors.

(3) Fluctuation in economic and inflation

After discussing with the expert group, it leaded to the conclusion that this feature of LCRM system would not be used to evaluate the LLH of this risk. The LLH for factors would be inputted directly instead of predication by the MDM because the LLH of these risk is require the complicated model to predict due to the large number of sources and their changing nature. Normally, the contractors have their financial model or their own custom-made model to help predicting these LLH.

8.3 Set of Determinants

With in-depth literature review and interview with expert group, it was found that each determinant has different characteristic to effect LLH increase or decrease. Table 8-2 presents the overall relationship between 48 determinants and 30 risks which are the results from the discussion with the expert group with the concept of Delphi technique.

As can be seen in the table, the number of determinants for each risk are not equal. The risks, such as INT 03: Changes in partners, EXT02: Language barrier and etc. have seven determinants for its own set which is the maximum numbers. For the least, there is only determinant in the set of some risk including EXT09: corruption and bribery or EXT11: fluctuation in economic and inflation. On the other hand, the determinant named “Contractor policies for JV” affect the LLH of six risks, while the determinant named “Status of government” affect LLH of only risk. Table 8-3 to Table 8-32 show the conclusion of set of determinants for each risk.

Table 8-2 Relationship between Determinants and Risks

No	Determinants	INT01	INT02	INT03	INT04	INT05	INT06	INT07	INT08	INT09	INT10	INT11	INT12	PRO01	PRO02	PRO03	PRO04	PRO05	PRO06	PRO07	PRO08	EXT01	EXT02	EXT03	EXT04	EXT05	EXT06	EXT07	EXT08	EXT09	EXT10
1	Contractor policies for JV			X			X	X	X				X																X		
2	Contractor cash flow	X	X																												
3	Contractor JV experiences			X	X	X	X		X		X		X																		
4	Contractor experiences in international project									X												X	X								
5	Contractor staff with language capabilities																						X								
6	Contractor staff with JV experiences					X					X	X																			
7	Contractor workload	X	X																												
8	Contractor consturction site experiences				X											X								X	X						
9	Contractor consturction experiences		X											X	X																
10	Cash flow of partners	X	X																												
11	Policies of partners			X			X	X	X				X																X		
12	Legal status of partners			X																											
13	Financial status of partners			X																											
14	Past performance of partners		X											X	X																
15	Local experiences of partners				X					X						X						X	X				X				
16	Workload of partners	X	X																												
17	JV experiences of partners			X	X	X	X		X		X		X																		
18	Language capabilities in staff of partners																						X								
19	JV experiences in staff of partners					X					X	X																			
20	Specializations among partners							X	X																						
21	Diversity in JV						X			X	X	X										X	X								
22	Partnership between partners			X		X	X	X	X	X	X	X	X									X	X								
23	Relationship with owner																				X										
24	Relationship with owner representatives																				X										
25	Relationship with government																				X							X	X		
26	JV experiences in staff at management-level					X						X																			
27	Policies for environment and pollution																								X						
28	Performance of subcontractor															X											X				
29	Performance of suppliers															X															
30	Type of subcontractor															X															
31	Characteristic of project cash flow	X																										X			
32	Level of project preparation														X		X	X	X	X	X					X		X			
33	Type of structures													X	X		X			X											
34	Type of technology													X	X	X	X			X											
35	EIA & EHIA status																		X							X	X				
36	Level of health and environment effects																								X						
37	Sensitivity of project to disaster																							X							
38	Environment of project sites																								X	X					
39	Disaster of project sites																							X							
40	Previous landowners of project sites																									X	X				
41	Public attitudes towards project																		X	X						X					
42	JV experiences in owner																	X													
43	Performance of owner & representatives													X			X	X		X	X										
44	Status of government																												X		
45	Political issues																		X												
46	Type of JV organization structure							X	X			X										X	X								
47	Corruption and bribery																		X											X	
48	Fluctuation in economic and inflation																														X

Table 8-3 Set of Determinants for INT01: Cash Flow Problems in Partners

No.	Determinants
1	Characteristic of project cash flow
2	Contractor cash flow
3	Cash flow of partners
4	Contractor workload
5	Workload of partners

Table 8-4 Set of Determinants for INT02: Incompetent Construction in Partners

No.	Determinants
1	Past performance of partners
2	Contractor construction experiences
3	Contractor cash flow
4	Cash flow of partners
5	Workload of partners
6	Contractor workload

Table 8-5 Set of Determinants for INT03: Changes in Partners

No.	Determinants
1	Legal status of partners
2	Financial status of partners
3	Contractor JV experiences
4	JV experiences of partners
5	Partnership between partners
6	Contractor policies for JV
7	Policies of partners

Table 8-6 Set of Determinants for INT04: Lack of Local Experience in Partners

No.	Determinants
1	JV experiences of partners
2	Local experiences of partners
3	Contractor JV experiences
4	Contractor construction site experiences

Table 8-7 Set of Determinants for INT05: Lack of JV Experience in Partners

No.	Determinants
1	Contractor staff with JV experiences
2	JV experiences in staff of partners
3	Contractor JV experiences
4	JV experiences of partners
5	JV experiences in staff at management-level
6	Partnership between partners

Table 8-8 Set of Determinants for INT06: Difference on Accounting of Profit & Losses between Partners

No.	Determinants
1	JV experiences of partners
2	Contractor JV experiences
3	Contractor policies for JV
4	Policies of partners
5	Partnership between partners
6	Diversity in JV

Table 8-9 Set of Determinants for INT07: Difference on Resource Allocation between Partners

No.	Determinants
1	Specializations among partners
2	Contractor policies for JV
3	Policies of partners
4	Type of JV organization structure
5	Partnership between partners

Table 8-10 Set of Determinants for INT08: Improper Intervention by Partners

No.	Determinants
1	Contractor JV experiences
2	JV experiences of partners
3	Partnership between partners
4	Contractor policies for JV
5	Policies of partners
6	Type of JV organization structure**
7	Diversity in JV

Note ** This determinant affects LLH of "INT08: Improper Intervention by Partners" in four phases of CJV life cycle except the formation phase, as the results from the second hypothesis test in the Chapter 6.

Table 8-11 Set of Determinants for INT09: Difference on Organizational Structure and Culture between Partners

No.	Determinants
1	Diversity in JV
2	Partnership between partners
3	Contractor experiences in international project
4	Local experiences of partners

Table 8-12 Set of Determinants for INT10: Distrust between Partners

No.	Determinants
1	Partnership between partners
2	JV experiences of partners
3	Contractor JV experiences
4	Contractor staff with JV experiences
5	JV experiences in staff of partners
6	Diversity in JV

Table 8-13 Set of Determinants for INT11: Lack of Communication between Partners

No.	Determinants
1	Partnership between partners
2	Contractor staff with JV experiences
3	JV experiences in staff of partners
4	Diversity in JV
5	JV experiences in staff at management-level
6	Type of JV organization structure

Table 8-14 Set of Determinants for INT12: Incomplete in Venture Agreements

No.	Determinants
1	Contractor JV experiences
2	JV experiences of partners
3	Partnership between partners
4	Contractor policies for JV
5	Policies of partners

Table 8-15 Set of Determinants for PRO01: Improper Project Planning and Budgeting

No.	Determinants
1	Contractor construction experiences
2	Type of technology
3	Type of structures
4	Past performance of partners
5	Performance of owner & representatives

Table 8-16 Set of Determinants for PRO02: Problems in Construction Techniques

No.	Determinants
1	Level of project preparation
2	Contractor construction experiences
3	Type of technology
4	Type of structures
5	Past performance of partners

Table 8-17 Set of Determinants for PRO03: Incompetent Subcontractors and Suppliers

No.	Determinants
1	Performance of subcontractor
2	Performance of suppliers
3	Type of subcontractor
4	Type of technology
5	Contractor construction site experiences
6	Local experiences of partners

Table 8-18 Set of Determinants for PRO04: Problems in Contract Drawings and Specifications

No.	Determinants
1	Performance of owner & representatives
2	Type of technology
3	Type of structures
4	Level of project preparation

Table 8-19 Set of Determinants for PRO05: Problems in Construction Contracts

No.	Determinants
1	JV experiences in owner
2	Performance of owner & representatives
3	Level of project preparation

Table 8-20 Set of Determinants for PRO06: Improper Project Profit and Risk Sharing

No.	Determinants
1	Level of project preparation
2	Political issues
3	EIA & EHIA status
4	Public attitudes towards project
5	Corruption and bribery

Table 8-21 Set of Determinants for PRO07: Excessive Demands and Variation Orders

No.	Determinants
1	Level of project preparation
2	Type of technology
3	Type of structures
4	Performance of owner & representatives
5	Public attitudes towards project

Table 8-22 Set of Determinants for PRO08: Intervention and Delay by Owner or Its Representatives

No.	Determinants
1	Relationship with owner
2	Relationship with owner representatives
3	Level of project preparation
4	Performance of owner & representatives
5	Relationship with government

Table 8-23 Set of Determinants for EXT01: Differences in Social, Culture and Religions

No.	Determinants
1	Diversity in JV
2	Contractor experiences in international project
3	Local experiences of partners
4	Partnership between partners
5	Type of JV organization structure**

Note ** This determinant affects LLH of "EXT01: Differences in Social, Culture and Religions" in only the construction phases of CJV life cycle, as the results from the second hypothesis test in the Chapter 6.

Table 8-24 Set of Determinants for EXT02: Language Barrier

No.	Determinants
1	Diversity in JV
2	Contractor staff with language capabilities
3	Language capabilities in staff of partners
4	Partnership between partners
5	Contractor experiences in international project
6	Local experiences of partners
7	Type of JV organization structure**

Note ** This determinant affects LLH of "EXT02: Language Barrier" in only the construction phases of CJV life cycle, as the results from the second hypothesis test in the Chapter 6.

Table 8-25 Set of Determinants for EXT03: Natural Disasters and Unpredictable Weather

No.	Determinants
1	Disaster of project sites
2	Sensitivity of project to disaster
3	Contractor construction site experiences

Table 8-26 Set of Determinants for EXT04: Pollution

No.	Determinants
1	Environment of project sites
2	Level of health and environment effects
3	Policies for environment and pollution
4	Contractor construction site experiences

Table 8-27 Set of Determinants for EXT05: Resistance from Society

No.	Determinants
1	EIA & EHIA status
2	Public attitudes towards project
3	Previous landowners of project sites
4	Environment of project sites
5	Level of project preparation

Table 8-28 Set of Determinants for EXT06: Security Problems and Social Disorder

No.	Determinants
1	Local experiences of partners
2	EIA & EHIA status
3	Performance of subcontractor
4	Previous landowners of project sites

Table 8-29 Set of Determinants for EXT07: Inconsistency in Government Policies

No.	Determinants
1	Relationship with government
2	Status of government
3	Political issues

Table 8-30 Set of Determinants for EXT08: Investment Restriction

No.	Determinants
1	Relationship with government
2	Status of government
3	Contractor policies for JV
4	Policies of partners

Table 8-31 Set of Determinants for EXT09: Corruption and Bribery

No.	Determinants
1	Corruption and bribery

Table 8-32 Set of Determinants for EXT10: Fluctuation in Economic and Inflation

No.	Determinants
1	Fluctuation in economic and inflation

8.4 Summary

To predict risk parameter, being CSQ and LLH, for all risks in all phases according to the situation of the future CJVs, the LCRMP system has the specific function, namely Multi-Determinant Risk Prediction (M-DRP) subsystem.

However, due to the time constraint of the study and the limitation of the expert for participating the development process, the study have to make the assumption for the predication process in this subsystem. As the results of CJV risk evaluation in the Chapter 6, it was found that when the characteristics of the CJVs are controlled with the same conditions, the CSQ are rarely change. So, M-DRP subsystem would not predict the new CSQ but the subsystem would be used as the CSQ database form the M-ORM subsystem. On the other hand, it can be conclude that the LLH still vary, although the characteristics of the CJVs for the survey process were controlled. So, the study decide to focus on the predication of the LLH for all risks according to changing situations of each CJV project.

Because the prediction process in M-DRP subsystem is based on the consideration of impacts and relationship by future situation, denoted by determinant, the identification of determinants for CJVs had to done as the first step. With the in-depth literature review and the in-depth interview with the expert group, it is found that there are 48 determinants which have enough significant implication to change the LLH for 30 risks. These determinants are categorized into ten groups based on their characteristics and how they relate to the situations of the CJVs. They are (1) determinants of the contractor, (2) determinants of the partners, (3) determinants of the cooperation, (4) determinants of the sub-parties, (5) determinants of the project policies, (6) determinants of the project characteristics, (7) determinants of the environment, (8) determinants of the owner, (9) determinants of the political factor, and (10) special determinants.

After the definitions of all determinants were explored, it was found that each determinant has different characteristic to effect LLH of each risk to increase or decrease. Moreover, the number of determinants for each risk are not equal. So, the sets of determinants for 30 risks were developed.

CHAPTER IX
CJV RISK PARAMETER PREDICTION MODULE

This chapter presents the development of the module P2 of the Multi-Determinant Risk Prediction (M-DRP) subsystem. The module is about the predictive function for assessing the consequence (CSQ) and likelihood (LLH) of the future construction joint ventures (CJVs). The weight of determinants in each multi determinant matrix (MDM) for each risk were evaluated by concept of the analytic hierarchy process (AHP) in detail. In addition, the whole process to predict the risk parameter was developed and presented

9.1 Multi Determinant Matrix

The set of determinant is the group of determinants affecting on LLH of a risk to increase or decrease, as discussed in Section 8.3. When considering the relationship of determinants in a set, it is possible that some determinants may have more affect to LLH of a risk than other determinants. This is called the prioritized weights between determinants. To find these weights, the concept of the analytic hierarchy process (AHP) was be applied. The pairwise comparison process of AHP was used as the tool to find the prioritized weights.

With the pairwise comparison process of AHP, each set of determinant for a risk was changed into the format of multi determinants matrix (MDM). As the results, there are 33 MDMs with the respect to the LLH for 30 risks. The extra three MDMs were the results of the hypothesis 2 testing. It was found that the LLH of three risks are affected by types of CJV organization structure. However, the effects does not happen in every phases of CJV life cycle. So, each of these risks had to have two MDMs, one MDM with the determinant named “Type of CJV organization structure” and one MDM without this determinant.

Figure 9-1 illustrates the example of MDM for the risk named “INT11: Lack of communication”.

LLH	Partnership between partners	Your staff with JV experiences	JV experiences in staff of partners	Diversity in JV	JV experiences in staff at management-level	Type of JV organization structure
Partnership between partners						
Your staff with JV experiences						
JV experiences in staff of partners						
Diversity in JV						
JV experiences in staff at management-level						
Type of JV organization structure						

Figure 9-1 MDM for INT11: Lack of Communication

9.2 Prioritized Weights

The principle of the pairwise comparison as the part of AHP was used as the tool for the computation prioritized weight of determinants in MDMs. To get these values, the expert group was asked to make the comparison by using the nine point scale of numbers (discussed in Section 3.3.8). For the study, the computation processes of pairwise comparison were set into the format of tables instead the normal description, used in many previous studies.

9.2.1 Development by AHP

The detail of pairwise comparison process and its example was presented together as follow:

The "INT10: Distrust between partners" was selected for this demonstration.

Step 1 : Prepare the main matrix for this risk factor by concluding the score of comparison between each determinant for the risk factor.

These score are the results from the survey with the expert group. All of scores were aggregate between the experts by the process of the Delphi method. Table 9-1 shows the first draft of the main matrix for INT10.

Step 2 : Compute the total score for each column of the main matrix. These total scores are denoted as *"m.Total$_x$"*, when x is the order of columns.

The 7th row of the main matrix as shown in Figure 9-2 is the row for the total score.

The sample of the calculation in this step is:

For the 6th column,

$Total_6$ = 4.00 + 5.00 + 4.00 + 3.00 + 1.00 + 1.00 = 18.00

		1	2	3	4	5	6
	LLH	Partnership between partners	JV experiences of partners	Your JV experiences	Your staff with JV experiences	JV experiences in staff of	Diversity in JV
1	Partnership between partners	1.00	2.00	2.00	3.00	3.00	4.00
2	JV experiences of partners	1.00	1.00	1.00	2.00	2.00	5.00
3	Your JV experiences	1.00	1.00	1.00	2.00	2.00	4.00
4	Your staff with JV experiences	0.50	0.50	0.50	1.00	1.00	3.00
5	JV experiences in staff of	0.50	0.50	0.50	1.00	1.00	1.00
6	Diversity in JV	0.25	0.20	0.25	0.33	1.00	1.00
7	Total	4.25	5.20	5.25	9.33	10.00	18.00

Figure 9-2 Main Matrix with Respect to LLH for INT10

Step 3 : Create "the support matrix".

The format of this matrix is based on the format of the main matrix in step 1 with more three columns on the left side as shown in Figure 9-3. The cells in the new columns is called that "the add cells", while the cell in the original columns are denoted as "the main cells". However, at this step, all values in all cells of the support matrix still blank.

Step 4 : Compute the value for the main cells in the support matrix by the equation 9.1

$$s.Cell_{xy} = \frac{m.Cell_{xy}}{m.Total_x} \tag{9.1}$$

Where $s.Cell_{xy}$ = the value of the main cell in the support matrix at the intersection with the column x and the row y

$m.Cell_{xy}$ = the value of the cell in the main matrix at the intersection with the column x and the row y

$m.Total_x$ = the total value of column x in the main matrix

The main cell values for INT10: Distrust between partners, computed by the equation 9.1, were indicated in Figure 9-3.

The samples of the calculation in this step are:

$s.Cell_{11}$ = 1.00 / 4.25 = 0.24

$s.Cell_{61}$ = 4.00 / 18.00 = 0.22

$s.Cell_{34}$ = 0.50 / 5.25 = 0.10

	1	2	3	4	5	6	7	8	9
	Partnership between partners	JV experiences of partners	Your JV experiences	Your staff with JV experiences	JV experiences in staff of	Diversity in JV	Summary	Weight	consistency measure
1 Partnership between partners	0.24	0.38	0.38	0.32	0.30	0.22			
2 JV experiences of partners	0.24	0.19	0.19	0.21	0.20	0.28			
3 Your JV experiences	0.24	0.19	0.19	0.21	0.20	0.22			
4 Your staff with JV experiences	0.12	0.10	0.10	0.11	0.10	0.17			
5 JV experiences in staff of	0.12	0.10	0.10	0.11	0.10	0.06			
6 Diversity in JV	0.06	0.04	0.05	0.04	0.10	0.06			
7 Total	1.00	1.00	1.00	1.00	1.00	1.00			

Figure 9-3 Support Matrix and Value of Main cells

To check the accuracy of the computation by the equation 9.1, the total value for each column in the support matrix, denoted as *"$s.Total_x$"*, have to be always 1.00.

As can be seen in Figure 9-3., the values of $s.Total_1$ to $s.Total_6$ were 1.00.

Step 5 : Compute the value for the Summary column (7th column) by the equation 9.2

$$Sum_{7y} = \sum_{x=1}^{n} s.Cell_{xy} \qquad (9.2)$$

Where Sum_{7y} = the value of the cell in the summary column at the row y

n = the maximum number of determinants for the considering factors or the total column of the main matrix

The results of the summary column for INT10 were indicated in Figure 9-4. The sample of the calculation in this step is:

Sum_{72} = 0.24 + 0.19 + 0.19 + 0.21 + 0.20 + 0.28 = 1.31

Step 6 : Compute the value for the weight column (8th column) by the equation 9.3

$$Weight_{8y} = \frac{Sum_{7y}}{n} \tag{9.3}$$

Where $Weight_{8y}$ = the value of the cell in the average column at the row y

The results of the average column for INT10 were indicated in Figure 9-4. The samples of the calculation in this step are:

Avg_{82} = 1.31 / 6 = 0.22

Avg_{85} = 0.57 / 6 = 0.10

To check the accuracy of the computation by the equation 9.3, the total value for the weight column have to be always 1.00.

Step 7 : Compute the value for the consistency measure column (9th column) by the equation 9.4

$$CM_{9y} = \frac{1}{Weight_{8y}} \times \sum_{x=1}^{n} \left(m.Cell_{xy} \times Weight_{8x} \right) \tag{9.4}$$

		1	2	3	4	5	6	7	8	9
		Partnership between partners	JV experiences of partners	Your JV experiences	Your staff with JV experiences	JV experiences in staff of	Diversity in JV	Total	Weight	consistency measure
1	Partnership between partners	0.24	0.38	0.38	0.32	0.30	0.22	1.84	0.31	6.55
2	JV experiences of partners	0.24	0.19	0.19	0.21	0.20	0.28	1.31	0.22	6.56
3	Your JV experiences	0.24	0.19	0.19	0.21	0.20	0.22	1.25	0.21	6.59
4	Your staff with JV experiences	0.12	0.10	0.10	0.11	0.10	0.17	0.68	0.11	6.54
5	JV experiences in staff of	0.12	0.10	0.10	0.11	0.10	0.06	0.57	0.10	6.64
6	Diversity in JV	0.06	0.04	0.05	0.04	0.10	0.06	0.34	0.06	6.46
7	Total	1.00	1.00	1.00	1.00	1.00	1.00		1.00	

Figure 9-4 Detailed Support Matrix of INT10

Where CM_{9y} = the value of the cell in the consistency measure column at the row y

The results of the consistency measure column for INT10 were indicated in Figure 9-4.. The sample of the calculation in this step is:

$$CM_{91} = (1/0.31) \times [(0.24 \times 0.31) + (0.38 \times 0.22) + (0.38 \times 0.21) + (0.32\times 0.11) + (0.30 \times 0.10) + (0.22 \times 0.60)]$$

$$= 6.55$$

$$CM_{94} = (1/0.31) \times [(0.24 \times 0.31) + (0.38 \times 0.22) + (0.38 \times 0.21) + (0.32\times 0.11) + (0.30 \times 0.10) + (0.22 \times 0.60)]$$

$$= 6.54$$

All above process in the study was done by the Microsoft Excel with the functions which are developed specifically for this study, as shown in Figure 9-5.

9.2.2 Weights of Multi Determinant Matrixes

The prioritized weight of the sets of determinants were developed through the process of pairwise comparison as described in the previous sections. The results of weight for 33 MDMs of 30 risks factors are indicated in Table 9-1 to Table 9-33.

Factor	EIA & EHIA status	Public attitudes towards project	Previous landowners of project sites	Environment of project sites	Level of project preparation
EIA & EHIA status	1.00	3.00	2.00	2.00	0.50
Public attitudes towards project	0.33	1.00	0.50	0.50	0.33
Previous landowners of project sites	0.50	2.00	1.00	2.00	1.00
Environment of project sites	0.50	3.00	0.50	1.00	1.00
Level of project preparation	2.00	3.00	1.00	1.00	1.00
Total	4.33	12.00	5.00	6.50	3.83

Level of Consistency	
Accep	
CI	0.09
RI	1.12
C. Ratio	0.08

Factor	EIA & EHIA status	Public attitudes towards project	Previous landowners of project sites	Environment of project sites	Level of project preparation	Total	Average	Consistency Measure
EIA & EHIA status	0.23	0.25	0.40	0.31	0.13	1.32	0.26	5.40
Public attitudes towards project	0.08	0.08	0.10	0.08	0.09	0.42	0.08	5.35
Previous landowners of project sites	0.12	0.17	0.20	0.31	0.26	1.05	0.21	5.37
Environment of project sites	0.12	0.25	0.10	0.15	0.26	0.88	0.18	5.30
Level of project preparation	0.46	0.25	0.20	0.15	0.26	1.33	0.27	5.40
Total	1.00	1.00	1.00	1.00	1.00		1.00	

Figure 9-5 Example of Pairwise Comparison Process by Microsoft Excel

Table 9-1 Weights of Determinants for INT01: Cash Flow Problems in Partners

No.	Determinants	Weights
1	Characteristic of project cash flow	0.12
2	Contractor cash flow	0.30
3	Cash flow of partners	0.30
4	Contractor workload	0.14
5	Workload of partners	0.14

Table 9-2 Weights of Determinants for INT02: Incompetent Construction in Partners

No.	Determinants	Weights
1	Past performance of partners	0.10
2	Contractor construction experiences	0.10
3	Contractor cash flow	0.22
4	Cash flow of partners	0.22
5	Workload of partners	0.18
6	Contractor workload	0.19

Table 9-3 Weights of Determinants for INT03: Changes in Partners

No.	Determinants	Weights
1	Legal status of partners	0.11
2	Financial status of partners	0.21
3	Contractor JV experiences	0.21
4	JV experiences of partners	0.23
5	Partnership between partners	0.11
6	Contractor policies for JV	0.06
7	Policies of partners	0.06

Table 9-4 **Weights of Determinants for INT04: Lack of Local Experience in Partners**

No.	Determinants	Weights
1	JV experiences of partners	0.14
2	Local experiences of partners	0.31
3	Contractor JV experiences	0.14
4	Contractor construction site experiences	0.41

Table 9-5 **Weights of Determinants for INT05: Lack of JV Experience in Partners**

No.	Determinants	Weights
1	Contractor staff with JV experiences	0.18
2	JV experiences in staff of partners	0.16
3	Contractor JV experiences	0.12
4	JV experiences of partners	0.12
5	JV experiences in staff at management-level	0.37
6	Partnership between partners	0.05

Table 9-6 **Weights of Determinants for INT06: Difference on Accounting of Profit & Losses between Partners**

No.	Determinants	Weights
1	JV experiences of partners	0.09
2	Contractor JV experiences	0.09
3	Contractor policies for JV	0.27
4	Policies of partners	0.27
5	Partnership between partners	0.23
6	Diversity in JV	0.05

Table 9-7 Weights of Determinants for INT07: Difference on Resource Allocation between Partners

No.	Determinants	Weights
1	Specializations among partners	0.10
2	Contractor policies for JV	0.20
3	Policies of partners	0.20
4	Type of JV organization structure	0.16
5	Partnership between partners	0.34

Table 9-8 Weights of Determinants for INT08: Improper Intervention by Partners

No.	Determinants	Weights
1	Contractor JV experiences	0.08
2	JV experiences of partners	0.08
3	Partnership between partners	0.12
4	Contractor policies for JV	0.22
5	Policies of partners	0.22
6	Type of JV organization structure**	0.18
7	Diversity in JV	0.10

Table 9-9 Weights of Determinants for INT08: Improper Intervention by Partners (Without CJV organization structure)

No.	Determinants	Weights
1	Contractor JV experiences	0.10
2	JV experiences of partners	0.10
3	Partnership between partners	0.15
4	Contractor policies for JV	0.29
5	Policies of partners	0.28
7	Diversity in JV	0.08

Table 9-10 Weights of Determinants for INT09: Difference on Organizational Structure and Culture between Partners

No.	Determinants	Weights
1	Diversity in JV	0.45
2	Partnership between partners	0.29
3	Contractor experiences in international project	0.14
4	Local experiences of partners	0.13

Table 9-11 Weights of Determinants for INT10: Distrust between Partners

No.	Determinants	Weights
1	Partnership between partners	0.31
2	JV experiences of partners	0.22
3	Contractor JV experiences	0.21
4	Contractor staff with JV experiences	0.11
5	JV experiences in staff of partners	0.10
6	Diversity in JV	0.06

Table 9-12 Weights of Determinants for INT11: Lack of Communication between Partners

No.	Determinants	Weights
1	Partnership between partners	0.08
2	Contractor staff with JV experiences	0.20
3	JV experiences in staff of partners	0.20
4	Diversity in JV	0.12
5	JV experiences in staff at management-level	0.22
6	Type of JV organization structure	0.17

Table 9-13 Weights of Determinants for INT12: Incomplete in Venture Agreements

No.	Determinants	Weights
1	Contractor JV experiences	0.22
2	JV experiences of partners	0.25
3	Partnership between partners	0.13
4	Contractor policies for JV	0.22
5	Policies of partners	0.19

Table 9-14 Weights of Determinants for PRO01: Improper Project Planning and Budgeting

No.	Determinants	Weights
1	Contractor construction experiences	0.27
2	Type of technology	0.25
3	Type of structures	0.14
4	Past performance of partners	0.25
5	Performance of owner & representatives	0.09

Table 9-15 Weights of Determinants for PRO02: Problems in Construction Techniques

No.	Determinants	Weights
1	Level of project preparation	0.34
2	Contractor construction experiences	0.21
3	Type of technology	0.15
4	Type of structures	0.07
5	Past performance of partners	0.23

Table 9-16 Weights of Determinants for PRO03: Incompetent Subcontractors and Suppliers

No.	Determinants	Weights
1	Performance of subcontractor	0.21
2	Performance of suppliers	0.11
3	Type of subcontractor	0.30
4	Type of technology	0.08
5	Contractor construction site experiences	0.16
6	Local experiences of partners	0.14

Table 9-17 Weights of Determinants for PRO04: Problems in Contract Drawings and Specifications

No.	Determinants	Weights
1	Performance of owner & representatives	0.15
2	Type of technology	0.33
3	Type of structures	0.08
4	Level of project preparation	0.44

Table 9-18 Weights of Determinants for PRO05: Problems in Construction Contracts

No.	Determinants	Weights
1	JV experiences in owner	0.33
2	Performance of owner & representatives	0.33
3	Level of project preparation	0.33

Table 9-19 Weights of Determinants for PRO06: Improper Project Profit and Risk Sharing

No.	Determinants	Weights
1	Level of project preparation	0.24
2	Political issues	0.21
3	EIA & EHIA status	0.28
4	Public attitudes towards project	0.14
5	Corruption and bribery	0.14

Table 9-20 Weights of Determinants for PRO07: Excessive Demands and Variation Orders

No.	Determinants	Weights
1	Level of project preparation	0.38
2	Type of technology	0.20
3	Type of structures	0.09
4	Performance of owner & representatives	0.14
5	Public attitudes towards project	0.19

Table 9-21 Weights of Determinants for PRO08: Intervention and Delay by Owner or Its Representatives

No.	Determinants	Weights
1	Relationship with owner	0.17
2	Relationship with owner representatives	0.15
3	Level of project preparation	0.12
4	Performance of owner & representatives	0.42
5	Relationship with government	0.13

Table 9-22 Weights of Determinants for EXT01: Differences in Social, Culture and Religions

No.	Determinants	Weights
1	Diversity in JV	0.31
2	Contractor experiences in international project	0.15
3	Local experiences of partners	0.15
4	Partnership between partners	0.09
5	Type of JV organization structure**	0.29

Table 9-23 Weights of Determinants for EXT01: Differences in Social, Culture and Religions (Without CJV organization structure)

No.	Determinants	Weights
1	Diversity in JV	0.43
2	Contractor experiences in international project	0.22
3	Local experiences of partners	0.22
4	Partnership between partners	0.13

Table 9-24 Weights of Determinants for EXT02: Language Barrier

No.	Determinants	Weights
1	Diversity in JV	0.09
2	Contractor staff with language capabilities	0.15
3	Language capabilities in staff of partners	0.15
4	Partnership between partners	0.04
5	Contractor experiences in international project	0.14
6	Local experiences of partners	0.14
7	Type of JV organization structure**	0.29

Table 9-25 Weights of Determinants for EXT02: Language Barrier (Without CJV organization structure)

No.	Determinants	Weights
1	Diversity in JV	0.12
2	Contractor staff with language capabilities	0.22
3	Language capabilities in staff of partners	0.22
4	Partnership between partners	0.05
5	Contractor experiences in international project	0.20
6	Local experiences of partners	0.20

Table 9-26 Weights of Determinants for EXT03: Natural Disasters and Unpredictable Weather

No.	Determinants	Weights
1	Disaster of project sites	0.49
2	Sensitivity of project to disaster	0.31
3	Contractor construction site experiences	0.20

Table 9-27 Weights of Determinants for EXT04: Pollution

No.	Determinants	Weights
1	Environment of project sites	0.29
2	Level of health and environment effects	0.29
3	Policies for environment and pollution	0.21
4	Contractor construction site experiences	0.21

Table 9-28 Weights of Determinants for EXT05: Resistance from Society

No.	Determinants	Weights
1	EIA & EHIA status	0.26
2	Public attitudes towards project	0.08
3	Previous landowners of project sites	0.21
4	Environment of project sites	0.18
5	Level of project preparation	0.27

Table 9-29 Weights of Determinants for EXT06: Security Problems and Social Disorder

No.	Determinants	Weights
1	Local experiences of partners	0.18
2	EIA & EHIA status	0.45
3	Performance of subcontractor	0.14
4	Previous landowners of project sites	0.24

Table 9-30 Weights of Determinants for EXT07: Inconsistency in Government Policies

No.	Determinants	Weights
1	Relationship with government	0.47
2	Status of government	0.15
3	Political issues	0.38

Table 9-31 Weights of Determinants for EXT08: Investment Restriction

No.	Determinants	Weights
1	Relationship with government	0.32
2	Status of government	0.36
3	Contractor policies for JV	0.19
4	Policies of partners	0.13

Table 9-32 Weights of Determinants for EXT09: Corruption and Bribery

No.	Determinants	Weights
1	Corruption and bribery	1.00

Table 9-33 Weights of Determinants for EXT10: Fluctuation in Economic and Inflation

No.	Determinants	Weights
1	Fluctuation in economic and inflation	1.00

9.3 CJV Appraisal Form

As each determinant which represents the situation of the future CJVs, it tends to be varied under different situation. This variation of determinant would be called that "the status of determinant". In order to make sure that the consideration of the status of all determinants for M-DRP subsystem goes in the same direction for each contractor, as the user of subsystem. This study had to analyze each status of the determinant in details and create "the CJV appraisal form" which is the set of questions and answers for evaluating the status of determinants (discussed in Section 3.3.8). The details of CJV appraisal form are shown in Appendix E. For the examples, the sample of some questions presents here:

Determinant:

Contractor experiences in international project

Questions:

Have the contractor ever experienced in the international project before?

Possible status and its impact scale:

Scale		Status
5	:	Never work in any international project at all
5	:	Worked only as sub-contractor
4	:	Worked in international project in Thailand once
3	:	Worked on a few of international project in Thailand
3	:	Worked in international project in neighboring countries
2	:	Worked in a project in foreign country which is not a member of AEC
2	:	Worked more than 4 of international project in Thailand
1	:	Work on 2-3 international project in foreign countries which are not member of AEC

9.4 Process of Likelihood Prediction

To predict the LLH of risks through all five phases of future CJVs in harmony with the real situation of determents. The processes are as follow:

(1) Answer all questions in the CJV appraisal form (Appendix E).

(2) Find the score for each answer in all questions. As well, the score guideline describes in Appendix E. As the result, there have to be 48 scores for 48 determinants.

(3) Consider the MDMs for each risk and check the determinants and theirs weights in this MDM from Table 9-1 to Table 9-33.

(4) Multiply the score of each determinant from Step 2 with the weight of that determinant in the considering MDM from Step 3. Then, find the summary.

The total value from Step 4 is the LLH for the risk factor evaluated by MDM of the M-DRP subsystem. Table 9-34 shows the example of LLH evaluation by MDM for INT10: Distrust between partners.

From the table, the score of each determinant is the suppose value from Step 2 gotten by the answering in CJV appraisal form. The value of 2.67 in the table is the LLH for INT10: Distrust between partners. However, this value has to be adjusted by the trend of LLH which is the results of hypothesis No.1 test. Then, the five values by this adjustment are the LLH values of INT10 for each phase of CJV life cycle.

Table 9-34 Example of LLH prediction for INT10

Determinants	Weight	Score	Multiple result
Partnership between partners	0.31	2	0.62
JV experiences of partners	0.22	2	0.44
Contractor JV experiences	0.21	3	0.63
Your staff with JV experiences	0.11	4	0.44
JV experiences in staff of partners	0.10	3	0.30
Diversity in JV	0.06	4	0.24
Total (Approx.)	1.00		2.67

9.5 Summary

This chapter presents the development of the module P2 of the Multi-Determinant Risk Prediction (M-DRP) subsystem. The module is about the predictive function for assessing CSQ and LLH of the future CJVs.

First, the set of determinant is the group of determinants affecting on LLH was found these weights with the concept of the analytic hierarchy process (AHP) was be applied. With the pairwise comparison process of AHP, each set of determinant for a risk was changed into the format of multi determinants matrix (MDM). As the results, there are 33 MDMs with the respect to the LLH for 30 risks. Then, the principle of the pairwise comparison as the part of AHP was used as the tool for the computation prioritized weight of determinants in MDMs. To get these values, the expert group was asked to make the comparison by using the nine point scale of numbers.

Moreover, as each determinant which represents the situation of the future CJVs, it tends to be varied under different situation. This variation of determinant would be called that “the status of determinant”. In order to make sure that the consideration of the status of all determinants for M-DRP subsystem goes in the same direction for each contractor, as the user of subsystem. This study had to analyze each status of the determinant in details and create “the CJV appraisal form” which is the set of questions and answers for evaluating the status of determinants

CHAPTER X
DEVELOP APPICATION SOFTWARE FOR M-DRP SUBSYSTEM

This chapter introduces the application software for the Multi-Determinant Risk Prediction (M-DRP) subsystem. The software is programed by the spreadsheets and functions of the Microsoft Excel. All prediction processes of risk parameter, being consequence (CSQ) and likelihood (LLH) for the future construction joint ventures (CJVs) would be automated by this application software. The predictive outputs can be used with other modules in the life cycle risk management and prediction (LCRMP) system to make the risk management plans.

10.1 Description of Application Software

From Chapter 8 to Chapter 9 within this thesis, a function of M-DRP subsystem were completely presented and explained. The contractor, who would be the partner of the future CJVs, can use this function of M-DRP subsystem to predict risk parameter of risks in the first phase through the final phase of CJV life cycle.

However, the all processes of M-DRP subsystem are collected as the information on the paper. It means that the contractor is required to fill, pick, calculate, estimate and present all data by himself or herself. While the M-DRP subsystem is quite detailed and complicated, the contractor may need to spend a lot of time. Following that, the data input or calculation by the contractor may lead to the errors during any processed of the M-DRP subsystem. These are known as "human error". In order to make sure that usage of this M-DRP subsystem would be according to the objectives of the study, which are;

"To be able to assess and/or predict the risk parameter of CJV fast and to get accurate data in appropriate level"

The function of M-DRP subsystem was developed into the format of the application software. Within this application software, the user interface would be used to communicate with the contractor for inputting data and the presenting the predictive outcomes. All of the computations and the database linking will be done behind the user interface in order to lessen the possibility of human error to be as low as possible.

10.2 Programming for Application Software

Nowadays, the application software development for the general purpose or the specific purpose usage can be done via various programming software generally used. They are:

(1) The programming language

The examples are the JAVA, JavaScript, C Language, C++, Visual Basic and etc. Most of these software can be designed to control interaction between user and computer effectively and time saving. On the other hand, it requires learning time due to its complicated database. Moreover, developing totally new software, it has to be done from a scratch such as.

(2) The Visual Basic

It is a kind of the event-driven programming. It is easier to learn and apply than other programming languages. The several applied programs can be collected and developed into a single program. However, the capability of the application software is lower than others and it is difficult for additional development in the future.

(3) The Visual Basic for Applications

It is the program which uses the Visual Basic language in order to write codes to control other applied programs like Microsoft Office, AutoCAD and etc. Its pro is that it can be developed into program fast and easy by using components provided within applied software. Its cons are about its security and freedom of development.

In order to pick which the programming fits the best with M-DRP subsystem used within the study, there were two main factors for consideration;

(1) The actual usage of M-DRP subsystem

The risk evaluation in most of CJV projects usually takes place during CJV's planning and meeting which also include hearing opinion from related people. These meeting can be done in the small group or the larger group within the formal or informal pattern. Following that, the time needed for the meeting is not certain as there are changes in details and planning all the time because many of CJV's elements are not concluded yet.

That is why the model's application software is needed to be flexible. In short, it should be able to evaluate risk fast (which is also the objective of this study) and model should be suitable to work under any circumstances which may occur during meeting or planning.

Nowadays, as technology has become much more advanced, meeting or planning session usually support using of application software. There are varieties of IT tools and equipment to assist user. Instead of PC and notebook, smart phone and tablet have become famous. The trend of people who use smart phone or tablet for their meeting is rising, as they provide higher portability than PC or notebook, while a number of people who bring PC or notebook to meeting are decreasing.

That is why the application software used with LCRM system should be the one that supports working on several platforms as many as possible, so it is convenient for user to apply on their own.

(2) The consideration of key objectives within this study

This study is a research done as a requirement of the curriculum on the department of Civil Engineering. So, it focuses mainly on how to develop the system which evaluates risk within CJV to boost its efficiency and effectiveness on construction's management in term of cost, time, quality and learning. The developing model's application software is just a part of the research which helps support the information mentioned throughout the research and makes it more effective.

So, the platform of programming used should be easy to operate with little complexity while able to function as expected. On the opposite, if complicated programming software is used, the lot of resources and time would be inevitable. Even, in the end, the application software may have high efficacy and can be further developed, it may affects the key objective for this research which is improving efficiency of project to creating application software instead.

With those two above considerations, the study has decided to develop the application software by the Microsoft Excel,

The main reason is that the Microsoft Excel is one of fundamental programs from Microsoft Office which, at present, can be used on several platforms such as PC using Windows, Mac OS, online working through browsers, iOS devices (iPhone and iPad) and, in the future, android devices. Although there are some limitations on program usage on certain devices, the trend shows that it will be developed to operate fully later. So, the using application software in form of Microsoft Office is convenient for user in term of supported devices and its usage.

10.3 Structures of Application Software

The application software of M-DRP subsystem had been developed with structure of spreadsheets. Most of the contents were be linked together by using the formulas and functions provided in the Microsoft Excel. As the final version of the application software, it consists of the 90 spreadsheets which can be classified into three groups based on their functions. They are:

10.3.1 Spreadsheets for user interface

It is the group of spreadsheets which work as front desk for the application software. These spreadsheets are everything of software that the contractor can see and interact with. The contractor can communicate with the application software via the prepared menus and commands to start the risk prediction process for a future CJV, to see the database of risks in five phases of CJV life cycle and to view the introduction of M-DRP subsystem. Figure 10-1 show the first page of application software.

In this group, the spreadsheets serve together to communicate with the contractor, to receive the important data from the contractor and to display the results of risk assessment. There are 27 spreadsheets for responding these functions. In additional, they group are also classified into three sub-groups. They are

(1) The Cover spreadsheets

All of ten spreadsheets in this sub-group have almost the same interface with little differences depend on the choice of contractor as shown in Figure 10-2. The reason why these spreadsheets were divided into many sheets is creating experience for the contractor. The contractor should be able to feel movement in the application software after each command.

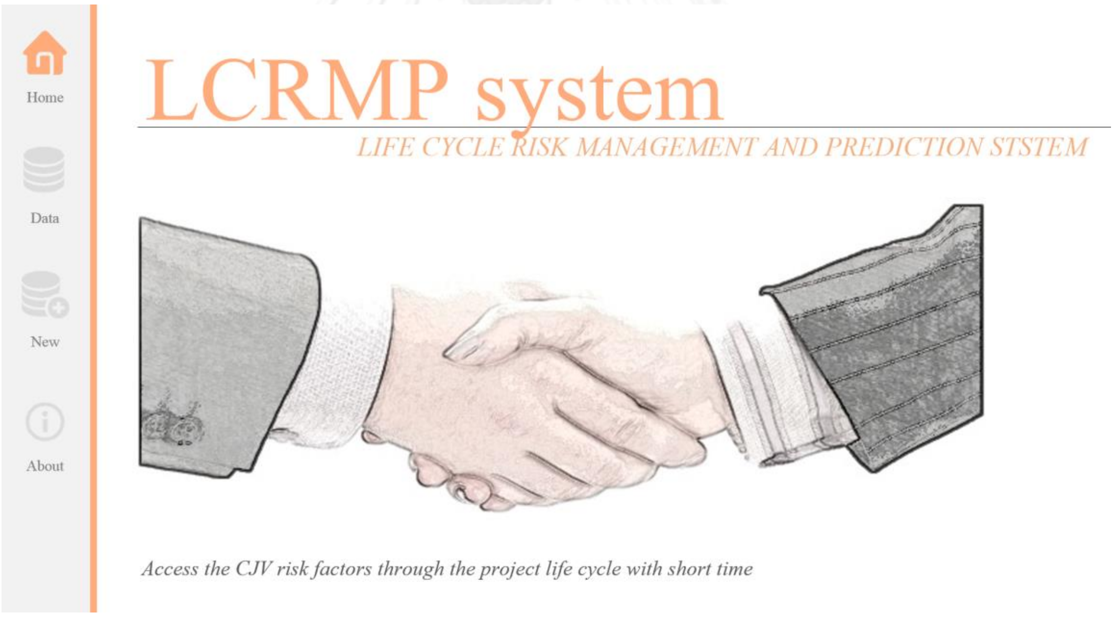


Figure 10-1 First Page of Application Software

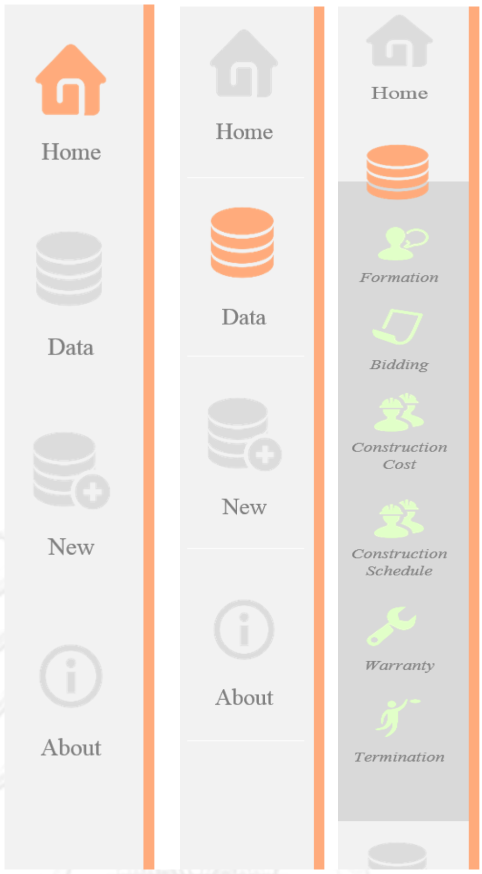


Figure 10-2 Example of Difference Menu between Spreadsheets

(2) The Form spreadsheets

To predict the risk parameters, including consequence (CSQ) and likelihood (LLH), for all risks in all five phases of CJV life cycle, as close to the reality of CJV project as possible. The contractor have to rate the status of all determinants which are the representatives of the situations of the future CJV. So, the function of the spreadsheets in this sub-group responses for taking the answers form the contractor and refers them to the next process of software, afterward.

There are total of 11 spreadsheets for the form spreadsheets.

a) The first of 11 spreadsheets are the blank forms with the set of question and the multiple choices. The contractor can rate the status of each determinant by answering these questions. The reason for separating of 51 determinants into 11 spreadsheets is that the contractor can be easier to focus on the question of each determinants.

Each of these spreadsheets is given the process bar as shown in Figure 10-3 which helps the contractor to know the status of data input and how many steps are required to complete the process.

b) The last spreadsheet is the summary sheet which collect all answers from the contractor after he or she has rated them in the first of 16 spreadsheets. This sheet is responsible for checking whether the contractor has answered all questions in the question spreadsheets or not. If the contractors forget or ignore putting in any answer, LCRM system cannot calculate the parameter of risks. Then the contractor has to back to answer any missing questions from the command button provided within this spreadsheet. Figure 10-4 and Figure 10- 5 illustrates the example of the spreadsheet.

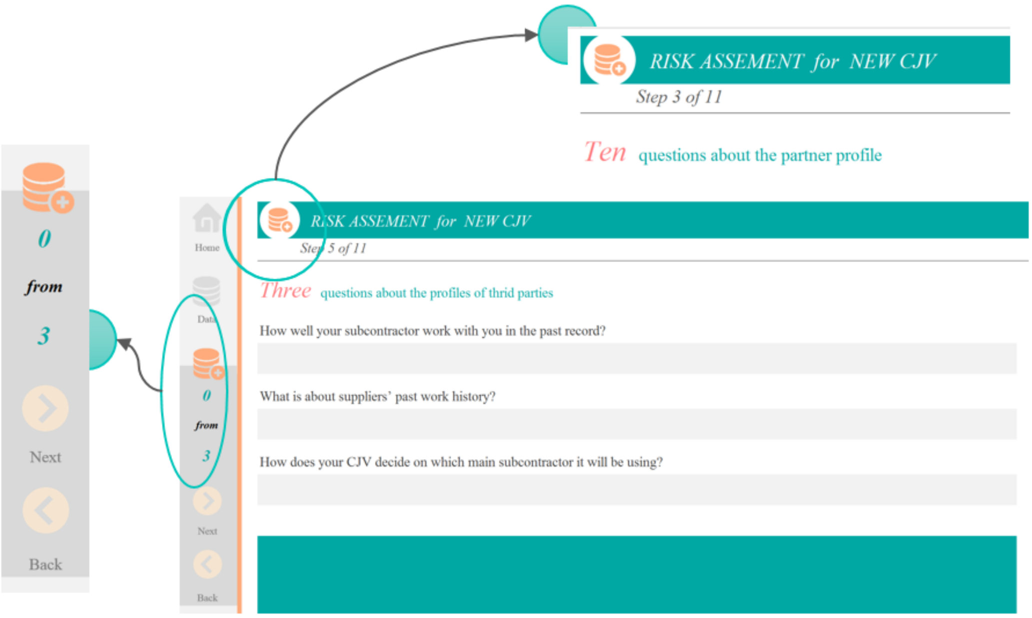


Figure 10-3 Process Bar in Form Spreadsheets

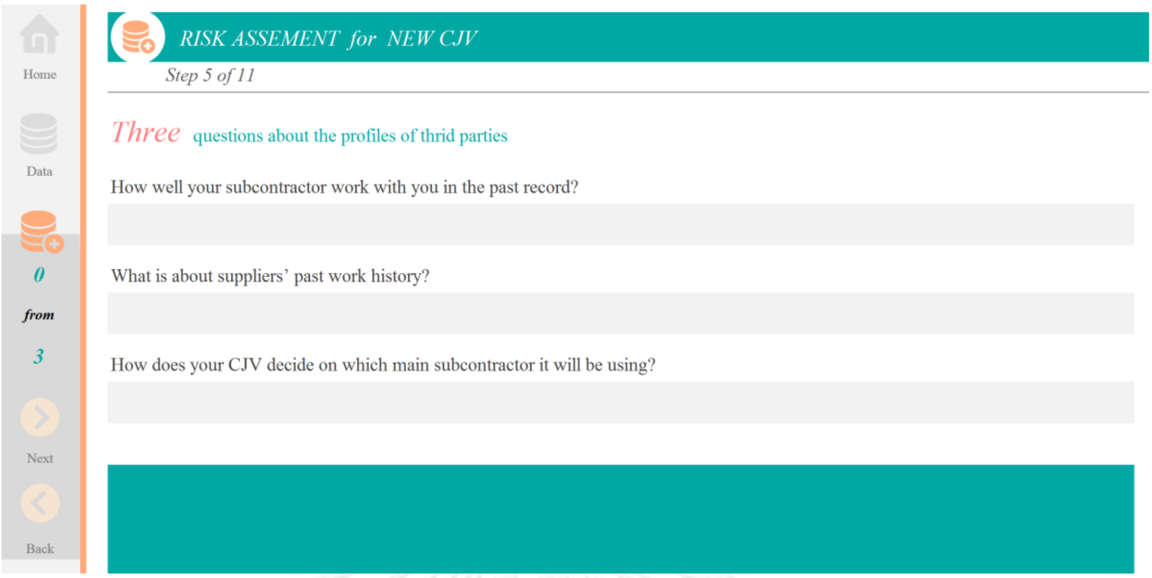


Figure 10-4 Example of Form Spreadsheets

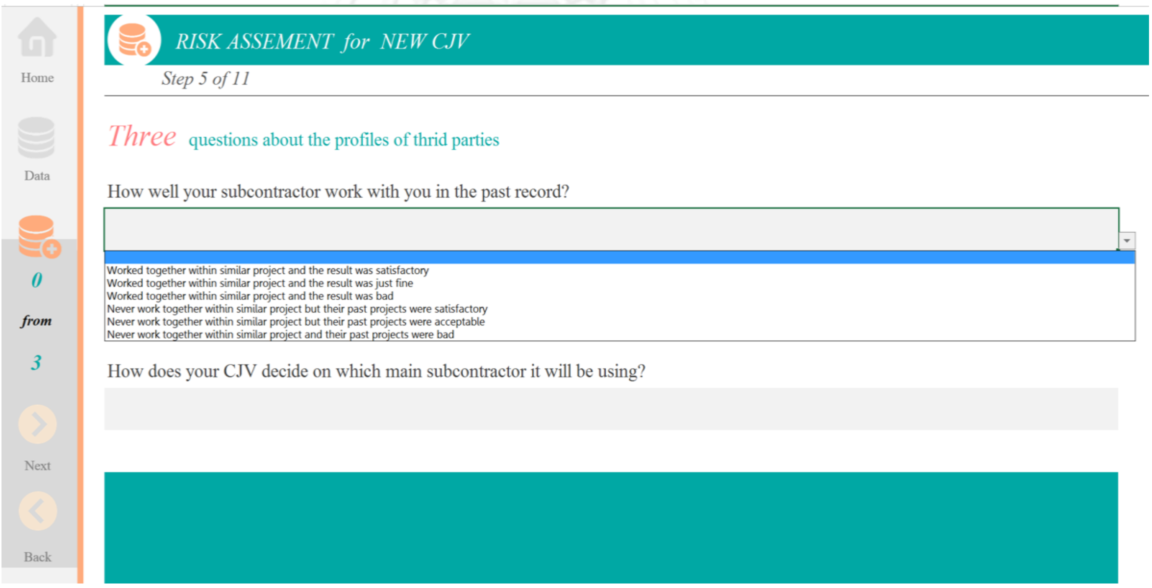


Figure 10-5 Example Multiple Choices in Forms Spreadsheets

(3) The outcome spreadsheets

It is the sub-group of spreadsheets which has the function to present:

- The result of the risk prediction process based on the data input by the contractor
- The predictive results of risk parameter for risks in selected phase

It capability of this part of model goes according to principle of basic of system in term of output part. The application software has total of output spreadsheets.

The main result sheet is a sheet which shows the overall result from risk evaluation along five phases of CJV life cycle so contractor can consider overall picture of operation. Moreover, the contractor can also use command to see result of evaluation in thorough detail for each phase within this sheet. The code name for the outcome spreadsheets is “OUT”.

Figure 10-6 and Figure 10-6 show the example for the output spreadsheets.

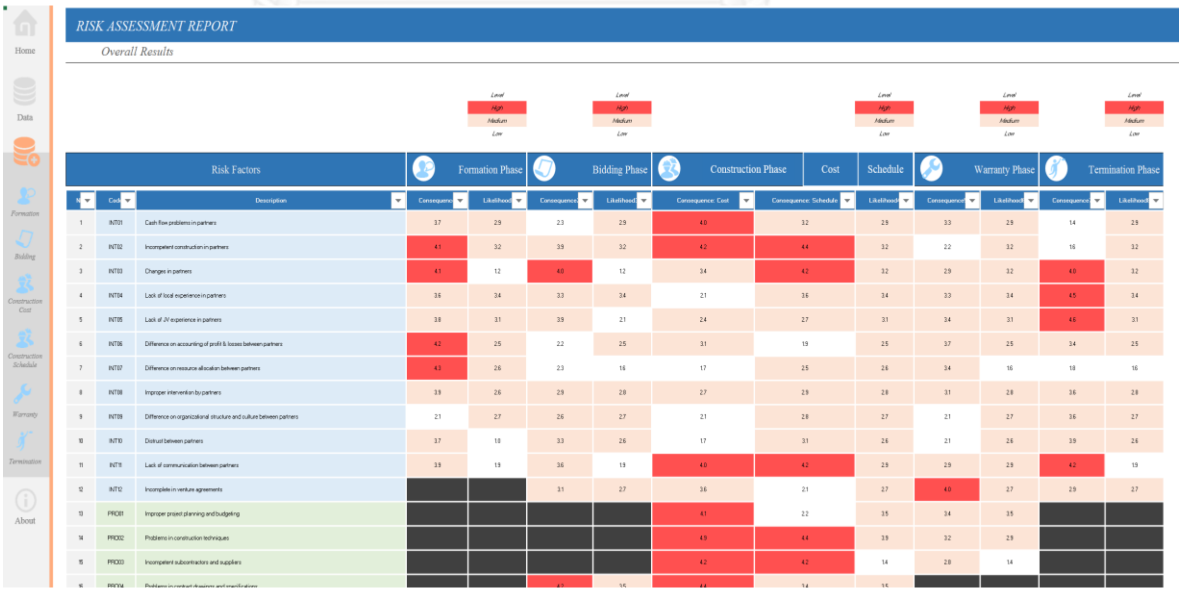
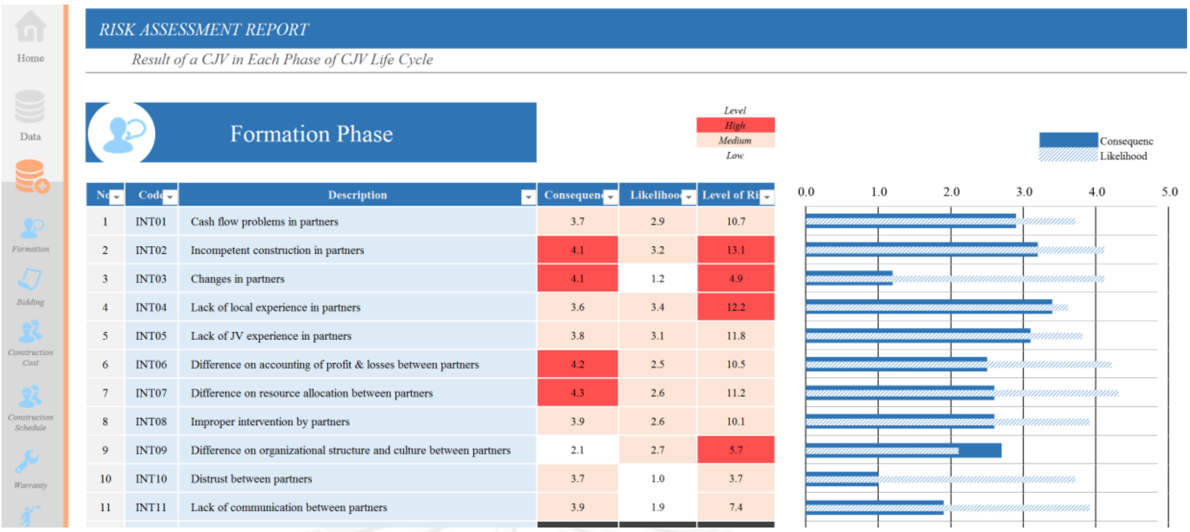


Figure 10-6 Example Output Spreadsheets



No	Code	Description	Consequen	Likelihoo	Level of Ri
1	INT01	Cash flow problems in partners	3.7	2.9	10.7
2	INT02	Incompetent construction in partners	4.1	3.2	13.1
3	INT03	Changes in partners	4.1	1.2	4.9
4	INT04	Lack of local experience in partners	3.6	3.4	12.2
5	INT05	Lack of JV experience in partners	3.8	3.1	11.8
6	INT06	Difference on accounting of profit & losses between partners	4.2	2.5	10.5
7	INT07	Difference on resource allocation between partners	4.3	2.6	11.2
8	INT08	Improper intervention by partners	3.9	2.6	10.1
9	INT09	Difference on organizational structure and culture between partners	2.1	2.7	5.7
10	INT10	Distrust between partners	3.7	1.0	3.7
11	INT11	Lack of communication between partners	3.9	1.9	7.4

Figure 10-7 Example Output Spreadsheets

10.3.2 Spreadsheet for database

The spreadsheets in this group contain the important information of LCRMP system. They are the database, based on previous experience in CJVs in Thailand, of risk parameters for all risks in five phase of CJV life cycle. This is the outcome of Module M2 in the Multi-Objective Risk Management (M-ORM) subsystem.

All of these would be used for the process of the CVJ risk prediction by the principle of M-DRP subsystem. The other spreadsheets in the application software would pull these information to refer or calculate according to the conditions given by the contractor.

10.3.3 Spreadsheet for background computation

They are the set of spreadsheets which have the function to predict the risk parameter of risks for five phases in CJV life cycle. The risk prediction process of these spreadsheets would be done according to the function of the M-DRP subsystem. The data given by the contractor in the form spreadsheets and the database in the spreadsheet for database would be linked by the formula in these spreadsheets. The total of five spreadsheets are served together as the background computation.

10.4 Security of Application Software

As the M-DRP subsystem is developed under the Microsoft Excel, it has fundamental function which allow the contractor to change setting and preferences of the program such as the collocation, the size of row, the size of column, the formula, the linking, the spreadsheets number and etc. Although its advantage is that it allows contractor to update information easily but it still has its flaws in operation.

Its strength is also its main flaws. For example, the contractor may intentionally or unintentionally change settings, the formula, the database and etc., which all of them lead to M-DRP subsystem's inaccurate calculation and in the worst case, M-DRP subsystem may not be able to calculate the results at all. To prevent those man-made mistake to occur while using the application software, during development process, the following procedures are executed.

(1) Fixing cell and area for the contractor interaction

Almost cells in the spreadsheets of application software will be using the function which helps block the contractor from changing details within specific cells, unless the contractor inputs correct password. The contractor can only click or input the data on the cells which are prepared in advance.

(2) Hiding spreadsheets

The application software consists of many spreadsheets which each of them have a specific function which linking and instruction input from contractor will be pre-determined. From the Microsoft Excel's fundamental function, these spreadsheets can be accessed directly, without using any function from model. However, for this software, if the contractor can go directly into any spreadsheets, many of errors may occur. For example, they are the contractor may skip some spreadsheets which require the contractors to input key data, the contractor may edit the database of the model which is supposed to be hidden and etc.

In order to make sure that the contractor use model correctly with less chance to create problem with database and background sheet, during model development, those spreadsheets will be hidden. The only important spreadsheets are shown for the contractor. In the future purposes, the contractor may choose to unhide sheets by inputting required password.

10.5 Summary

The aim of this chapter is the development of the application software to easily evaluate the determinants of the project and to easily predict CSQ and LLH of risks in each phase of CJV life cycle for future CVJs. Because M-DRP subsystem is quite detailed and complicated, the contractor may need to spend a lot of time. Following that, the data input or calculation by the contractor may lead to the errors during any processed of the M-DRP subsystem.

The study had selected "Microsoft excel" as the program to develop the application software for LCRM system. There are three sections of the application software, including the contractor interface section, the database section and the processing section was developed in the spreadsheet to fulfill the requirement of the processes of the determinant and the risk parameter prediction in M-DRP subsystem. The function of M-DRP subsystem was developed into the format of the application software. Within this application software, the user interface would be used to communicate with the contractor for inputting data and the presenting the predictive outcomes. All of the computations and the database linking will be done behind the user interface in order to lessen the possibility of human error to be as low as possible. As the results, there are totally 90 worksheets in the spreadsheet as the application software.

CHAPTER XI
VERIFICATION AND VALIDATION OF M-DRP SUBSYSTEM

After the development of the two modules of the Multi-Determinant Risk Prediction (M-DRP) subsystem and its application software was completed. In this chapter, the final research step for development of the life cycle risk management and prediction (LCRMP) system were conducted. It is the processes of system verification and validation. The objectives of both processes is to verify that M-DRP subsystem and its application software can comply with requirement and imposed condition of this study without errors and bugs. Moreover, it also ensures that the results of the risk assessment by M-DRP subsystem are accurate information which can actually be used in the real world of construction joint ventures (CJVs).

11.1 Concept of System Verification and Validation

In practice, the system development needs to be verified and validated in order to make sure that:

1) The operation of the system is according to requirements and specification.

2) The results of the system are according to the purposed objectives.

Even though, the above process is not the required process for the system development but in order to make the system reliable and does not cause any damage After a third party used, most developers have to verify and validate their system. The verification and validation has distinctively different concepts and processes. These are as follows:

1) System verification

It is the process in verifying that the application software have been created correctly according to the process specified or not without error and bugs. It is the process in order to make sure that the structure, process and various components inside the software is not the cause of receiving errors from the result that should be received according to the specified process.

Therefore, the verification is not the process that can tell that the system can be used in a suitable way to the problem chosen or the result received from the subsystem is consistent with the real world practice. Moreover, this system has passed the verification process. It does not mean that the said system would be complete and has no errors or bugs when used in a real situation because it can always be possible that the case that would be used with the verification process would not cover enough in order to meet with error or bugs hidden in the application software.

2) System validation

It is the process in verifying that the system meet the real world situation in term of the method employed and the results obtained. It is an inspection process in order to confirm that the system that has been developed can actually be used.

The validation process is to compare the results received from the system and the actual results under the same situation. There are two types of the process: (1) to test the system with the actual case and (2) to test the system with the actual case with controlling of various specified variables. The first type of validation process is the best method but it is hard to develop. In general, the second method is used the most in many studies. However, in the case that the actual case cannot be found and/or to test, the process might be able to use the system and test it with the hypothetical case but it is considered the least reliable validation process.

There is no definite rules for the consideration of the validation process. Surely, the best method is the result from the system comparing with the actual result under the same circumstance and consistent in every aspect. However, this method is hard to happen especially with the system relating to the prediction of the value in the future such as risk assessment. Therefore, for this type of system, the rules, used to judge that the results from the validation process is in a satisfactory level and whether it can actually be used, would depend on the opinion and circumstance of the users of that system which normally is different and ready to be changed all the time.

11.2 Characteristics of Case studies

The verification and validation for M-DRP subsystem had been done through the applying the system with its application software for three projects of CJVs operating in Thailand. These projects were called as “the case studies” or abbreviated “cases”.

When considering the details of the all three cases, it was found that there are sharing project components which consistent with the conditions of M-DRP subsystem. These are:

1) Thai partners are the leader of CJVs.
2) All foreign partners in CJVs are from the same country.
3) All CJVs are the design bid build project.
4) The owner of CJVs is a government agency.

For the detail of the characteristics for three cases of this study, they are as follows

1) Case No. 1

Project Name	:	Suvarnabhumi Airport
Owner	:	Airports of Thailand (transferred from New Bangkok International Airport or NBIA)
Contractor	:	ITO Joint Venture or ITO JV
Partners of CJV	:	1) Italian Thai Development Public Co. Ltd. 2) Takenaka Corporation and 3) Obayashi Corporation
Status of the project	:	In the post construction phase
Status of CJV	:	In the termination phase
Type of the project	:	The design bid build project (mostly)

Budget	:	30,000 Million Baht
Start year	:	2002

2) Case No. 2

Project Name	:	The north contract of Metropolitan Rapid Transit Chaloem Ratchamongkhon Line or MRT Blue Line
Owner	:	Mass Rapid Transit Authority of Thailand
Contractor	:	ION Joint Venture or ION JV
Partners of CJV	:	1) Italian Thai Development Public Co. Ltd. 2) Obayashi Corporation 3) Nishimatsu Construction Co. Ltd.
Status of the project	:	Operation by the owner
Status of CJV	:	Closed
Type of the project	:	The design bid build project
Budget	:	28,550 Million Baht
Start year	:	1997

3) Case No. 3

Project Name	:	Chao Phraya River Crossing Bridge at Nonthaburi 1Road Construction Project
Owner	:	Department of Rural Roads, Ministry of Transport
Contractor	:	ITD SMCC Joint Venture or ITD SMCC JV
Partners of CJV	:	1) Italian Thai Development Public Co. Ltd. 2) Sumitomo Mitsui Construction Co. Ltd.

Status of the project	:	In the construction phase
Status of CJV	:	In the construction phase
Type of the project	:	The design bid build project
Budget	:	3,790 Million Baht
Start year	:	2012

11.3 Verification of Application Software

The objective of verification for this study is to test the application software of M-DRP subsystem with a case study in order to:

1) Find error or bugs during the usage via the system through application software by monitoring what the problem a user finds when using the software
2) Find the error in the calculation processes by comparing the result from the software that is called "results by software" with the result calculating by hand, called "results by hand"

11.3.1 Process of Verification

To verify the application software of M-DRP subsystem, the process consisted of:

1) Take CJV appraisal form to the participants of the case for accessing their determinants of CJV.
2) Calculate the LLH by using the set of determinant results getting in the previous process with the methods by software and hands.
3) Find the CSQ from the database in LCRM system with the methods by software and hands.
4) Compare the results of the risk parameter, especially for the LLH, and the level of risk between results by software and results by hand.

However, it was found that the results by hand for the system has a lot of work. So, to evaluate all values of risk parameter, including consequence and likelihood, for one case with five phases of CJV life cycles consideration, there are more than 200 times of calculation which have to be done by hands. Therefore, the system verification process of the study was made with only one case which was case. No 1. It should be anticipated to be sufficient for the test of the correction of the calculation process within the application software of M-DRP subsystem

11.3.2 Verification Result and Discussion

The results is shown in Table 11-1 to Table 11-3. Because the focused issue in this table and furthers is about the accuracy of values, the code for risks are only shown in the tables. The summary of finding in the system verification can be described as follows.

(1) The user experience

The interesting issues and recommendation from the participants who joined the process can be concluded as follows.

a) The participants can answer the questions in CJV appraisal form without confusion.

b) The participants can use the results from LCRM system conveniently and through the various order options of Microsoft excel such as copy-paste for specific cells, copy totally the sheet to the new file.

c) The participants recommend that the font size of the option choices for answer are too small comparing to the font size in other parts in the system. This is the result that the font size of the drop box list in Microsoft Excel cannot be adjusted.

d) There were the interface errors when the application software was opened in the computers which have the different solution for display.

Table 11-1 Comparison of Risk Assessment for CSQ between the Results by Software and Results by Hand

Risk Code	Results of CSQ by software						Results of CSQ by hand						Difference of CSQ at the same phase					
	For. P. (a)	Bid. P. (b)	ConC. P. (c)	ConS. P. (d)	War. P. (e)	Ter. P. (f)	For. P. (g)	Bid. P. (h)	ConC. P. (i)	ConS. P. (j)	War. P. (k)	Ter. P. (l)	For. P. (a-g)	Bid. P. (b-h)	ConC. P. (c-i)	ConS. P. (d-j)	War. P. (e-k)	Ter. P. (f-l)
INT01	3.7	1.7	3.2	2.3	2.2	1.3	3.7	1.7	3.2	2.3	2.2	1.3	0	0	0	0	0	0
INT02	3.8	3.3	4.1	3.6	2.2	1.4	3.8	3.3	4.1	3.6	2.2	1.4	0	0	0	0	0	0
INT03	4.0	3.7	3.3	4.1	2.9	4.0	4.0	3.7	3.3	4.1	2.9	4.0	0	0	0	0	0	0
INT04	3.3	3.2	2.8	2.9	2.2	3.4	3.3	3.2	2.8	2.9	2.2	3.4	0	0	0	0	0	0
INT05	2.9	3.6	2.6	3.5	3.4	4.6	2.9	3.6	2.6	3.5	3.4	4.6	0	0	0	0	0	0
INT06	4.3	2.2	3.3	2.0	3.3	4.2	4.3	2.2	3.3	2.0	3.3	4.2	0	0	0	0	0	0
INT07	4.2	2.7	2.9	2.4	2.4	2.6	4.2	2.7	2.9	2.4	2.4	2.6	0	0	0	0	0	0
INT08	3.3	2.7	3.4	2.6	2.4	3.2	3.3	2.7	3.4	2.6	2.4	3.2	0	0	0	0	0	0
INT09	1.9	3.3	2.9	3.4	2.2	2.8	1.9	3.3	2.9	3.4	2.2	2.8	0	0	0	0	0	0
INT10	3.1	3.4	1.6	3.3	2.1	3.8	3.1	3.4	1.6	3.3	2.1	3.8	0	0	0	0	0	0
INT11	3.2	3.6	3.1	3.4	2.1	3.1	3.2	3.6	3.1	3.4	2.1	3.1	0	0	0	0	0	0
INT12	-	2.2	3.3	2.2	3.6	2.8	-	2.2	3.3	2.2	3.6	2.8	-	0	0	0	0	0
PRO01	-	-	3.1	2.3	2.9	-	-	-	3.1	2.3	2.9	-	-	-	0	0	0	-
PRO02	-	-	4.1	4.2	2.8	-	-	-	4.1	4.2	2.8	-	-	-	0	0	0	-
PRO03	-	-	3.3	4.1	2.4	-	-	-	3.3	4.1	2.4	-	-	-	0	0	0	-
PRO04	-	4.0	3.7	3.3	-	-	-	4.0	3.7	3.3	-	-	-	0	0	0	-	-
PRO05	-	-	2.9	2.3	2.8	2.4	-	-	2.9	2.3	2.8	2.4	-	-	0	0	0	0
PRO06	4.3	-	-	-	-	-	4.3	-	-	-	-	-	0	-	-	-	-	-
PRO07	-	3.4	3.3	3.4	-	-	-	3.4	3.3	3.4	-	-		0	0	0	0	0
PRO08	3.3	2.6	2.5	2.2	3.1	3.2	3.3	2.6	2.5	2.2	3.1	3.2	0	0	0	0	0	0
EXT01	1.7	2.1	2.4	3.4	2.4	2.4	1.7	2.1	2.4	3.4	2.4	2.4	0	0	0	0	0	0
EXT02	2.8	3.4	2.2	3.4	2.1	2.6	2.8	3.4	2.2	3.4	2.1	2.6	0	0	0	0	0	0
EXT03	-	-	1.6	3.8	1.7	-	-	-	1.6	3.8	1.7	-	-	-	0	0	0	-
EXT04	-	-	2.2	2.1	1.2	-	-	-	2.2	2.1	1.2	-	-	-	0	0	0	-
EXT05	2.8	1.4	3.2	4.6	-	-	2.8	1.4	3.2	4.6	-	-	0	0	0	0	-	-
EXT06	1.2	1.1	2.2	1.7	1.7	-	1.2	1.1	2.2	1.7	1.7	-	0	0	0	0	0	-
EXT07	2.2	2.2	1.6	2.1	2.8	3.6	2.2	2.2	1.6	2.1	2.8	3.6	0	0	0	0	0	0
EXT08	2.3	-	2.0	2.7	-	1.8	2.3	-	2.0	2.7	-	1.8	0	-	0	0	-	0
EXT09	1.7	2.2	4.7	3.4	1.7	3.1	1.7	2.2	4.7	3.4	1.7	3.1	0	0	0	0	0	0
EXT10	-	-	2.6	1.3	2.1	-	-	-	2.6	1.3	2.1	-	-	-	0	0	0	-

Table 11-2 Comparison of Risk Assessment for LLH between the Results by Software and Results by Hand

Risk Code	Results of LLH by software					Results of LLH by hand					Difference of LLH at the same phase				
	For. P. *(a)*	Bid. P. *(b)*	Con. P. *(c)*	War. P. *(d)*	Ter. P. *(e)*	For. P. *(f)*	Bid. P. *(g)*	Con. P. *(h)*	War. P. *(i)*	Ter. P. *(j)*	For. P. *(a-f)*	Bid. P. *(b-g)*	Con. P. *(c-h)*	War. P. *(d-i)*	Ter. P. *(e-j)*
INT01	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	0	0	0	0	0
INT02	3.5	3.5	3.5	3.5	3.5	3.6	3.6	3.6	3.6	3.6	-0.1	-0.1	-0.1	-0.1	-0.1
INT03	1	1	2.8	2.8	2.8	1	1	2.8	2.8	2.8	0	0	0	0	0
INT04	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	0	0	0	0	0
INT05	2.9	1.9	2.9	2.9	2.9	2.9	1.9	2.9	2.9	2.9	0	0	0	0	0
INT06	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	0	0	0	0	0
INT07	2.7	1.7	2.7	1.7	1.7	2.8	1.8	2.8	1.8	1.8	-0.1	-0.1	-0.1	-0.1	-0.1
INT08	2.3	2.7	2.7	2.7	2.7	2.3	2.7	2.7	2.7	2.7	0	0	0	0	0
INT09	3.1	3.1	3.1	3.1	3.1	3.2	3.2	3.2	3.2	3.2	-0.1	-0.1	-0.1	-0.1	-0.1
INT10	1	2.6	2.6	2.6	2.6	1	2.6	2.6	2.6	2.6	0	0	0	0	0
INT11	1.6	1.6	2.6	2.6	1.6	1.6	1.6	2.6	2.6	1.6	0	0	0	0	0
INT12	-	2.4	2.4	2.4	2.4	-	2.4	2.4	2.4	2.4	-	0	0	0	0
PRO01	-	-	3.2	3.2	-	-	-	3.2	3.2	-	-	-	0	0	-
PRO02	-	-	3.3	2.3	-	-	-	3.3	2.3	-	-	-	0	0	-
PRO03	-	-	3	3	-	-	-	3	3	-	-	-	0	0	-
PRO04	-	4	4	-	-	-	4	4	-	-	-	0	0	-	-
PRO05	-	-	4	4	4	-	-	4	4	4	-	-	0	0	0
PRO06	3	-	-	-	-	3	-	-	-	-	0	-	-	-	-
PRO07	-	2.4	3.4	-	-	-	2.4	3.4	-	-		0	0	0	0
PRO08	3.7	3.7	3.7	3.7	2.7	3.7	3.7	3.7	3.7	2.7	0	0	0	0	0
EXT01	3.2	3.2	3.4	2.2	2.2	3.2	3.2	3.4	2.2	2.2	0	0	0	0	0
EXT02	3.4	3.4	3.6	2.4	2.4	3.5	3.5	3.6	2.5	2.5	-0.1	-0.1	0	-0.1	-0.1
EXT03	-	-	2.2	2.2	-	-	-	2.2	2.2	-	-	-	0	0	-
EXT04	-	-	2.2	1.2	-	-	-	2.2	1.2	-	-	-	0	0	-
EXT05	1.2	1.2	2.2		-	1.3	1.3	2.3	-	-	-0.1	-0.1	-0.1	-	-
EXT06	2.1	2.1	2.1	2-.1	-	2.1	2.1	2.1	2.1	-	0	0	0	0	-
EXT07	3	3	3	3	3	3	3	3	3	3	0	0	0	0	0
EXT08	2.7	-	2.7	-	3.7	2.7	-	2.7	-	3.7	0	-	0	-	0
EXT09	5	5	5	5	5	5	5	5	5	5	0	0	0	0	0
EXT10	-	-	4	4	-	-	-	4	4	-	-	-	0	0	-

Table 11-3 Comparison of Risk Assessment for LOR between the Results by Software and Results by Hand

Risk code	Results of LOR by software						Results of LOR by hand						Difference of LOR at the same phase					
	For. P. (a)	Bid. P. (b)	ConC. P. (c)	ConS. P. (d)	War. P. (e)	Ter. P. (f)	For. P. (g)	Bid. P. (h)	ConC. P. (i)	ConS. P. (j)	War. P. (k)	Ter. P. (l)	For. P. (a-g)	Bid. P. (b-h)	ConC. P. (c-i)	ConS. P. (d-j)	War. P. (e-k)	Ter. P. (f-l)
INT01	13.7	6.3	11.8	8.5	8.1	4.8	13.7	6.3	11.8	8.5	8.1	4.8	0	0	0	0	0	0
INT02	13.3	11.6	14.4	12.6	7.7	4.9	13.7	11.9	14.8	13.0	7.9	5.0	-0.4	-0.3	-0.4	-0.4	-0.2	-0.1
INT03	4.0	3.7	9.2	11.5	8.1	11.2	4.0	3.7	9.2	11.5	8.1	11.2	0	0	0	0	0	0
INT04	10.6	10.2	9.0	9.3	7.0	10.9	10.6	10.2	9.0	9.3	7.0	10.9	0	0	0	0	0	0
INT05	8.4	6.8	7.5	10.2	9.9	13.3	8.4	6.8	7.5	10.2	9.9	13.3	0	0	0	0	0	0
INT06	10.3	5.3	7.9	4.8	7.9	10.1	10.3	5.3	7.9	4.8	7.9	10.1	0	0	0	0	0	0
INT07	11.3	4.6	7.8	6.5	4.1	4.4	11.8	4.9	8.1	6.7	4.3	4.7	-0.5	-0.3	-0.3	-0.2	-0.2	-0.3
INT08	7.6	7.3	9.2	7.0	6.5	8.6	7.6	7.3	9.2	7.0	6.5	8.6	0	0	0	0	0	0
INT09	5.9	10.2	9.0	10.5	6.8	8.7	6.1	10.6	9.3	10.9	7.0	9.0	-0.2	-0.4	-0.3	-0.4	-0.2	-0.3
INT10	3.1	8.8	4.2	8.6	5.5	9.9	3.1	8.8	4.2	8.6	5.5	9.9	0	0	0	0	0	0
INT11	5.1	5.8	8.1	8.8	5.5	5.0	5.1	5.8	8.1	8.8	5.5	5.0	0	0	0	0	0	0
INT12	-	5.3	7.9	5.3	8.6	6.7	-	5.3	7.9	5.3	8.6	6.7	-	0	0	0	0	0
PRO01	-	-	9.9	7.4	9.3	-	-	-	9.9	7.4	9.3	-	-	-	0	0	0	-
PRO02	-	-	13.5	13.9	6.4	-	-	-	13.5	13.9	6.4	-	-	-	0	0	0	-
PRO03	-	-	9.9	12.3	7.2	-	-	-	9.9	12.3	7.2	-	-	-	0	0	0	-
PRO04	-	16.0	14.8	13.2	-	-	-	16.0	14.8	13.2	-	-	-	0	0	0	-	-
PRO05	-	-	11.6	9.2	11.2	9.6	-	-	11.6	9.2	11.2	9.6	-	-	0	0	0	0
PRO06	12.9	-	-	-	-	-	12.9	-	-	-	-	-	0	-	-	-	-	-
PRO07	-	8.2	11.2	11.6	-	-	-	8.2	11.2	11.6	-	-	-	0	0	0	-	-
PRO08	12.2	9.6	9.3	8.1	11.5	8.6	12.2	9.6	9.3	8.1	11.5	8.6	0	0	0	0	0	0
EXT01	5.4	6.7	8.2	11.6	5.3	5.3	5.4	6.7	8.2	11.6	5.3	5.3	0	0	0	0	0	0
EXT02	9.5	11.6	7.9	12.2	5.0	6.2	9.8	11.9	7.9	12.2	5.3	6.5	-0.3	-0.3	0	0	-0.3	-0.3
EXT03	-	-	3.5	8.4	3.7	-	-	-	3.5	8.4	3.7	-	-	-	0	0	0	-
EXT04	-	-	4.8	4.6	1.4	-	-	-	4.8	4.6	1.4	-	-	-	0	0	0	-
EXT05	3.4	1.7	7.0	10.1	-	-	3.6	1.8	7.4	10.6	-	-	-0.2	-0.1	-0.4	-.5	-	-
EXT06	2.5	2.3	4.6	3.6	3.6	-	2.5	2.3	4.6	3.6	3.6	-	0	0	0	0	0	-
EXT07	6.6	6.6	4.8	6.3	8.4	10.8	6.6	6.6	4.8	6.3	8.4	10.8	0	0	0	0	0	-
EXT08	6.2	-	5.4	7.3	-	6.7	6.2	-	5.4	7.3	-	6.7	0	-	0	0	-	0
EXT09	8.5	11.0	23.5	17.0	8.5	15.5	8.5	11.0	23.5	17.0	8.5	15.5	0	0	0	0	0	0
EXT10	-	-	10.4	5.2	8.4	-	-	-	10.4	5.2	8.4	-	-	-	-	0	0	-

(2) The correction in the calculation process

As shown in Table 11-1 to Table 11-3, from comparing results by software with results by hand, in the overall, it was found that the results from both methods for case No. 1 are almost no different.

However, if the results are considered in the details, they would be found that the results from both processes are different in the one digit after the point. They are that the errors of some LLH are always “-0.1” while the error range of LOR is “-0.1” to “-0.4”.

It can be explained that the errors happened from the fact that the results by software were from the calculation which did not round the point position even though the value shown in the user interface of the application software would be shown as one-position digit after the point but the actual value used in the calculation of the software, there would be more digits than that.

As for the results by hand, it would be the calculation that used rounding up of one-position digit after the point for the entire processes. So, it could lead to the conclusion that the system and its application software gives the correct result with the specified process. The reasons to not make application software to round up of one-position digit are:

1) The weight of determinants value for one risk must always must be the total of 1.00. Therefore, if there is rounding up of the said weight value sometimes it would make the above result to be more than or less than 1.00 which would cause error in the calculation for the next system process.

   Moreover, the user who uses the system might misunderstand that the weight of determination value is wrong.

2) Rounding up of decimal number is the principle made in order to simplify the said digit in writing or using. However, rounding of decimal number would unavoidably lead to error in the result.

   When the calculation process of the system has been made by the ability of the application software through the ability of Microsoft excel there is no need to round up the digits for the various variables until the part that the user would use that viable which is CSQ and LLH which is the last result of the system.

11.4 Validation of M-DRP subsystem

The validation process for this study aims to consider and compare the results of CJV risk assessment predicted by the M-DRP subsystem with the actual results from the real situations of that CJV. The M-DRP subsystem were tested with three cases which are CJVs operating in Thailand, mentioned in the section 11.2 of this chapter.

11.4.1 Process of Validation

To validate M-DRP subsystem, each case was tested by the following process.

1) Take CJV appraisal form to the participants of the case for accessing their determinants of CJV.

2) Predict CSQ and LLH for risks in all phases of CJV life cycle by the process of M-DRP subsystem with the application software. Both values are called the predictive results

3) Let same participants in the first step to evaluate the actual characteristics of risks, including the actual impact (AI) and the actual frequency (AF), based on the real situations of CJV operation which has passed. The questions, in which the participants ware asked, are “how does the risk have an impact to the objective of the project?” and “how often did it happen?”

   The values of AI and AF, called the actual results, are the actual impact and frequency for each risks in each phases of CJV life cycle which happened in the past of CJV.

4) Compare the results from the step 2 and the step 3. That is to compare CSQ with AI values and to compare LLH with AF values. Then, the errors, which are the difference between two values, were calculated. These errors would be analyzed by the criterion, detailed in the section 11.4.2.

Please note that the actual impact (AI) and the actual frequency (AF) are different from the predictive results because it is not anticipation of situation in advance but it is the consideration of the situations that really happened in the past. However, in order to be able to compare between the predictive results with the real results. The AI and AF assessment still use the same five likert scale used in assessing the predictive results. The CSQ is equivalent to AI and LLG is equivalent to AF.

The important issue, which must be discussed before going into the validation result analysis, is the fact that the process of risk assessment that happens in the validation process might be an action different from operation guidelines that it is supposed to be.

The best way of the validation process for M-DRP subsystem is to test the system with a case which its operation is just in the formation phase in order to predict the CSQ and LLH of risks in the future phases of CJV life cycle. When the case pass through each phase, the evaluation for AI and AF values of risks, which really happens, will be conducted. This kind of process will make the CSQ and LLH of the risk evaluation to be according to the theory the most and to receive the AI and AF values that are near the actual values. By the time specification of the study, the above process cannot be happened because it mean that the validation process take at least two or three years.

In this study, the case studies are CJVs which has been completed or almost completed as mentioned in the section 11.2. All of them have already passed the stage of the pre-construction phase. Therefore, it can be seen that participants were asked to evaluate the risk even though the project has been complete for many years or has been operated for more than half. Because participants have to assess the risk for the past project, they might provide the wrong information because the time has passed for a long time or to answer with the actual results instead of guessing CSQ or LLH.

However, it is considered a great luck that the risk assessment process of M-DRP subsystem does not let the participants to directly assess the CSQ or LLH as the traditional method. But the system let the participants answer questions to describe the various conditions of member, cooperation, project and the outside environment which really happened at the beginning of CJV.

The validation process in the study has the attempt to reduce the mistake that might happens for the risk parameter prediction by M-DRP subsystem in the validation process. The participants were always emphasized to reminisce the situation at the early period of the project during the process of answering the questions in CJV appraisal form. Moreover, the researchers would accompany the participants during the risk evaluation all the time in order to reduce answers deviating from what they are supposed to be.

11.4.2 Validation Criterion

The error value (ER), which is the difference between the real result and the predictive result, would be analyzed by the following principles:

1) To specify the real results as the main thing for finding the difference. Therefore, the ER was received might be in three formats including:

    a) Positive value (+)

       It means that the value of predictive results is less than its real results. So, it can be concluded that the value, assessed by LCRM system, is underestimated.

    b) Negative value (-)

       It means that the value of predictive results is higher than its real results. So, it can be concluded that the value, assessed by LCRM system, is overestimated.

    c) Zero value (0)

       It means that the value of predictive results is equal its real results. So, it can be concluded that the value, assessed by LCRM system, is accurate.

2) Because the fact that the lowest point of CSQ, LLH, AI and AF is 1.0 whereas the possible maximum value is 5.0, the range of the errors is rather narrow

(0 to 4.0). So, a little ER between CSQ and AI or between LLH and AF might cause that LCRM system has the significant error.

For this study, the ER that is more than 1.0 is specified that it has the sufficient significant error for determining the system to be less reliable.

3) From the above assumption, the possible range of the ER can be divided into four formats. These are the major error, the acceptable error, the minor error and none error. Table 11-4 provides the definitions for each range of the error.

Apart from the criterion for considering the error values, there are another issue which still is required before determining the errors. That is the difference numerical format between the real results and the predictive results. They are:

1) The CSQ and LLH by M-DRP subsystem would be shown in the numbers with one decimal digit.

   The values are the results of the prediction processes in M-DRP subsystem which comprises of the calculation according to the mathematic processes and referring of many variables in the numbers with two or more decimal digits. However, for the final values, they are always round to the numbers with one decimal digit.

2) The AI and AF values would be always in the integer values.

   Mostly, the values happen from the evaluation by testing one participant in each phase. In the case that there are two participants or more, there would be a deciding vote. The answers do not have to go through any mathematical calculation process. Moreover, the evaluation would also use the answering format of the likert scale (5, 4, 3, 2 and 1).

Table 11-4 Criterion of Errors for System Validation

Type of errors	Value of error (ER.)		
	General term		Absolute term
Major error	-1.0 ≤ ER or	ER ≥ 1.0	|ER| ≥ 1.0
Acceptable error	-1.0 < ER ≤ -0.5 or	0.50 ≤ ER < 1.00	0.50 ≤ |ER| < 1.00
Minor error	-0.5 < ER < 0 or	0 < ER < 0.50	0 < |ER| < 0.50
None error	ER = 0		ER = 0

So, it can be seen that the format of the predictive results and the actual results are different. The fact that assessing people cannot evaluate the real results as decimal number according to likert scale so there is an opportunity to evaluate the real results that would happen to rounding up or rounding down more than the actual value. For example, the assessing people think that the actual effect of one factor is around 3.5 but it cannot be answered so the answer must be 3 or 4 instead. The said rounding up of value can make the value increase or decrease.

11.4.3 Validation Results

For detailed results for each case, Table 11-5 and Table 11-6 show the summary for the case No.1. While the details of the case No.2 indicate in Table 11-7 and Table 11-8, Table 11-9 and Table 11-10 presents the conclusion for the case No. 3. For overview of the validation for LCRM system, Table 11-11 indicates the comparison summary of CSQ and LLH for three cases.

Table 11-5 Comparison of CSQ and AI for Case No.1

Risk code	Consequence by system (CSQ)						Actual impact (AI)						Error value (ER)					
	For. P.	Bid. P.	Con. P.		War. P.	Ter. P.	For. P.	Bid. P.	Con. P.		War. P.	Ter. P.	For. P.	Bid. P.	Con. P.		War. P.	Ter. P.
			Cost	Sche.					Cost	Sche.					Cost	Sche.		
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(k)*	*(l)*	*(a-g)*	*(b-h)*	*(c-i)*	*(d-j)*	*(e-k)*	*(f-l)*
INT01	3.7	1.7	3.2	2.3	2.2	1.3	4.0	2.0	3.0	2.0	2.0	2.0	-0.3	-0.3	0.2	0.3	0.2	-0.7
INT02	3.8	3.3	4.1	3.6	2.2	1.4	4.0	3.0	4.0	4.0	2.0	2.0	-0.2	0.3	0.1	-0.4	0.2	-0.6
INT03	4.0	3.7	3.3	4.1	2.9	4.0	4.0	4.0	3.0	4.0	3.0	4.0	0.0	-0.3	0.3	0.1	-0.1	0.0
INT04	3.3	3.2	2.8	2.9	2.2	3.4	3.0	4.0	3.0	3.0	2.0	3.0	0.3	-0.8	-0.2	-0.1	0.2	0.4
INT05	2.9	3.6	2.6	3.5	3.4	4.6	3.0	4.0	3.0	4.0	3.0	4.0	-0.1	-0.4	-0.4	-0.5	0.4	0.6
INT06	4.3	2.2	3.3	2.0	3.3	4.2	4.0	2.0	3.0	2.0	3.0	4.0	0.3	0.2	0.3	0.0	0.3	0.2
INT07	4.2	2.7	2.9	2.4	2.4	2.6	4.0	3.0	3.0	3.0	3.0	3.0	0.2	-0.3	-0.1	-0.6	-0.6	-0.4
INT08	3.3	2.7	3.4	2.6	2.4	3.2	3.0	3.0	3.0	3.0	3.0	3.0	0.3	-0.3	0.4	-0.4	-0.6	0.2
INT09	1.9	3.3	2.9	3.4	2.2	2.8	2.0	4.0	3.0	3.0	3.0	3.0	-0.1	-0.7	-0.1	0.4	-0.8	-0.2
INT10	3.1	3.4	1.6	3.3	2.1	3.8	3.0	3.0	2.0	3.0	2.0	3.0	0.1	0.4	-0.4	0.3	0.1	0.8
INT11	3.2	3.6	3.1	3.4	2.1	3.1	3.0	3.0	3.0	4.0	2.0	3.0	0.2	0.6	0.1	-0.6	0.1	0.1
INT12	-	2.2	3.3	2.2	3.6	2.8	-	2.0	4.0	2.0	4.0	3.0	-	0.2	-0.7	0.2	-0.4	-0.2
PRO01	-	-	3.1	2.3	2.9	-	-	-	3.0	2.0	3.0	-	-	-	0.1	0.3	-0.1	-
PRO02	-	-	4.1	4.2	2.8	-	-	-	4.0	4.0	3.0	-	-	-	0.1	0.2	-0.2	-
PRO03	-	-	3.3	4.1	2.4	-	-	-	3.0	4.0	3.0	-	-	-	0.3	0.1	-0.6	-
PRO04	-	4.0	3.7	3.3	-	-	-	4.0	4.0	3.0	-	-	-	0.0	-0.3	0.3	-	-
PRO05	-	-	2.9	2.3	2.8	2.4	-	-	3.0	2.0	3.0	2.0	-	-	-0.1	0.3	-0.2	0.4
PRO06	4.3	-	-	-	-	-	4.0	-	-	-	-	-	0.3	-	-	-	-	-
PRO07	-	3.4	3.3	3.4	-	-	-	3.0	4.0	4.0	-	-	-	0.4	-0.7	-0.6	-	-
PRO08	3.3	2.6	2.5	2.2	3.1	3.2	3.0	3.0	3.0	3.0	4.0	5.0	0.3	-0.4	-0.5	-0.8	-0.9	-1.8
EXT01	1.7	2.1	2.4	3.4	2.4	2.4	2.0	2.0	2.0	3.0	2.0	2.0	-0.3	0.1	0.4	0.4	0.4	0.4
EXT02	2.8	3.4	2.2	3.4	2.1	2.6	3.0	3.0	3.0	3.0	2.0	3.0	-0.2	0.4	-0.8	0.4	0.1	-0.4
EXT03	-	-	1.6	3.8	1.7	-	-	-	1.0	3.0	2.0	-	-	-	0.6	0.8	-0.3	-
EXT04	-	-	2.2	2.1	1.2	-	-	-	2.0	2.0	2.0	-	-	-	0.2	0.1	-0.8	-
EXT05	2.8	1.4	3.2	4.6	-	-	2.0	1.5	3.0	4.0	-	-	0.8	-0.1	0.2	0.6	-	-
EXT06	1.2	1.1	2.2	1.7	1.7	-	2.0	1.5	2.0	2.0	2.0	-	-0.8	-0.4	0.2	-0.3	-0.3	-
EXT07	2.2	2.2	1.6	2.1	2.8	3.6	2.0	2.0	2.0	2.0	3.0	4.0	0.2	0.2	-0.4	0.1	-0.2	-0.4
EXT08	2.3	-	2.0	2.7	-	1.8	3.0	-	2.0	3.0	-	2.0	-0.7	-	0.0	-0.3	-	-0.2
EXT09	1.7	2.2	4.7	3.4	1.7	3.1	2.0	3.0	5.0	4.0	2.0	3.0	-0.3	-0.8	-0.3	-0.6	-0.3	0.1
EXT10	-	-	2.6	1.3	2.1	-	-	-	3.0	2.0	2.0	-	-	-	-0.4	-0.7	0.1	-
							|ER| ≥ 1.0		Major error				0	0	0	0	0	1
							0.50 ≤ |ER| < 1.00		Acceptable error				3	4	5	9	6	4
							0 < |ER| < 0.50		Minor error				16	16	23	19	19	13
							ER = 0		None error				1	2	1	1	0	1
							Total risks						20	21	29	29	25	19

Table 11-6 Comparison of LLH and AF for Case No.1

Risk Code	Consequence by system (LLH)					Actual impact (AF)					Error value (ER)				
	For. P.	Bid. P.	Con. P.	War. P.	Ter. P.	For. P.	Bid. P.	Con. P.	War. P.	Ter. P.	For. P.	Bid. P.	Con. P.	War. P.	Ter. P.
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(a-f)*	*(b-g)*	*(c-h)*	*(d-i)*	*(e-j)*
INT01	3.7	3.7	3.7	3.7	3.7	3.0	3.0	3.0	3.0	3.0	0.7	0.7	0.7	0.7	0.7
INT02	3.5	3.5	3.5	3.5	3.5	3.0	3.0	3.0	4.0	3.0	0.5	0.5	0.5	-0.5	0.5
INT03	1.0	1.0	2.8	2.8	2.8	1.0	1.0	3.0	3.0	3.0	0.0	0.0	-0.2	-0.2	-0.2
INT04	3.2	3.2	3.2	3.2	3.2	3.0	3.0	3.0	3.0	3.0	0.2	0.2	0.2	0.2	0.2
INT05	2.9	1.9	2.9	2.9	2.9	3.0	2.0	3.0	3.0	3.0	-0.1	-0.1	-0.1	-0.1	-0.1
INT06	2.4	2.4	2.4	2.4	2.4	2.0	3.0	2.0	3.0	2.0	0.4	-0.6	0.4	-0.6	0.4
INT07	2.7	1.7	2.7	1.7	1.7	3.0	2.0	3.0	2.0	2.0	-0.3	-0.3	-0.3	-0.3	-0.3
INT08	2.3	2.7	2.7	2.7	2.7	3.0	3.0	3.0	3.0	3.0	-0.7	-0.3	-0.3	-0.3	-0.3
INT09	3.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0	3.0	3.0	0.1	0.1	0.1	0.1	0.1
INT10	1.0	2.6	2.6	2.6	2.6	1.0	3.0	3.0	3.0	3.0	0.0	-0.4	-0.4	-0.4	-0.4
INT11	1.6	1.6	2.6	2.6	1.6	2.0	2.0	3.0	3.0	2.0	-0.4	-0.4	-0.4	-0.4	-0.4
INT12	-	2.4	2.4	2.4	2.4	-	3.0	2.0	2.0	2.0	-	-0.6	0.4	0.4	0.4
PRO01	-	-	3.2	3.2	-	-	-	3.0	3.0	-	-	-	0.2	0.2	-
PRO02	-	-	3.3	2.3	-	-	-	4.0	2.0	-	-	-	-0.7	0.3	-
PRO03	-	-	3.0	3.0	-	-	-	3.0	3.0	-	-	-	0.0	0.0	-
PRO04	-	4.0	4.0	-	-	-	4.0	4.0	-	-	-	0.0	0.0	-	-
PRO05	-	-	4.0	4.0	4.0	-	-	4.0	4.0	4.0	-	-	0.0	0.0	0.0
PRO06	3.0	-	-	-	-	3.0	-	-	-	-	0.0	-	-	-	-
PRO07	-	2.4	3.4	-	-	-	3.0	3.0	-	-	-	-0.6	0.4	-	-
PRO08	3.7	3.7	3.7	3.7	2.7	3.0	4.0	4.0	4.0	4.0	0.7	-0.3	-0.3	-0.3	-1.3
EXT01	3.2	3.2	3.4	2.2	2.2	3.0	3.0	3.0	2.0	2.0	0.2	0.2	0.4	0.2	0.2
EXT02	3.4	3.4	3.6	2.4	2.4	3.0	3.0	3.0	2.0	2.0	0.4	0.4	0.6	0.4	0.4
EXT03	-	-	2.2	2.2	-	-	-	2.0	2.0	-	-	-	0.2	0.2	-
EXT04	-	-	2.2	1.2	-	-	-	2.0	1.0	-	-	-	0.2	0.2	-
EXT05	1.2	1.2	2.2	-	-	1.0	1.0	2.0	-	-	0.2	0.2	0.2	-	-
EXT06	2.1	2.1	2.1	2.1	-	2.0	2.0	2.0	2.0	-	0.1	0.1	0.1	0.1	-
EXT07	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0
EXT08	2.7	-	2.7	-	3.7	3.0	-	3.0	-	4.0	-0.3	-	-0.3	-	-0.3
EXT09	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0
EXT10	-	-	4.0	4.0	-	-	-	4.0	4.0	-	-	-	0.0	0.0	-
					|ER| ≥ 1.0			Major error			0	0	0	0	1
					0.50 ≤ |ER| < 1.00			Acceptable error			4	5	4	3	2
					0 < |ER| < 0.50			Minor error			11	12	19	17	13
					ER = 0			None error			5	4	6	5	3
					Total risks						20	21	29	25	19

Table 11-7 Comparison of CSQ and AI for Case No.2

Risk code	Consequence by system (CSQ)						Actual impact (AI)						Error value (ER)					
	For. P.	Bid. P.	Con. P.		War. P.	Ter. P.	For. P.	Bid. P.	Con. P.		War. P.	Ter. P.	For. P.	Bid. P.	Con. P.		War. P.	Ter. P.
			Cost	Sche.					Cost	Sche.					Cost	Sche.		
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(k)*	*(l)*	*(a-g)*	*(b-h)*	*(c-i)*	*(d-j)*	*(e-k)*	*(f-l)*
INT01	3.7	1.7	3.2	2.3	2.2	1.3	3.0	2.0	4.0	3.0	3.0	2.0	0.7	-0.3	-0.8	-0.7	-0.8	-0.7
INT02	3.8	3.3	4.1	3.6	2.2	1.4	4.0	3.0	4.0	4.0	2.0	2.0	-0.2	0.3	0.1	-0.4	0.2	-0.6
INT03	4.0	3.7	3.3	4.1	2.9	4.0	4.0	4.0	3.0	4.0	3.0	4.0	0.0	-0.3	0.3	0.1	-0.1	0.0
INT04	3.3	3.2	2.8	2.9	2.2	3.4	3.5	3.0	3.0	3.0	3.0	4.0	-0.2	0.2	-0.2	-0.1	-0.8	-0.6
INT05	2.9	3.6	2.6	3.5	3.4	4.6	3.0	3.0	3.0	3.0	3.0	4.0	-0.1	0.6	-0.4	0.5	0.4	0.6
INT06	4.3	2.2	3.3	2.0	3.3	4.2	4.0	3.0	3.0	2.0	3.0	4.0	0.3	-0.8	0.3	0.0	0.3	0.2
INT07	4.2	2.7	2.9	2.4	2.4	2.6	4.0	3.0	2.0	3.0	3.0	2.0	0.2	-0.3	0.9	-0.6	-0.6	0.6
INT08	3.3	2.7	3.4	2.6	2.4	3.2	4.0	3.0	3.0	3.0	3.0	3.0	-0.7	-0.3	0.4	-0.4	-0.6	0.2
INT09	1.9	3.3	2.9	3.4	2.2	2.8	2.0	3.0	3.0	3.0	2.0	3.0	-0.1	0.3	-0.1	0.4	0.2	-0.2
INT10	3.1	3.4	1.6	3.3	2.1	3.8	3.0	4.0	2.0	3.0	2.0	4.0	0.1	-0.6	-0.4	0.3	0.1	-0.2
INT11	3.2	3.6	3.1	3.4	2.1	3.1	3.0	3.0	4.0	4.0	3.0	4.0	0.2	0.6	-0.9	-0.6	-0.9	-0.9
INT12	-	2.2	3.3	2.2	3.6	2.8	-	3.0	3.0	2.0	4.0	3.0	-	-0.8	0.3	0.2	-0.4	-0.2
PRO01	-	-	3.1	2.3	2.9	-	-	-	4.0	2.0	3.0	-	-	-	-0.9	0.3	-0.1	-
PRO02	-	-	4.1	4.2	2.8	-	-	-	4.0	4.0	3.0	-	-	-	0.1	0.2	-0.2	-
PRO03	-	-	3.3	4.1	2.4	-	-	-	4.0	4.0	3.0	-	-	-	-0.7	0.1	-0.6	-
PRO04	-	4.0	3.7	3.3	-	-	-	4.0	4.0	3.0	-	-	-	0.0	-0.3	0.3	-	-
PRO05	-	-	2.9	2.3	2.8	2.4	-	-	3.0	2.0	3.0	3.0	-	-	-0.1	0.3	-0.2	-0.6
PRO06	4.3	-	-	-	-	-	4.0	-	-	-	-	-	0.3	-	-	-	-	-
PRO07	-	3.4	3.3	3.4	-	-	-	3.0	4.0	3.0	-	-	-	0.4	-0.7	0.4	-	-
PRO08	3.3	2.6	2.5	2.2	3.1	3.2	4.0	3.0	3.0	2.0	3.0	4.0	-0.7	-0.4	-0.5	0.2	0.1	-0.8
EXT01	1.7	2.1	2.4	3.4	2.4	2.4	2.0	2.0	2.0	3.0	3.0	2.0	-0.3	0.1	0.4	0.4	-0.6	0.4
EXT02	2.8	3.4	2.2	3.4	2.1	2.6	3.0	3.0	2.0	3.0	2.0	3.0	-0.2	0.4	0.2	0.4	0.1	-0.4
EXT03	-	-	1.6	3.8	1.7	-	-	-	2.0	4.0	2.0	-	-	-	-0.4	-0.2	-0.3	-
EXT04	-	-	2.2	2.1	1.2	-	-	-	3.0	3.0	2.0	-	-	-	-0.8	-0.9	-0.8	-
EXT05	2.8	1.4	3.2	4.6	-	-	3.0	2.0	3.0	4.0	-	-	-0.2	-0.6	0.2	0.6	-	-
EXT06	1.2	1.1	2.2	1.7	1.7	-	2.0	1.0	2.5	2.0	2.0	-	-0.8	0.1	-0.3	-0.3	-0.3	-
EXT07	2.2	2.2	1.6	2.1	2.8	3.6	2.0	2.0	2.0	2.0	3.0	4.0	0.2	0.2	-0.4	0.1	-0.2	-0.4
EXT08	2.3	-	2.0	2.7	-	1.8	2.0	-	2.0	2.0	-	2.0	0.3	-	0.0	0.7	-	-0.2
EXT09	1.7	2.2	4.7	3.4	1.7	3.1	2.0	2.0	5.0	3.0	2.0	3.0	-0.3	0.2	-0.3	0.4	-0.3	0.1
EXT10	-	-	2.6	1.3	2.1	-	-	-	3.0	2.0	2.0	-	-	-	-0.4	-0.7	0.1	-
							$\lvert ER \rvert \geq 1.0$			Major error			0	0	0	0	0	0
							$0.50 \leq \lvert ER \rvert < 1.00$			Acceptable error			4	6	8	8	8	8
							$0 < \lvert ER \rvert < 0.50$			Minor error			15	14	20	20	17	10
							$ER = 0$			None error			1	1	1	1	0	1
							Total risks						20	21	29	29	25	19

Table 11-8 Comparison of LLH and AF for Case No.2

Risk Code	Consequence by system (LLH)					Actual impact (AF)					Error value (ER)				
	For. P.	Bid. P.	Con. P.	War. P.	Ter. P.	For. P.	Bid. P.	Con. P.	War. P.	Ter. P.	For. P.	Bid. P.	Con. P.	War. P.	Ter. P.
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(a-f)*	*(b-g)*	*(c-h)*	*(d-i)*	*(e-j)*
INT01	2.7	2.7	2.7	2.7	2.7	3.0	3.0	3.0	3.0	2.0	-0.3	-0.3	-0.3	-0.3	0.7
INT02	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0	-0.1	-0.1	-0.1	-0.1	-0.1
INT03	1.0	1.0	3.0	3.0	3.0	1.0	1.0	3.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0
INT04	3.5	3.5	3.5	3.5	3.5	3.0	3.0	3.0	3.0	3.0	0.5	0.5	0.5	0.5	0.5
INT05	3.3	2.3	3.3	3.3	3.3	3.0	2.0	3.0	3.0	3.0	0.3	0.3	0.3	0.3	0.3
INT06	3.1	3.1	3.1	3.1	3.1	3.0	3.0	3.0	4.0	3.0	0.1	0.1	0.1	-0.9	0.1
INT07	3.1	2.1	3.1	2.1	2.1	3.0	3.0	3.0	2.0	2.0	0.1	-0.9	0.1	0.1	0.1
INT08	3.0	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0	0.0	-0.1	-0.1	-0.1	-0.1
INT09	3.9	3.9	3.9	3.9	3.9	4.0	4.0	4.0	3.0	4.0	-0.1	-0.1	-0.1	0.9	-0.1
INT10	1.7	3.7	3.7	3.7	3.7	1.0	3.0	4.0	4.0	4.0	0.7	0.7	-0.3	-0.3	-0.3
INT11	2.6	2.6	3.6	3.6	2.6	2.0	2.0	3.0	4.0	3.0	0.6	0.6	0.6	-0.4	-0.4
INT12	-	3.1	3.1	3.1	3.1	-	3.0	4.0	4.0	3.0	-	0.1	-0.9	-0.9	0.1
PRO01	-	-	3.5	3.5	-	-	-	4.0	4.0	-	-	-	-0.5	-0.5	-
PRO02	-	-	3.2	2.2	-	-	-	3.0	2.0	-	-	-	0.2	0.2	-
PRO03	-	-	3.6	3.6	-	-	-	3.0	3.0	-	-	-	0.6	0.6	-
PRO04	-	3.6	3.6	-	-	-	3.0	4.0	-	-	-	0.6	-0.4	-	-
PRO05	-	-	3.7	3.7	3.7	-	-	4.0	4.0	4.0	-	-	-0.3	-0.3	-0.3
PRO06	3.0	-	-	-	-	3.0	-	-	-	-	0.0	-	-	-	-
PRO07	-	2.2	3.2	-	-	-	2.0	3.0	-	-	-	0.2	0.2	-	-
PRO08	3.4	3.4	3.4	3.4	2.4	3.0	3.0	3.0	3.0	2.0	0.4	0.4	0.4	0.4	0.4
EXT01	3.8	3.8	3.3	2.8	2.8	4.0	4.0	3.0	2.0	3.0	-0.2	-0.2	0.3	0.8	-0.2
EXT02	3.6	3.6	3.1	2.6	2.6	3.0	3.0	3.0	3.0	2.0	0.6	0.6	0.1	-0.4	0.6
EXT03	-	-	2.8	2.8	-	-	-	3.0	2.0	-	-	-	-0.2	0.8	-
EXT04	-	-	3.4	2.4	-	-	-	4.0	2.0	-	-	-	-0.6	0.4	-
EXT05	2.1	2.1	3.1	-	-	2.0	2.0	3.0	-	-	0.1	0.1	0.1	-	-
EXT06	3.2	3.2	3.2	3.2	-	3.0	3.0	3.0	3.0	-	0.2	0.2	0.2	0.2	-
EXT07	2.5	2.5	2.5	2.5	2.5	3.0	3.0	3.0	3.0	3.0	-0.5	-0.5	-0.5	-0.5	-0.5
EXT08	2.5	-	2.5	-	3.5	3.0	-	3.0	-	3.0	-0.5	-	-0.5	-	0.5
EXT09	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	0.0	0.0	0.0	0.0	0.0
EXT10	-	-	4.0	4.0	-	-	-	4.0	4.0	-	-	-	0.0	0.0	-
					|ER| ≥ 1.0			Major error			0	0	0	0	0
					0.50 ≤ |ER| < 1.00			Acceptable error			6	7	8	9	5
					0 < |ER| < 0.50			Minor error			10	12	18	13	12
					ER = 0			None error			4	2	3	3	2
					Total risks						20	21	29	25	19

Table 11-9 Comparison of CSQ and AI for Case No.3

Risk code	Consequence by system (CSQ)						Actual impact (AI)						Error value (ER)					
	For. P.	Bid. P.	Con. P.		War. P.	Ter. P.	For. P.	Bid. P.	Con. P.		War. P.	Ter. P.	For. P.	Bid. P.	Con. P.		War. P.	Ter. P.
			Cost	Sche.					Cost	Sche.					Cost	Sche.		
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(k)*	*(l)*	*(a-g)*	*(b-h)*	*(c-i)*	*(d-j)*	*(e-k)*	*(f-l)*
INT01	3.7	1.7	3.2	2.3	-	-	4.0	2.0	3.0	2.0	-	-	-0.3	-0.3	0.2	0.3	-	-
INT02	3.8	3.3	4.1	3.6	-	-	4.0	3.0	4.0	4.0	-	-	-0.2	0.3	0.1	-0.4	-	-
INT03	4.0	3.7	3.3	4.1	-	-	4.0	4.0	3.0	4.0	-	-	0.0	-0.3	0.3	0.1	-	-
INT04	3.3	3.2	2.8	2.9	-	-	3.0	4.0	3.0	3.0	-	-	0.3	-0.8	-0.2	-0.1	-	-
INT05	2.9	3.6	2.6	3.5	-	-	3.0	4.0	3.0	4.0	-	-	-0.1	-0.4	-0.4	-0.5	-	-
INT06	4.3	2.2	3.3	2.0	-	-	4.0	2.0	4.0	2.0	-	-	0.3	0.2	-0.7	0.0	-	-
INT07	4.2	2.7	2.9	2.4	-	-	4.0	3.0	3.0	3.0	-	-	0.2	-0.3	-0.1	-0.6	-	-
INT08	3.3	2.7	3.4	2.6	-	-	3.0	3.0	4.0	3.0	-	-	0.3	-0.3	-0.6	-0.4	-	-
INT09	1.9	3.3	2.9	3.4	-	-	2.0	3.0	3.0	3.0	-	-	-0.1	0.3	-0.1	0.4	-	-
INT10	3.1	3.4	1.6	3.3	-	-	3.0	3.0	2.0	3.0	-	-	0.1	0.4	-0.4	0.3	-	-
INT11	3.2	3.6	3.1	3.4	-	-	3.0	4.0	3.0	3.0	-	-	0.2	-0.4	0.1	0.4	-	-
INT12	-	2.2	3.3	2.2	-	-	-	2.0	3.0	2.0	-	-	-	0.2	0.3	0.2	-	-
PRO01	-	-	3.1	2.3	-	-	-	-	3.0	3.0	-	-	-	-	0.1	-0.7	-	-
PRO02	-	-	4.1	4.2	-	-	-	-	4.0	4.0	-	-	-	-	0.1	0.2	-	-
PRO03	-	-	3.3	4.1	-	-	-	-	4.0	4.0	-	-	-	-	-0.7	0.1	-	-
PRO04	-	4.0	3.7	3.3	-	-	-	4.0	3.0	3.0	-	-	-	0.0	0.7	0.3	-	-
PRO05	-	-	2.9	2.3	-	-	-	-	3.0	2.0	-	-	-	-	-0.1	0.3	-	-
PRO06	4.3	-	-	-	-	-	4.0	-	-	-	-	-	0.3	-	-	-	-	-
PRO07	-	3.4	3.3	3.4	-	-	-	4.0	3.0	3.0	-	-	-	-0.6	0.3	0.4	-	-
PRO08	3.3	2.6	2.5	2.2	-	-	3.0	3.0	3.0	3.0	-	-	0.3	-0.4	-0.5	-0.8	-	-
EXT01	1.7	2.1	2.4	3.4	-	-	2.0	2.0	2.0	3.0	-	-	-0.3	0.1	0.4	0.4	-	-
EXT02	2.8	3.4	2.2	3.4	-	-	3.0	3.0	3.0	3.0	-	-	-0.2	0.4	-0.8	0.4	-	-
EXT03	-	-	1.6	3.8	-	-	-	-	2.0	4.0	-	-	-	-	-0.4	-0.2	-	-
EXT04	-	-	2.2	2.1	-	-	-	-	2.0	2.0	-	-	-	-	0.2	0.1	-	-
EXT05	2.8	1.4	3.2	4.6	-	-	2.0	1.0	3.0	4.0	-	-	0.8	0.4	0.2	0.6	-	-
EXT06	1.2	1.1	2.2	1.7	-	-	1.0	1.0	2.0	2.0	-	-	0.2	0.1	0.2	-0.3	-	-
EXT07	2.2	2.2	1.6	2.1	-	-	2.0	2.0	2.0	2.0	-	-	0.2	0.2	-0.4	0.1	-	-
EXT08	2.3	-	2.0	2.7	-	-	2.0	-	2.0	3.0	-	-	0.3	-	0.0	-0.3	-	-
EXT09	1.7	2.2	4.7	3.4	-	-	2.0	2.0	5.0	3.0	-	-	-0.3	0.2	-0.3	0.4	-	-
EXT10	-	-	2.6	1.3	-	-	-	-	3.0	2.0	-	-	-	-	-0.4	-0.7	-	-
							|ER| ≥ 1.0		Major error				0	0	0	0	-	-
							0.50 ≤ |ER| < 1.00		Acceptable error				1	2	6	6	-	-
							0 < |ER| < 0.50		Minor error				18	18	22	22	-	-
							ER = 0		None error				1	1	1	1	-	-
							Total risks						20	21	29	29	-	-

Table 11-10 Comparison of LLH and AF values for case No.3

Risk Code	Consequence by system (LLH)					Actual impact (AF)					Error value (ER)				
	For. P.	Bid. P.	Con. P.	War. P.	Ter. P.	For. P.	Bid. P.	Con. P.	War. P.	Ter. P.	For. P.	Bid. P.	Con. P.	War. P.	Ter. P.
	(a)	*(b)*	*(c)*	*(d)*	*(e)*	*(f)*	*(g)*	*(h)*	*(i)*	*(j)*	*(a-f)*	*(b-g)*	*(c-h)*	*(d-i)*	*(e-j)*
INT01	3.1	3.1	3.1	-	-	3.0	3.0	3.0	-	-	0.1	0.1	0.1	-	-
INT02	3.1	3.1	3.1	-	-	3.0	3.0	3.0	-	-	0.1	0.1	0.1	-	-
INT03	1.0	1.0	2.5	-	-	1.0	1.0	2.0	-	-	0.0	0.0	0.5	-	-
INT04	2.1	2.1	2.1	-	-	2.0	2.0	2.0	-	-	0.1	0.1	0.1	-	-
INT05	2.9	1.9	2.9	-	-	2.0	2.0	3.0	-	-	0.9	-0.1	-0.1	-	-
INT06	3.2	3.2	3.2	-	-	3.0	4.0	3.0	-	-	0.2	-0.8	0.2	-	-
INT07	3.5	2.5	3.5	-	-	3.0	2.0	3.0	-	-	0.5	0.5	0.5	-	-
INT08	3.3	3.4	3.4	-	-	3.0	3.0	3.0	-	-	0.3	0.4	0.4	-	-
INT09	3.0	3.0	3.0	-	-	3.0	3.0	3.0	-	-	0.0	0.0	0.0	-	-
INT10	1.1	3.1	3.1	-	-	1.0	3.0	3.0	-	-	0.1	0.1	0.1	-	-
INT11	2.1	2.1	3.1	-	-	3.0	3.0	3.0	-	-	-0.9	-0.9	0.1	-	-
INT12	-	3.0	3.0	-	-	-	3.0	3.0	-	-	-	0.0	0.0	-	-
PRO01	-	-	2.7	-	-	-	-	3.0	-	-	-	-	-0.3	-	-
PRO02	-	-	2.4	-	-	-	-	3.0	-	-	-	-	-0.6	-	-
PRO03	-	-	3.0	-	-	-	-	3.0	-	-	-	-	0.0	-	-
PRO04	-	2.7	2.7	-	-	-	3.0	3.0	-	-	-	-0.3	-0.3	-	-
PRO05	-	-	3.0	-	-	-	-	3.0	-	-	-	-	0.0	-	-
PRO06	3.2	-	-	-	-	3.0	-	-	-	-	0.2	-	-	-	-
PRO07	-	1.8	2.8	-	-	-	2.0	3.0	-	-	-	-0.2	-0.2	-	-
PRO08	3.2	3.2	3.2	-	-	3.0	3.0	3.0	-	-	0.2	0.2	0.2	-	-
EXT01	2.8	2.8	3.1	-	-	3.0	3.0	3.0	-	-	-0.2	-0.2	0.1	-	-
EXT02	2.5	2.5	3.0	-	-	2.0	2.0	3.0	-	-	0.5	0.5	0.0	-	-
EXT03	-	-	2.0	-	-	-	-	4.0	-	-	-	-	-2.0	-	-
EXT04	-	-	2.3	-	-	-	-	2.0	-	-	-	-	0.3	-	-
EXT05	1.3	1.3	2.3	-	-	1.0	2.0	2.0	-	-	0.3	-0.7	0.3	-	-
EXT06	2.6	2.6	2.6	-	-	2.0	2.0	2.0	-	-	0.6	0.6	0.6	-	-
EXT07	3.1	3.1	3.1	-	-	3.0	3.0	3.0	-	-	0.1	0.1	0.1	-	-
EXT08	3.2	-	3.2	-	-	3.0	-	3.0	-	-	0.2	-	0.2	-	-
EXT09	5.0	5.0	5.0	-	-	5.0	5.0	5.0	-	-	0.0	0.0	0.0	-	-
EXT10	-	-	4.0	-	-	-	-	4.0	-	-	-	-	0.0	-	-
					|ER| ≥ 1.0		Major error				0	0	1	-	-
					0.50 ≤ |ER| < 1.00		Acceptable error				5	6	4	-	-
					0 < |ER| < 0.50		Minor error				12	11	17	-	-
					ER = 0		None error				3	4	7	-	-
					Total risks						20	21	29	-	-

Table 11-11 Overview of System Validation Results for 3 cases

Phase of CJV life cycle	Case study	CSQ and AI				LLH and AF				Total per Value
		Major error	Accept. error	Minor error	None error	Major error	Accept. error	Minor error	None error	
		|ER| ≥ 1.0	0.50 ≤ |ER| < 1.00	0 < |ER| < 0.50	ER = 0	|ER| ≥ 1.0	0.50 ≤ |ER| < 1.00	0 < |ER| < 0.50	ER = 0	
For. P.	case No.1	0 *0.0%*	3 *15.0%*	16 *80.0%*	1 *5.0%*	0 *0.0%*	4 *20.0%*	11 *55.0%*	5 *25.0%*	20 *100%*
	case No.2	0 *0.0%*	4 *20.0%*	15 *75.0%*	1 *5.0%*	0 *0.0%*	6 *30.0%*	10 *50.0%*	4 *20.0%*	20 *100%*
	case No.3	0 *0.0%*	1 *5.0%*	18 *90.0%*	1 *5.0%*	0 *0.0%*	5 *25.0%*	12 *60.0%*	3 *15.0%*	20 *100%*
Bid. P.	case No.1	0 *0.0%*	4 *19.0%*	16 *76.2%*	1 *4.8%*	0 *0.0%*	5 *23.8%*	12 *57.1%*	4 *19.0%*	21 *100%*
	case No.2	0 *0.0%*	6 *28.6%*	14 *66.7%*	1 *4.8%*	0 *0.0%*	7 *33.3%*	12 *57.1%*	2 *9.5%*	21 *100%*
	case No.3	0 *0.0%*	2 *9.5%*	18 *85.7%*	1 *4.8%*	0 *0.0%*	6 *28.6%*	11 *52.4%*	4 *19.0%*	21 *100%*
Con. P. (Cost)	case No.1	0 *0.0%*	5 *17.2%*	23 *79.3%*	1 *3.4%*	0 *0.0%*	4 *13.7%*	19 *65.5%*	6 *20.1%*	29 *100%*
	case No.2	0 *0.0%*	8 *27.5%*	20 *69.0%*	1 *3.4%*	0 *0.0%*	8 *27.5%*	18 *62.1%*	3 *10.3%*	29 *100%*
	case No.3	0 *0.0%*	6 *20.1%*	22 *75.9%*	1 *3.4%*	1 *3.4%*	4 *13.7%*	17 *58.6%*	7 *24.1%*	29 *100%*
Con. P. (Sche.)	case No.1	0 *0.0%*	9 *31.0%*	19 *65.5%*	1 *3.4%*					29 *100%*
	case No.2	0 *0.0%*	8 *27.5%*	20 *69.0%*	1 *3.4%*					29 *100%*
	case No.3	0 *0.0%*	6 *20.1%*	22 *75.9%*	1 *3.4%*					29 *100%*
War. P.	case No.1	0 *0.0%*	6 *24.0%*	19 *76.0%*	0 *0.0%*	0 *0.0%*	3 *12.0%*	17 *68.0%*	5 *20.0%*	25 *100%*
	case No.2	0 *0.0%*	8 *32.0%*	17 *68.0%*	0 *0.0%*	0 *0.0%*	9 *36.0%*	13 *52.0%*	3 *12.0%*	25 *100%*
	case No.3	- -	- -	- -	- -	- -	- -	- -	- -	- -
Ter. P.	case No.1	1 *5.3%*	4 *21.1%*	13 *68.4.0%*	1 *5.3%*	1 *5.3%*	2 *10.5%*	13 *68.4%*	3 *15.8%*	19 *100%*
	case No.2	0 *0.0%*	8 *42.1%*	10 *52.6%*	1 *5.3%*	0 *0.0%*	5 *26.3%*	12 *63.2%*	2 *10.5%*	19 *100%*
	case No.3	- -	- -	- -	- -	- -	- -	- -	- -	- -
Total	case No.1 (5 phases)	0.7%	21.7%	74.1%	3.5%	0.9%	15.8%	63.2%	20.2%	
	case No.2 (5 phases)	0.0%	29.4%	67.1%	3.5%	0.0%	30.7%	57.0%	12.3%	
	case No.3 (3 phases)	0.0%	15.2%	80.8%	4.0%	1.4%	21.1%	57.1%	20.0%	

11.4.4 Validation Analysis and Discussion

When considering the results of M-DRP subsystem validation in the overall picture, as shown in Table 11-11, it can be found that the characteristic of the ER for the three cases are very similar. That is M-DRP subsystem could predict the risk parameter, including the CSQ and LLH, for CJV operation in the five phases of CJV Life cycle so that it is close to the AI and AF value of each factor which really happened.

In additional, the difference between the real results and the predictive results or ER mostly were fallen in the minor error ($0 < |ER| < 0.50$). In every cases, this error would be the ratio of 60-90% of the entire risks when considering in the overall picture of five phases. Whereas the difference in the acceptable error ($0.50 \leq |ER| < 1.00$) is next in the amount. It is the ratio of 10-40%. The major error ($|ER| \geq 1.0$) is rare. On average, it is at 5% except for the case No.2 which is 0%.

From the fact that most error value is the minor error while the difference is the major error has a very little ratio. For overview, the total amount of risk parameter with the mirror error to none error of case No. 1, No. 2, and No.3 are 77.6%, 70.6% and 84.8% for CSQ and 83.3%, 69.2%, 77.1% for LLH. Therefore, it can be concluded that LCRM system has enough ability to be used in the real world.

As for the results, the analysis of the validation process for three cases in details are as follows.

(1) Results with none error

In the overview, M-DRP subsystem gives the results of risk prediction with none error in the low rate.

That is, the amount of none error for CSQ in the overall picture is only 3.5%, 3.5% and 4.0% for case No. 1, No. 2, and No.3, respectively. For LLH in the overall picture, the amount of none error is only 20.2%, 12.3% and 20.0% for the case No. 1, No. 2, and No.3, respectively.

When considering in each phase, it is found that the trends for phases are not different. The highest amount of risk parameter with none error is 20% in the formation phase of case No. 2, while the lowest amount is zero in the warranty phase of both case No. 1 and No. 2.

The reason that makes the result of the validation process to have the amount of difference in the results in none error way in a very little amount because while the real results compared when finding the error is always in full amount but the predictive results would often be in the one decimal number.

(2) Results with the minor error

It could be said that most of the CSQ and LLH predicted by M-DRP subsystem are the values with the minor error ($0 < |ER| < 0.50$).

In the overall, for CSQ, the number of results with the minor error for case No. 1, No. 2, and No.3 are 74.1%, 67.1% and 80.8%, respectively. It decreased slightly for LLH. They are 63.2%, 57.0% and 57.1% for the case No. 1, No. 2, and No.3, respectively.

For each phase in each case, the trends are also same. The average amount of CSQ, in each phase, with the minor error 60%-80% except that the warranty phase of case No. 2 are only 52%. For the LLH, the 55%-65% of factors in each phase for three cases are the values with the minor error

(3) Results with the acceptable error

Considering all risk parameters in the five phases of the three cases, it is found that around one in three of total have the ER in the acceptable range ($0.50 \leq |ER| < 1.00$).

When considering in overall, there are 21.7%, 29.3% and 15.2% of the CSQ with the acceptable error for case No. 1, No. 2, and No.3, respectively. As well for the LLH, the case No. 1, No. 2, and No.3 have 15.7%, 30.7% and 21.4% of factors with the acceptable LLH. These trends of the CSQ and LLH were found for each phase of three cases.

The fact that the error value almost one third has error in an acceptable Error, in some viewpoint, we can consider that it is rather high but for this study it is considered to be in an acceptable level because the number format restriction between the system and real results as the details are explained above.

(4) Results with major error

As for the value that uses the scale with the interval of one pint to five point, the fact that the ER with the major error ($|ER| \geq 1.0$) is considered as the significance because this error would make the interpretation of the result and to use the said result would cause mistakes.

When considering the results of the CSQ and LLH predicted from M-DRP subsystem in three cases, it was found that the results with the major error were very low, as follows:

1) For the case No.1

There are only two ERs with the major error. Each ER is for CSQ and LLH in the termination phase.

2) For the case No.2

It was found that there is none both CSQ and LLH in all five phases of CVJ life cycle with the major error.

3) For the case No.3

It was found that there is none CSQ with the major error. However, for LLH, there is one LLH value with the major error.

From interviewing with the participants who joined the system validation process, it was found that the reasons, to cause the errors of CSQ and/or LLH with the major error, are from the facts that the some situations of cases were abnormal. These situations made the CSQ and/or LLH gotten from M-DRP subsystem were lower than the actual. The situation for each case can be explained as follows.

1) Reason for the major error in the case No. 1

Both the CSQ and LLH, which have the major errors, belong to be the risk that uses the name "Intervention and delay by owner or its representative" in the termination phase.

The said project has revised a large amount of the details which causes the expense that the contractor sees that it does not include in the contract so there is a negotiating process to request additional wage. The said process has not been settled until today because the owner has not decide the results of the claims by trying to hold the various matter even though it has been many years. It is considered longer than what would happen in general projects so the testing people give the real results of the AI and AF value in a very high value. As for the CSQ and LLH that has been evaluated from that system is lower because it is evaluated from a normal format that happens from general project. The testing people see that the said problem is from the delay of owner represent and leave the entire work burden to the owner and political problem and organizational image.

2) **Reason for the major error in for the case No. 2**

There is none value with the major error for discussion.

3) **Reason for the major error in for the case No. 3**

The LLH that happens in the major error level is the opportunity in occurrence of "Natural disasters and Unpredictable weather" during the construction phase.

During the construction, the case had encountered the flood of Thailand at the end of 2012 which is a natural disaster which happened almost a month around the construction site of the case. This made the participant to give the real results of AF for this risk that is very high. Whereas, the LLH for the same factor from M-DRP subsystem is low because the evaluation process in the system was based in the format of the natural disaster that would happen regularly in the area.

11.5 Summary

After the development of two modules in the M-DRP subsystem as well as, its application software were complete. It needs to be verified and validated in order to make sure that the process of application software and the results by this subsystem are according to the purposed objectives.

For the verification, the application software of M-DRP subsystem was required the process to validate can comply with requirement and imposed condition of this study without errors and bugs. As the results of verification process by comparing results by application software with results by hands, it was found that the results from both methods are almost no different. However, if the results are considered in the details, they would be found that the results from both processes are different in the one digit after the point. They are that the errors of some LLH are always "-0.1" while the error range of LOR is "-0.1" to "-0.4". Finally, it could lead to the conclusion that the system and its application software gives the correct result with the specified process.

For the validation, the results from prediction process in M-DRP subsystem have to be validated by compare the predictive results with the actual results from the real situations of that CJV. So, the M-DRP subsystem were tested with three cases which are CJVs operating in Thailand. After the process of validation, it was found that the difference between the real results and the predictive results or "ER" mostly were fallen in the minor error ($0 < |ER| < 0.50$). In every cases, this error would be the ratio of 60-90% of the entire risks when considering in the overall picture of five phases. Whereas the difference in the acceptable error ($0.50 \leq |ER| < 1.00$) is next in the amount. It is the ratio of 10-40%. The major error ($|ER| \geq 1.0$) is rare. On average, it is at 5% except for the case No.2 which is 0%. For overview, the total amount of risk parameter with the mirror error to none error of case No. 1, No. 2, and No.3 are 77.6%, 70.6% and 84.8% for CSQ and 83.3%, 69.2%, 77.1% for LLH. Therefore, it can be concluded that LCRM system has enough ability to be used in the real world.

CHAPTER XII
CONCLUSIONS AND RECOMMENDATIONS

For the final Chapter, it is focused on summarizing the details of the study to develop the Life Cycle Risk Management and Prediction (LCRMP) system with two subsystem, namely the Multi-Objective Risk Management (M-ORM) subsystem and the Multi-Determinant Risk Prediction (M-DRP) subsystem. It starts with the section of the summaries and conclusions for the results. Next, it is the section of the study and model limitations. Then, the recommendations for the study are described in the last parts of Chapter.

12.1 Summaries and Conclusions of Study

Via the processes of the study, it can be concluded that this study achieves the objectives to develop the specific model, called the life cycle risk management and prediction (LCRMP) system), to access the risks in all five phases of CJV life cycle under the effect of CJV organization structure, including the cooperative governance joint venture (CG-JV) and the separate governance joint venture (SG-JV). A contractor, as the user of the system, can realize the details, including the characteristic and the risk treatment options, for each risks in each phase via the functions in the subsystem of LCRMP system, namely Multi-Objective Risk Management (M-ORM) subsystem. Furthermore, the contract predict the risk parameter (consequence and likelihood) of risks for a future CJV via the another subsystem of LCRMP system, namely Multi-Determinant Risk Prediction (M-DRP) subsystem.

The fundamental basis of LCRMP system is focused on the CJV operation through life cycle. The scope of the system including the definition of five phases in CJV life cycle, the objectives of CJV or CJV project operation in each phase, sets of likert scale for evaluating consequence and likelihood in each phase and different forms of CJV organization had to be established. The details scopes for the LCRMP system are described in the Chapter 4 which can be summarized as follow:

1) The formation phase

   The main goal of the phase is the contractor could agree the details of partnership and sign the joint venture agreement (JVA) in time. Normally, the due date for this phase is the times before the final date to submit the bidding documents. From the study, there are 20 risks which should be considered to increase the chances of the goal achievement.

2) The bidding phase

   The preparation of the efficiency bid proposal and other documents is the main objective for this phase. This operation have to be finished. To increase the achievement of the objective during this phase, it was found that CJV management must to determine the 21 risks.

3) The construction phase

   The interesting objectives for CJV management in this phase are that the project can be finished on time and the project cost is still under the budget. As the study results, there 30 risks to consider for the construction success in the part of the cooperation between partners.

4) The warranty phase

   The cost for warranty and other related tasks as low as possible is the main objective for this phase. It was found that the 26 risks should be considered to help the success of this aim.

5) The termination phase

   To complete the disposal of CJV assets, the accounting entries for a closing venture unit and the legal processes is the objective for CJV management in this phase. The study indicated that there are 20 risks which affect the success of this operation.

Apart from considering the risks according to sequence phases of CJV life cycle, the study also focused on the impact of CJV organization structures. The responsibility and liability, as well as, the communication and coordination between partners of CJVs can be vary according to the organization structures. The detailed description about

CJV organization structures and the adaption into the study are indicated in Chapter 4. As the results, the two from four types of CJV organization structures are added as the component of risk assessment in LCRMP system. They are:

1) The cooperative governance joint venture (CG-JV)

They are CJVs which most tasks in project are handled by the cooperation of all partners. All partners would share the capital money, the staff, the resource, the responsibility and liability for the whole CJV project, mostly together.

2) The separate governance joint venture (SG-JV)

They are CJVs which most tasks are divided into work packages and each partner will handle them separately. The capital money, the staff, the resource, the responsibility and liability for each package are also responsible by a certain partner. However, all partners are still jointly and severally liable for obligations to the project owner and the third parties.

After the scopes of LCRMP system, being the risks in each phase of CJV life cycle and the types of CJV organization structures, were mentioned, there are two hypotheses which have to be answered:

1) Hypothesis No. 1

For a risk, its values of CSQ and LLH should be changes, when it is evaluated under the difference phase of CJV life cycle.

2) Hypothesis No. 2:

For a risk, its values of CSQ and LLH may be different, when it is evaluated under the difference of CJV organization structures.

Then, the processes to develop the M-ORM subsystem were started. The module M1 was to identifying risks for five phases of CJV life cycle. As the results, the 30 risks in the five phases of the CJV life cycle were identified and analyzed in detail. These risks are also categorized into three categories according to their characteristics. First, it is the internal risk category (INT). It is the group of risks which their source of risk relate to the internal environment of CJVs. So, the partners could control the source of risks in this category by the process of partner selection and the negotiation. The second group is the project risk category. The risks in this category mostly relate to the details in the construction contract documents and the capability of the owner and its representatives which CJV partner can rarely control their sources. For the final category, it is the external risk category which related to the external parameters of CJVs including the social, law, economic, environment and etc. The partners could not control the source of these risks. All details of this risks presents in the Chapter 5.

After identifying risks, the module M2 is that the consequence (CSQ) and likelihood (LLH), for all risks in all phases were be evaluated through the process of in-depth interviews and surveyed with 34 sample in each phase. These sample are the engineers who have experienced with CJVs in Thailand. The Delphi method for the process of data collection and the nonparametric statistic, as well as, the measures of central tendency for the process of data analysis and hypothesis testing were used as the main techniques.

The results of the testing, as shown in Chapter 6, confirmed the answers of the two hypotheses. First, the value of CSQ and LLH for the 30 risks would be different between the phases of CJV life cycle. When a CJV is managed through its life span, CSQ and LLH may be more or less from their values in the previous phase. This finding is the results that there are the difference in each phase of CJV life cycle including the objectives and the constraints, although these objectives would be the key pieces of the accomplishment of the objectives for the partnership and CJV management. Next, when CJVs are managed under the difference organization structures, being the CG-JV or the SG-JV, the CSQ and/or LLH for some risk at the same phase may be different. The possible cases can be that the CSQ and/or LLH of the CG-JV are higher than them of the SG-JV or, conversely, the values in the SG-JV are higher. The unique of the power to control, the responsibility and the liability between both organization structures are the main reason for the difference in the CSQ and/or LLH.

As well, M-ORM subsystem also has the module M3 and M4 to guide the partners to consider the critical risks to response. In additional, the guideline of risk treatment options also presents in the system. However, it should be noted that these guidelines are just the instruction. CJV partners can modify criterion and/or the treatment options as appropriate for their CJV. Chapter 7 describes the details of both guidelines.

The answers from both hypotheses lead to the assumption for another subsystem of LCRMP system, named M-DRP subsystem. For the first module of this subsystem, the module P1 is the identification process for determents which are the representatives of CJV situations. It is found that there are 48 determinants which have enough significant implication to change the LLH for 30 risks. These determinants are categorized into ten groups based on their characteristics and how they relate to the situations of the CJVs. They are (1) determinants of the contractor, (2) determinants of the partners, (3) determinants of the cooperation, (4) determinants of the sub-parties, (5) determinants of the project policies, (6) determinants of the project characteristics, (7) determinants of the environment, (8) determinants of the owner, (9) determinants of the political factor, and (10) special determinants. The Chapter 8 show the details of these determinants.

As well, the assumptions for prediction process were summarized. First, the database of CSQ which will be used as the references of the CSQ for the further risk assessment by M-DRP subsystem. The information of this database is the CSQ of all risks in all phases gotten from the process of data analysis during the hypothesis testing. The study decided to assign the CSQ as the fixed information for the risk prediction process of M-DRP subsystem due to the constraints of time and scope of research process, as well as, taking the time of the respondents. The decision for fixed CSQs based on the study results which was found that the standard deviation and the consensus values for all CSQs are fit the appropriate level. It can be deduced that this information is likely to be very little variation under the same circumstances of CJVs.

The second module (P2) is the multi determinant matrix (MDM). The purpose of these matrixes is to predict the LLH for the further CJVs by M-DRP subsystem. These values will be correspond to the real situations of the interesting CJV. To create the MDMs, the 48 determinants, which are the representatives of CJV situations, were identified. Then, the matrix of determinants for each risk was developed. Because there are 30 risks in LCRMP system and the consideration is based on the answers of two hypotheses, the 33 MDMs were created. Finally, the weight each determinant in each MDM were developed from the concept of pairwise comparison which is the part of the analytic hierarchy process (AHP). The full details for this development were described in the Chapter 9.

To assess the risks for the future CJV by M-DRP subsystem, the user, who is a partner of a CJV, begins by answering the questions about the status of the determinants for the interesting CJV project. It can be done through the questionnaire comprising 48 questions on the form of multiple-choice questions, as shown in Chapter 9. The status of the determinant about CJV organization structure will be linked to the CSQ database of the model to determine the appropriate CSQ for to the interesting project. Meanwhile, all statuses will be converted to the format of five point scores to calculate with the weights of determinants in each MDM to predict the value of LLH for each risk.

As the results by the M-DRP subsystem, the user would get the important information of the risk parameters for risks in each phase in harmony with the type of CJV organization structure and the determinant of situations for the interesting CJV project. This information, including that the value of CSQ, LLH and LOR for each risk throughout five phases, as well as, the rank of each values can be adapted for use by CJVS partners in several aspects. For examples, if the contractors are still in the process of partner selection, the information can help them to select the appropriate partners for the CJV. In other way, if the member of CJV is complete, the results by LCRMP system can use for stipulating the plans for responding the critical risks to increase the success of CJV operation in each phase of CJV life cycle.

Moreover, the process of M-DRP subsystem em can be done through the features of the application software for the model. The functions and features of the Microsoft Excel were used as the base for the software development. The total of 90 spreadsheets with many formulas and functions in the Microsoft Excel are combined together to server the risk assessment process for CJV project according to the concepts of M-DRP subsystem. The aim of this application software is to reduce any possible errors by human. The details for the application software are indicated in Chapter 10.

To ensure the results of risk assessment by M-DRP subsystem, the system verification and validation were conducted with three case studies, as described in

Chapter 10. Around 70% to 90% of CSQ and LLH generated by M-DRP subsystem has the error value in the range of 0 to 0.50, when they are compared with the real results of the case studies. Therefore, it can be concluded that M-DRP subsystem has enough ability to be used in the real world.

Finally, the partners of CJV, especially the Thai partners, should be aware of the importance of risk assessment for their own CJV project from the beginning of CJV life cycle. So, the partners are able to plan the appropriate risk treatment options to reduce the impact (or the CSQ) and/or the change of the occurrence (or the LLH) of the critical risks. These awareness and actions of partners would increase the success rate of CJV management both in terms of the overall project success, being time, cost and quality, and the individual success pf each partners such as the learnings, the construction market expansion and etc.

12.2 Limitations of Study

The important limitations in this study to develop LCRMP system could be discussed as follows:

1) The sampling variation of the survey processes is not good enough to be the representative for all CJVs in the Thailand contrition industry. Over 80 percent of the respondents in the professional group and the expert group are the persons who have had CJV experience with Japanese partners. When the user would like to use LCRMP system for CJV which its partner will not the Japanese contractors, the accuracy of the results from the model may be less accurate.

2) The information in the risk database and the weight of the MDMs is not good enough to be the representative for all CJVs in the Thailand contrition industry. This information was be collected and analyzed from the data surveyed by the professional group and the expert group. The sample size of these groups seem not large enough at the statistical significance. In additional, it may be argued that the development should be based on the other statistical methods which are higher efficient.

3) The user of M-DRP subsystem still need the other risk models, used together with LCRMP system, for CJV project management. Because LCRMP system can only manage the risks in the part of the cooperation between partners, there are still other parts of risks for CJVs. Especially, the user have to focus on the risk for the construction parts which it has elements that vary based on the types and details of the construction tasks.

4) Although the LLH of risks would be predicted through the five phases of CJV life cycle by the M-DRP subsystem which are the part of LCRMP system. There are still the chance which these values, especially the latter phases, would be adjusted. The status for some determinants is subjected to change over time, while the prediction of the LLH in M-DRP subsystem use the data of the determinant statuses at the beginning of CJV life cycle.

5) CJV projects, which can use M-DRP subsystem to predict risks, have to be managed under either the CG-JV or the SG-JV only. M-DRP subsystem cannot apply with CJVs which are operated by the mix characteristics between the CG-JV and the SG-JV.

12.3 Recommendations for Further Study

From the study, though the accuracy of the risk assessment by LCRMP system is in the acceptable level. There are some recommendations to improve the efficiency of the model. They are:

1) The development of the M-DRP subsystem for the CSQs is suggested to be the next the first further study. M-DRP subsystem with both types of the predication, being MDM for LLH and MDM for CSQ, can increase the perfection of the risk assessment to more close the real situations of CJV management.

2) The characteristics of the status for the determinants through CJV life cycle should be studied and analyzed for developing the new feature in LCRMP system. This feature should be increase the efficient predication of the risk parameters.

3) To increase the efficiency of the information in LCRMP system, the larger sample with more variation is required. This process needs to be a lot of cooperation from the construction industry. On the other hand, it may be reduce the scope of the construction types in CJVs.

4) The current LCRMP system in not informed to the partners of overall risks for CJV project. It is only assess the risk for the cooperation tasks between partners. To facilitate the risk assessment, the further study is to integrate the construction risk model for CJV with LCRMP system into the new model.

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APPENDIX

APPENDIX A

EXAMPLE OF QUESTIONNAIRE

APPENDIX A-1
EXAMPLE OF QUESTIONNAIRE FOR FORMATION PHASE

Ref: START

แบบสอบถาม

เรื่อง

ระดับความรุนแรงของผลกระทบเกิดในกิจการร่วมค้า

ตามทัศนคติของบุคลากรในอุตสาหกรรมก่อสร้าง

คำชี้แจง

แบบสอบถามชุดนี้จัดทำขึ้น ด้วยวัตถุประสงค์ที่ต้องการศึกษาถึงระดับความรุนแรงของผลกระทบที่เกิดในกิจการร่วมค้างานก่อสร้างที่ตั้งอยู่ในประเทศไทย ตามทัศนคติของบุคลากรในอุตสาหกรรมก่อสร้าง

ข้อมูลทั้งหมดที่ได้จากแบบสอบถามฉบับนี้ โดยเฉพาะอย่างยิ่งข้อมูลเกี่ยวกับตัวของผู้ตอบแบบสอบถามจะถือเป็นความลับสูงสุดที่จะใช้สำหรับการศึกษานี้เท่านั้น ทางผู้วิจัยจึงใคร่ขอความกรุณาท่านในการตอบคำถามตามความเป็นจริง คำตอบของท่านจะเป็นข้อมูลที่สำคัญยิ่งเพื่อพัฒนางานวิจัยเชิงคุณภาพสำหรับอุตสาหกรรมก่อสร้างต่อไปในอนาคต

หากท่านมีข้อสงสัย ต้องการข้อมูลเพิ่มเติม หรือต้องการให้ข้อเสนอแนะ ขอความกรุณาท่านติดต่อมายังผู้วิจัยได้โดยตรงตามที่อยู่ด้านล่างนี้

ขอกราบขอบพระคุณอย่างยิ่งในความร่วมมือของท่าน

อภิชาต ประสิทธิ์สม

นิสิตสาขาบริหารงานก่อสร้าง

จุฬาลงกรณ์มหาวิทยาลัย

โทร XXX-XXX-XXXX อีเมล์: XXXXXXX@gmail.com

ผู้ตอบแบบสอบถาม: บุคลากรในบริษัทก่อสร้าง ผู้มีประสบการณ์การทำงานในกิจการร่วมค้างานก่อสร้าง (Construction Joint Venture)

หมายเหตุ:

1. ขอความกรุณาท่านช่วยตอบแบบสอบถามชุดนี้และส่งคืนมายังผู้วิจัย อย่างเร็วที่สุดเท่าที่จะเป็นไปได้
2. สามารถส่งคืนแบบสอบถามคืน ได้โดยการสอดแบบสอบถามลงในซองไปรษณีย์เปล่าที่ได้แนบมาพร้อมกันนี้ แล้วนำไปส่ง ณ ตู้ไปรษณีย์ ที่ท่านสะดวก โดยไม่ต้องเสียค่าใช้จ่ายใดๆ ทั้งสิ้น

Ref: BID

ตอนที่ 1

ข้อมูลส่วนตัวของผู้ตอบแบบสอบถาม

คำชี้แจง

ข้อมูลในส่วนนี้มีความสำคัญอย่างยิ่งต่อการประเมินผลทางสถิติสำหรับงานวิจัย ทั้งนี้ข้อมูลของท่านทั้งหมดจะถูกเก็บไว้เป็นความลับ

โปรดกรอกข้อมูลหรือทำเครื่องหมายลงในที่ว่างทุกข้อ

1. ชื่อและนามสกุล ____

2. สถานที่ทำงานปัจจุบัน ____
3. ตำแหน่งงานปัจจุบัน ____
4. ท่านมีประสบการณ์การทำงานในกิจการร่วมค้างานก่อสร้าง (Construction Joint Venture)

   ประมาณ ___________ โครงการขึ้นไป
5. องค์กรแม่ของสมาชิกในกิจการร่วมค้างานก่อสร้างที่ท่านเคยหรือกำลังร่วมงานด้วย มาจากประเทศใดบ้าง

   (เลือกตอบได้มากกว่า 1 ตัวเลือก)

   ☐ ประเทศญี่ปุ่น ☐ ประเทศจีน

   ☐ ประเทศเกาหลี ☐ ประเทศไต้หวัน

   ☐ ประเทศมาเลเซีย ☐ ประเทศสิงค์โปร

   ☐ ประเทศอื่นๆ ____

Ref: BID

ตอนที่ 2
การสอบถามความสนใจในการเข้าร่วมเป็นผู้เชี่ยวชาญเกียรติมาศักดิ์ของงานวิจัย

คำชี้แจง

งานวิจัยในครั้งนี้ ผู้วิจัยได้พัฒนากระบวนการที่จะลดความคลาดเคลื่อนของผลลัพธ์ที่ได้จากแบบสอบถาม ด้วยการเพิ่มเติมกระบวนการวิจัยที่จะย้อนกลับไปสอบถามความคิดเห็นของผู้ตอบแบบสอบถามกลุ่มเดิมอีกครั้ง แต่มุ่งประเด็นไปที่การขอความคิดเห็นที่มีต่อผลลัพธ์ซึ่งได้จากแบบสอบถามในรอบก่อน (ซึ่งก็คือ ผลของแบบสอบถามฉบับนี้) ผ่านการใช้รูปแบบของข้อคำถามหรือแบบสอบถามขนาดสั้นที่จะส่งไปถึงผู้ตอบแบบสอบแต่ละท่านโดยตรง เพื่อให้เกิดการรบกวนเวลาอันมีค่าของผู้ตอบแบบสอบน้อยที่สุดเท่าที่จะเป็นไปได้

1. ท่านมีความยินดีหรือไม่ ที่จะเข้าร่วมกระบวนการวิจัยข้างต้น (ท่านจะกลายเป็นผู้เชี่ยวชาญเกียรติมาศักดิ์ของงานวิจัยในครั้งนี้) ทั้งนี้ผู้วิจัยขอความกรุณาที่จะรบกวนท่านเพื่อตอบข้อคำถามหรือแบบสอบถามขนาดสั้นเพิ่มเติมผ่านทางจดหมายหรืออีเมล์เท่านั้น และผู้วิจัยจะไม่ขอรบกวนท่านมากเกินกว่า 2 ครั้ง

☐ มีความยินดีเข้าร่วม ☐ ไม่สะดวกเข้าร่วม

2. ถ้าท่านมีความยินดีที่จะเข้าร่วมกระบวนการวิจัยนี้ ท่านสะดวกให้ผู้วิจัยติดต่อท่าน

☐ ผ่านทางจดหมาย โดยผ่านทางที่อยู่ คือ ____________________

____

☐ ผ่านทางอีเมล์ โดยผ่านทางอีเมล์ของท่านคือ ____________________

ผู้วิจัยขอขอบพระคุณท่านเป็นอย่างยิ่งในความเมตตาที่จะสละเวลาอันมีค่าของท่าน ในการเข้าร่วมเป็นส่วนหนึ่งของกระบวนการวิจัยข้างต้น สำหรับท่านที่ไม่สะดวกในการเข้าร่วมกระบวนการวิจัยในครั้งนี้ ผู้วิจัยขอขอบพระคุณและหวังเป็นอย่างยิ่งว่าจะได้มีความร่วมมือกับท่านในโอกาสหน้า

ขอกราบขอบพระคุณในความร่วมมือของท่าน
อภิชาต ประสิทธิ์สม
นิสิตสาขาบริหารงานก่อสร้าง จุฬาลงกรณ์มหาวิทยาลัย

Ref: FOR

ตอนที่ 3
คำถามเกี่ยวกับ "ระดับความรุนแรง" และ "โอกาสในการเกิด" ของปัจจัยเสี่ยง
ที่มีต่อการบริหารงานกิจการร่วมค้างานก่อสร้าง ในช่วง "จัดตั้งหน่วยความร่วมมือ"

คำชี้แจง

แบบสอบถามในตอนนี้เป็นคำถามแบบเติมคำตอบ
กรุณาเติมคำตอบด้วยระดับคะแนน 1 ถึง 5 ลงในแต่ละข้อ ซึ่งมีค่าตรงกับ

1) ระดับความรุนแรงของปัจจัยเสี่ยง ที่มีต่อการบริหารกิจการร่วมค้างานก่อสร้าง และ

2) โอกาสในการเกิดของปัจจัยเสี่ยง ซึ่งจะเกิดขึ้นในช่วงจัดตั้งหน่วยความร่วมมือ

ซึ่งเป็นไปตามมุมมองและทัศนคติของท่าน โดยการพิจารณาประสบการณ์ในอดีตจากกิจการร่วมค้างานก่อสร้างในประเทศไทย โดยสามารถพิจารณารายละเอียดเพิ่มเติมสำหรับช่วงจัดตั้งหน่วยความร่วมมือ ได้ใน "คำชี้แจง" (กระดาษสีฟ้า) ทั้งนี้ความหมายของระดับคะแนน 1 ถึง 5 แสดงอยู่ใน "ใบคะแนน" ซึ่งแนบมาพร้อมกับแบบสอบถามนี้ (กระดาษสีชมพู) ส่วนการพิจารณารายละเอียดเพิ่มเติมของ

ตัวอย่างการตอบแบบสอบถาม

	ระดับความรุนแรง	โอกาสในการเกิด
สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรผลกำไรและขาดทุน รวมถึงความรับผิดชอบด้านการเงินระหว่างกัน	4	3

กลุ่มที่ 1 ปัจจัยเสี่ยงที่เกี่ยวกับสมาชิก

INT01

	ระดับความรุนแรง	โอกาสในการเกิด
(1) สมาชิกประสบปัญหาขาดสภาพคล่องทางการเงิน สำหรับนำมาใช้สนับสนุนการดำเนินงานในกิจการร่วมค้า		

INT02

	ระดับความรุนแรง	โอกาสในการเกิด
(2) สมาชิกขาดความสามารถในการดำเนินงานก่อสร้าง หรือไม่สามารถดำเนินงานก่อสร้าง		

Ref: FOR

INT03	ระดับความรุนแรง	โอกาสในการเกิด
(3) สมาชิกเปลี่ยนแปลงนโยบายด้านความร่วมมือที่มีต่อสมาชิกฝ่ายอื่นๆ ในกิจการร่วมค้า		

INT04	ระดับความรุนแรง	โอกาสในการเกิด
(4) สมาชิกขาดประสบการณ์การดำเนินงานโครงการในประเทศไทยและในพื้นที่บริเวณซึ่งโครงการก่อสร้างก่อสร้างจะเข้าไปตั้งอยู่		

INT05	ระดับความรุนแรง	โอกาสในการเกิด
(5) สมาชิกขาดประสบการณ์การดำเนินงานโครงการก่อสร้างในรูปแบบกิจการร่วมค้า ในฐานะที่เป็นหนึ่งในสมาชิกของหน่วยความร่วมมือนั้น		

INT06	ระดับความรุนแรง	โอกาสในการเกิด
(6) สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรผลกำไรและขาดทุน รวมถึงความรับผิดชอบด้านการเงินระหว่างกัน		

INT07	ระดับความรุนแรง	โอกาสในการเกิด
(7) สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรบุคลากร เครื่องจักร ที่ดิน หรือวัสดุอุปกรณ์อื่นๆ ระหว่างกัน		

INT08	ระดับความรุนแรง	โอกาสในการเกิด
(8) สมาชิกเข้ามาแทรกแซงกระบวนการทำงานของกิจการร่วมค้าหรือของสมาชิกรายอื่นๆ ซึ่งอยู่นอกเหนือภาระหน้าที่ซึ่งกำหนดไว้		

INT09	ระดับความรุนแรง	โอกาสในการเกิด
(9) สมาชิกมีความแตกต่างด้านวัฒนธรรมการทำงานและโครงสร้างการสั่งงานและควบคุมภายในองค์กรที่แตกต่างกัน		

Ref: FOR

INT10	ระดับความรุนแรง	โอกาสในการเกิด
(10) สมาชิกมีไม่เชื่อใจระหว่างกัน ในการปล่อยให้สมาชิกฝ่ายอื่นๆ รับทราบข้อมูลภายในโครงการ หรือการดำเนินงานใดๆ ทั้งภายในหรือกับภายนอก		

INT11	ระดับความรุนแรง	โอกาสในการเกิด
(11) สมาชิกขาดการสื่อสารที่มีประสิทธิภาพระหว่างกัน เพื่อแลกเปลี่ยนข้อมูลภายในโครงการให้ถูกต้อง หรือมีข้อมูลล่าสุด		

กลุ่มที่ 2 ปัจจัยเสี่ยงที่เกี่ยวกับโครงการก่อสร้าง

PRO06	ระดับความรุนแรง	โอกาสในการเกิด
(1) โครงการก่อสร้างถ่ายโอนความเสี่ยงในการดำเนินงานมาให้ผู้รับเหมาในสัดส่วนที่ไม่เหมาสมหรือเป็นธรรม		

PRO08	ระดับความรุนแรง	โอกาสในการเกิด
(2) ผู้ว่าจ้างหรือตัวแทนแทรกแซงกระบวนการทำงานของกิจการร่วมค้า หรือของสมาชิกรายอื่นๆ ซึ่งอยู่นอกเหนือภาระหน้าที่ซึ่งกำหนดไว้		

กลุ่มที่ 3 ปัจจัยเสี่ยงที่เกี่ยวกับสภาพแวดล้อมภายนอก

EXT01	ระดับความรุนแรง	โอกาสในการเกิด
(1) ความแตกต่างด้านวัฒนธรรมการใช้ชีวิต เชื้อชาติ และศาสนา ของบุคลากรระหว่างสมาชิก		

Ref: FOR

EXT02

	ระดับความรุนแรง	โอกาสในการเกิด
(2) ความแตกต่างด้านภาษาที่ใช้สื่อสารในในชีวิตประจำวัน ของบุคลากรระหว่างสมาชิก		

EXT05

	ระดับความรุนแรง	โอกาสในการเกิด
(5) การต่อต้านจากคนในพื้นที่ซึ่งเป็นที่ตั้งของโครงการ รวมถึงจากคนในสังคม		

EXT06

	ระดับความรุนแรง	โอกาสในการเกิด
(6) ความปลอดภัยจากการโจรกรรมหรืออาชญากรรม และการก่อจลาจล ณ ณ บริเวณพื้นที่ตั้งของโครงการก่อสร้าง		

EXT07

	ระดับความรุนแรง	โอกาสในการเกิด
(7) ความไม่แน่นอนทางนโยบายจากหน่วยงานภาครัฐและรัฐบาล		

EXT08

	ระดับความรุนแรง	โอกาสในการเกิด
(8) ผลจากนโยบายการจำกัดการลงทุนโดยชาวต่างชาติ รวมถึงการนำเข้าสินค้าหรือบริการจากต่างประเทศ		

EXT09

	ระดับความรุนแรง	โอกาสในการเกิด
(9) การทุจริตที่เกิดขึ้นในระดับผู้ว่าจ้าง ตัวแทนผู้ว่าจ้าง ทางการเมือง หรือภายในสมาชิกด้วยกันเอง		

APPENDIX A-2

EXAMPLE OF QUESTIONNAIRE FOR BIDDING PHASE

Ref: BID

ตอนที่ 3
คำถามเกี่ยวกับ "ระดับความรุนแรง" และ "โอกาสในการเกิด" ของปัจจัยเสี่ยง
ที่มีต่อการบริหารงานกิจการร่วมค้างานก่อสร้าง ในช่วง "ประมูลงาน"

คำชี้แจง

แบบสอบถามในตอนนี้เป็นคำถามแบบเติมคำตอบ

กรุณาเติมคำตอบด้วยระดับคะแนน 1 ถึง 5 ลงในแต่ละข้อ ซึ่งมีค่าตรงกับ

1) ระดับความรุนแรงของปัจจัยเสี่ยง ที่มีต่อการบริหารกิจการร่วมค้างานก่อสร้าง และ

2) โอกาสในการเกิดของปัจจัยเสี่ยง ซึ่งจะเกิดขึ้นในช่วงประมูลงาน

ซึ่งเป็นไปตามมุมมองและทัศนคติของท่าน โดยการพิจารณาประสบการณ์ในอดีตจากกิจการร่วมค้างานก่อสร้างในประเทศไทย โดยสามารถพิจารณารายละเอียดเพิ่มเติมสำหรับช่วงประมูลงาน ได้ใน "คำชี้แจง" (กระดาษสีฟ้า) ทั้งนี้ความหมายของระดับคะแนน 1 ถึง 5 แสดงอยู่ใน "ใบคะแนน" ซึ่งแนบมาพร้อมกับแบบสอบถามนี้ (กระดาษสีชมพู) ส่วนการพิจารณารายละเอียดเพิ่มเติมของ

ตัวอย่างการตอบแบบสอบถาม

	ระดับความรุนแรง	โอกาสในการเกิด
สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรผลกำไรและขาดทุน รวมถึงความรับผิดชอบด้านการเงินระหว่างกัน	4	3

กลุ่มที่ 1 ปัจจัยเสี่ยงที่เกี่ยวกับสมาชิก

INT01	ระดับความรุนแรง	โอกาสในการเกิด
(1) สมาชิกประสบปัญหาขาดสภาพคล่องทางการเงิน สำหรับนำมาใช้สนับสนุนการดำเนินงานในกิจการร่วมค้า		

INT02	ระดับความรุนแรง	โอกาสในการเกิด
(2) สมาชิกขาดความสามารถในการดำเนินงานก่อสร้าง หรือไม่สามารถดำเนินงานก่อสร้าง		

Ref: BID

INT03

	ระดับความรุนแรง	โอกาสในการเกิด
(3) สมาชิกเปลี่ยนแปลงนโยบายด้านความร่วมมือที่มีต่อสมาชิกฝ่ายอื่นๆ ในกิจการร่วมค้า		

INT04

	ระดับความรุนแรง	โอกาสในการเกิด
(4) สมาชิกขาดประสบการณ์การดำเนินงานโครงการในประเทศไทย และในพื้นที่บริเวณซึ่งโครงการก่อสร้างก่อสร้างจะเข้าไปตั้งอยู่		

INT05

	ระดับความรุนแรง	โอกาสในการเกิด
(5) สมาชิกขาดประสบการณ์การดำเนินงานโครงการก่อสร้างในรูปแบบกิจการร่วมค้า ในฐานะที่เป็นหนึ่งในสมาชิกของหน่วยความร่วมมือนั้น		

INT06

	ระดับความรุนแรง	โอกาสในการเกิด
(6) สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรผลกำไรและขาดทุน รวมถึงความรับผิดชอบด้านการเงินระหว่างกัน		

INT07

	ระดับความรุนแรง	โอกาสในการเกิด
(7) สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรบุคลากร เครื่องจักร ที่ดิน หรือวัสดุอุปกรณ์อื่นๆ ระหว่างกัน		

INT08

	ระดับความรุนแรง	โอกาสในการเกิด
(8) สมาชิกเข้ามาแทรกแซงกระบวนการทำงานของกิจการร่วมค้า หรือของสมาชิกรายอื่นๆ ซึ่งอยู่นอกเหนือภาระหน้าที่ซึ่งกำหนดไว้		

INT09

	ระดับความรุนแรง	โอกาสในการเกิด
(9) สมาชิกมีความแตกต่างด้านวัฒนธรรมการทำงาน และโครงสร้างการสั่งงานและควบคุมภายในองค์กรที่แตกต่างกัน		

Ref: BID

INT10	ระดับความรุนแรง	โอกาสในการเกิด
(10) สมาชิกมีไม่เชื่อใจระหว่างกัน ในการปล่อยให้สมาชิกฝ่ายอื่นๆ รับทราบข้อมูลภายในโครงการ หรือการดำเนินงานใดๆ ทั้งภายในหรือกับภายนอก		

INT11	ระดับความรุนแรง	โอกาสในการเกิด
(11) สมาชิกขาดการสื่อสารที่มีประสิทธิภาพระหว่างกัน เพื่อแลกเปลี่ยนข้อมูลภายในโครงการให้ถูกต้อง หรือมีข้อมูลล่าสุด		

INT12	ระดับความรุนแรง	โอกาสในการเกิด
(12) สัญญาความร่วมมือระหว่างสมาชิกมีข้อบกพร่อง ทั้งในกรณีที่รายละเอียดหละหลวมหรือมีความรัดกุมจนเกินไป		

กลุ่มที่ 2 ปัจจัยเสี่ยงที่เกี่ยวกับโครงการก่อสร้าง

PRO04	ระดับความรุนแรง	โอกาสในการเกิด
(1) แบบก่อสร้างและรายการข้อกำหนดไม่สมบูรณ์ มีรายละเอียดที่ผิดพลาด หรือกำหนดในสิ่งที่ไม่สามารถปฏิบัติได้		

PRO07	ระดับความรุนแรง	โอกาสในการเกิด
(2) โครงการก่อสร้างได้รับคำสั่งให้เปลี่ยนแปลงรายละเอียดหรือปริมาณของงานในสัญญา ในแบบก่อสร้าง ในรายการข้อกำหนด ในปริมาณที่มากเกินไป		

PRO08	ระดับความรุนแรง	โอกาสในการเกิด
(3) ผู้ว่าจ้างหรือตัวแทนแทรกแซงกระบวนการทำงานของกิจการร่วมค้า หรือของสมาชิกรายอื่นๆ ซึ่งอยู่นอกเหนือภาระหน้าที่ซึ่งกำหนดไว้		

กลุ่มที่ 3 ปัจจัยเสี่ยงที่เกี่ยวกับสภาพแวดล้อมภายนอก

EXT01

	ระดับความรุนแรง	โอกาสในการเกิด
(1) ความแตกต่างด้านวัฒนธรรมการใช้ชีวิต เชื้อชาติ และศาสนา ของบุคลากรระหว่างสมาชิก		

EXT02

	ระดับความรุนแรง	โอกาสในการเกิด
(2) ความแตกต่างด้านภาษาที่ใช้สื่อสารในในชีวิตประจำวัน ของบุคลากรระหว่างสมาชิก		

EXT05

	ระดับความรุนแรง	โอกาสในการเกิด
(3) การต่อต้านจากคนในพื้นที่ซึ่งเป็นที่ตั้งของโครงการ รวมถึงจากคนในสังคม		

EXT06

	ระดับความรุนแรง	โอกาสในการเกิด
(4) ความปลอดภัยจากการโจรกรรมหรืออาชญากรรม และการก่อจลาจล ณ ณ บริเวณพื้นที่ตั้งของโครงการก่อสร้าง		

EXT07

	ระดับความรุนแรง	โอกาสในการเกิด
(5) ความไม่แน่นอนทางนโยบายจากหน่วยงานภาครัฐและรัฐบาล		

EXT09

	ระดับความรุนแรง	โอกาสในการเกิด
(6) การทุจริตที่เกิดขึ้นในระดับผู้ว่าจ้าง ตัวแทนผู้ว่าจ้าง ทางการเมือง หรือภายในสมาชิกด้วยกันเอง		

APPENDIX A-3
EXAMPLE OF QUESTIONNAIRE FOR CONSTRUCTION PHASE

ตอนที่ 3

คำถามเกี่ยวกับ “ระดับความรุนแรง” และ “โอกาสในการเกิด” ของปัจจัยเสี่ยง ที่มีต่อการบริหารงานกิจการร่วมค้างานก่อสร้าง ในช่วง “บริหารงานก่อสร้าง”

คำชี้แจง

แบบสอบถามในตอนนี้เป็นคำถามแบบเติมคำตอบ

กรุณาเติมคำตอบด้วยระดับคะแนน 1 ถึง 5 ลงในแต่ละข้อ ซึ่งมีค่าตรงกับ

1) ระดับความรุนแรงของปัจจัยเสี่ยง ที่มีต่อการบริหารกิจการร่วมค้างานก่อสร้าง และ

2) โอกาสในการเกิดของปัจจัยเสี่ยง ซึ่งจะเกิดขึ้นในช่วงบริหารงานก่อสร้าง

ซึ่งเป็นไปตามมุมมองและทัศนคติของท่าน โดยการพิจารณาประสบการณ์ในอดีตจากกิจการร่วมค้างานก่อสร้างในประเทศไทย โดยสามารถพิจารณารายละเอียดเพิ่มเติมสำหรับช่วงบริหารงานก่อสร้างได้ใน “คำชี้แจง” (กระดาษสีฟ้า) ทั้งนี้ความหมายของระดับคะแนน 1 ถึง 5 แสดงอยู่ใน “ใบคะแนน” ซึ่งแนบมาพร้อมกับแบบสอบถามนี้ (กระดาษสีชมพู) ส่วนการพิจารณารายละเอียดเพิ่มเติมของ

ตัวอย่างการตอบแบบสอบถาม

	ระดับความรุนแรง	โอกาสในการเกิด
สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรผลกำไรและขาดทุน รวมถึงความรับผิดชอบด้านการเงินระหว่างกัน	4	3

กลุ่มที่ 1 ปัจจัยเสี่ยงที่เกี่ยวกับสมาชิก

INT01	ระดับความรุนแรง	โอกาสในการเกิด
(1) สมาชิกประสบปัญหาขาดสภาพคล่องทางการเงิน สำหรับนำมาใช้สนับสนุนการดำเนินงานในกิจการร่วมค้า		

INT02	ระดับความรุนแรง	โอกาสในการเกิด
(2) สมาชิกขาดความสามารถในการดำเนินงานก่อสร้าง หรือไม่สามารถดำเนินงานก่อสร้าง		

Ref: CON

INT03	ระดับความรุนแรง	โอกาสในการเกิด
(3) สมาชิกเปลี่ยนแปลงนโยบายด้านความร่วมมือที่มีต่อสมาชิกฝ่ายอื่นๆ ในกิจการร่วมค้า		

INT04	ระดับความรุนแรง	โอกาสในการเกิด
(4) สมาชิกขาดประสบการณ์การดำเนินงานโครงการในประเทศไทยและในพื้นที่บริเวณซึ่งโครงการก่อสร้างก่อสร้างจะเข้าไปตั้งอยู่		

INT05	ระดับความรุนแรง	โอกาสในการเกิด
(5) สมาชิกขาดประสบการณ์การดำเนินงานโครงการก่อสร้างในรูปแบบกิจการร่วมค้า ในฐานะที่เป็นหนึ่งในสมาชิกของหน่วยความร่วมมือนั้น		

INT06	ระดับความรุนแรง	โอกาสในการเกิด
(6) สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรผลกำไรและขาดทุน รวมถึงความรับผิดชอบด้านการเงินระหว่างกัน		

INT07	ระดับความรุนแรง	โอกาสในการเกิด
(7) สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรบุคลากร เครื่องจักร ที่ดิน หรือวัสดุอุปกรณ์อื่นๆ ระหว่างกัน		

INT08	ระดับความรุนแรง	โอกาสในการเกิด
(8) สมาชิกเข้ามาแทรกแซงกระบวนการทำงานของกิจการร่วมค้าหรือของสมาชิกรายอื่นๆ ซึ่งอยู่นอกเหนือภาระหน้าที่ซึ่งกำหนดไว้		

INT09	ระดับความรุนแรง	โอกาสในการเกิด
(9) สมาชิกมีความแตกต่างด้านวัฒนธรรมการทำงานและโครงสร้างการสั่งงานและควบคุมภายในองค์กรที่แตกต่างกัน		

Ref: CON

INT10

	ระดับความรุนแรง	โอกาสในการเกิด
(10) สมาชิกมีไม่เชื่อใจระหว่างกัน ในการปล่อยให้สมาชิกฝ่ายอื่นๆ รับทราบข้อมูลภายในโครงการ หรือการดำเนินงานใดๆ ทั้งภายในหรือกับภายนอก		

INT11

	ระดับความรุนแรง	โอกาสในการเกิด
(11) สมาชิกขาดการสื่อสารที่มีประสิทธิภาพระหว่างกัน เพื่อแลกเปลี่ยนข้อมูลภายในโครงการให้ถูกต้อง หรือมีข้อมูลล่าสุด		

INT12

	ระดับความรุนแรง	โอกาสในการเกิด
(12) สัญญาความร่วมมือระหว่างสมาชิกมีข้อบกพร่อง ทั้งในกรณีที่รายละเอียดหละหลวมหรือมีความรัดกุมจนเกินไป		

กลุ่มที่ 2 ปัจจัยเสี่ยงที่เกี่ยวกับโครงการก่อสร้าง

PRO01

	ระดับความรุนแรง	โอกาสในการเกิด
(1) การวางแผนการทำงานและการกำหนดงบประมาณสำหรับการดำเนินโครงการเกิดความผิดพลาดหรือมีรายละเอียดที่ไม่เหมาะสม		

PRO02

	ระดับความรุนแรง	โอกาสในการเกิด
(2) ปัญหาการดำเนินงานก่อสร้างทางด้านเทคนิค ทั้งในรูปแบบของการไม่สามารถปฏิบัติได้จริง หรือปฏิบัติแล้วไม่มีคุณภาพตามที่กำหนด		

PRO03

	ระดับความรุนแรง	โอกาสในการเกิด
(3) ผู้รับเหมารายย่อย และตัวแทนจำหน่ายวัสดุ ไม่สามารถดำเนินงานได้ตามรายละเอียดของการว่าจ้าง		

Ref: CON

PRO04

	ระดับความรุนแรง	โอกาสในการเกิด
(4) แบบก่อสร้างและรายการข้อกำหนดไม่สมบูรณ์ มีรายละเอียดที่ผิดพลาด หรือกำหนดในสิ่งที่ไม่สามารถปฏิบัติได้		

PRO05

	ระดับความรุนแรง	โอกาสในการเกิด
(5) สัญญาก่อสร้างไม่สมบูรณ์ มีรายละเอียดที่ผิดพลาด ไม่ยุติธรรม หรือกำหนดในสิ่งที่ไม่สามารถปฏิบัติได้		

PRO07

	ระดับความรุนแรง	โอกาสในการเกิด
(6) โครงการก่อสร้างได้รับคำสั่งให้เปลี่ยนแปลงรายละเอียดหรือปริมาณของงานในสัญญา ในแบบก่อสร้าง ในรายการข้อกำหนด ในปริมาณที่มากเกินไป		

PRO08

	ระดับความรุนแรง	โอกาสในการเกิด
(7) ผู้ว่าจ้างหรือตัวแทนแทรกแซงกระบวนการทำงานของกิจการร่วมค้า หรือของสมาชิกรายอื่นๆ ซึ่งอยู่นอกเหนือภาระหน้าที่ซึ่งกำหนดไว้		

กลุ่มที่ 3 ปัจจัยเสี่ยงที่เกี่ยวกับสภาพแวดล้อมภายนอก

EXT01

	ระดับความรุนแรง	โอกาสในการเกิด
(1) ความแตกต่างด้านวัฒนธรรมการใช้ชีวิต เชื้อชาติ และศาสนา ของบุคลากรระหว่างสมาชิก		

EXT02

	ระดับความรุนแรง	โอกาสในการเกิด
(2) ความแตกต่างด้านภาษาที่ใช้สื่อสารในในชีวิตประจำวัน ของบุคลากรระหว่างสมาชิก		

Ref: CON

EXT03	ระดับความรุนแรง	โอกาสในการเกิด
(3) ภัยทางธรรมชาติ และสภาพอากาศที่ผิดปกติ ณ บริเวณพื้นที่ตั้งของโครงการก่อสร้าง		

EXT04	ระดับความรุนแรง	โอกาสในการเกิด
(4) มลภาวะจากโครงการก่อสร้าง เช่น ฝุ่น เสียง แรงสั่นสะเทือน กลิ่น ฯลฯ ซึ่งส่งผลต่อพื้นที่โดยรอบโครงการ		

EXT05	ระดับความรุนแรง	โอกาสในการเกิด
(5) การต่อต้านจากคนในพื้นที่ซึ่งเป็นที่ตั้งของโครงการ รวมถึงจากคนในสังคม		

EXT06	ระดับความรุนแรง	โอกาสในการเกิด
(6) ความปลอดภัยจากการโจรกรรมหรืออาชญากรรม และการก่อจลาจล ณ ณ บริเวณพื้นที่ตั้งของโครงการก่อสร้าง		

EXT07	ระดับความรุนแรง	โอกาสในการเกิด
(7) ความไม่แน่นอนทางนโยบายจากหน่วยงานภาครัฐและรัฐบาล		

EXT08	ระดับความรุนแรง	โอกาสในการเกิด
(8) ผลจากนโยบายการจำกัดการลงทุนโดยชาวต่างชาติ รวมถึงการนำเข้าสินค้าหรือบริการจากต่างประเทศ		

EXT09	ระดับความรุนแรง	โอกาสในการเกิด
(9) การทุจริตที่เกิดขึ้นในระดับผู้ว่าจ้าง ตัวแทนผู้ว่าจ้าง ทางการเมือง หรือภายในสมาชิกด้วยกันเอง		

Ref: CON

EXT10	ระดับความรุนแรง	โอกาสในการเกิด
(10) ผลจากความผันผวนด้านอัตราแลกเปลี่ยนเงินตราระหว่างประเทศ		

EXT11	ระดับความรุนแรง	โอกาสในการเกิด
(11) ผลจากความผันผวนด้านเศรษฐกิจทั้งภายในประเทศและต่างประเทศ รวมถึงผลจากเงินเฟ้อ		

APPENDIX A-4
EXAMPLE OF QUESTIONNAIRE FOR WARRANTY PHASE

Ref: WAR

ตอนที่ 3
คำถามเกี่ยวกับ "ระดับความรุนแรง" และ "โอกาสในการเกิด" ของปัจจัยเสี่ยง ที่มีต่อการบริหารงานกิจการร่วมค้างานก่อสร้าง ในช่วง "รับประกันผลงาน"

คำชี้แจง

แบบสอบถามในตอนนี้เป็นคำถามแบบเติมคำตอบ
กรุณาเติมคำตอบด้วยระดับคะแนน 1 ถึง 5 ลงในแต่ละข้อ ซึ่งมีค่าตรงกับ

1) ระดับความรุนแรงของปัจจัยเสี่ยง ที่มีต่อการบริหารกิจการร่วมค้างานก่อสร้าง และ

2) โอกาสในการเกิดของปัจจัยเสี่ยง ซึ่งจะเกิดขึ้นในช่วงรับประกันผลงาน

ซึ่งเป็นไปตามมุมมองและทัศนคติของท่าน โดยการพิจารณาประสบการณ์ในอดีตจากกิจการร่วมค้างานก่อสร้างในประเทศไทย โดยสามารถพิจารณารายละเอียดเพิ่มเติมสำหรับช่วงรับประกันผลงาน ได้ใน "คำชี้แจง" (กระดาษสีฟ้า) ทั้งนี้ความหมายของระดับคะแนน 1 ถึง 5 แสดงอยู่ใน "ใบคะแนน" ซึ่งแนบมาพร้อมกับแบบสอบถามนี้ (กระดาษสีชมพู) ส่วนการพิจารณารายละเอียดเพิ่มเติมของ

ตัวอย่างการตอบแบบสอบถาม

	ระดับความรุนแรง	โอกาสในการเกิด
สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรผลกำไรและขาดทุน รวมถึงความรับผิดชอบด้านการเงินระหว่างกัน	4	3

กลุ่มที่ 1 ปัจจัยเสี่ยงที่เกี่ยวกับสมาชิก

INT01

	ระดับความรุนแรง	โอกาสในการเกิด
(1) สมาชิกประสบปัญหาขาดสภาพคล่องทางการเงิน สำหรับนำมาใช้สนับสนุนการดำเนินงานในกิจการร่วมค้า		

INT02

	ระดับความรุนแรง	โอกาสในการเกิด
(2) สมาชิกขาดความสามารถในการดำเนินงานก่อสร้าง หรือไม่สามารถดำเนินงานก่อสร้าง		

INT03

	ระดับความรุนแรง	โอกาสในการเกิด
(3) สมาชิกเปลี่ยนแปลงนโยบายด้านความร่วมมือที่มีต่อสมาชิกฝ่ายอื่นๆ ในกิจการร่วมค้า		

INT04

	ระดับความรุนแรง	โอกาสในการเกิด
(4) สมาชิกขาดประสบการณ์การดำเนินงานโครงการในประเทศไทย และในพื้นที่บริเวณซึ่งโครงการก่อสร้างก่อสร้างจะเข้าไปตั้งอยู่		

INT05

	ระดับความรุนแรง	โอกาสในการเกิด
(5) สมาชิกขาดประสบการณ์การดำเนินงานโครงการก่อสร้างในรูปแบบกิจการร่วมค้า ในฐานะที่เป็นหนึ่งในสมาชิกของหน่วยความร่วมมือนั้น		

INT06

	ระดับความรุนแรง	โอกาสในการเกิด
(6) สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรผลกำไรและขาดทุน รวมถึงความรับผิดชอบด้านการเงินระหว่างกัน		

INT07

	ระดับความรุนแรง	โอกาสในการเกิด
(7) สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรบุคลากร เครื่องจักร ที่ดิน หรือวัสดุอุปกรณ์อื่นๆ ระหว่างกัน		

INT08

	ระดับความรุนแรง	โอกาสในการเกิด
(8) สมาชิกเข้ามาแทรกแซงกระบวนการทำงานของกิจการร่วมค้า หรือของสมาชิกรายอื่นๆ ซึ่งอยู่นอกเหนือภาระหน้าที่ซึ่งกำหนดไว้		

INT09

	ระดับความรุนแรง	โอกาสในการเกิด
(9) สมาชิกมีความแตกต่างด้านวัฒนธรรมการทำงาน และโครงสร้างการสั่งงานและควบคุมภายในองค์กรที่แตกต่างกัน		

Ref: WAR

INT10

	ระดับความรุนแรง	โอกาสในการเกิด
(10) สมาชิกมีไม่เชื่อใจระหว่างกัน ในการปล่อยให้สมาชิกฝ่ายอื่นๆ รับทราบข้อมูลภายในโครงการ หรือการดำเนินงานใดๆ ทั้งภายในหรือกับภายนอก		

INT11

	ระดับความรุนแรง	โอกาสในการเกิด
(11) สมาชิกขาดการสื่อสารที่มีประสิทธิภาพระหว่างกัน เพื่อแลกเปลี่ยนข้อมูลภายในโครงการให้ถูกต้อง หรือมีข้อมูลล่าสุด		

INT12

	ระดับความรุนแรง	โอกาสในการเกิด
(12) สัญญาความร่วมมือระหว่างสมาชิกมีข้อบกพร่อง ทั้งในกรณีที่รายละเอียดหละหลวมหรือมีความรัดกุมจนเกินไป		

กลุ่มที่ 2 ปัจจัยเสี่ยงที่เกี่ยวกับโครงการก่อสร้าง

PRO01

	ระดับความรุนแรง	โอกาสในการเกิด
(1) การวางแผนการทำงานและการกำหนดงบประมาณสำหรับการดำเนินโครงการเกิดความผิดพลาดหรือมีรายละเอียดที่ไม่เหมาะสม		

PRO02

	ระดับความรุนแรง	โอกาสในการเกิด
(2) ปัญหาการดำเนินงานก่อสร้างทางด้านเทคนิค ทั้งในรูปแบบของการไม่สามารถปฏิบัติได้จริง หรือปฏิบัติแล้วไม่มีคุณภาพตามที่กำหนด		

PRO03

	ระดับความรุนแรง	โอกาสในการเกิด
(3) ผู้รับเหมารายย่อย และตัวแทนจำหน่ายวัสดุ ไม่สามารถดำเนินงานได้ตามรายละเอียดของการว่าจ้าง		

PRO05

	ระดับความรุนแรง	โอกาสในการเกิด
(4) สัญญาก่อสร้างไม่สมบูรณ์ มีรายละเอียดที่ผิดพลาด ไม่ยุติธรรม หรือกำหนดในสิ่งที่ไม่สามารถปฏิบัติได้		

PRO08

	ระดับความรุนแรง	โอกาสในการเกิด
(5) ผู้ว่าจ้างหรือตัวแทนแทรกแซงกระบวนการทำงานของกิจการร่วมค้า หรือของสมาชิกรายอื่นๆ ซึ่งอยู่นอกเหนือภาระหน้าที่ซึ่งกำหนดไว้		

กลุ่มที่ 3 ปัจจัยเสี่ยงที่เกี่ยวกับสภาพแวดล้อมภายนอก

EXT01

	ระดับความรุนแรง	โอกาสในการเกิด
(1) ความแตกต่างด้านวัฒนธรรมการใช้ชีวิต เชื้อชาติ และศาสนา ของบุคลากรระหว่างสมาชิก		

EXT02

	ระดับความรุนแรง	โอกาสในการเกิด
(2) ความแตกต่างด้านภาษาที่ใช้สื่อสารในในชีวิตประจำวัน ของบุคลากรระหว่างสมาชิก		

EXT03

	ระดับความรุนแรง	โอกาสในการเกิด
(3) ภัยทางธรรมชาติ และสภาพอากาศที่ผิดปกติ ณ บริเวณพื้นที่ตั้งของโครงการก่อสร้าง		

EXT04

	ระดับความรุนแรง	โอกาสในการเกิด
(4) มลภาวะจากโครงการก่อสร้าง เช่น ฝุ่น เสียง แรงสั่นสะเทือน กลิ่น ฯลฯ ซึ่งส่งผลต่อพื้นที่โดยรอบโครงการ		

Ref: WAR

EXT06	ระดับความรุนแรง	โอกาสในการเกิด
(5) ความปลอดภัยจากการโจรกรรมหรืออาชญากรรม และการก่อจลาจล ณ ณ บริเวณพื้นที่ตั้งของโครงการก่อสร้าง		

EXT07	ระดับความรุนแรง	โอกาสในการเกิด
(6) ความไม่แน่นอนทางนโยบายจากหน่วยงานภาครัฐและรัฐบาล		

EXT09	ระดับความรุนแรง	โอกาสในการเกิด
(7) การทุจริตที่เกิดขึ้นในระดับผู้ว่าจ้าง ตัวแทนผู้ว่าจ้าง ทางการเมือง หรือภายในสมาชิกด้วยกันเอง		

EXT10	ระดับความรุนแรง	โอกาสในการเกิด
(8) ผลจากความผันผวนด้านอัตราแลกเปลี่ยนเงินตราระหว่างประเทศ		

EXT11	ระดับความรุนแรง	โอกาสในการเกิด
(9) ผลจากความผันผวนด้านเศรษฐกิจทั้งภายในประเทศและต่างประเทศ รวมถึงผลจากเงินเฟ้อ		

APPENDIX A-5

EXAMPLE OF QUESTIONNAIRE FOR TERMINATION PHASE

ตอนที่ 3
คำถามเกี่ยวกับ "ระดับความรุนแรง" และ "โอกาสในการเกิด" ของปัจจัยเสี่ยง ที่มีต่อการบริหารงานกิจการร่วมค้างานก่อสร้าง ในช่วง "เลิกกิจการร่วมค้า"

คำชี้แจง

แบบสอบถามในตอนนี้เป็นคำถามแบบเติมคำตอบ

กรุณาเติมคำตอบด้วยระดับคะแนน 1 ถึง 5 ลงในแต่ละข้อ ซึ่งมีค่าตรงกับ

1) ระดับความรุนแรงของปัจจัยเสี่ยง ที่มีต่อการบริหารกิจการร่วมค้างานก่อสร้าง และ

2) โอกาสในการเกิดของปัจจัยเสี่ยง ซึ่งจะเกิดขึ้นในช่วงเลิกกิจการร่วมค้า

ซึ่งเป็นไปตามมุมมองและทัศนคติของท่าน โดยการพิจารณาประสบการณ์ในอดีตจากกิจการร่วมค้างานก่อสร้างในประเทศไทย โดยสามารถพิจารณารายละเอียดเพิ่มเติมสำหรับช่วงเลิกกิจการร่วมค้า ได้ใน "คำชี้แจง" (กระดาษสีฟ้า) ทั้งนี้ความหมายของระดับคะแนน 1 ถึง 5 แสดงอยู่ใน "ใบคะแนน" ซึ่งแนบมาพร้อมกับแบบสอบถามนี้ (กระดาษสีชมพู) ส่วนการพิจารณารายละเอียดเพิ่มเติมของ

ตัวอย่างการตอบแบบสอบถาม

	ระดับความรุนแรง	โอกาสในการเกิด
สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรผลกำไรและขาดทุน รวมถึงความรับผิดชอบด้านการเงินระหว่างกัน	4	3

กลุ่มที่ 1 ปัจจัยเสี่ยงที่เกี่ยวกับสมาชิก

INT01	ระดับความรุนแรง	โอกาสในการเกิด
(1) สมาชิกประสบปัญหาขาดสภาพคล่องทางการเงิน สำหรับนำมาใช้สนับสนุนการดำเนินงานในกิจการร่วมค้า		

INT02	ระดับความรุนแรง	โอกาสในการเกิด
(2) สมาชิกขาดความสามารถในการดำเนินงานก่อสร้าง หรือไม่สามารถดำเนินงานก่อสร้าง		

Ref: TER

INT03

	ระดับความรุนแรง	โอกาสในการเกิด
(3) สมาชิกเปลี่ยนแปลงนโยบายด้านความร่วมมือที่มีต่อสมาชิกฝ่ายอื่นๆ ในกิจการร่วมค้า		

INT04

	ระดับความรุนแรง	โอกาสในการเกิด
(4) สมาชิกขาดประสบการณ์การดำเนินงานโครงการในประเทศไทย และในพื้นที่บริเวณซึ่งโครงการก่อสร้างก่อสร้างจะเข้าไปตั้งอยู่		

INT05

	ระดับความรุนแรง	โอกาสในการเกิด
(5) สมาชิกขาดประสบการณ์การดำเนินงานโครงการก่อสร้างในรูปแบบกิจการร่วมค้า ในฐานะที่เป็นหนึ่งในสมาชิกของหน่วยความร่วมมือนั้น		

INT06

	ระดับความรุนแรง	โอกาสในการเกิด
(6) สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรผลกำไรและขาดทุน รวมถึงความรับผิดชอบด้านการเงินระหว่างกัน		

INT07

	ระดับความรุนแรง	โอกาสในการเกิด
(7) สมาชิกของกิจการร่วมค้ามีมุมมองที่แตกต่างกันในเรื่องของการจัดสรรบุคลากร เครื่องจักร ที่ดิน หรือวัสดุอุปกรณ์อื่นๆ ระหว่างกัน		

INT08

	ระดับความรุนแรง	โอกาสในการเกิด
(8) สมาชิกเข้ามาแทรกแซงกระบวนการทำงานของกิจการร่วมค้า หรือของสมาชิกรายอื่นๆ ซึ่งอยู่นอกเหนือภาระหน้าที่ซึ่งกำหนดไว้		

INT09

	ระดับความรุนแรง	โอกาสในการเกิด
(9) สมาชิกมีความแตกต่างด้านวัฒนธรรมการทำงาน และโครงสร้างการสั่งงานและควบคุมภายในองค์กรที่แตกต่างกัน		

Ref: TER

INT10

	ระดับความรุนแรง	โอกาสในการเกิด
(10) สมาชิกมีไม่เชื่อใจระหว่างกัน ในการปล่อยให้สมาชิกฝ่ายอื่นๆ รับทราบข้อมูลภายในโครงการ หรือการดำเนินงานใดๆ ทั้งภายในหรือกับภายนอก		

INT11

	ระดับความรุนแรง	โอกาสในการเกิด
(11) สมาชิกขาดการสื่อสารที่มีประสิทธิภาพระหว่างกัน เพื่อแลกเปลี่ยนข้อมูลภายในโครงการให้ถูกต้อง หรือมีข้อมูลล่าสุด		

INT12

	ระดับความรุนแรง	โอกาสในการเกิด
(12) สัญญาความร่วมมือระหว่างสมาชิกมีข้อบกพร่อง ทั้งในกรณีที่รายละเอียดหละหลวมหรือมีความรัดกุมจนเกินไป		

กลุ่มที่ 2 ปัจจัยเสี่ยงที่เกี่ยวกับโครงการก่อสร้าง

PRO05

	ระดับความรุนแรง	โอกาสในการเกิด
(1) สัญญาก่อสร้างไม่สมบูรณ์ มีรายละเอียดที่ผิดพลาด ไม่ยุติธรรม หรือกำหนดในสิ่งที่ไม่สามารถปฏิบัติได้		

PRO08

	ระดับความรุนแรง	โอกาสในการเกิด
(2) ผู้ว่าจ้างหรือตัวแทนแทรกแซงกระบวนการทำงานของกิจการร่วมค้า หรือของสมาชิกรายอื่นๆ ซึ่งอยู่นอกเหนือภาระหน้าที่ซึ่งกำหนดไว้		

กลุ่มที่ 3 ปัจจัยเสี่ยงที่เกี่ยวกับสภาพแวดล้อมภายนอก

EXT01

	ระดับความรุนแรง	โอกาสในการเกิด
(1) ความแตกต่างด้านวัฒนธรรมการใช้ชีวิต เชื้อชาติ และศาสนา ของบุคลากรระหว่างสมาชิก		

EXT02

	ระดับความรุนแรง	โอกาสในการเกิด
(2) ความแตกต่างด้านภาษาที่ใช้สื่อสารในในชีวิตประจำวัน ของบุคลากรระหว่างสมาชิก		

EXT07

	ระดับความรุนแรง	โอกาสในการเกิด
(3) ความไม่แน่นอนทางนโยบายจากหน่วยงานภาครัฐและรัฐบาล		

EXT08

	ระดับความรุนแรง	โอกาสในการเกิด
(4) ผลจากนโยบายการจำกัดการลงทุนโดยชาวต่างชาติ รวมถึงการนำเข้าสินค้าหรือบริการจากต่างประเทศ		

EXT09

	ระดับความรุนแรง	โอกาสในการเกิด
(5) การทุจริตที่เกิดขึ้นในระดับผู้ว่าจ้าง ตัวแทนผู้ว่าจ้าง ทางการเมือง หรือภายในสมาชิกด้วยกันเอง		

EXT10

	ระดับความรุนแรง	โอกาสในการเกิด
(6) ผลจากความผันผวนด้านอัตราแลกเปลี่ยนเงินตราระหว่างประเทศ		

APPENDIX B
LIST OF RESPONDENTS

Table B-1 Data Format of Members in Professional Group

ลำดับที่	ชื่อ นามสกุล	CG-JVs					SG-JVs				
		For.	Bid.	Con.	War.	Ter.	For.	Bid.	Con.	War.	Ter.
1	PRO01	x	x	x	x	x					
2	PRO02	x	x	x	x	x	x	x	x	x	x
3	PRO03			x							
4	PRO04	x	x	x	x	x	x	x	x	x	x
5	PRO05	x	x	x	x	x					
6	PRO06			x	x	x					
7	PRO07								x	x	x
8	PRO08								x	x	
9	PRO09	x	x	x	x	x	x	x	x	x	x
10	PRO10	x	x								
11	PRO11								x	x	
12	PRO12						x	x			x
13	PRO13						x				x
14	PRO14						x	x	x	x	x
15	PRO15						x			x	x
16	PRO16				x						
17	PRO17								x	x	
18	PRO18						x	x			x
19	PRO19	x	x	x	x	x	x	x	x	x	x
20	PRO20	x	x								
21	PRO21	x	x			x					
22	PRO22						x	x			
23	PRO23	x	x			x					
24	PRO24	x	x	x	x	x	x	x	x	x	x
25	PRO25								x		
26	PRO26	x	x	x	x	x	x	x	x	x	x
27	PRO27			x	x	x					
28	PRO28	x	x								
29	PRO29						x				
30	PRO30		x								
31	PRO31	x	x	x	x	x	x	x	x	x	x
32	PRO32						x	x			x
33	PRO33			x	x						
34	PRO34			x	x	x					
35	PRO35							x	x	x	x
36	PRO36							x	x	x	
37	PRO37			x	x	x					
38	PRO38	x	x	x	x						
39	PRO39			x	x	x					
40	PRO40								x	x	x
41	PRO41	x	x								
42	PRO42						x	x			
43	PRO43						x	x			
44	PRO44							x	x	x	x
45	PRO45	x				x					
รวมจำนวนข้อมูล		17	17	17	17	17	17	17	17	17	17

Table B-2 Schedule of Delphi Survey for Professional Group

ลำดับที่	ชื่อ นามสกุล	2011				2012										
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
1	PRO01	1							2					3		
2	PRO02		1						2					3		
3	PRO03	1							2						3	
4	PRO04		1						2							3
5	PRO05		1						2					3		
6	PRO06	1							2						3	
7	PRO07						1			2						3
8	PRO08						1			2						3
9	PRO09	1								2						3
10	PRO10						1		2							3
11	PRO11		1						2					3		
12	PRO12						1				2			3		
13	PRO13						1			2						
14	PRO14							1			2					
15	PRO15	1												3		
16	PRO16							1		2						
17	PRO17						1			2						
18	PRO18						1			2						
19	PRO19	1							2	2				3		
20	PRO20						1				2					
21	PRO21	1							2							3
22	PRO22	1								2						
23	PRO23		1						2						3	
24	PRO24		1						2					3		
25	PRO25							1			2					3
26	PRO26		1							2						
27	PRO27		1						2							
28	PRO28						1			2						
29	PRO29	1	1						2						3	
30	PRO30						1			2						3
31	PRO31		1								2					3
32	PRO32							1			2					3
33	PRO33		1						2							
34	PRO34						1			2						
35	PRO35							1		2					3	
36	PRO36							1				2				3
37	PRO37							1				2				
38	PRO38							1				2				3
39	PRO39							1				2				
40	PRO40						1				2				3	
41	PRO41							1			2					
42	PRO42						1				2			3		
43	PRO43						1				2					
44	PRO44							1				2				3
45	PRO45		1							2					3	

Table B-3 Schedule of Delphi Survey for Expert Group

ลำดับที่	ชื่อ นามสกุล	2013											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	EXT01		X	X	X		X	X		X			
2	EXT02			X	X	X					X	X	
3	EXT03		X	X			X	X			X		
4	EXT04		X	X				X	X			X	
5	EXT05			X	X	X		X	X				
6	EXT06			X	X		X		X	X	X		
7	EXT07					X			X		X	X	
8	EXT08				X	X		X	X		X		

APPENDIX C
EXAMPLE OF DATA ANALYSIS

APPENDIX C-1

COMPUTATION OF RISK PARAMETER

The example for finding the CSQ, LLH and LOR

For the total sample (n = 34)

$$CSQ_{Total}^{EXT01} = \frac{1}{34}\sum_{j=1}^{34} CSQ_j^{EXT01} \qquad = 2.8$$

$$LLH_{Total}^{EXT01} = \frac{1}{34}\sum_{j=1}^{34} LLH_j^{EXT01} \qquad = 2.4$$

$$LOR_{Total}^{EXT01} = CSQ_{Total}^{EXT01} \times LLH_{Total}^{EXT01} \qquad = 2.8 \text{ X } 2.4 \qquad = 6.7$$

For the CG-JVS Group (n = 17)

$$CSQ_{CG-JVs}^{EXT01} = \frac{1}{17}\sum_{j=1}^{17} CSQ_j^{EXT01} \qquad = 2.4$$

$$LLH_{CG-JVs}^{EXT01} = \frac{1}{17}\sum_{j=1}^{17} LLH_j^{EXT01} \qquad = 2.4$$

$$LOR_{CG-JVs}^{EXT01} = CSQ_{CG-JVs}^{EXT01} \times LLH_{CG-JVs}^{EXT01} \qquad = 2.4 \text{ X } 2.4 \qquad = 5.8$$

For the SG-JVS Group (n = 17)

$$CSQ_{SG-JVs}^{EXT01} = \frac{1}{17}\sum_{j=1}^{17} CSQ_j^{EXT01} \qquad = 3.3$$

$$LLH_{SG-JVs}^{EXT01} = \frac{1}{17}\sum_{j=1}^{17} LLH_j^{EXT01} \qquad = 2.4$$

$$LOR_{SG-JVs}^{EXT01} = CSQ_{SG-JVs}^{EXT01} \times LLH_{SG-JVs}^{EXT01} \qquad = 3.3 \text{ X } 2.4 \qquad = 7.92$$

APPENDIX C-2

FIND OF RANK FOR MANN-WHITNEY U TEST

The rank of data for the Mann–Whitney U test

Situation 1:

Group	A	A	B	A	B	B
Data	2	3	4	7	9	10
Rank	*1*	*2*	*3*	*4*	*5*	*6*

Situation 2:

Group	A	A	B	A	B	B
Data	2	3	3	7	9	10
Rank	*1*	*2.5*	*2.5*	*4*	*5*	*6*

Note the average = (2 + 3)/2 = 2.5

Situation 3:

Group	A	A	B	A	B	B
Data	2	3	5	5	5	10
Rank	*1*	*2*	*4*	*4*	*4*	*6*

Note the average = (3 + 4 + 5)/3 = 3

APPENDIX C-3
COMPUTATION OF MANN-WHITNEY U TEST

The calculation examples the Mann–Whitney U test by using the data of this study are described as follow:

The data of the risk parameter for the risk factor named "INT 08: Improper intervention by partners" are shown in Table 6.3 and Table 6.4.

Table C-1 Data of CSQ of INT 08 in the Bidding phase for CG-JVS group

Risk parameter	CE01	CE02	CE03	CE04	CE05	CE06	CE07	CE08	CE09	CE10	CE11	CE12	CE13	CE14	CE15	CE16	CE17
CSQ	3	3	2	3	3	2	3	2	3	3	3	2	2	3	3	3	3
LLH	2	2	3	3	3	2	3	3	3	2	3	3	3	2	3	2	2

Table C-2 Data of Risk Parameter of INT 08 for the Bidding phase for SG-JVS group

Risk parameter	SE01	SE02	SE03	SE04	SE05	SE06	SE07	SE08	SE09	SE10	SE11	SE12	SE13	SE14	SE15	SE16	SE17
CSQ	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
LLH	2	1	1	2	2	1	2	2	1	2	1	2	1	2	2	2	1

The example of the Mann–Whitney U test for the situation that H_0 would be accepted.

Hypothesis test for the CSQ value of INT 08 in the Bidding phase

Step 1 : The all CSQ data for both the CG-JVs group and the SG-JVs group be rearranged and ranked were shown in Table C-3, as follow:

Step 2 : From the ranks of each group shown in Table 6.5

$T_{CG\text{-}JVs}$ = 263.5

$T_{SG\text{-}JVs}$ = 331.5

Step 3 : So, T_x = 331.5

Table C-3 Rank for each CSQ data of INT 08 for the Mann–Whitney U test

CG-JVs Group		SG-JVs Group	
Scores	Rank	Scores	Rank
3	20.5	3	20.5
3	20.5	3	20.5
2	3.5	3	20.5
3	20.5	3	20.5
3	20.5	3	20.5
2	3.5	3	20.5
3	20.5	3	20.5
2	3.5	3	20.5
3	20.5	2	3.5
3	20.5	3	20.5
3	20.5	3	20.5
2	3.5	3	20.5
2	3.5	3	20.5
3	20.5	3	20.5
3	20.5	3	20.5
3	20.5	3	20.5
3	20.5	3	20.5
Total	263.5	Total	331.5

Step 4 : The group size for the CG-JVs group and the SG-JVs group are equal as 17.

So, $N_1 = N_2 = 17$

Note because the group size for the CG-JVs group and the SG-JVs group for all risk factors in all phase of this study are always as 17, so the N_1 and N_2 are always as "17".

Step 5 : Calculate the computed U, by $N_x = 17$

$$\mathrm{U} = (17)\cdot(17) + (17)\cdot\frac{(17)+1}{2} - 331.5 \qquad = 110.5$$

Step 6 : Find the critical U

From the Table D-1 in Appendix D when the level of significance = 0.10 and N_1 = N_2 = 17

The critical U = 96

Note because the level of significance, N_1 and N_2 are the consistency values for the whole study, so the critical U is always as "96".

Step 7 : The computed U is more than the critical chi-square

Or 100.5 < 96

So, the H_0 is accepted.

Step 8 **:** It can be conclude that

For the CSQ value of INT 08: Improper intervention by partners between, there is no difference between the CG-JVs and the SG-JVs at the 90% level of confidence.

The example of the Mann–Whitney U test for the situation that H_0 would be rejected.

Hypothesis test for the LLH value of INT 08 in the Bidding phase

Step 1 : The all LLH data for both the CG-JVs group and the SG-JVs group be rearranged and ranked were shown in Table 6.6, as follow:

Step 2 : From the ranks of each group shown in Table C-4

Table C-4 Rank for each LLH data of INT 08 for the Mann–Whitney U test

CG-JVs Group		SG-JVs Group	
Scores	Rank	Scores	Rank
2	16	2	16
2	16	1	4
3	29.5	1	4
3	29.5	2	16
3	29.5	2	16
2	16	1	4
3	29.5	2	16
3	29.5	2	16
3	29.5	1	4
2	16	2	16
3	29.5	1	4
3	29.5	2	16
3	29.5	1	4
2	16	2	16
3	29.5	2	16
2	16	2	16
2	16	1	4
Total	407		188

$T_{CG\text{-}JVs}$ = 407

$T_{SG\text{-}JVs}$ = 188

Step 3 : So, T_x = 407

Step 4 : $N_1 = N_2 = 17$

Step 5 : Calculate the computed U, by N_x = 17

$$U = (17)\cdot(17) + (17)\cdot\frac{(17)+1}{2} - 407 \qquad = 35$$

Step 6 : The critical U = 96

Step 7 : The computed U is less than the critical chi-square

Or 35 < 96

So, the H_0 is rejected.

Step 8 **:** It can be conclude that

For the CSQ value of INT 08: Improper intervention by partners between, there is difference between the CG-JVs and the SG-JVs at the 90% level of confidence.

APPENDIX C-4

COMPUTATION OF MEDIAN TEST

Again, "INT 08: Improper intervention by partners" are used as the example. Their data from the survey already shown in Table C-1 and Table C-2.

The example of the median test for the situation that H_0 would be accepted.

Hypothesis test for the CSQ value of INT 08 in the Bidding phase

Step 1 : The overall median is 3.0.

When the total sample (*N*) is 34.

Step 2 : After considering the amount of case in each sub-group using the over median as criterion, the 2 x 2 contingency table for this CSQ value of the risk factor show in Table 6.8.

Step 3 : Compute the chi-square test

$$\chi^2 = \frac{34(|6\times9-8\times11|-34/2)^2}{(6+8)(11+9)(6+11)(8+9)} \qquad = 0.12$$

Step 3 : Compute *df*

$$\mathrm{df} = (2-1)(2-1) \qquad = 1$$

Note because the number of columns and rows for all risk factors in all phase of this study are always as 2, so the df is always as "1".

Table C-5 The 2 x 2 Contingency Table for CSQ of INT 08 in the Bidding Phase

Score	Group No. 1	Group No. 2	Total
> overall median	6	8	14
≤ overall median	11	9	20
Total	17	17	34

Step 4 : Find the critical chi-square

From the Table D-2 in Appendix D when the level of significance = 0.10 and df = 1

The critical chi-square = 2.71

Note because the level of significance and df are the consistency values for the whole study, so the critical chi-square is always as "2.71".

Step 5 : The computed chi-square is less than the critical chi-square

Or $0.12 < 2.71$

So, the H_0 is accepted.

Step 6 : It can be conclude that

For the CSQ value of INT 08: Improper intervention by partners between, there is no difference between the CG-JVs and the SG-JVs at the 90% level of confidence.

The example of the median test for the situation that H_0 would be rejected

Testing the hypothesis for the LLH value of INT 08 in the Bidding phase

Step 1 : The overall median is 2.0.

When the total sample (N) is 34.

Step 2 : After considering the amount of case in each sub-group using the over median as criterion, the 2 x 2 contingency table for this CSQ value of the risk factor show in Table C-6.

Table C-6 The 2 x 2 Contingency Table for LLH of INT 08 in the Bidding Phase

Score	Group No. 1	Group No. 2	Total
> overall median	13	5	18
≤ overall median	4	12	16
Total	17	17	34

Step 3 : Compute the chi-square test

$$\chi^2 = \frac{34(|13\times12-5\times4|-34/2)^2}{(13+5)(4+12)(6+4)(5+12)} = 5.78$$

Step 4 : The computed chi-square is more than the critical chi-square

Or 5.78 > 2.71

So, the H_0 is rejected.

Step 5 : It can be conclude that

For the LLH value of INT 08: Improper intervention by partners between, there is difference between the CG-JVs and the SG-JVs at the 90% level of confidence.

APPENDIX D

RISK TABLE

Table D-1 Critical U Values

N_1 \ N_2	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
5	2	3	5	6	7	8	9	11	12	13	14	15	17	18	19	20
6	3	5	6	8	10	11	13	14	16	17	19	21	22	24	25	27
7	5	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34
8	6	8	10	13	15	17	19	22	24	26	29	31	34	36	38	41
9	7	10	12	15	17	20	23	26	28	31	34	37	39	42	45	48
10	8	11	14	17	20	23	26	29	33	36	39	42	45	48	52	55
11	9	13	16	19	23	26	30	33	37	40	44	47	51	55	58	62
12	11	14	18	22	26	29	33	37	41	45	49	53	57	61	65	69
13	12	16	20	24	28	33	37	41	45	50	54	59	63	67	72	76
14	13	17	22	26	31	36	40	45	50	55	59	64	67	74	78	83
15	14	19	24	29	34	39	44	49	54	59	64	70	75	80	85	90
16	15	21	26	31	37	42	47	53	59	64	70	75	81	86	92	98
17	17	22	28	34	39	45	51	57	63	67	75	81	87	93	99	105
18	18	24	30	36	42	48	55	61	67	74	80	86	93	99	106	112
19	19	25	32	38	45	52	58	65	72	78	85	92	99	106	113	119
20	20	27	34	41	48	55	62	69	76	83	90	98	105	112	119	127

Table D-2 Chi Square Distribution

	Significance Level				
df	0.10	0.05	0.025	0.01	0.005
1	2.7055	3.8415	5.0239	6.6349	7.8794
2	4.6052	5.9915	7.3778	9.2104	10.5965
3	6.2514	7.8147	9.3484	11.3449	12.8381
4	7.7794	9.4877	11.1433	13.2767	14.8602
5	9.2363	11.0705	12.8325	15.0863	16.7496
6	10.6446	12.5916	14.4494	16.8119	18.5475
7	12.017	14.0671	16.0128	18.4753	20.2777
8	13.3616	15.5073	17.5345	20.0902	21.9549
9	14.6837	16.919	19.0228	21.666	23.5893
10	15.9872	18.307	20.4832	23.2093	25.1881

APPENDIX E
CJV APPRAISAL FORM

1) **Contractor policies for CJV**

Questions:

How well are you intend to cooperate on the CJV?

Possible status and its impact scale:

Scale		Status
2	:	Plan to put all of my effort and cooperation into CJV
3	:	Plan to put moderate effort into CJV and tend to avoid unnecessary work
4	:	Plan to put little effort into CJV or work only on required parts
5	:	Plan to co-operate only by name and try to limit or even prevent resource sharing among members

2) **Contractor cash flow**

Questions: How is your cash flow status?

Possible status and its impact scale:

Scale		Status
5	:	Additional financial sources are required
4	:	Lack cash on hand
3	:	Somewhat ready
2	:	Have cash on hand
1	:	Have cash ready for operation

3) **Contractor CJV experiences**

Have you ever experienced in the CJVs in Thailand before?

Possible status and its impact scale:

Scale		**Status**
5	:	Never be a member of any CJV at all
5	:	Used to be a partner in the local CJV
4	:	Only a few times in the local CJVs
3	:	Join an ICJV only once
2	:	Only a few times in ICJVs (2-3 times)
1	:	Worked in ICJVs more than 4 times

4) **Contractor experiences in international projects**

Questions:

Have you ever experienced in the international projects before?

Possible status and its impact scale:

Scale		**Status**
5	:	Never work in any international project at all
5	:	Worked only as sub-contractor in the international project
4	:	Worked in the international project in Thailand once
3	:	Worked on a few of international projects in Thailand

3	:	Worked in international projects in neighboring countries
2	:	Worked in a project in foreign country which is not a member of AEC
2	:	Worked more than 4 of international projects in Thailand
1	:	Work on 2-3 international projects in foreign countries which are not member of AEC

5) Contractor's staff with language capabilities

Questions:

How fluent your staff are in English?

Possible status and its impact scale:

Scale		Status
1	:	Most of them are fluent in English.
2	:	Most of them can read, listen and speak English but not well in writing.
3	:	Most of them can read and listen well but cannot speak or write well.
4	:	Most of them can read well but cannot speak, listen or write well.
5	:	Most of them cannot read, speak, listen and write English well.

6) Contractor's staff with CJV experiences

Questions:

Have your staff, who will be operating in this CJV project, ever experienced in the CJVs before?

Possible status and its impact scale:

Scale		Status
1	:	Most of them have experience in ICJVs with the same members.
2	:	Most of them have experience in ICJVs and all members are from the same country.
3	:	Most of them have experience in CJVs.
2	:	Most of them have experience in both CJVs and ICJVs before hand in the same country as members.
3	:	Most of them have experience in both CJVs and ICJVs.
4	:	Most of them have experience in international project within the same country of JV's member.
5	:	Most of them have experience in international project.
5	:	None of them have experience working within this kind of project.

7) **Contractor workload**

Questions:

How is your workload?

Possible status and its impact scale:

Scale		Status
5	:	Work on project requires almost all of company's resources
4	:	Work on project requires most of company's resources
3	:	Work on project requires half of company's resources
2	:	Work on project requires one-third of all company's resources

1 : Load free or closing a project

8) Contractor construction site experiences

Have you ever worked around the areas of the project sites?

Possible status and its impact scale:

Scale		Status
5	:	Never
5	:	Only once for a long time
4	:	Only once in last few years
3	:	Regularly
2	:	Frequently

9) Contractor construction experiences

Questions:

What is about your construction performance in the previous projects?

Possible status and its impact scale:

Scale		Status
5	:	Never have any record
5	:	Have less capability than requirement
4	:	Have adequate capability for requirement
3	:	Have capability equal requirement
2	:	Have more capability than requirement

10) Cash flow of partners

Questions:

How are your partner cash flow status?

Possible status and its impact scale:

Scale		Status
5	:	Additional financial sources are required
4	:	Lack cash on hand
3	:	Somewhat ready
2	:	Have cash on hand
1	:	Have cash ready for operation

11) **Policies of partners**

In your expectation, how well are your partners intend to cooperate on the CJV?

Possible status and its impact scale:

Scale		Status
2	:	Plan to put all of their effort and cooperation into CJV.
3	:	Plan to put moderate effort into CJV and tend to avoid unnecessary work.
4	:	Plan to put little effort into CJV or work only on required parts.
5	:	Plan to co-operate only by name and try to limit or even prevent resource sharing among members.

12) **Legal status of partners**

Questions:

What is your partner’s legal status in Thailand?

Possible status and its impact scale:

Scale		**Status**
5	:	None is subsidiary or branch of any company.
5	:	A subsidiary or branch of a company which have been registered in Thailand for less than 3 years with inappropriate registered capital.
4	:	A subsidiary or branch of a company which have been registered in Thailand for 4-8 years with inappropriate registered capital.
3	:	A subsidiary or branch of a company which have been registered in Thailand over 8 years with inappropriate registered capital.
3	:	A subsidiary or branch of a company which have been registered in Thailand for less than 3 year with appropriate registered capital.
2	:	A subsidiary or branch of a company which have been registered in Thailand for 4-8 years with appropriate registered capital.
1	:	A subsidiary or branch of a company which have been registered in Thailand over 8 years with appropriate registered capital.

13) Financial status of partners

Questions:

What is about your partner’s financial status?

Possible status and its impact scale:

Scale		Status
5	:	No idea at all
5	:	Have very bad or dangerous financial stability
4	:	Have a bad financial stability
3	:	Have an average financial stability
2	:	Have high financial stability
1	:	Have very high financial stability

14) Past performance of partners

Questions:

What is about the construction performance in the previous projects of your partner?

Possible status and its impact scale:

Scale		Status
5	:	Never have any record
5	:	Stop or drop project mid-way
5	:	Being sued by owner or customer
4	:	Ordinary, Usually finish late
3	:	Good, Only a bit delay
2	:	Very effective and finish work on time

15) Local experiences of partner

Questions:

Have your partner ever worked in Thailand?

Possible status and its impact scale:

Scale		Status
5	:	Never do a single project
5	:	Only once and on different type of project
4	:	Worked in Thailand several times but on different types of project
3	:	Worked in Thailand with quite similar type of project
1	:	Worked in Thailand many times on similar project
2	:	Have subsidiary or branch in Thailand for more than 3 years
3	:	Have subsidiary or branch in Thailand for 4-8 years
1	:	Have subsidiary or branch in Thailand for more than 8 years

16) Workload of partners

Questions:

How is the workload of your partner?

Possible status and its impact scale:

Scale		Status
5	:	Work on project requires almost all of their company's resources.
4	:	Work on project requires most of their company's resources.
3	:	Work on project requires half of their company's resources.

2 : Work on project requires one-third of all their company's resources.

1 : Load free or closing a project

17) CJV experiences of partners

Questions:

Have your partner experienced in the CJVs in Thailand before?

Possible status and its impact scale:

Scale	Status
5 :	Never worked as CJV
4 :	Worked once as a member of CJV
3 :	Worked 2-3 times as a member of CJVs
2 :	Worked in international JV more than 4 times

18) Language capabilities in staff of partners

Questions:

What level are the English capabilities for other partners' staff?

Possible status and its impact scale:

Scale	Status
2 :	Most of their staffs are fluent in English
3 :	Most of their staffs can communicate moderately
5 :	Most of their staffs cannot communicate much
1 :	Most of their staffs can communicate well with some knowledge on local language

2	:	Most of their staffs can communicate moderately with some knowledge on local language
4	:	Most of their staffs can't communicate much have some knowledge on local language

19) CJV experiences in staff of partners

Questions:

Have other partners' staff ever experienced in the CJVs before?

Possible status and its impact scale:

Scale		Status
1	:	Most of their staffs have experience in ICJVs within Thailand
3	:	Most of their staffs have experience in ICJVs other than Thailand
4	:	Most of their staffs have experience in CJVs within their own countries
3	:	Most of their staffs have experience in ICJVs within their own countries
4	:	Most of their staffs have experience in ICJVs in other countries
5	:	Most of their staffs have no experience at all

20) Specializations among partners

Questions:

How is the difference of specialize between you and your partners?

Possible status and its impact scale:

Scale		Status
4	:	All partners work in the same field, same expertise but different experience
5	:	All partners work in the same field with similar expertise
3	:	All partners work in the same field but with different expertise
1	:	All partners have totally different expertise

21) Diversity in JV

Questions:

When considering staffs, how is the diversity in the CJV project?

Possible status and its impact scale:

Scale		Status
2	:	Come from 2 nations. All are East or Southeast Asian countries
3	:	Come from 2 nations with Asian and Western countries
4	:	Come from 2 nations with East and Southeast Asian or Western countries
3	:	Consist of 3-5 nations. All are East or Southeast Asian countries
4	:	Consist of 3-5 nations who are Asian and Western countries
5	:	Consist of 3-5 nations who are Asian and Southeast Asian or Western countries

22) Partnership between partners

Questions:

How is the relationship between you and your partners?

Possible status and its impact scale:

Scale		Status
1	:	Used to work together in previous CJV and have a very strong relationship
2	:	Used to work together in previous CJV with good relationship
4	:	Used to work together in previous CJV but have a bad relationship among each other
2	:	Worked together on other projects and have a very strong relationship
3	:	Worked together on other projects with a good relationship
5	:	Worked together on other projects but have a bad relationship
3	:	Never work together but have a very strong relationship
4	:	Never work together but have a good relationship
5	:	Never work together and have a bad relationship

23) Relationship with owner

Questions:

How is your CJV's relationship with the project owner?

Possible status and its impact scale:

Scale		Status
1	:	Have a very good relationship from previous projects
2	:	Have a good relationship from previous projects
3	:	Have no relationship and never work together
4	:	Have a bad relationship from previous projects
5	:	Have a very bad relationship from previous projects

24) Relationship with owner representatives

Questions:

How is your CJV's relationship with owner's representatives?

Possible status and its impact scale:

Scale		Status
1	:	Have a very good relationship from previous projects
2	:	Have a good relationship from previous projects
3	:	Have no relationship and never work together
4	:	Have a bad relationship from previous projects
5	:	Have a very bad relationship from previous projects

25) **Relationship with government**

Questions:

How is your ICJV's relationship with the political party?

Possible status and its impact scale:

Scale		Status
2	:	Some partners support / have a good relationship with political party in power while others are neutral.
5	:	Some partners oppose / have a bad relationship with political party in power while others are neutral.
3	:	All partners are neutral / don't have any relationship with any party.
4	:	Both supporting and opposing members are together.

26) **CJV experiences in staff at management-level**

Questions:

Have the staff at management-level ever experienced in the CJVs before?

Possible status and its impact scale:

Scale		Status
1	:	Most of staff have experience in ICJVs within Thailand.
3	:	Most of staff have experience in ICJVs other than Thailand.
4	:	Most of staff have experience in CJVs within their own countries.
3	:	Most of staff have experience in ICJVs within their own countries.

4	:	Most of staff have experience in ICJVs in other countries.
5	:	Most of staff have no experience at all.

27) Performance of subcontractor

Questions:

How well your subcontractor work with you in the past record?

Possible status and its impact scale:

Scale		Status
2	:	Worked together within similar project and the result was satisfactory
3	:	Worked together within similar project and the result was just fine
5	:	Worked together within similar project and the result was bad
4	:	Never work together within similar project but their past projects were satisfactory
5	:	Never work together within similar project but their past projects were acceptable
5	:	Never work together within similar project and their past projects were bad

28) Performance of suppliers

Questions:

What is about suppliers' past work history?

Possible status and its impact scale:

Scale		**Status**
1	:	Worked together before and have a good record of delivery
3	:	Worked together before with moderate record of delivery
5	:	Worked together before but have a bad record of delivery
2	:	Never work together but have a good delivery record
4	:	Never work together but have a moderate delivery record
5	:	Never work together and past delivery record can't be checked

29) Type of subcontractor

Questions:

How does your CJV decide on which main subcontractor it will be using?

Possible status and its impact scale:

Scale		**Status**
2	:	Mostly pick from contractors who used to work together
4	:	Pick both contractor who have and have not worked together by equal proportion
5	:	Mostly pick from contractors who have never worked together
1	:	Have partners as key subcontractor within project
2	:	Have partners as key subcontractor within project with contractor who used to work together

3	:	Have partners as key subcontractor within project with contractor who never work together
4	:	Have partners as key subcontractor within project with both contractor who used to and never work together

30) Policies for environment and pollution

Questions:

How does your CJV decide on which the options for responding the environment effect and the pollution caused by the project?

Possible status and its impact scale:

Scale		**Status**
5	:	No plan for them at all.
5	:	Have the plan but not operate it.
4	:	Prepare the acceptable plans and the budget for them.
3	:	Prepare the perfect plans and the acceptable budget for them.
2	:	Prepare the perfect plans and the suitable budget for them.

31) Currency used in the project

Questions:

What is the main currency used for income allocation among members?

Possible status and its impact scale:

Scale		**Status**
2	:	Single currency based on the country project situates in
3	:	Multiple currencies but more than 70% is based on the country project situates in

4 : Multiple currencies but around 45-70% is based on the country project situates in

5 : Multiple currencies but less than 45% is based on the country project situates in

32) Schedule for extra currency

Questions:

What is a time span for income allocation among members by foreign currencies?

Possible status and its impact scale:

Scale		Status
1	:	Within 3 month since the project start
2	:	Within 1 year since the project start
3	:	Within 2-3 years since the project start
4	:	Within 3-5 years since the project start
5	:	After closing cooperating unit

33) Currency used for owner's payment

Questions:

What is the agreed currency paid from project owner?

Possible status and its impact scale:

Scale		Status
5	:	Owner pay everything with single currency.
5	:	Owner pay with several currencies but not the ones asked by partner.

4	:	Owner pay with several currencies which goes according to partner's request but it is not enough to cover everything.
3	:	Owner pay with several currencies which goes according to partner's request and it is enough to cover everything.
1	:	Owner pay with several currencies which goes according to partner's request but it is more than enough to cover everything.

34) Characteristic of project cash flow

Questions:

What is the cash flow pattern for the construction project?

Possible status and its impact scale:

Scale		Status
5	:	Require high investment during the first phase of the project
4	:	Require high investment during the middle phase of the project
2	:	Require high investment during the final phase of the project
3	:	Require spreading of investment along the project
5	:	Require high investment all along the project
3	:	Require high and low investment respectively during each period of the project

35) Level of project preparation

Questions:

How ready is the details in term of development and arrangement for the construction project?

Possible status and its impact scale:

Scale		Status
1	:	The project is studied in details, project arrangement and design is prepared very well.
2	:	The project is studied in details, project arrangement and design is prepared moderately.
3	:	The project is studied in detail with well-prepared project arrangement but with not so good design.
4	:	The project is studied in detail but project arrangement and design are not done well.
4	:	The project is studied along with project arrangement moderately but design are not done well.
5	:	The project is studied moderately while project arrangement and design are not so well.
5	:	The project rarely conduct study and arrangement.

36) Type of structures

Questions:

What is the characteristic of structure being used within the construction project?

Possible status and its impact scale:

Scale		Status
1	:	Ordinary structure which can be found anywhere
2	:	Special structure which requires expert but still able to find generally
3	:	Special structure which requires expert but can be found in some projects
4	:	Special structure which requires expert and cannot be found easily elsewhere
5	:	Special structure which requires expert and can be rarely found elsewhere

37) Type of technology

Questions:

What is the type of technology used within the construction project?

Possible status and its impact scale:

Scale		Status
5	:	Latest world innovation which has never been used in Thailand before
4	:	New technology to Thailand but normally used within foreign countries
4	:	New technology to Thailand and rarely used within foreign countries
2	:	Use technology, which is used occasionally locally but very famous within foreign countries

3	:	Use technology, which is used occasionally locally and rarely used within foreign countries
1	:	Use technology which has been being used in Thailand for long

38) EIA & EHIA status

Questions:

What is about the status of EIA & EHIA study on the project?

Possible status and its impact scale:

Scale		Status
1	:	All EIA & EHIA result is processed and no opposition occurs.
3	:	All EIA & EHIA result is processed and opposition occurs.
2	:	All EIA & EHIA result is still in progress and no opposition occurs.
4	:	All EIA & EHIA result is still in progress but opposition occurs.
3	:	No EIA & EHIA study done yet but no opposition.
5	:	No EIA & EHIA study done yet but now has opposition.

39) Level of health and environment effects

Questions:

During construction period, how will the project affect surrounding area?

Possible status and its impact scale:

Scale		Status
5	:	It causes vibrancy and noise in noticeable level to most of people around half of total operation period.
4	:	It causes vibrancy and noise in noticeable level to most of people around1/3 of total operation period.
3	:	It causes vibrancy and noise in noticeable level to most of people around 1/4 of total operation period.
2	:	It causes vibrancy and noise in noticeable level to most of people sometime.
1	:	It causes very little vibrancy and noise.

40) Sensitivity of project to disaster

Questions:

When flooding occurs, how will it affect project's establishment?

Possible status and its impact scale:

Scale		Status
1	:	Rarely get any effect
2	:	10% of building is flooded
3	:	Less than 10% of structure is flooded and working site can't be reached
3	:	10 – 30% of structure is flooded
4	:	10 – 30% of structure is flooded and working site can't be reached
4	:	31 – 60% of structure is flooded
5	:	More than 60% of structure is flooded

41) Environment of project sites

Questions:

What is the characteristic of areas surrounding the project site?

Possible status and its impact scale:

Scale		Status
1	:	Most of the area are unused space, farm and plantation.
4	:	Most of area are building and residence with dense population.
3	:	Most of area are building and residence with moderate population.
2	:	Most of area are building and residence with sparse population.
5	:	Most of area are on street surrounded by highly populated area.
4	:	Most of area are on street surrounded by moderately populated area.
3	:	Most of area are on street surrounded by sparsely populated area.
4	:	Most of area are underground but most of entrance are in highly populated area.
3	:	Most of area are underground but most of entrance are in moderately populated area.
2	:	Most of area are underground but most of entrance are in sparsely populated area.

42) Disaster of project sites

Questions:

Based on past record of the areas around the project site, have the areas ever faced with flooding?

Possible status and its impact scale:

Scale		Status
1	:	Never have a flooding
2	:	Flooding occurs within 10 years span
3	:	Flooding occurs every 5-9 years
4	:	Flooding occurs every 2-3 years
5	:	Flooding occurs every year

43) Previous landowners of project sites

Questions:

What is the attitude of land's previous owners toward project?

Possible status and its impact scale:

Scale		Status
2	:	All of them are willing to move out.
2	:	Previous owner is the project's owner itself.
3	:	Some of previous owners are not willing to move.
4	:	About half of previous owners are not willing to move out.
5	:	Almost all of previous owners are not willing to move out.
5	:	They do not know anything yet.

44) Public attitudes towards project

Questions:

What is about public's attitude and attention toward project?

Possible status and its impact scale:

Scale		Status
3	:	Public pay high attention to the project and most of them are in a positive way.
5	:	Public pay high attention to the project and most of them are in a negative way.
2	:	Public pay moderate attention to the project and most of them are in a positive way.
4	:	Public pay moderate attention to the project and most of them are in a negative way.
1	:	Public do not pay attention to the project at all.

45) CJV experiences in owner

Questions:

What is about owner and its representatives' experience in hiring the contractor in form of CJV?

Possible status and its impact scale:

Scale		Status
1	:	Have worked many times with CJVs
2	:	Have worked around 2-3 projects with CJVs
3	:	Have worked with CJV only once
4	:	Have worked with local CJV only once
5	:	Have no experience at all

46) Performance of owner & representatives

Questions:

What is about owner and its representatives' capability on managing and controlling the project?

Possible status and its impact scale:

Scale		Status
5	:	Never have any experience on current project's structure.
4	:	Worked only once in a similar project structure
2	:	Operated in similar project and came up with a good result
4	:	Operated in similar project but the outcome is not well
4	:	Set up by several companies but key company has never had any experience on similar project
3	:	Set up by several companies and key company has experience on similar project
1	:	Used to work in similar project and result has been good all along

47) Status of government

Questions:

How stabilized the current government is?

Possible status and its impact scale:

Scale		Status
1	:	Very stable and new election will be more than 2 years away
3	:	There should be a new election soon.

2	:	There should be a new election soon but the old party will win again.
4	:	There should be a new election soon and the new party will win.
3	:	There should be a new election soon but the result is not certain.
3	:	Very shaky situation. Parliament may be dissolved but the old party will come back.
5	:	Very shaky situation. Parliament may be dissolved and the new party will win.
4	:	Very shaky situation. Parliament may be dissolved but the result can't be certain.
5	:	Coup D'état may happen

48) Political issues

Questions:

How serious is it for those with political conflict?

Possible status and its impact scale:

Scale		**Status**
5	:	A mob may occur
5	:	Violence may be used
3	:	Drag-on rally in closed area
4	:	Drag-on rally, road and government offices closed
2	:	Rally may occur occasionally in closed area
3	:	Rally may occur occasionally with road and government offices blocked

2 : Debate and speech on media

1 : Dissertation through normal channel

49) Type of CJV organization structure

Questions:

What type of CJV organization structure is your CJV managed under?

Possible status and its impact scale:

Scale		Status
2 and 4	:	Collaborated governance structure (CG-JVs)
4 and 2	:	Separated governance structure (SG-JVs)

50) Corruption and bribery

Questions:

What do you think about the corruption within this project?

Possible status and its impact scale:

Scale		Status
5	:	Certainly happen. You take whatever you can.
4	:	Certainly happen. It will be in a noticeable level.
3	:	Certainly happen but it will not be in a noticeable level.
2	:	May happen but only just a little
1	:	Not likely to happen

51) Fluctuation in economic and inflation

Questions:

How is the fluctuation in economic and inflation during the project life cycle?

Possible status and its impact scale:

Scale		Status
5	:	Extremely fluctuation
4	:	Vary fluctuation
3	:	Fluctuation in the normal level
2	:	Less fluctuation
1	:	Least fluctuation

VITA

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During the study at Chulalongkorn University, he has the experiences in special research projects in the field of the construction standard, the building code, the construction claim management, the construction contract, the construction law, the precast concrete, the environment feasibility study and the building information modeling (BIM). He also is the special lecture at department of Civil Engineer, Kasetsart University, Kamphaeng Sean Campus for three years.