A STUDY OF RISK FACTORS IN CIVIL ENGINEERING PROJECTS

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CERTIFICATION OF APPROVAL

A Study of Risk Factors in Civil Engineering Projects

by

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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ABSTRACT

The objective of the study is to recognize risk factors within the context of the Malaysian construction industry and to prioritize those risk factors based on feedback of respondents. It was conduct towards G5 to G7 construction companies that been registered with Construction Industry Development Board (CIDB) Malaysia. The data was collected using survey research methodology. Questionnaire was sent to random selected construction companies and interview conducted for certain companies to obtain additional information. The data obtain was analyzed using severity index and these risk factors were ranked according to the percentage. Overall respondents ranked delayed payment on contract and safety/accident are two most important risks while weather condition and changes in government policy are two least important risks. Among other factors that respondents add and believe can develop into a risk are material price increases, variation order, failure to follow method of statement and stability of government.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

1.1 Background Of Study

The construction industry is one of the industries that involved many uncertainties in its everyday operations. All the processes in the projects from the starting conceptual phase of the project until the completion of the project will involve risks that might cause troubles in terms of cost, time and quality. Kangari (1995) points out that risks cannot be eliminated but they can be managed and reduced. Other than that Smith, Merna and Jobling (2006) state that to prevent the risk event from occurs, their root causes must be identified and managed (p.2). Risks in the construction industry can cause lack of ability to achieve the project targets and can bring tremendously negative implications for the parties involved.

Different types of construction projects will require involvement of many parties such as contractors, clients, architects, government bodies and others. It also involves resources such as construction materials, equipment and machinery, technical workers and labors, funds and time. All of these parties and resources have some risks that can be related to them. Risk management provides a framework that assists in minimization of such risks and their consequences. It can help the contractors determine risks that been associated with their project.

Generally, risk management in every industry will follow a basic systematic approach. According to Smith, Merna and Jobling (2006) it consist with four main steps:

i. identify the risk source
ii. measure risk effects
iii. develop management responses to risk

iv. provide residual risk in the project estimates

In risk management, all four steps are the core of the course of action (p.2).For this study it will be limited to identify and prioritize the risk factors. In Malaysia, however there has not been much attention given to the identification of risk factors in the Malaysian construction industry. This study is intended to identify and prioritize risk factors within the context of the Malaysian construction industry.

1.2 Problem Statement

Malaysia is one of the developing countries in the world with construction as one of the industries that grows rapidly. Many construction projects in Malaysia had been completed with a success despite the challenge or obstacle that been faced. Mega construction projects such as PETRONAS Twin Towers, Kuala Lumpur International Airport (KLIA), Cyberjaya City and Storm water Management and Road Tunnel (SMART Tunnel) are the few examples that show the success of Malaysian construction companies.

Other than that, the construction industry has made successful inroads into the Middle East, South Asia and other countries. According to the Construction Industry Development Board (CIDB) (2009), Malaysian companies were awarded 447 projects, worth RM81.2 billion in 43 countries last year building infrastructure such as roads, highways, bridges, power plants, airports, housing, hotels and commercial centers.

However there are still projects in Malaysia that fail to be completed in time and being abandoned. According to Master Builders Association Malaysia (MBAM) (2006), Malaysian government paid out RM 11bilion to take over seven privatized projects including highway and national sewerage system that had run up losses and debts. These projects not only bring losses to the government but also to the public.

Implementing risk management in overall project management can help the industry to minimize the problem. Contractors that can recognize these risk factors that might affect their project will be able to make judgment of tender price with due consideration of risk factors, and manage the risk properly during the construction process. However, because of lack of research about risk being accomplished within the perspective of Malaysian construction industry, the implementation of systematic approach might be a setback. This study is intended to overcome the first step in risk management that is identifying and prioritizing the risk factors.

1.3 Objectives

The objective of the study is to recognize risk factors within the context of the Malaysian construction industry. In details, the study is:

i. To identify risk factors in civil engineering works based on project types such as building, road and water works.
ii. To prioritize those risk factors which have been identified.

1.4 Scope of Study and Limitation

This study mainly focused on the risk identification in Malaysian construction industry. It will be conduct towards construction companies that been registered with Construction Industry Development Board (CIDB) Malaysia. The study will be limited to:

i. G5 to G7 class contractors registered with CIDB Malaysia.
ii. Contractors that involved in building, road or water works construction.

CHAPTER TWO

LITERATURE REVIEW

This chapter summarizes the literature review on the focus of risk and its factors in construction and infrastructure works of the available work reported before.

2.1 Definition of Risk, Risk Factors and Risk Identification

Risk can bring many definitions to the parties that involved in the construction industry. They are seeing the risk from different point of view, where it can refer to the possibility to the chance of good or bad consequences. The Little Oxford English Dictionary (1996) definition of risk is "the possibility that something unpleasant will happen". Such definition emphasize that risk is the possibility of suffering loss (or harm) and the impact that loss has on the involved party while risk factor is every possible event or issue that can create the risk.

In this section, risk is defined from the construction point of view. The following are some of these definitions:

i. Flanagan and Norman (1993) define risk as: "stems from uncertainty, which in turn is caused by a lack of information."
ii. Smith, Merna and Jobling (2006) define risk as: "a decision is expressed in terms of a range of possibilities outcomes and when probabilities can be attached to the outcomes."
iii. Bunni (2003) define risk as "the combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence."
iv. Leslie (1995) defines risk as "the multiple of the cost of that hazardous consequence and its possibility of occurrence."

Despite the possibility of good or bad consequences, many opted to think of risk in terms of largely downside and threat, and project risk management as a proper outline, which assists in minimization of such risks and their consequences. Assessing sources of risk at the earliest time enables controllable risk factors to be allocated to the areas of dependability, so that those responsible can respond appropriately to eliminate or minimize them. The identification of the relevant risk factors for project relies on both the input of the project management team and an historical risk management database that is maintained and continuously updated.

Risk identification is the basic stage in risk management. The importance to identify risk is to make sure the risks can be managed effectively in construction projects.

Williams et al. (1998) defines risk identification as: "a process that reveals and determines the possible organizational risks as well as condition, arising risks. By risk identification the organization is able to study activities and places where its resources are exposed to risk."

Identifying all the risk is impossible but the outcome of risk identification will produce a list of risks that linked to the project. The risks then will be ranked from the most to the less critical. Giving risk a rank is only the first phase in the management of risk and appropriate measures then need to be identified.

2.2 Risk History in Construction Industry

Construction as one of human basic needs is the process in building a protection from bad weather or threat from enemies. Since early civilization until now, the process of construction had become more complicated with introduction of new materials, design, construction methods, technology and others. The entire latest introduction somehow will set up a new type of risk in each part of the construction. From this it shows that risk has evolve together with this industry.

Bunni (2003) explains that based on the data that been collected on the past about risk in construction, it could be concluded that construction projects are sensitive to risks (p.33). He claims this sensitivity is due to some of characteristic of construction projects where he summarizes as follows:

i. The time required from planning to completion of project spans a long period where projects could exposed to range of hazards. Any steps taken to reduce the period of the project could initiate its own risks.
ii. The massive number of people from different background, cultures and countries that required for many tasks in the project will need proper coordination.
iii. Some construction projects are built in remote places with difficult terrain, which exposed to natural hazards or unpredictable events.
iv. New material products included for used in construction sometimes come with unproved performance or strength.
v. Different commitments and goals among the suppliers, manufacturers, consultant firms, contractors and others causing general interaction is needed. Miscommunication can cause a problem.

From this summary, it is clear the link between risk and construction industry has to do with the characteristic of the industry.

2.3 Risk Identification

There are several previous works that been discussing the risk identification. The identification varies from one another because of scope of study and their limitation. The risk factors also depend on the type of constructions such as building, highways and water works. Here are the few examples of the previous study on risk identification.

From Kangari (1995), based on survey conducted by American Society of Civil Engineers (ASCE) on top 100 large United States of America contractors listed the identification of risk description as follow:

- Permits and ordinances
- Delayed site access or right of way
- Availability of labor, material and equipment
- Productivity of labor
- Productivity of equipment
- Defective design
- Changes in work
- Subsurface conditions
- Acts of God
- Suitability , availability and accessibility of materials
- Government acts and regulation
- Labor disputes
- Accident/Safety
- Inflation
- Contractor Competence
- Change-order negotiations
- Environmental
- Public Disorder
- Delayed dispute resolution
- Delayed payment on contract
- Mistakes/defective work
- Indemnification and hold harmless
- Owner, contractor, subcontractor, supplier failure
- Actual quantities of work

Diana (2000) categorized the risk based on outer and inner factors where outer factors arise within the environment, and inner factors within the project itself. The factors are contain in Table 2.1.

Table 2.1: Review of risk based on outer and inner factors

Outer Factors		Inner Factors	
LEGISLATIVE	• local regulations • permits and agreements • law changes • standards	CONTRACT	• unrealistic deadline • unrealistic price • other contract provisions
POLITICAL	• policy changes • elections • war • existing agreements	TECHNOLOGY *DOCUMENTATION*	• delay • incompleteness • imprecision
ECONOMICAL	• economic regulations • price rises • exchange rates • financing conditions • economic policy changes	ORGANIZATION	• bad management • bad organization of works
SOCIAL	• education, culture • seasonal work • strike • human fluctuation	TECHNOLOGY	• poorly chosen tech. solutions • obsolete technology
NATURAL	• climate • soil • subterranean waters • natural disasters	RESOURCES	• shortage of workers • shortage of machinery • machinery breakdowns • late delivery of materials
		HUMAN FACTOR	• productivity • sick leaves • motivation • errors and omissions

Source: Diana (2000)

Schatteman, Herroelen, Vonder, and Boone (2008) on their study of integrated risk management described that "the risk identification process involves the identification of the major potential sources of risk associated with the project objectives. Based on checklists of potential risks available in the literature and maintained at the Belgian Building Research Institute (BBRI), a limited, workable list of risk factor classes has been established. This list allows for the generation of sector and specialisation specific risk profiles of the construction industry. (p.4)" The list is contains in Table 2.2.

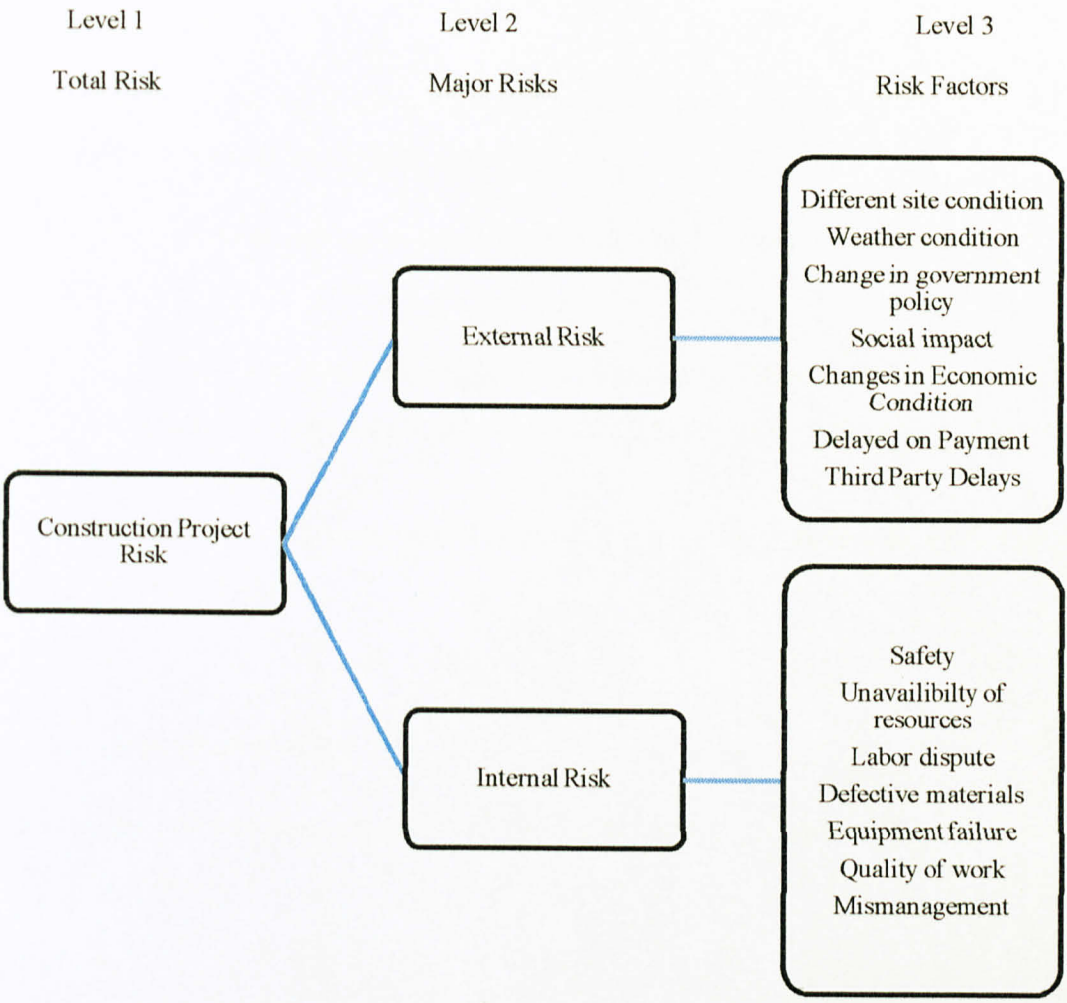
Table 2.2: Checklists of potential risks

Environment	Third party	Damage to surrounding elements Obstruction to surrounding businesses or others Other claims Violation of legal requirements Provisions
	Accessibility of the construction site	Accidents Vandalism Weather delay Risks related to the accessibility
	Soil	Pollution Archaeological finds Soil quality
Organisation	Plan	Supply of plan Changes in plan Change of requirements Claims related to not keeping to promises
	Task	Extra work Errors in execution Inaccurate estimation of duration Indistinctness on who will perform the task
	Permits	Lack of timeliness/documentation/permits
Consumer goods	General	Price increase/decrease Material supply Availability Theft
Workforce	Expertise	Lack of expertise Absence of key persons
	Social	Difficulties within teams
	Availability	Absenteeism
Machines	Availability	Machine breakdown Supply Availability Damage Theft
Subcontractor	General	Price increase/decrease Failure of company Respecting lead time Errors in execution

Source: Schatteman, Herroelen, Vonder, and Boone (2008)

Rohman, Idrus, and Nuruddin (2008) on their research about project cost contingency during the tendering process present the risk factors in hierarchy form. Figure 2.1 shows the project risk hierarchy.

Figure 2.1: Project risk hierarchy for cost contingency model



Source: Rohman, Idrus, and Nuruddin (2008)

From all the previous works that been reported, the list of the risk factors can be use in designing the survey questionnaire. Other than that the interview with the contractors will add other risk factors that seems applicable.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This section explains the methods for conducting the study, the type of data required and the technique that will be apply to collect the data.

Survey research methodology is chosen as a technique to collect data because of these reasons.

- It is effective tool to collect opinion of respondents based on their experience and perception in construction industry because the method is based on "questioning the respondents".
- It can reach wider respondents because it is possible to collect data from large or small populations.

3.2 Research Methodology

The survey research methodology will be use for this study and will consist of these following steps:

Step One:

A wide-ranging literature review of the available work reported on risk, its factors and identification in construction industry. The literature review will include recent and past study of the subjects. Most of the literature source will be from books, journals and resources available from Universiti Teknologi PETRONAS Resources Centre and online resources.

Step Two:

Research on definition of main risk parameters, risk categories and effects of risks on different types of civil engineering works or projects.

Step Three:

Design of questionnaire based on risk factors that being identify and choose.

Step Four:

Sending the questionnaire to construction companies in Malaysia based on the list from Construction Industry Development Board (CIDB) Malaysia.

Step Five:

Conduct interview for selected companies to obtain additional information.

Step Six:

Collection and compilation of the data using Microsoft Excel.

Step Seven:

The collected data will be analyzed.

Step Eight:

The result of the analyzed data will be summarized and presented.

Step Nine:

Conclusion about the research, recommendation and suggestion for further research will be presented.

3.3 Design of Questionnaire

The questionnaire contains ten risk factors that required the respondent to rate them based on the priority scale given. In addition, there are spaces for two additional risk factors that the respondent can add and rate. It is designed in such a way that completing it should not take more than 10-15 minutes considering the busy schedule of project managers or project engineers that completing the survey questionnaire.

There are four sections in the questionnaire. The first section will provide general information about the construction contractor such as company's main business, how long the company has been in business and background information about the correspondent that completing the questionnaire.

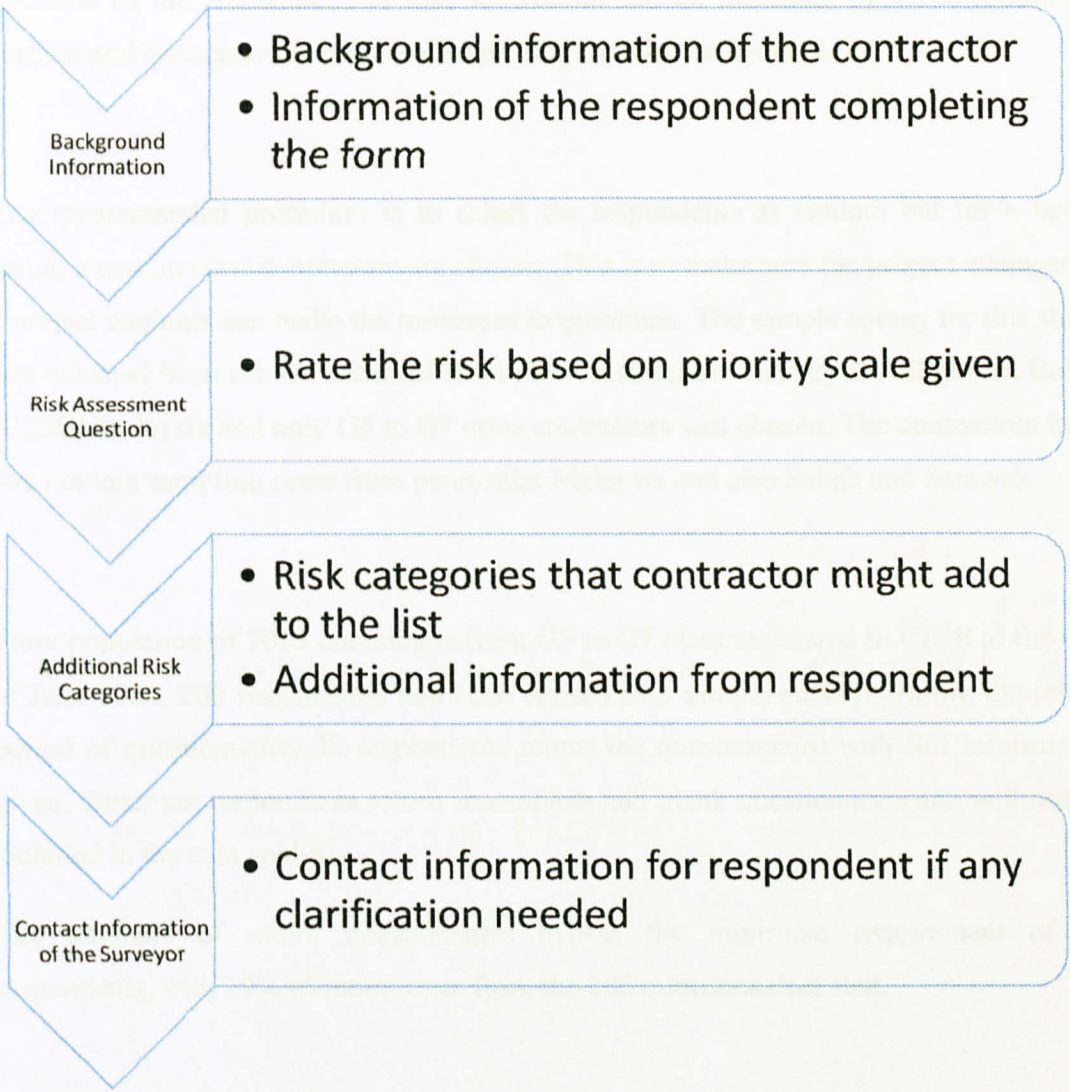
The second section will consist of main question about the assessment of construction risks. It will list ten risk factors that been choose based on previous works. In this survey, all the risk factors are similar to those factors being used by Kangari (1995). Other studies had also used these risk factors such as by Rohman, Idrus, and Nuruddin (2008), Diana (2000), Schatteman, Herroelen, Vonder, and Boone (2008) and Hlaing, Singh, Tiong, and Ehrlich (2008). At the end of the section the respondent is given a chance to add and rate two additional risk factors that he might think has any significance for this study.

The third section provide a space for respondent to add any additional information that seem suitable. Finally, in the fourth section respondents can choose either they want to know the result of the research. Full contact information of the surveyor is included in the questionnaire for the respondent if they need any clarification or if they have any questions regarding the study. The questionnaire is available in Appendix IV.

Layout of the Questionnaire

The layout of the questionnaire is shown in figure 3.1.

Figure 3.1: Layout of Questionnaire



3.4 Sample Survey and Distribution of Questionnaire

Sampling is a process to select a limited number of units from a group in order to illustrate the group. Selecting a sample of survey for this study is important in order to make sure the study will be more effective. According to Saris and Gallhofer (2007), the sampling should be prepared in such a way that the surveyor has no influence on the selection of the respondents or else the results can be influence by it. Any possible conflict and discrepancies in the collected data can also be avoided.

The recommended procedure is to select the respondents at random but for a better result, a certain class contractors are chosen. This is to make sure the project manager or a project engineer can make the responses to questions. The sample survey for this study was selected from the list obtained from the Construction Industry Development Board (CIDB) Malaysia and only G5 to G7 class contractors was chosen. The contractors from this random sampling came from peninsular Malaysia and also Sabah and Sarawak.

From population of 7015 contractors from G5 to G7 class registered in CIDB at the end of June 2008, 200 respondents had been chosen as a sample survey. During the return period of questionnaire, 38 respondents return the questionnaire with full information given. Other six respondents return incomplete and blank questionnaire and will not be included in the data analysis.

The amounts of return questionnaire bypass the minimum requirement of 30 respondents, with 19% of return rates from the 200 questionnaires sent.

3.5 Data Analysis

Data gathered from the questionnaire will be analyze and used to identify overall respondents' rating on each type of risk categories. We use severity index to analyze and rank the risk factors based on the feedback from respondents.

Severity index was calculated based on the response of the survey to reflect the level of severity effect. According to Idrus and Newman (2002) and Al-Hammad (2000), this index was calculated as follow:

Severity Index (I) = [$\sum$ ai . xi] / [4 $\sum$ xi] x 100%

Where:
xi = variable expressing the frequency of the response for *i* ;

i = 0, 1,2,3,4 and illustrate as follow;

x0 = frequency of the 'very high extend' response and corresponding to ***a0 = 4***

x1 = frequency of the 'high extend' response and corresponding to ***a1 = 3***

x2 = frequency of the 'moderate' response and corresponding to ***a2 = 2***

x3 = frequency of the 'small extend' response and corresponding to ***a3 = 1***

x4 = frequency of the 'very small extend' response and corresponding to ***a4 = 0***

The percentage of the severity index then categorized as below in order to reflect the scale of the answer of the respondents to the questionnaire.

- 0% - 20% ~ 'non-severe'
- 20% - 40% ~ 'somewhat non-severe'
- 40% - 60% ~ 'moderately severe'
- 60% - 80% ~ 'severe'
- 80% - 100% ~ 'most severe'

CHAPTER FOUR

RISK CATEGORIES

4.1 Introduction

In this chapter, the risk categories used to create the survey questionnaire is explained with details.

4.2 Risk Categories

Ten risk categories were selected to compose the questionnaire. All the categories been chosen from previous study like Kangari (1995) and Al Salman (2004) and they can be either direct or indirect factors towards budget, safety, schedule and quality of the project. From previous study, most of these risk factors had been allocated to the contractor. These categories are:

a) Safety/Accidents

This is one of the main risk factors and will always happen in the construction industry. It can be minimized by following safety rules and the use of safety equipment such as goggles, shoes and safety hats.

b) Labor, material and equipment availability

Availability of some of the resources such as labor, material and equipment may affect the progress of the project. Certain jobs may require specific skilled expertise and special material and equipment that might not be available in the local market and take a long time to obtain.

c) Weather condition

This risk category can force the contractor to alter his work schedule due to bad weather conditions. Example of these weather conditions are heavy downpour, flood, high wind gust and others. Malaysia has a year-round equatorial climate that is warm and sunny, along with abundant rainfall, especially during the southwest monsoon season from September to April.

d) Changes in economic condition

This risk is depends on economic conditions of the country. As the inflation rate increases, the risk becomes more important.

e) Differing site conditions

This risk category could happen in most construction projects especially during excavation process. For example, the soil condition might changes where the contractor might face rock or hard soil instead of soft soil that being indicate in the tender document. Other than that, underground buried utility such as piping, power cables and others that not being indicate can cause additional equipments and excavation needed.

f) Changes in government policy

The contractor and the owner of the project must follow government policy especially in design and environmental codes. However, these specific codes and policy might change or revised from time to time. These new policy may be issued between designed and construction process phases and may force some changes to the original scope and plans. This can affect the schedule and budget of the project.

g) Delayed payment on contract

It is very important to the contractor to get the payment on time in order to make sure the cash flow is maintain and eliminate financial difficulties. Delayed

payment can cause financial trouble to the contractor especially if it delayed for a long time.

h) Defective materials

Material is an important resource in construction projects where quality control and quality assurance is needed to eliminate re-work and material replacement. Defective materials not only can cause problems in budget and schedule but safety of the structure.

i) Third party delays

Delays from these parties could affect the schedule and consequently the budget of the project. Examples of these parties include subcontractors, material suppliers and government agencies such as customs and transportation agency.

j) Quality of work

Quality of work would reflect the reputation of the contractor and might either position him on top of other contractors or force him out from the market. Owners strive to get a quality product by their project and contractors try their best to deliver quality projects. However, poor workmanship can lead to demolition and re-work that need to done. This can affect project budget and schedule and contractor might have to bear the cost of the re-work.

CHAPTER FIVE

DATA ANALYSIS AND RESULTS DISCUSSION

5.1 Introduction

After all data have been collected through the questionnaire survey, the data is then analyzed and discussed. This chapter presents the analysis and the results of the research derived from the data gathered from the questionnaires.

5.2 Description of Results

The results are presented in three main parts. The first part discusses the general background information of the respondents. The results of this section were obtained from the answers of section "A" of the questionnaire.

The second part discusses the risk factors importance, its overall ranking and ranking of risk factors based on the project types. The results of this section were obtained from the answers of section "B" of the questionnaire.

The third part discusses other risk factors that were specified and rate by respondents or any additional information from them. The results of this section were obtained from the answers of section "B" and "C" of the questionnaire.

5.2.1 Part 1: General Background Information

This part presents the general background information of the respondents completing the questionnaire.

Based on Table 5.1, it shows that most of the respondent's companies usually deal with building projects at 74%, road projects at 18% and water works projects at 8%.

Table 5.1: Respondent's company main project

Main Project	Number of Respondents (Frequency)	Percent (%)
Building projects	**28**	**74**
Road projects	**7**	**18**
Water works projects	**3**	**8**
TOTAL	**38**	**100**

Based on Table 5.2, the companies surveyed have different level of involvement in construction industry. The survey shows that these companies have involved in the local construction industry with less than 5 years at 3%, in range of 5-10 years at 18%, in range of 11-15 years at 29%, in range of 16-20 years at 21% and more than 20 years at 29%.

Table 5.2: Respondent's company experience in the construction industry

Company Experience (Years)	Number of Respondents (Frequency)	Percent (%)
<5	**1**	**3**
5-10	**7**	**18**
11-15	**11**	**29**
16-20	**8**	**21**
20>	**11**	**29**
TOTAL	**38**	**100**

Based on Table 5.3, the respondents come from different class of construction companies. It shows most of respondent's companies are G7 contractor company at 42%, while others are G6 contractor company at 26% and G5 contractor company at 32%.

Table 5.3: Respondent's company class of contractor based on CIDB Contractor Grade

Class (G)	Number of Respondents (Frequency)	Percent (%)
5	12	32
6	10	26
7	16	42
TOTAL	38	100

Based on Table 5.4, different professions had answered the questionnaire. It shows most of the respondents are project manager at 45%, managing director at 13%, general manager at 16%, contract manager at 5%, quantity surveyor at 16% and project director at 5%.

Table 5.4: Respondent's position in the company

Respondent's Position	Number of Respondents (Frequency)	Percent (%)
Project Manager	17	45
Managing Director	5	13
General Manager	6	16
Contract Manager	2	5
Quantity Surveyor	6	16
Project Director	2	5
TOTAL	38	100

Based on Table 5.5, the respondents surveyed have different level of experience in construction industry. The survey shows that the respondents have experience in the local construction industry mostly more that 20 years at 34%, in range of 16-20 years at 16%, in range of 11-15 years at 18%, in range of 5-10 years at 24% and less than 5 years at 8%.

Table 5.5: Respondent's experience in the construction industry

Respondent's Experience (Years)	Number of Respondents (Frequency)	Percent (%)
<5	3	8
5-10	9	24
11-15	7	18
16-20	6	16
20>	13	34
TOTAL	38	100

From all results in this part it shows majority of the respondents are from G7 companies, have a position as a project manager in their companies and have experience in construction industry more than 20 years. The age's level may affect individual personal and commercial encounter or experience, which may helps in providing a better understanding of the industry and in better position in giving much precise answer required by the questionnaire.

5.2.2 Part 2: Risk Factors Importance and Ranking

This part discusses risk factors importance, its overall ranking and ranking of risk factors based on the project types. There are 10 risk factors in section "B" and respondents were asked to rate them based on their experience and perception.

Table 5.6 shows severity index for every risk factors that were rated by questionnaire respondents. Severity index formula was use to calculate the ratings and was presented in percentage. The calculation is shown in **Appendix IV**. Higher percentage of severity index shows which factor is most severe compare to other.

Table 5.6: Severity index of risk factors

Risk Factors	Severity index for ranking (%) based on Al-Hammad, 2000
Safety/Accidents	**88.16**
Labor, material and equipment availability	**85.53**
Weather condition	**68.42**
Changes in economic conditions	**78.95**
Differing site conditions	**69.74**
Changes in government policy	**63.16**
Delayed payment on contract	**89.47**
Defective materials	**72.37**
Third party delays (subcontractors, material suppliers)	**76.32**
Quality of work	**86.84**

Figure 5.6: Severity index of risk factors

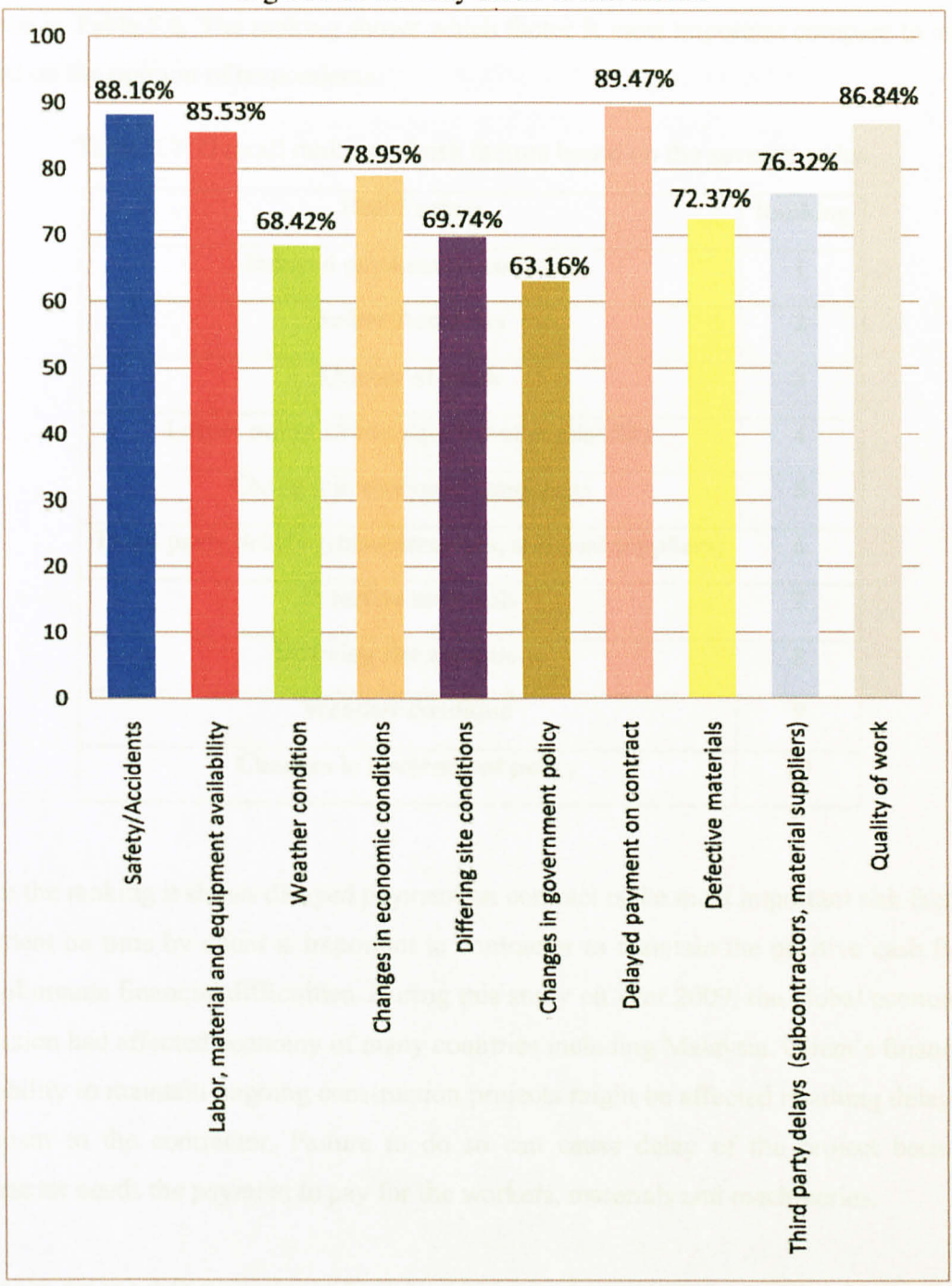


Table 5.7 shows the overall ranking of the risk factors. It is based on the severity index shown in Table 5.6. The ranking shows which factor is most important compare to other based on the opinion of respondents.

Table 5.7: Overall ranking of risk factors based on the severity index

Risk Factors	Ranking
Delayed payment on contract	**1**
Safety/Accidents	**2**
Quality of work	**3**
Labor, material and equipment availability	**4**
Changes in economic conditions	**5**
Third party delays (subcontractors, material suppliers)	**6**
Defective materials	**7**
Differing site conditions	**8**
Weather condition	**9**
Changes in government policy	**10**

From the ranking it shows delayed payment on contract is the most important risk factor. Payment on time by client is important to contractor to maintain the positive cash flow and eliminate financial difficulties. During this study on year 2009, the global economic recession had affected economy of many countries including Malaysia. Client's financial capability to maintain ongoing construction projects might be affected resulting delay of payment to the contractor. Failure to do so can cause delay of the project because contractor needs the payment to pay for the workers, materials and machineries.

Delay in payment that continues for a long time may permit the contractor to terminate the contract if permitted by the termination clause. This situation can cause a dispute between the contractor and the client, causing a bad relationship between them.

The second most important risk factor is safety/accidents. Safety is one of the top priorities in construction site. However according to Abdul Hamid, Abd Majid and Singh (2008), the number of construction accidents from 1995 to 2003 in Malaysia has increased by 5.6 per cent from 4,406 cases in 1995 to 4,654 cases in 2003. In addition, the fatality rate has increased by 58.3 per cent from 60 cases in 1995 to 95 cases in 2003.

The fatality rate from construction accidents are among the highest compared to the overall industry. The raise of the accident rate might increase the awareness of contractors about safety, as they realize lack of safety could affect productivity, causing lost of lives and consequently affect timely project completion in the various development corridors if safety is not taken seriously.

In Malaysia, the Department of Safety and Health can issue the stop-work order if any accident occurs at the site and they can issue it without timeframe, until they are satisfied with safety at the site that complies with the Occupational Safety and Health Act (OSHA) 1994 (DOSH,1994). Contractors will like to avoid it from happen because the stop-work order will bring delays to the schedule and planning of the project.

The third most important risk factor is quality of work. If client are not satisfied with the quality of work, it might leads to demolition and rework and will negatively affect the project budget and schedule. Quality of work will also reflect the reputation of the contractor among clients. Contractor with history of low quality of work will be a having a hard time when bidding for a new project in the future.

Labor, material and equipment availability is the fourth important risk factor. Labor here can be refers as skilled workers. The construction industry in Malaysia is highly dependent on 300,000 people foreign labors. Most of them are unskilled and therefore, produce below par work if left unsupervised. However, it was a relief to the industry when Construction Industry Development Board (CIDB) during Malaysian Budget 2009 was directed to provide at least 100,000 industrial training opportunities in technical fields such as welding, management and safety in 2009. It is to address the shortage of

skilled construction workers, as well as the need to emphasize on increasing the quality of trained construction workers (MBAM, 2009).

In year 2007, most of contractors having difficulties sourcing for adequate supply of steel bars of certain size because shortage of steel fiasco causing them to pay more for a tonne for steel bars (The Star, 2007).

A change in economic condition is the fifth risk factor in the ranking. Most contractor view this factor is important because it bring domino effect not only to the construction industry but also to other industries as well. Growth in this industry in fact is an indicator of the economic conditions of a country.

The sixth risk factor in the ranking is third party delays. Third party can be referring as subcontractors and material suppliers. To avoid this risk, most of the contractors chose the third party based on experience of working with them on the past or good reputation of the third parties themselves.

A defective material is the seventh risk factor in the ranking. It can bring delay to the schedule and affect the quality of the structure causing re-work that need to be done.

The eighth risk factor in the ranking is differing site conditions. It is rated as low risk category might be for the reason that it happen rarely or only happen when expansion of existing projects, where its new construction interfere with the existing structure such as underground utilities piping, power cables and others.

Weather condition is rank at ninth place among the ten risk factors. Weather condition can affect the schedule of the project but most contractors rank it as low risk category compare to others. It might be for the reason that in Malaysia contractors can forecast the weather condition based on the weather reports and their experience on Malaysia weather throughout the year. For example, most of the project manager knew it would be raining heavily (monsoon season) on east coast of peninsular Malaysia at the end of

the year and heavy rain lasting about a few days are common. Any planning for earthworks in the schedule should be avoided during this time.

Change in government policy is the lowest rank risk factor among the others. New policy is not issue regularly and usually new policies will be announce earlier before it being implement, giving enough time for contractors to respond.

Table 5.8, 5.9 and 5.10 shows the ranking of risk factors based upon the project types. It was also calculate using severity index formula.

Table 5.8: Ranking of risk factors based upon building projects

Risk Factors	Severity index for ranking (%) based on Al-Hammad, 2000	Ranking based on building projects
Safety/Accidents	**91.07**	**1**
Delayed payment on contract	**89.29**	**2**
Labor, material and equipment availability	**89.29**	**2**
Quality of work	**87.50**	**3**
Changes in economic conditions	**80.36**	**4**
Third party delays (subcontractors, material suppliers)	**80.36**	**4**
Defective materials	**73.21**	**5**
Differing site conditions	**67.86**	**6**
Weather condition	**67.86**	**6**
Changes in government policy	**66.07**	**7**

Table 5.9: Ranking of risk factors based upon road projects

Risk Factors	Severity index for ranking (%) based on Al-Hammad, 2000	Ranking based on road projects
Delayed payment on contract	92.86	1
Safety/Accidents	85.71	2
Quality of work	85.71	2
Labor, material and equipment availability	85.71	2
Defective materials	71.43	3
Differing site conditions	71.43	3
Weather condition	71.43	3
Changes in government policy	57.14	4
Changes in economic conditions	57.14	4
Third party delays (subcontractors, material suppliers)	50.00	5

Table 5.10: Ranking of risk factors based upon water works projects

Risk Factors	*Severity index for* ranking (%) based on Al-Hammad, 2000	*Ranking based on* water works projects
Delayed payment on contract	83.33	1
Changes in economic conditions	83.33	1
Third party delays (subcontractors, material suppliers)	83.33	1
Safety/Accidents	66.67	2
Quality of work	66.67	2
Differing site conditions	66.67	2
Weather condition	66.67	2
Labor, material and equipment availability	50.00	3
Weather condition	50.00	3
Changes in government policy	33.33	4

From Table 5.9 to 5.10, it shows some risk factors share the same rank in the ranking. For example in Table 5.8 for building projects, "delayed payment on contract" factor and "labor, material and equipment availability" factor share the second place in the ranking. It is because number of respondent for each type of project is different causing abnormal distribution of data. For further study, it is recommended that number of respondent is same for each type of project.

The table shows the ranking is different between the project types. For example, safety/accident factor is the most important for building projects but second for road and water works projects. It might be for the reason that building projects need more amounts of workers compare to road and water works projects, where most of the work mostly depends on machineries. More workers bring more possibility an accident can happen.

The difference can also be seen in weather condition factor. While building projects rate it at sixth place, road and water works projects rate it as third and second place respectively. It might be for the reason that both road and water works required more earthworks compare to building projects. Road projects also required a wide area of lands to be covered compare to building that stay only at one place.

The ranking for differing site conditions is rated as same as weather condition by all project types. It might be for a reason that the possibility of different site condition compare to the drawing is higher in water works and road types. It is because both projects covers wide area of lands compare to building projects.

Other than that, changes in government policy is consider low risk category in all project types. It might be for a reason that most of the policy will take time before it being implemented, giving much time for contractors to react.

5.2.3 Part 3: Added Risk Factors

This part discusses added risk factors and additional information provided by respondents.

Table 5.8 shows other risk factors that were added and rate by respondents. It shows what respondents think of other factors that might affect the construction project and its importance.

Table 5.11: Other Risk Factors by Respondents

Other Risk Factors by Respondents	Importance
Materials price increase	Very Important
Approval and instruction by relevant parties	Very Important
Slow/ incompetent decision making	Very Important
Revise the design during construction period (Variation Order)	Very Important
Failure to follow method of statement	Very Important
Stability of government	Very Important
Financial	Very Important
Underestimate of the tender price	Important

Materials price increase

Respondents believe this as a very important risk especially when the contract do not provide for the "fluctuation of price" clause. Such contracts are subject to the instability of construction materials price and if the price increase, contractors will have to absorb this increase.

Approval and instruction by relevant parties

This factor might be a risk when approvals by certain parties are delay, affecting the planning and schedule of the project. These approvals might include approved building plans from local municipality or state government. In addition, construction materials listed in the Custom Act must have "Certificate of Approval" from CIDB, before the materials can be imported into Malaysia (CIDB, 2004).

Slow/ incompetent decision-making

Slowness of the owners' decision-making process might cause delay in the project. Other than that having an inexperience personnel making a decision during the construction process might bring failure to the project.

Variation Order

Variation order can be a risk when in some cases, the construction works may overlap the design where the contractor will have to wait for the detailed design. As a result, some works are put on hold and others are subject to abortion or demolition. It is indicated that projects impacted by variation orders cause the contractor to achieve lower productivity level than planned (Hanna et al, 2002).

Failure to follow method of statement

Method of statement is the most commonly used procedure in monitoring and supervising a construction sequence of works. It is a requirement for the contractor to submit the proposed method statement of works outlining the sequence of work to be carried out in detail for approval by the consultants, prior to the actual work on site. However, it is hardly to be enforced on the contractor by consultants.

This failure has resulted in work done not according to specifications, leading to increases in the number of hidden defects that may eventually result in serious consequences such as structural distress.

Stability of government

Stability of government is important because any turmoil and change of government of a country can bring government related projects hanging in balance. It can bring confusion on approval and funding of the projects and implementation of new policy by the new government.

Financial

Financial here refers to contractor's financial capability, whether the contractor company has the means and capabilities to carry out on the project. Contractors feel that financing problems are most severe at the bidding stage. Inability to secure financing at this stage will prevent contractors from participating in bidding the project tender. This situation is especially common amongst the small to medium-sized contractors. Financial institutions, on the other hand, have restrained lending to certain contractors because of poor credit rating and incomplete loan application information.

Underestimate of the tender price

This factor becomes a risk when contractor in order to win the tender, bid at a lower price compare to other bidders consequently lowering their profit margin. Other than that, quoting a lower sum might win the bidder the project, but only at a higher risk of project delays or failures if any uncertainties occur during the construction process. Quoting a high tender sum would allow sufficient contingencies, but placing the bidder at a disadvantage.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

Implementation of risk management in the project could help to identify and minimize the risks from causing losses. Identifying risk factors is the initial step in risk management. This study had identified risk factors based on the literature review and feedback from respondents in construction industry. These risk factors had been ranked according to their priority based on the rating given by the respondents.

Based on the results of previous chapter, it shows:

- Delayed payment on contract and safety/accident are the two most important risk factors according to the experience and perception of contractors in Malaysia.
- *Weather condition and changes in government policy are the two least important* risk factors compare to other factors.
- Other than that, respondents of this study had added other eight factors that they consider as risks. These factors can be implemented in future study of risk in construction.

Recommendations for further study of this topic in the future are listed below.

- A study to investigate the influence of these risks factors, in order of their importance, on only specific aspects of construction such as budget or schedule or technical (quality).
- Other than that further study can focus on allocation of risks, where it gain perception on who should be responsible for these risks, either client, contractor, or shared between both parties.

- A study on how contractors in Malaysia mitigate risks that occur in their projects based on their own approach.
- To complement the results of this research, a case study on a failed and a successful construction projects in Malaysia can be done to give deeper insight and comparison on how significant these risks affect both the projects.

References

1. Abdul Hamid, A. R., Abd Majid, M. Z., & Singh, B. (2008). Causes of Accident at Construction Sites . *Malaysian Journal of Civil Engineering* , 242 - 259.

2. Al Salman, A. A. (2004). *Assessment of Risk Management Perceptions and Practices of Construction Contractors in Saudi Arabia.* United States: ProQuest Information and Learning Company.

3. Board, C. I. (2004). *QUEST program.* Retrieved October 10, 2009, from Construction Industry Development Board site: http://www.cidb.gov.my/v6/?q=en/content/168

4. Bunni, N. G. (2003). *Risk and Insurance in Construction.* London and New York: Spoon Press.

5. Diana, C.-P. (2000). Abilities and Limitations of Risk Analysis And Management at Civil Enginnering Project . 51.

6. Edwards, L. (1995). *Practical risk management in the construction industry.* London: Thomas Telford.

7. Flanagan, R., & Norman, G. (1993). *Risk Management and Construction.* Oxford: Blackwell Science.

8. Hammad, A. M. (2000). Common Interface Problems among Various Construction Parties. *Journal Performance Construction Faculties* , 71-74.

9. Hanna, A. C. (2002). Quantitative Definition of Projects Impacted by Change Orders. *Journal of Construction Engineering and Management* , 57-64.

10. Hawker, S., & Cowley, C. (1996). *The Little Oxford English Dictionary.* United States: Oxford University Press.

11. Hlaing, N., Singh, D., Tiong, R., & Ehrlich, M. (2008). Perceptions of Singapore construction contractors on construction risk identification. *Journal of Financial Management of Property and Construction* , 85-95.

12. Idrus, A. B., & Newman, J. B. (2002). Construction related factors influencing the choice of concrete floorsystem. *Construction Management and Economic* , 13-19.

13. Kangari, R. (1995). Risk Management Perceptions and Trends of U.S Construction. *Journal of Construction Engineering and Management* , 422.

14. Malaysia, M. B. (2009, February 3). *Sustainable manpower and skills needed for nation to grow.* Retrieved September 2, 2009, from The Star: http://biz.thestar.com.my/news/story.asp?file=/2009/2/3/business/3177099&sec=business

15. MBAM. (2006, December 14). *Malaysia Master Builders Association Malaysia (MBAM).* Retrieved February 24, 2009, from Malaysia Master Builders Association Malaysia (MBAM) Web site: http://www.mbam.org.my/mbam/index.php?option=com_content&task=view&id=424&Itemid=331

16. Ng, A. (2007, June 4). *Shortage of steel to impact projects.* Retrieved September 10, 2009, from The Star: http://biz.thestar.com.my/news/story.asp?file=/2007/6/4/business/17912531&sec=business

17. Nordin, N. (2009, 3 9). *Malaysian services going global.* Retrieved 4 2, 2009, from Business Times: http://www.btimes.com.my/Current_News/BTIMES/articles/nohas2/Article/index_html

18. Rohman, M., Idrus, A., & Nuruddin, M. F. (2008). Project Cost Contingency Using Risk Analysis and Fuzzy Expert System. *The 8th Biannual Symposium Paper, January 2008* , 3.

19. Safety, D. o. (1994). *ACT 514 Occuaptional Safety and Health Act 1994* .

20. Saris, W. E., & Gallhofer, I. N. (2007). *Design, Evaluation, and Analysis of Questionnaires for Survey Research.* New Jersey: Wiley Interscience.

21. Schatteman, D., Herroelen, W., Vonder, S. V., & Boone, A. (2008). *A methodology for integrated risk management.* Belgium: Katholieke Universiteit Leuven.

22. Smith, Merna, & Jobling. (2006). Projects and Risk. In N. J. Smith, T. Merna, & P. Jobling, *Managing Risk in Construction Projects* (p. 2). Oxford: Blackwell Publishing.

23. Williams, C. S. (1998). *Risk Management and Insurance.* Irwin McGraw Hill.

APPENDICES

APPENDIX I

Milestone for the first semester Final Year Project

	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Selection of Project Topic															
2	Preliminary Research Work															
3	Submission of Preliminary Report															
4	Seminar 1															
5	Literature review and designing questionnaire															
6	Submission of Progress Report															
7	Seminar 2															
8	Pilot survey															
9	Submission of Interim Report Final Draft															
10	Oral Presentation															

Completed

APPENDIX II

Milestone for the second semester Final Year Project

No.	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14
1	Collection of data continue															
2	Submission of Progress Report 1															
3	Analysis of data															
4	Submission of Progress Report 2															
5	Seminar															
5	Preparing discussion and conclusion of study															
6	Poster Exhibition															
7	Submission of Dissertation (soft bound)															
8	Oral Presentation															
9	Submission of Project Dissertation (Hard Bound)															

Completed

APPENDIX III: Questionnaire Cover Letter

To: Project Manager Date: 10th June 2009

Dear Sir/Madam,

A Study of Risk Factors in Civil Engineering Projects

We seek your help in a university research survey on risk factors in civil engineering projects within the construction industry in Malaysia.

The construction industry is one of the industries that involved many uncertainties in its everyday operations. All the processes in the projects from the starting conceptual phase of the project until the completion of the project will involve risks that might cause troubles in terms of cost, time and quality. Risk management provides a framework that assists in minimization of such risks and their consequences where contractors can determine risks that been associated with their project. Identifying the risk factors and prioritizing them are important steps in risk management. In Malaysia, however there has not been much attention given to the identification of risk factors in the construction industry.

Therefore, this study is intended to identify and prioritize risk factors within the context of the Malaysian construction industry. This study hopes to be able to help contractors to recognize and rank risk factors that might affect their project. By doing so they will able to make judgment of tender price with due consideration of signification of risk factors, and manage the risks properly during the construction process.

In relation to the above, we have devised a questionnaire which we would like you to complete and return and which will only take no more than 15 minutes of your time. With your cooperation, we should be able to collect as many data as possible regarding the risk factors in civil engineering project.

It would help us very much if you could complete and return the questionnaire attached by 10th July 2009. As an enclosure, please find a self-addressed and stamped envelope to return the questionnaire. Alternatively, you could also return it by fax on 05-3656716 (Attn: Assoc. Prof. Ir. Dr. Arazi Idrus).

Should you require any further information regarding this questionnaire, please do not hesitate to contact **Mohd Muzani bin Mustafa at 019-3033189** or email mohd_muzani@utp.edu.my.

We thank you in advance for your support.

Yours truly,

_____

(Assoc. Prof. Ir. Dr. Arazi Idrus)
Associate Professor/Research Cluster Leader
Civil Engineering Department,
Universiti Teknologi PETRONAS

cc: Assoc. Prof. Dr. Shamsul Rahman Mohamed Kutty
Mohd Muzani bin Mustafa

APPENDIX IV: Questionnaire

SURVEY QUESTIONNAIRE

A Study of Risk Factors in Civil Engineering Projects.

The construction industry is one of the industries that involved many uncertainties in its everyday operations. All the processes in the projects from the starting conceptual phase of the project until the completion of the project involve risks that might cause problems in terms of cost, time and quality. Risk cannot be eliminated, but they can be managed and reduced. Identifying the type of risk factors in a construction project is very important in project management. This information would help project managers manage risk factors during the construction process.

This questionnaire is aim to gain feedback from the company in their construction project according to type of works:

- building
- water works
- roads

The questionnaire below is divided into 4 sections which are A, B, C and D. Please answer the questionnaire by referring to the instructions in each section.

Section A: General / Background Information

Respondent can tick more than one for each [ ] provided or fill in the blanks.

I. Company Information:

1. Name of Company: _____

2. Company's main business:
   [ ] Building projects [ ] Road projects [ ] Water works projects
   [ ] Other: _____

3. Company experienced in construction (years) :
   [ ] < 5 [ ] 5-10 [ ] 11-15 [ ] 16-20 [ ] 20>

4. Class of Contractor :

   CIDB [ ] G5 [ ] G6 [ ] G7

II. Respondent's Information:

1. What is your designation with the company?
   [ ] General Manager [ ] Project Manager
   [ ] Construction Superintendent [ ] Project Engineer
   [ ] Quantity Surveyor [ ] Other: _____

2. Respondent's experienced in construction(years):
   [ ] < 5 [ ] 5-10 [ ] 11-15 [ ] 16-20 [ ] 20>

Section B: Risk Factors Importance in Construction Project

For this section, please rate the risk factors that might affect construction process by ticking the appropriate number according to the priority scale given below. Please tick according to your company's main business:

[1] Less important **[2] Important** **[3] Very important**

1. Risk factors that might affect construction process :

Risk Factors	Building Construction			Road Construction			Water works Construction		
a) Safety/Accidents	1	2	3	1	2	3	1	2	3
b) Labor, material and equipment availability	1	2	3	1	2	3	1	2	3
c) Weather condition	1	2	3	1	2	3	1	2	3
d) Changes in economic conditions	1	2	3	1	2	3	1	2	3
e) Differing site conditions	1	2	3	1	2	3	1	2	3
f) Changes in government policy	1	2	3	1	2	3	1	2	3
g) Delayed payment on contract	1	2	3	1	2	3	1	2	3
h) Defective materials	1	2	3	1	2	3	1	2	3
i) Third party delays (subcontractors, material suppliers)	1	2	3	1	2	3	1	2	3
j) Quality of work	1	2	3	1	2	3	1	2	3

k) Other risk factors (Please specify and rate) :

i.	1	2	3	1	2	3	1	2	3
ii.	1	2	3	1	2	3	1	2	3

Section C: Additional Information

For this section, please write any information you want to add.

_____

_____

_____

_____

_____

Section D: Feedback

1. Do you prefer to know result of the research?
   [ ] Yes [ ] No

2. Would you willing to be contacted to provide additional information to support this research?

   [ ] Yes.
   My name is _____
   My contact telephone number is _____ ext: _____ (Office)
   _____ (Mobile)

   [ ] No

Thank you for your time and cooperation in completing the questionnaire. Your response will be used for research purpose only. It would be appreciated if you could return this questionnaire as soon as possible, if possible by 10th July 2009.

APPENDIX V: Calculation of severity index

Risk Factors	Low	Average	High	Total	Mean	Severity index for ranking (%) based on Abdulmohsen al hammad and sadi assaf, 1996	Ranking
Safety/Accidents	1	7	30	38	1,7631579	88,15789474	2
Labor, material and equipment availability	0	11	27	38	1,7105263	85,52631579	4
Weather condition	5	14	19	38	1,3684211	68,42105263	9
Changes in economic conditions	2	12	24	38	1,5789474	78,94736842	5
Differing site conditions	3	17	18	38	1,3947368	69,73684211	8
Changes in government policy	6	16	16	38	1,2631579	63,15789474	10
Delayed payment on contract	1	6	31	38	1,7894737	89,47368421	1
Defective materials	1	19	18	38	1,4473684	72,36842105	7
Third party delays (subcontractors, material suppliers)	1	16	21	38	1,5263158	76,31578947	6
Quality of work	1	8	29	38	1,7368421	86,84210526	3