THE INFLUENCE OF UNCERTAINTY VARIABLES ON PROJECT COST ESTIMATION

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THE INFLUENCE OF UNCERTAINTY VARIABLES ON PROJECT COST ESTIMATION

by

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LIST OF ABBREVIATIONS

AACE	Association for the Advancement of Cost Engineering
BTN	Bank Tabungan Negara, Indonesia
GDP	Gross domestic product
GRDP	Gross regional domestic product
UMR	Regional minimum wage
WCC	Working capital credit

PENGARUH PEMBOLEH UBAH KETIDAKPASTIAN KE ATAS PENGANGGARAN KOS PROJEK

ABSTRAK

Anggaran kos ialah satu ramalan tentang kuantiti, kos, dan harga sumber yang diperlukan oleh skop sesuatu opsyen pelaburan aset, aktiviti, atau projek. Dalam peramalan kos sesuatu projek, kos yang akan dibelanjakan pada masa pembinaan projek tersebut tidak boleh diketahui dengan pasti. Kos projek berkait rapat dengan pemboleh ubah yang tidak boleh dianggar dengan pasti, ataupun pemboleh ketidakpastian semasa fasa pembinaan. Dalam jangkaan kerugian yang ditanggung sebagai akibat pemboleh ubah yang tidak boleh dianggar dengan pasti pada masa anggaran dibuat, kos tak langsung yang dicaskan kepada kos risiko terpaksa diperuntukkan. Kos ini dikenali sebagai kos kontingensi.

Kajian ini bertujuan untuk mengenal pasti pemboleh-pemboleh ubah ketidakpastian dan menentukan tahap pengaruh pemboleh-pemboleh ubah ini dalam penganggaran kos projek. Tambahan lagi, kajian ini bertujuan untuk mengenal pasti pemboleh-pemboleh ubah ketidakpastian yang penting yang mempunyai pengaruh yang lebih besar dalam penganggaran kos projek, untuk mengkaji kesan pemboleh-pemboleh ubah penting ini ke atas kos kontingensi.

Data yang digunakan dalam penyelidikan ini termasuk data primer dan data sekunder. Pengumpulan data telah dilaksanakan di kota Medan. Responden sasaran kajian ini terdiri daripada 151 penganggar pakar dalam syarikat kontrak. Data dalam kajian ini dianalisis menggunakan statistik perihalan dan kaedah regresi ordinal. Kajian ini menggunakan soal selidik dan temu bual untuk mengumpul data tentang

pemboleh-pemboleh ubah ketidakpastian yang paling berpengaruh dalam penganggaran kos projek, berasaskan persepsi dan pendapat responden. Bagi pemboleh ubah kadar inflasi, daripada 6 pemboleh ubah bebas, hanya 3 pemboleh ubah mempunyai pengaruh ke atas kos kontingensi. Pemboleh-pemboleh ubah tersebut ialah geografi (0.003), dasar kerajaan (0,001), kendalian dan pengurusan (0.000). Pemboleh-pemboleh ubah ini signifikan pada tahap keertian 0.05. Jumlah kos kontingensi yang dikenal pasti bagi menghadapi ketidakpastian adalah $11\% \leq C \leq 15\%$ daripada kos pembinaan keseluruhannya.

THE INFLUENCE OF UNCERTAINTY VARIABLES ON PROJECT COST ESTIMATION

ABSTRACT

Cost estimate is a prediction of quantities, cost, and price of resources required by the scope of an asset investment option, activity, or project. In estimating the cost of a project, the cost to be incurred at the time of construction of the project cannot be known for certain. Project cost is closely related to variables that cannot be estimated with certainty or uncertainty variables during the construction phase. In anticipation of losses that would be incurred as a result of variables that cannot be estimated with certainty at the time of estimation, indirect costs charged to the cost of risk have to be allocated. This cost is known as contingency cost.

This study aims to identify these uncertainty variables and to determine their level of influence in the estimation of project cost. Furthermore, this study aims to identify the key uncertainty variables that have greater influence in the estimation of project cost, to study the impact of the key uncertainty variables on contingency cost.

Data used in this research include primary data and secondary data. Data collection was conducted in the city of Medan. Target respondents in this study are 151 expert estimators in contraction companies. Data in this study were analysed using descriptive statistics and ordinal regression method. The study used the questionnaire and interviews to gather data on the uncertainty variables most influential in the estimation of project cost, based on the perceptions or opinions of respondents. For the inflation rate variable, from 6 independent variables, only 3 variables have influence the contingency cost. They are geography (0.003), government policy (0.001) handling and management (0.000). These variables were

significant at 0.05 significance level. The amount of contingency cost that was identified for facing uncertainty was $11\% \leq C \leq 15\%$ of the overall construction costs.

Descriptives

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E3	151	3	5	3.90	.700
E4	151	1	4	3.52	.609
E5	151	3	5	3.68	.734
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G5	151	3	5	3.68	.570
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P5	151	3	5	3.81	.608
P6	151	2	5	3.62	.597
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PCONVERGE(1.0E-6) SINGULAR(1.0E-8)
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PLUM - Ordinal Regression

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Case Processing Summary

		N	Marginal Percentage
Y	1	8	5.3%
	2	49	32.5%
	3	65	43.0%
	4	29	19.2%
Valid		151	100.0%
Missing		0	
Total		151	

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	357.030			
Final	291.140	65.890	6	.000

Link function: Logit.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	645.276	336	.000
Deviance	285.595	336	.979

Link function: Logit.

Pseudo R-Square

Cox and Snell	.354
Nagelkerke	.389
McFadden	.182

Link function: Logit.

Parameter Estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Y = 1]	-32.831	6.555	25.082	1	.000	-45.680	-19.983
	[Y = 2]	-29.518	6.424	21.112	1	.000	-42.109	-16.927
	[Y = 3]	-26.914	6.350	17.963	1	.000	-39.360	-14.468
Location	TOT_E	.138	.112	1.521	1	.217	-.081	.357
	TOT_SOC	-.154	.090	2.917	1	.088	-.330	.023
	TOT_GE	.448	.148	9.127	1	.003	-.738	.157
	TOT_GO	.460	.134	11.791	1	.001	-.722	.197
	TOT_CP	.089	.054	2.758	1	.097	-.016	.195
	TOT_M	.674	.104	42.370	1	.000	-.877	.471

Link function: Logit.

Test of Parallel Lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	291.140			
General	196.397	94.744	12	.230

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.[a]

a. Link function: Logit.

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The initial step in realizing a construction project is to understand the nature of the dynamic and complex projects. Construction project is a mission, undertaken to create a unique facility, product or service within the specified scope, quality, time, and cost (Chitkara, 2004). Construction activities are implemented only once and generally occur within a short period of time. The series of activities of a construction project is related to each other and they occur sequentially. It usually begins with the emergence of a necessity, followed by the feasibility study phase, design and planning stage of the procurement and implementation phase, to stage of use. Each stage of the activities has a different timescale and necessary cost estimates. The cost estimate aims to predict the magnitude of the costs incurred to implement an activity in the future. Conceptual cost estimation is one of the most critical tasks in the early stages in the life cycle of a building project (Trost et al., 2003). Fast and accurate estimation of project cost is becoming one of the key factors influencing the agility and competitiveness of enterprises. It also affects most project management activities including project bidding, project planning, risk control, quality and cost management, and resource allocation (Sung et al., 2007).

Cost estimate is a prediction of quantities, cost, or price of resources required by the scope of an asset investment option, activity, or project. As a prediction, an estimate must address risks and uncertainties (AACE, 2007). The cost estimate is performed in line with a series of project activities, beginning with the estimate until detailed estimate at this stage of the procurement and implementation. Each stage has

a different method of estimation as the estimation detail, beginning with the preparation or grouping level of employment activity or WBS (Work Breakdown Structure). A complex project is made manageable by first breaking it into individual components in a hierarchical structure, known as Work Breakdown Structure (NetMBA, 2010). This is then followed by calculation of the quantity of work (quantity take-off) based on the drawings and specifications. The next step is to perform a job analysis unit price, which consists of the calculation of resources which form the work that covers the cost of wages, the cost of the appropriate level of productivity tools, and the costs of materials, costs of subcontracting, and other costs necessary to support the implementation and the execution of work.

Detailed cost estimates conducted by the contractor or the owner, among others, aim to obtain the amount of the bid price of a project, to control or monitor action at the time of execution, and to know the magnitude of the owner's estimate as a reference when assessing bids submitted by contractors.

Park (1992) stated that in the bidding price of the work, the contractor aims to to submit a bid with the best price, which has a great opportunity to earn or win jobs and provides the maximum benefit. Cost project of work consists of material costs, equipment costs, and wage costs. The amount of each fee depends on the quantity of materials and level of equipment and labour productivity are used in accordance with the unit quantity of each kind of work area (m2), volume (m3), m ', unit of lump sum and others.

Barcarini (2004) noted that construction projects are notorious for overrunning budgets because of unforeseen factors. Many cases have been documented from around the world concerning increases in cost beyond the estimate.

In estimating the magnitude of the cost project, the amount of costs to be incurred at the time of construction cannot be known for certain. It is very closely related to the existence of variables that cannot be estimated with certainty, or the existence of uncertainties during the construction phase, so that it leads to variability in the unit price. For example, price fluctuations of materials, equipment and wages will also cause variability in the quantity of work, and create a difference between the quantities of work performed in the field and that stated in the Bill of quantity. All construction projects, regardless of type and size, involve many significant uncertainties and risks through all their construction phases, from the start up to the completion of the project. AACE (2007) defined uncertainty as unknown future events that cannot be predicted quantitatively within useful limits.

Flyvbjerg et al. (2002) found that project costs have been underestimated in approximately 90% of cases, and that the actual costs turned out to be on average 28% more than the estimated costs. There are many uncertain variables during project implementation that dynamically affect the project duration and cost (del Caño & de la Cruz, 2002).

Flyvbjerg et al. (2004) suggested that larger projects experience greater cost overruns on a percentage basis. In anticipation of losses that will occur as a result of variables that cannot be estimated with certainty or those estimated with uncertainty at the time of estimation, a number of costs need to be allocated as the indirect costs charged to the cost of risk; in this case, costs positioned as a contingency cost.

1.2 Research Problem

The problems that arise in this study are to identify the uncertainty variables and to determine their level of influence in estimating project costs. As pointed out by Flyvbjerg et al. (2003), change in project cost, or cost growth, occurs as a result of many related factors, all of which are associated with some form of uncertainties. This study is done to avoid the following issues:

1. The offer price is too low, which can result in cost overrun or expenditures greater than the estimated value, which would consequently lead to losses, or

2. The offer price is too high, such that it does not successfully help to win the auction.

A key component of a project budget is contingency cost (Baccarini, 2004). The level of project risk contingency cost in estimates has a major impact on financial outcomes for project owners. If the contingency cost is too high, it might encourage poor cost management, and causes the project to become uneconomical and finally aborted, or to cause the occurrence of lock-up funds that would not be available for other projects (Dey et al., 1996). On the other hand, if the contingency cost allocation is too low, then it may be too rigid and it may set an unrealistic financial environment, resulting in unsatisfactory performance outcomes (Touran, 2003). In some areas of the public sector there is a tendency for the financial authorities to remove contingency provisions in budget submissions, as contingencies are often seen as facts that leave no allowance for anticipating project risk (Yeo, 1990).

One way to face the problems mentioned is to use the estimated price at the time of the work unit, an estimator must be able to identify and analyse the uncertainty variables that must be calculated in accordance to situations and conditions that occurred during the implementation. This can be calculated based on past project experience, educational background, as well as information held by either of the tender documents, review the site and from other resources.

The gap between actual costs and estimated costs may result in losses and cost overruns on construction projects. This gap can be due to the uncertainty of the variables that occur in construction projects. Therefore, it is necessary to know and identify the variables of uncertainty to minimize the gap.

With respect to the mentioned opinions, further study needs to be done on the uncertainties that occur in construction projects in Indonesia. The uncertainty in construction projects in Indonesia will be more complex, given the condition of the country that has sociocultural diversity, geographical differences, low education levels, unequal living standards, public economics, social and often occurring political upheavals, and the economic crisis that has not yet recovered. These conditions will have a significant influence on the realization of a project as well. According to Tunardih et al. (2005), in Indonesia wastes in project costs mainly occur due to design changes and additional work required by project owners.

1.3 Research Gap

When determining the amount of the contingency cost at the time of project bidding, contractors often do not specify the uncertainty factors that affect the project cost estimate. Therefore, they need a study to identify and to analyse events that

cannot be predicted with certainty or that cannot be stated clearly, which is called the uncertainty factors. To avoid losses or cost overrun, the contractor is expected to estimate the cost of the project to the optimum.

Choudhry (2004) defined the cost overruns as the difference between the original cost estimate of project and actual construction cost on completion of works of a commercial sector construction project. Contingency cost allocation should be minimized by making the best estimate. To clarify any vagueness or if there is a lack of information about anything, contractors can ask directly the owner of the project or related parties.

Harbuck (2004) documented three major categories of uncertainty in construction projects as design problems, construction problems, and third party problems. Design problems include design changes, design errors, and ambiguous specifications. Construction problems include differing site conditions, delays, and scope additions. Finally, third party problems include utilities, local government, and permit agencies. Kalayjian (2000) stated that the uncertainty variables in construction projects may arise from ambiguously specified project scope, unclear boundaries of work, inaccurate estimation, and price fluctuations.

Frimpong (2003) added by saying that uncertainty variables in construction projects are affected by improper planning and management experience limitation. On a different but related perspective, Long et al. (2008) said that the uncertainty variables in construction projects are affected by poor site supervision and management and poor project management assistance. Then, Nega (2008) stated that the uncertainty variables in construction projects are affected by change of weather conditions or subsoil conditions. Huang (2006) concluded that the uncertainty

variables in construction projects are affected by the project design and construction. However, Ghosh and Jintanapakanont (2004) identified nine critical risk or uncertainty factors, which include financial and economic factors, contractual and legal factors, subcontractor-related factors, operational factors, safety and social factors, design factor, force majeure factors, physical factors, and delay.

With respect to the mentioned opinions, further study needs to be done on the uncertainties that occur in construction projects in Indonesia, it is aims to improve the current knowledge. Further study needs to know and identify the new uncertainty variables to minimize the gap, in which the uncertainty in construction projects in Indonesia will be more complex, given the condition of the country that has sociocultural diversity, geographical differences, low education levels, unequal living standards, public economics, social and often occurring political upheavals, and the economic crisis that has not yet recovered. These conditions will have a significant influence on the realization of a project as well, 12 new uncertainty variables were found affecting construction project

1.4 Research Questions (RQs)

The research questions (RQs) in this study are as follows:

RQ1: What are the uncertainty variables that influence the estimation of project costs?

RQ2: What are the key uncertainty variables that influence the estimation the costs of a project?

RQ3: How the uncertainty variables influence the variable of contingency cost?

1.5 Research Objectives (ROs)

In estimating the magnitude of project costs, the amount of costs to be incurred cannot be known for certain at the time of construction. This is because project costs are closely related to the presence of variables that cannot be estimated with certainty or the presence of uncertainties during the various stages of construction.

Therefore, the aims of this research are as follows:

RO1: To identify of uncertainty variables that influence the estimation project cost.

RO2: To identify the key uncertainty variables that has greater influence in estimating the costs of project work.

RO3: To investigate the impact of uncertainty variables on contingency cost.

1.6 Significance of the Research

As has been mentioned, the costs of a project work to be incurred cannot be known for certain at the time of construction. This is because project costs are closely related to the presence of variables that cannot be estimated with certainty at this stage or the presence of uncertainties during construction. Peeters and Madauss (2008) stated that inaccurate estimation of original or initial cost of a project are due to the technical problems on how to estimate project costs and insufficient project information in the early stages of a project.

To anticipate the losses that would occur as a result of variables that cannot be estimated with certainty or as a result of uncertainty that could occur, at the time of estimation, a number of costs need to be allocated. These are indirect costs charged as the cost of risk. In this case, the costs are positioned as a contingency cost. Sonmez et al. (2007) studied the financial impact of various uncertainty variables affecting contingency costs during the bidding stages of international construction projects. The cost performance of construction projects is a key success criterion for project sponsors. The cost performance can be measured by comparing project budgets against the final cost of the project. Therefore, the estimation of contingency costs is an important issue in construction projects and this topic is worthy of serious research (Baccarini, 2004).

To solve the aforementioned problems, when estimating the cost of the project work, an estimator must be able to identify and analyse the uncertainty variables that must be calculated in accordance to situations and conditions that would occur during the implementation of the project. Del Cana and De la Cruz (2002) pointed out that during project implementation, many uncertainty variables can dynamically affect the project duration and this would increase the costs of the project.

Research related to uncertainty analysis of the variables affecting construction projects can provide a great benefit to interested parties such as

(a) contractors who need to allocate more optimal contingency costs in accordance with the uncertainty of the most influential variables so as to calculate the best offer price.

(b) project owners, for them to understand the most influential uncertainty variable, so that they can develop a more realistic estimate, closer to the price offered by the contractor.

1.7 Scope of the Research

The scope of the discussion on the variables of uncertainty in the estimation of cost project work on construction projects is limited by the following points.

(a) This research done only on construction projects in the Province of North Sumatera, especially in the city of Medan. The reason for choosing the city as the location of the study is because the city has many large construction companies and many large projects are implemented by contractors in this city.

(b) In this study, respondents were determined by the qualification of contractors. The respondents were as follows: grade 5 (medium) contractors consisting of 203 respondents, grade 6 (large) contractors consisting of 30 respondents, and grade 7 (large) contractors consisting of 11 respondents. Reasons for choosing these contractors as respondents are that the contractors have a lot of experience and education in the construction field and they already have a pattern of complete and regular management. According to Department of Public Works (2001), the qualifications of contractor companies handling construction projects in Indonesia consist of grade 1, grade 2, grade 3, grade 4, grade 5, grade 6, and grade 7. Table 1.1 shows the level of qualification of contractors in Medan.

Table 1.1
Qualification of Construction Services Business

Qualifications of the construction (Contractor)			
Qualification	**Classes**	**Net worth (Rupiah)**	**The limit value of the project work (Rupiah)**
Grade 7	Large	> 10 Billion	> 2.5 Billion- unlimited
Grade 6	Large	> 3 Billion	> 2.5 Billion- 100 Billion
Grade 5	Medium	> 2.5 Billion	> 2.5 Billion- 50 Billion
Grade 4	Small	> 400 Million	≤ 2.5 Billion
Grade 3	Small	> 100 Million	≤ 1.75 Billion
Grade 2	Small	> 50 Million	≤ 1 Billion
Grade 1	Micro (Business Agency)	-	≤ 300 Million
Grade 1	Micro (Individual)	-	≤ 100 Million

Source. Department of Public Works (2014)

1.8 Definition of Key Terms

The terms used in this research have been defined differently by various researchers and practitioners depending on their individual contexts. The definitions of the terms used for the purpose of this study are therefore identified below:

Table. 1.2
Definitions of The Terms

Name	Definitions	Ref
Cost	The cash or the value of cash equivalent that is sacrificed for goods or services that are expected to provide benefits currently or in the future for the organization	(Hansen, 2005)
Cost	A key consideration throughout the project management life cycle and can be considered as one of the most important parameters of a project and the driving force a behind the success of the project	(Azhar et al., 2008).
Cost	Wealth, in the form of cash or noncash, sacrificed for goods and services which are expected to provide current or future benefits for the organization	(Hansen et al., 2009).

Estimates	Used primarily as inputs for budgeting cost in value analysis, in decision making in business, in asset and project planning, or in project cost, and in scheduling control processes.	(AACE, 2007)
Estimation	Estimation is conducted to assess the feasibility of a project to be implemented or to make a selection from several alternative designs.	(Ahuja, 1994)
Cost Estimation	Cost estimation is one of the most critical tasks in the early stages in the life cycle of a building project	(Trost et al., 2003).
Uncertainty	As unknown future events that cannot be predicted quantitatively within useful limits.	AACE (2007)
Uncertainties	Can cause losses that can lead to increased costs, time delays, and reduced project quality.	(Simu, 2006)
External uncertainty factors	Factors that are outside the project environment and influence the project activities.	(Yeo, 1990)
Internal uncertainty factors	Factors of uncertainty that arise from within the project environment.	(Yeo, 1990)
Contingency	Directly related to the accuracy of base estimates because it is included in the cost estimate, which is prepared before the start of project execution.	(Molenaar, 2005)
Contingency	The amount of funds available in reserve to face the uncertainties related to construction projects.	(Mak and Picken 2000)
Contingency	As an amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect are uncertain and that experience have shown would most likely result, in aggregate, in additional costs.	(AACE,2007)

Direct costs	All costs that become a permanent component of the final results of the project which consists of the following costs	(AACE, 2007)
Indirect Cost	Indirect costs are costs that support the work, but not listed as the nature of the current job payment.	(Ahuja. 1994)
Construction project	A mission, undertaken to create a unique facility, product or service within the specified scope, quality, time, and cost.	(Chitkara, 2004).
Cost overruns	Difference between the original cost estimate of project and actual construction cost on completion of works of a commercial sector construction project.	Choudhry (2004)

1.9 Organisation of the Thesis

The thesis is divided into six chapters. Chapter 1 provides an introduction to this study, background research, research problem, research questions, research objectives, significance of the research, scope of the research, and the organization of the thesis. Chapter 2 focuses on a review of existing literature in relation to the research topic. The first section reviews the history and evolution of the estimated cost of construction projects, especially about the variables related to the uncertainty in estimating the costs of construction projects. This is then followed by the identification of the uncertainty variables that occur in construction projects. Chapter 3 describes the research methodology used in this study. This chapter is divided into sections that discuss the sampling frame, the sample size, and the research instruments. This chapter was developed based on the literature review provided in Chapter 2. Chapter 4 explains the data collection methods and the validity and

reliability of measurement and statistical analysis. Chapter 5 focuses on the findings and discussion. Finally, Chapter 6 provides conclusion and recommendations of the study.

Table 2.1

The Uncertainties Variable That Influence Project Cost Estimate Based on Other Studies

No.	Uncertainty Variables	Authors/ Years																					
		Yeo (1990)	Kalayjian (2000)	Han et al (2001)	Chimwaso (2001)	Pakkala (2002)	Chan et al (2003)	Frimpong (2003)	Ghosh et al (2004)	Thevendran et al (2004)	Harbuck (2004)	Long et al (2004)	Ren et al (2004)	Bing et al (2005)	Chan et al (2005)	Azhar et al (2008)	Broadbent et al (2008)	Long et al (2008)	Nega (2008)	Creedy et.al (2010)	Memon et al (2011)	Subramanyan et al (2012)	Doloi (2013)	Frequency
1	The inflation rate	x															x							2
2	Exchange rate	x		x																				2
3	Social and cultural conditions		x				x	x						x										4
4	Work ethics and religious beliefs.		x																					1
5	The physical condition				x			x						x					x	x	x	x	x	8
6	Interpretation and implementation of government policy on construction sector	x												x		x								3
7	Scale or scope of project	x	x								x								x			x	x	6
8	The project site				x						x					x		x			x	x	x	7
9	The implementation period	x																					x	2
10	Managerial ability of the team involved								x					x				x			x	x	x	6

Table 2.1 continued.

No.	Uncertainty Variables	Authors/ Years																							
		Yeo (1990)	Kalayjian (2000)	Han et al (2001)	Chimwaso (2001)	Pakkala (2002)	Chan et al (2003)	Frimpong (2003)	Ghosh et al (2004)	Thevendran et al (2004)	Harbuck (2004)	Long et al (2004)	Ren et al (2004)	Bing et al (2005)	Chan et al (2005)	Azhar et al (2008)	Broadbent et al (2008)	Long et al (2008)	Nega (2008)	Creedy et.al (2010)	Memon et al (2011)	Subramanyan et al (2012)	Doloi (2013)	Frequency
11	Availability and the working relationship between the Contractor with the supplier													x				x					x	3
12	Technical problem	x																				x	x	3
13	Price fluctuations		x		x											x				x		x	x	6
14	Design changes				x	x			x		x			x			x			x	x	x	x	10
15	Inadequate planning				x			x								x					x	x	x	6
16	Experience limitation.							x							x						x	x	x	5
17	Financial and economic								x				x	x	x		x			x		x	x	8
18	Contractual and legal								x								x			x	x	x	x	6
19	Operational								x														x	2
20	Delay								x		x					x					x	x	x	6
21	Human risk									x		x		x								x	x	5
22	Local government										x													1
23	Permit agencies										x													1
24	Wrong methods											x				x						x	x	4
25	Political													x										1
26	Additional work															x						x	x	3
27	Insufficient data collection and survey before design																					x	x	2

2.4 Research Framework

The conceptual framework is a framework that illustrates the relationship between the variables in this study (Sekaran, 2003). The development of the conceptual framework is done after reviews of literature on uncertainty variable theories and concept, philosophies and empirical researches.

Base on the discussion in previous chapters, six independent variables that represent the uncertainty variables concept has been identified, selected and operationalized in this study (see Figure 2.1). These variables are economics, social and cultural, geography, government policy, complexity of the project, and project management handling. Meanwhile, the dependent variable in this study is contingency cost.

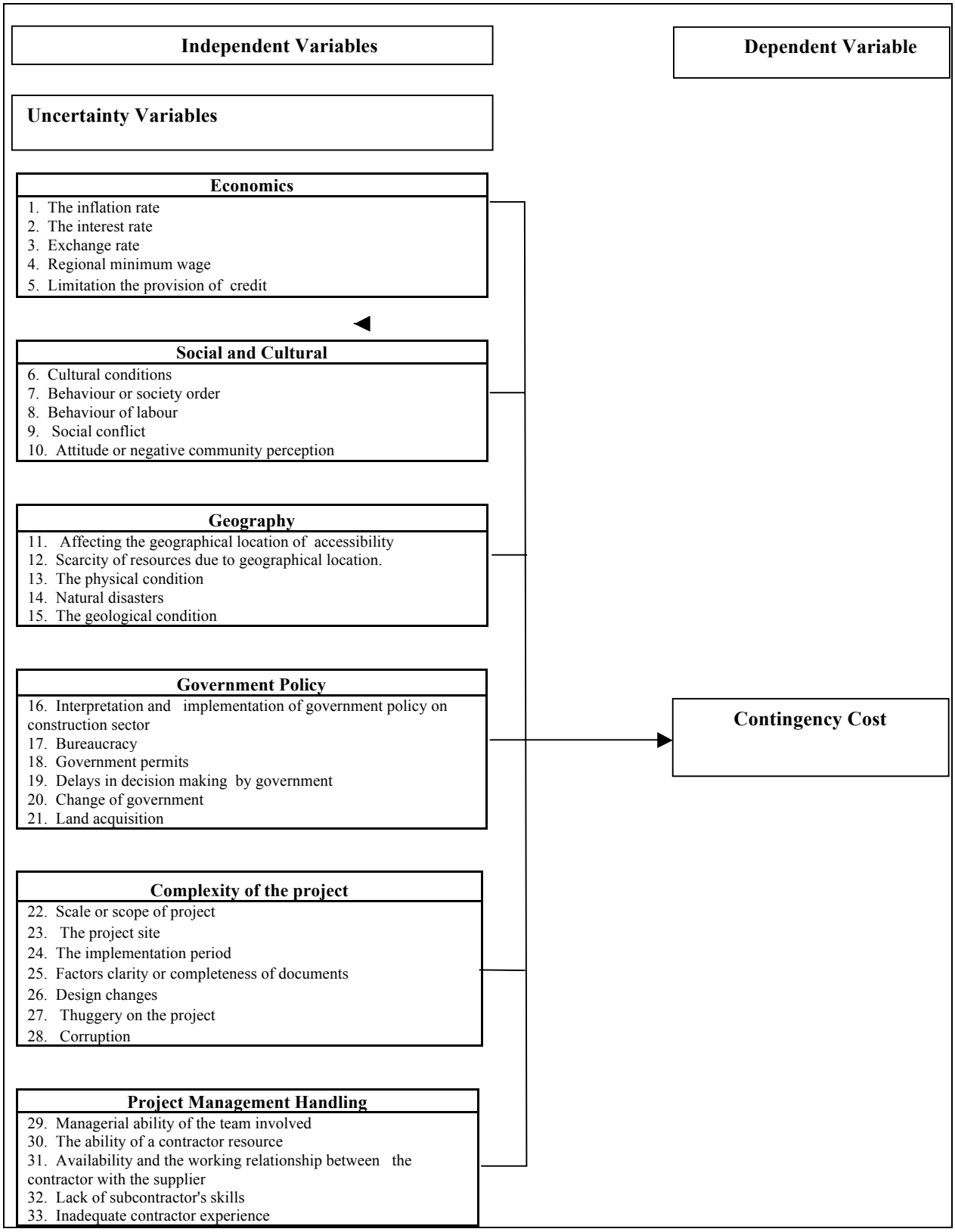

Figure 2.1. Research Framework

2.5 Summary

This chapter has highlighted the information from the literature review about the key concepts of theoretical construct of the study. The conceptual framework focusing on the uncertainty variables that influence the estimation of construction costs is also given. Six independent variables that represent the uncertainty variables concept have been identified, selected and operationalized. These variables are defined in terms of economics, social and cultural, geography, government policy, complexity of the project, and project management handling variables. Meanwhile, the dependent variable is contingency cost. The literature review will be the basis in developing the questionnaire or source of any secondary data that is needed to answer the research questions. The next chapter on research methodology will provide the research design and method, applied in this research to gather information.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature to identify and explore the uncertainty variables that influence estimated costs. The challenge is to apply those variables into the calculation of project construction costs.

2.2 Estimated costs

Cost is one important aspect of the cycle of business activities and the construction industry. Contractors who do not have an understanding of the components of costs, including indirect costs will increase the risk of failure (Shelton, 2002). According to Hansen (2005), the cost is the cash or the value of cash equivalent that is sacrificed for goods or services that are expected to provide benefits currently or in the future for the organization. As a business field that is classified as a high risk business, the success of construction activities must be very sensitive to changes in costs. It is now becoming very important to be noticed by the actors in the business field. Under such conditions, the ability and success of the contractors to survive tight competition in the industry will depend highly on how well they are able to overcome the uncertainty, especially in the aspect of costs. In this kind of competition, contractor success is reflected in his or her ability to win auctions and completing construction projects, while generating enough profits.

Cost is a key consideration throughout the project management life cycle and can be considered as one of the most important parameters of a project and the driving force behind the success of the project (Azhar et al., 2008).

According to AACE (2007), cost is the amount measured in money terms, cash expended or liability incurred, in consideration of goods and services received. From a total cost management perspective, cost may include any investment of resources in strategic assets including time, monetary, human, and physical resources. Generally, contractors who can successfully handle the cost of uncertainty are in a position to produce accurate cost estimates. As a guideline, the more accurate the resulting cost estimates, the lower will be the risk due to changes in the costs faced by the contractor. With reduced risk, the contractor can reduce the cost of risk, which could ultimately result in more competitive price offer. In an auction, contracting bid price includes components of direct and indirect costs. Cost is a wealth, in the form of cash or noncash, sacrificed for goods and services which are expected to provide current or future benefits for the organization (Hansen et al., 2009).

Ahuja (1994) said that the types of estimation for the various phases of activities in construction projects can be divided into several groups as follows:

(a) Order of Magnitude

Estimation is conducted to assess the feasibility of a project to be implemented or to make a selection from several alternative designs. At this time, the estimate made using the data or information available is very limited so that the accuracy of the resulting value gives a very wide range, varying from + 50% to - 30%. Order of magnitude estimation method uses several criteria such as the floor area of the the building, volume of work, and such other criteria.

(b) Budget estimates

The purpose of budget estimates is to find out how much money should be prepared for the implementation of the project. Budget estimates are not used for controlling project. Budget estimation is carried out in more detail than the previous estimate. Therefore, the values of these estimates range between +30% and -15%. The accuracy is dependent on the quality of information available.

(c) Detailed Estimates

Detailed estimates are made for two purposes: first is to submit a bid price for a job; and second, it is used as the basis for the control of a project. Detailed cost estimate can be made after complete data or information from the project such as the availability of the document images, technical specifications and other support requirements are obtained. This estimate will give more accurate results as more complete data and information are available. This estimate can also be done by the owner to know the size of owner cost that can be used as a reference for the bid price submitted by the bidder. The accuracy of these estimates ranged from +15% to -5%.

The main issue in making the estimated detail are to define the scope of work, and to do the grouping for the job. Some steps in preparing the details are as follows:

(i) Conduct a review of documents and the actual conditions of the project such as an explanation of documents including addenda, field conditions and the level of risk to be faced.

(ii) Describe and classify items employment.

(iii) Calculate the quantity of work in accordance with the units of measurement and types of jobs.

(iv) Calculate the price component of the cost of materials, equipment, and labour.

(v) Make an analysis of the prices offered by subcontractors and suppliers.

(vi) Calculate the amount of overhead costs, taxes, insurance, and guarantees necessary for the project.

(vii) Calculate the contingency costs, which is the risk associated with the work to be performed.

(viii) Calculate the greatest advantage to be gained from the project.

The initial cost estimates should be as accurate as possible. Accuracy of cost estimation allows the client to examine and determine the funds needed to implement the project (Kaliba et al., 2009). According to AACE (2007), estimates are used primarily as inputs for budgeting cost in value analysis, in decision making in business, in asset and project planning, or in project cost, and in scheduling control processes.

The details of the components in the construction cost estimates can be divided into two general categories, namely direct costs and indirect costs.

2.2.1 Direct Costs

According to the AACE (2007) detailed cost estimates, can be further divided into two components, namely direct costs, that is, cost of installed equipment, material and labour directly involved in the physical construction of the permanent facility and indirect costs, that is, all costs which do not become a final part of the installation, but which are required for the orderly completion of the installation and may include, but are not limited to, field administration, direct supervision, capital tools, start-up costs, contractor's fees, insurance, taxes, and so forth.

Direct costs are all costs that become a permanent component of the final results of the project which consists of the following costs.

(a) Cost of materials

AACE (2007) defined material cost as the cost of everything of substantial nature that is essential to the construction or operation of a facility, comprising both direct and indirect costs. Generally, it includes all manufactured equipment such as basic parts. This fee can be calculated in units multiplied by unit price or on a lump sum basis. It is highly dependent upon those involved in the procurement of materials. Apart from the price of materials, the estimator must also take into account other costs such as transportation costs, storage costs, wages unloading, cost of testing materials, the quantity of material available, cost of taxes, payment systems, delivery or arrival date, materials held directly by the owners, and others.

(b) Cost of equipment

According Soeharto (1999), contractors who handle jobs with huge costs and volumes, while the nature of the job involves much construction equipment, the cost of equipment must be determined, whether the procurement of equipment involves renting or purchasing. The cost of this equipment is needed to accommodate tool needs, particularly heavy equipment to be used during the construction phase. Calculation of the cost of equipment can be divided as follows:

(i) Cost of procurement

The cost of procurement of heavy equipment can be calculated based on how the equipment is handled as through ownership, lease, or leasing. In the case of ownership cost, things that should be taken into account are the cost of depreciation, interest charges, insurance, and taxes.

(ii) Cost of operations

Cost of operations consists of operator cost, fuel, lubricants, maintenance, replacement tires, and others.

(c) Cost of labour

ACCE (2007) defined labour costs as gross direct wages paid to workers, plus labour burden, field indirect, plus general and administrative cost, and profits. With regard to wages labour, costs to consider include straight-time wages, overtime wages, labour insurance, safety of workers, public facilities for labour, and fringe benefit. Fixed salary of the workers must consider factors associated with the project location, and the type or workforce skills. Wages of workers can be paid based on

union wage, one-shop wage, or prevailing wage. The amount of wages to be paid depends on the level of worker productivity, which is strongly influenced by attitude or personal characteristics of the workers, project type, climatic conditions, the complexity, and oversight functions.

(d) Cost of subcontractors

This fee is calculated for purposes of procurement of subcontractors by main contractors due to the transfer of a particular type of specific job skills. Some of the factors for the main contractor to watch in the choice of subcontractors involved are system estimation carried out by subcontractors, capability of the subcontractor, and the analysis of proposals submitted by the subcontractor.

2.2.2 Indirect Costs

Indirect costs are costs that support the work, but not listed as the nature of the current job payment, such as the following:

2.2.2.1 Overhead Costs

Overhead costs are divided into

(a) General overhead costs

General overhead costs are costs incurred for the operation of the company, but cannot be distributed into work packages. These costs include such costs as office rental, salaries, and benefits paid to all directors, employees (employee facilities, insurance), cost of utilities (electricity, water, telephone, and other retributions), marketing, depreciation, and others.

(b) Project overhead

Project overhead is the indirect costs which are spent for the purposes of the project and allocated proportionately to the work packages, such as the cost to estimate, the cost to participate in the tender, the cost for the project guarantees (bid bonds, performance bonds), the cost of labour insurance, equipment, materials, licensing, and the cost of utility used by the projects.

2.2.2.2 Contingencies

Contingency cost is an important item in the cost estimate used to compensate for unforeseen uncertainties and risks against underestimating budgets for the construction phase. In addition, contingency is directly related to the accuracy of base estimates because it is included in the cost estimate, which is prepared before the start of project execution (Molenaar, 2005).

The Association for the Advancement of Cost Engineering (AACE, 2007) defines contingency as an amount added to an estimate to allow for items, conditions, or events for which the state, occurrence, or effect are uncertain and that experience have shown would most likely result, in aggregate, in additional costs. These costs are allocated to anticipate over the lack of information and errors in interpreting the information obtained, giving rise to an uncertainty. This can be one of the risks to be faced in future implementation of a project. Allocation of these costs should be minimized, by making the best and complete estimate of the uncertainties, or in the case of deficiencies of such information, by asking directly the project owners or stakeholders. Its aim is to get value for the right offer. If the contingency allocation is

too low, then it may be too rigid and set an unrealistic financial environment, which may result in unsatisfactory performance outcomes (Touran, 2003).

According to Mak and Picken (2000), contingency cost is the amount of funds available in reserve to face the uncertainties related to construction projects. Contingency cost is very important if previous experiences related to costs indicate that there may be events which cannot be predicted that occurred resulting in increased costs. Therefore, contingency contracting costs can be viewed as an estimate of the cost of the risks due to uncertain conditions that will be faced by the contractor during the execution of the project, which is a function of the level of confidence that represents the level of risk accepted by the contractor.

This cost allocation should be minimized by contractors, by doing their best to estimate the complete vagueness or lack of information, by asking directly the owner of the project or related parties. Hendrickson (2003) stated that the majority of construction budgets provide a reserve for contingency costs or unexpected costs incurred during the construction. According to Latupeirissa et al. (2007), there is a common perception related to uncertainties and risks that have been identified by the respondents. The common perception is reflected in the answers of the respondents who agreed that contingency costs are a move prepared in anticipation of uncertainty and the risks. A total of 42 respondents (67%) gave the same answer about contingency costs.

According to Latupeirissa et al. (2007), approximately 32 respondents (51.6%) defined project contingency costs as a way to anticipate the cost overrun. This response implies that the respondents have noticed that nearly every budget overrun and contingency costs are provided to cover the cost overrun.

2.2.2.3 Profitability (Profit)

The purpose in analysing the benefits by the estimator is to get an estimate of the maximum expected profit. The advantages can be defined as something obtained over the risks faced. The value of benefits can be added to the value of the estimates made.

2.3 Uncertainty Variables in Construction Projects

In preparing cost estimates on construction projects, there are things that cannot be expected with certainty (that is, unforeseeable), or which cannot clearly stated (intangible), or cannot be predicted (unforeseen); all these can be categorized as an uncertainty. Uncertainties can cause losses that can lead to increased costs, time delays, and reduced project quality (Simu, 2006).

During project implementation, there are many uncertainty variables that dynamically affect duration of activity, and hence cost (Leu et al., 2001). Many uncertainties associated with international construction arise from differences in culture, economic conditions, specifications or standards, legal frameworks, and productivity levels (Dikmen & Birgonul, 2006).

The history of the construction industry is full of projects that were completed with significant cost overruns (Molenaar, 2005). In the face of uncertainty, many components of costs need to be allocated to one component of indirect costs that is contingency costs. In allocating for contingency cost it is necessary that the estimator has the assessment capabilities, to avoid cost overruns or the occurrence of low cost estimates, resulting in the loss (cost underrun). The uncertainty in the estimation of unit price work can be caused by two factors which