NATURE OF THE CRITICAL RISK FACTORS AFFECTING PROJECT PERFORMANCE IN INDONESIAN BUILDING CONTRACTS

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Project delay and cost overrun are recognised as the most common problems faced by contractors. The primary aim of the study reported in this paper was to collect information to allow the critical risk factors causing construction time and cost in building projects in Indonesia to be determined. The study was predominantly based on interviews with project managers using a structured questionnaire, which was designed to assess risk levels in terms of time and cost. It consisted of four risk factors in each of four major risk categories giving sixteen risk factors in all. A total of 22 building projects under construction in East Java and Bali provinces were surveyed. The respondents were asked to assess the probability that risks would occur, estimate the impact on cost and time if the risks did occur using a five point scale and consider the weight of risk importance using pair-wise comparison. The results showed the critical risks affecting both project time and cost perceived by the building contractors were similar. They were: high inflation/increased material price, design change by owner, defective design, weather conditions, delayed payments on contracts and defective construction work. A common theme amongst the critical risks identified appears to be that most of them cannot be controlled or managed by the contractors.

Keywords: building project, cost overrun, critical risk, delay, risk assessment.

INTRODUCTION

In construction projects, risks play a significant part in decision making and may affect the performance of a project. If they are not dealt with sensibly, they may cause cost overruns, delays on schedule and even poor quality. Each project has a different level and combination of risks and sites will adopt different strategies to minimise them because the characteristics of projects are unique and dynamic.

To identify factors causing project delays and cost overruns, a considerable number of studies have been conducted. Akinci and Fischer (1998) conducted a study to identify factors affecting cost overrun and surveys to collect factors causing project delays were conducted by Assaf *et al.* (1995), Nkado (1995), Ogunlana *et al.* (1996), Chan and Kumaraswamy (1997), Mezher and Tawil (1998), Kumaraswamy and Chan (1998), Al-Khalil and Al-Ghafly (1999), Al-Momani (2000), Elinwa and Joshua (2001) and Odeh and Battaineh (2002). The factors influencing cost overruns and delays were also identified by the surveys conducted by Mansfield *et al.* (1994) and Frimpong *et al.* (2003). Different survey methods have been adopted including intensive literature reviews, questionnaires and interviews with

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practitioners and experts. In the questionnaire surveys, the Likert scale and ranking in order on a single issue were the most common assessment approaches used. Most of the data obtained from the questionnaires was then assessed using relative weight, means, ranking and factor analysis.

Formal risk management guidance documents, including APM (1997), ICE and FIA (1998), AS/NZS (1999), and PMI (2000) propose the risk probability and impact approach to assess the degree of project risk. This approach is also accepted in many other publications on risk management in construction projects and was recognised in a survey by Raz and Michael (2001) as the most frequently used for assessing project risk, with most of the practitioners surveyed generally using their subjective judgements or experiences to estimate the probability of risk occurrence and their impact, in a range from very low to very high.

A modification of the risk assessment approach by combining pair-wise comparison on risk probability and impact was suggested by Hastak and Shaked (2000). Pair-wise comparison compares the elements in each level of a hierarchy in pairs, according to their contribution to the element at the level immediately above in order to determine their relative weight. By multiplying the relative weight of each risk factor by its probability and impact, the level of project risk can thus be determined. This procedure is described in more detail later in this paper.

In this paper, the most critical risk factors causing project time and cost in Indonesian building projects under construction were assessed using a risk assessment method similar to that proposed by Hastak and Shaked (2000).

CONDUCTING THE SURVEY

In this study, initially, the risk factors affecting project delay and cost overrun were identified through an intensive literature review and a comprehensive listing was established. A total of 30 risk factors were identified and found to fall easily into four major risk categories, which were: external and site condition risks, economic and financial risks, technical and contractual risks, and managerial risks.

In order to identify what were perceived to be the most significant risk factors in each major risk category, a preliminary questionnaire was designed that asked participants to rank the 30 risks in order of their importance. The intention was to produce a more manageable list of critical risk factors using a weighting approach. The participants who responded ranked each of the risk factors in each major risk category and this then allowed the top risk factors in each major risk category to be determined. In this event, four risk factors were identified in each major category.

The main survey that followed was predominantly based on a series of interviews with project teams. In the first interview, a structured questionnaire was used and divided into two sections: one devoted to risks affecting time, with a second section asking similar questions about risk affecting cost. The first section was designed to assess the ‘risk level of time’, which was defined as a measure of likelihood that each risk factor listed will affect project duration. The respondents, who were project managers, were asked to assess the probability that each of the 16 risks would occur on their projects and to estimate the impact on time if the risks did occur using a five point scale. They were also requested to assess the relative importance of each risk on time using pair-wise comparisons. A similar procedure was then followed to consider the ‘risk level of cost’. The intention of the subsequent interviews, arranged in the following months, was to identify the risk factors that had occurred in the previous month and to define the impacts of those risks on their project's performance.

A total of 22 building projects under construction in East Java and Bali provinces were surveyed during the period from mid December 2003 to the end of June 2004. The majority of the projects surveyed (13 projects) were assessed at the beginning of their construction period, but 5 projects were in the middle of their construction periods and 4 were in their final stages. Most of the projects were identified as commercial projects including offices, shopping centres, and hotels, although a few of them were public buildings including a sport centre and a recreation building. Most of the contract amounts ranged from 3.5 billion rupiahs to 34 billion rupiahs (£260K – 2518K, exchange rate in mid December 2003).

ASSESSING THE MOST CRITICAL RISK FACTORS

As discussed earlier, the 'risk level of time' was assessed using the following formula:

$RL = w \times P \times I$, where:

RL = risk level of time
w = weight of the importance of each risk on time (using pair-wise comparisons)
P = probability that risk would occur
I = impact on time if the risk did occur

This equation, with obvious modifications, was also used to assess the 'risk level of cost'.

In the interviews conducted as part of the main survey, the respondents were asked to assess the probability that each risk would occur and the impact on time if it did occur, using a five-point scale (from 1 = very low to 5 = very high). After assessing the probability and impact, the respondents were also requested to assess the relative importance of each risk on time using pair-wise comparison.

The pair-wise comparison method compares the elements in each level of a hierarchy in pairs, according to their contribution to the element at the level immediately above. To assess the relative importance of each risk factor, a model of risk hierarchy was developed. The lowest level of the hierarchy was the sixteen individual risk factors and the upper level was the four major risk categories. From the upper level, 6 sets of pair-wise comparisons were established to allow each major risk category to be compared with all the other major risk categories. Then, within each major risk category, 6 sets of pair-wise comparisons were established to allow each risk factor to be compared with all the other risk factors. Altogether, this produced 30 sets of pair-wise comparisons, all of which used a scale from 1 to 9, representing equal importance to extreme importance as proposed by Saaty (1995).

After all the major risk categories and risk factors had been compared, the weight of importance of each risk on time was obtained by synthesising all comparisons. For a more detailed procedure about how to develop pair-wise comparisons and to establish priorities, refer to Saaty (1995) and on how to assess risk level using pair-wise comparison similarly, refer to Zhi (1995), Dias and Ioannou (1996), Hastak and Shaked (2000) and Zayed and Chang (2002).

An example of a computation to determine the 'risk level of time' on the particular project is shown in table 1. The four major risk categories and their risk factors are shown in the left-hand column of table 1, followed by the three values assessed by the respondents for each risk factor which are: importance (w), probability (P) and impact (I) in the middle columns. By multiplying together the importance, probability and impact, the 'risk levels of time' for each risk factor were calculated as shown in the right-hand column.

The project risk index of time, which represents the likelihood that the risk factors in a project will affect the project completion time, was computed by summing up all risk levels in a project. Using this approach, the maximum possible value of the project risk index is 25 and the minimum value is 1, and therefore, the project risk index for each project was grouped into five classifications from very low risk (1 to 5) to very high risk (20 to 25)

Table 1: Analysing 'risk level of time' for a particular building project

Major Risk Categories and Risk Factors	Importance on time (w)	Probability (P)	Impact on time (I)	Risk Level of time (RL)
I. External and Site Condition Risks				
Unforeseen site ground condition	0.0174	2	1	0.0347
Weather condition	0.0293	1	1	0.0293
Difficulty in obtaining permits and ordinances	0.0055	3	2	0.0327
Changes in government actions	0.0031	1	1	0.0031
II. Economic and Financial Risks				
High inflation/increased price	0.0429	4	3	0.5144
Delayed payments on contract	0.1356	2	3	0.8134
High interest rate	0.0243	2	3	0.1460
Poor cost control	0.0799	3	3	0.7195
III. Technical and Contractual Risks				
Defective design	0.2905	2	4	2.3241
Design change by owner	0.1333	3	4	1.5995
Inadequately compensated variation order	0.0657	2	4	0.5256
Delay in providing detail drawing	0.0368	3	4	0.4420
IV. Managerial Risks				
Defective construction work	0.0687	2	3	0.4125
Low labour and equipment productivity	0.0200	2	4	0.1603
Inadequate project program	0.0371	2	3	0.2225
Problems with availability of labour, material and equipment	0.0099	2	2	0.0396
Project Risk Index of time (RI)				8.0194 (low risk)

The project risk index of time for this project was 8.0194, as show in the bottom row of table 1, and it was classified in the low risk category.

For the 22 projects surveyed, the project risk indices of time ranged from very low risk (1.07) to high risk (16.62). The majority (59.1%) of the projects surveyed were classified as low risk, with 18.2% classified as medium risk, 13.6% as very low risk and the rest of them (9.1%) categorised as high risk. None of them were in the very high risk category.

To determine the most critical risk factors affecting construction time for all projects surveyed, as perceived by the building contractors, descriptive statistics of the mean (the average of all risk levels of each risk factor in all projects surveyed) were used. The mean of each risk factor affecting project time for the 16 risk factors are shown in table 2. Clearly, the higher the mean value of the risk factor, the more critical it is perceived by the contractors. These values were then used to rank the most critical risk factors affecting project time as shown in the right-hand column of table 2.

The top-5 critical risk factors affecting project time in order of importance were thus:

- high inflation/ increased price,
- design change by owner,
- defective design,
- weather condition,
- delayed payments on contract.

Table 2: Mean of risk factors affecting project time and cost and their ranking

Major risk categories and risk factors	Affecting project time		Affecting project cost	
	Mean of risk factor	ranking	Mean of risk factor	ranking
External & site condition risks				
Unforeseen site ground condition	0.4191	7	0.4470	7
Weather condition	0.6979	4	0.3914	8
Difficult in obtaining permits and ordinances	0.0918	15	0.0628	16
Changes in government actions	0.0627	16	0.0841	15
Economic & financial risks				
High inflation/ increased price	1.4552	1	2.7453	1
Delayed payments on contract	0.5509	5	0.7393	4
High interest rate	0.2142	14	0.2621	14
Poor cost control	0.3774	10	0.5222	6
Technical and contractual risks				
Defective design	1.1932	3	0.9632	2
Design change by owner	1.2147	2	0.9067	3
Inadequately compensated variation order	0.3060	13	0.3912	9
Delay in providing detail drawing	0.4138	8	0.2967	11
Managerial risk				
Defective construction work	0.3649	11	0.5447	5
Low labour and equipment productivity	0.3288	12	0.2660	12
Inadequate project program	0.3781	9	0.2654	13
Problems with availability of labour, material and equipment	0.5266	6	0.3477	10

The same approach was applied to determine the project risk index of cost and these values for the projects ranged from very low risk (1.15) to high risk (18.50). Half (50%) of the projects were categorised as low risk, with 27.3% categorised as medium risk, 13.6% were categorised as very low risk and the rest (9.1%) were classified as high risk. Again, none of them was in the very high risk category.

Using the same procedure, high inflation/ increased price, defective design, design change by owner, delayed payments on contract and defective construction work were perceived as the most critical risk factors, in descending order, in terms of project cost.

DISCUSSION OF THE RESULTS

It can be seen that the most critical risk factors affecting project time, as perceived by contractors, were similar to those affecting construction cost. High inflation/ increased price was perceived as the top rank risk factor affecting both project time and cost. Design change by owner and defective design were assessed as the second and third most important factors affecting project time respectively, but were in third and second place respectively when their impact on project cost was considered. For delayed payments on contract, this was ranked in the fifth position with respect to project time and in forth position for project cost. The two risk factors that were not identified in the top-5 critical risk factors affecting both project time and project cost were weather condition (4^{th} position for time) and defective construction work (5^{th} position for cost).

The critical risk factors affecting project time and cost identified in this work were similar to the findings of other surveys conducted in several developing countries. In Indonesia, the findings from the survey conducted by Kaming *et al.* (1997) on high-rise building projects showed that increased material cost and inaccurate material estimation were the factors most affecting project cost overrun, whereas, design change and low labour productivity were identified as the factors most causing project delay. Another survey conducted by Al-Momani (2000) in Jordan identified the same findings as this study that a total of 106 from 130 projects surveyed were delayed and found that poor design, change orders, and weather conditions were perceived as the factors most causing project delay. Similarly, the problem of payment for completed work was found to be the highest ranking factor causing time overrun in Nigerian construction industries (Elinwa and Joshua 2001). In Ghana, the critical factors causing project delay and cost overrun were found by Frimpong *et al.* (2003) to include difficulty in obtaining monthly payments and material price escalation.

Based on the information obtained from the subsequent interviews with project managers, the most critical risk factors affecting project time and cost identified by this study will now be discussed:

High inflation/ increased price

High inflation/ increased price was recognised as the top critical risk factor affecting both project time and cost. On the projects surveyed, the prices of steel, aluminium, multiplex and timber had increased dramatically over a few months. These materials are commonly used in building projects, indeed, steel, multiplex and timber are intensively used at the early stage of such projects in the form of reinforcing bars and formwork for the building structure. As indicated, most of the construction projects were in the early stages, and consequently, most of them were affected by these unwelcome effects. These materials are also used to a lesser intent for finishing components, so other contracts, which were surveyed in the middle and final stages of construction, were inevitably influenced by this impact.

For these materials, based on the information obtained from the project managers interviewed, most of the contractors had contracts with variable prices with their suppliers. Contractors who had such contracts would typically attempt to find other suppliers who sold these materials at a lower price or renegotiate with their suppliers to get a more reasonable price. This response would not fully solve the problem of increased costs, and would also cause project delays as a result of renegotiation.

Design change by owner

In this study, design changes by the owner were identified as the most frequently occurring problems on commercial projects, including shopping centres, offices, and hotels. In all of these cases, the commercial projects were financed by the private sectors.

Based on the interviews with project managers, almost all of the design changes were made to meet owners' requirement, customers' demand, and marketing purposes to increase sales. An extreme example was an initial building that was designed as a shopping centre and changed to be a plaza and tower building, which was a combination of shopping centre and office. A few of the projects surveyed were changed in lay out and façade, with the intention to meet market demand and change building appearance to boost sales. Most of the projects had their specifications changed to meet customers' and tenants' requests. These facts are reflected in a study by Ogunlana *et al.* (1996) who found that more variation orders were likely to occur on projects funded by the private sector.

The contractors said that design changes by the owner caused lost time in preparing amended drawings and waiting for shop drawing approval; these would consequently cause inefficiency in labour and equipment productivity and finally these multiple effects would lead to construction delays. They also said that when the shop drawings of design changes were approved, contractors were expected to work at accelerated speeds. These changes might also lead to changes in the sequence of works or even cause rework. As a result, these situations would cause project cost overrun. Similar results were also found by the surveys carried out by Hanna *et al.* (1999), Hanna *et al.* (2002) and Moselhi *et al.* (2002).

The findings of this study were supported by the results of the survey conducted by Cox *et al.* (1999), which identified that variation orders would cause cost overruns in the range 5% to 8% from the original contract prices. Stocks and Singh (1999) concluded that owners' involvement in the design phase would reduce the number of variation orders affecting cost overrun. They found that cost overrun due to variation orders ranged from 2.2% when owners had been involved in the design phase to 18.30% if owners had less involvement. Hanna *et al.* (1999) conducted a similar work on 61 projects in the U.S, and found that the extension of time required to complete the projects, which were covered by many variation orders, were four times longer than the projects without variations. Similarly, Koushki *et al.* (2005) found that variation orders had a significant impact on project delay, and they also noted that the greater the number of variation orders requested by owners, the more the impacts on construction cost overrun and delay would be.

Defective design

According to the project managers interviewed, discrepancies on dimensions and/or the position of the structural, architectural, mechanical, electrical, ventilation, air-conditioning, plumbing and other systems commonly occurred in the construction drawings. Moreover, inconsistency between specifications and drawings also occasionally appeared. These were the most frequent problems perceived by contractors resulting from defective design. They were thought to have probably arisen because of lack of coordination between designers and lack of supervision among draftsmen in the design phase.

In this study, if the contractors found discrepancies between the various construction drawings and specifications, they asked the designer to solve these problems. However, this procedure would take time waiting for responses from the designers. The contractors preferred to provide more draftsmen to identify discrepancies in the drawings and to propose their own detailed drawings. These still required time to coordinate with the main designers. In addition, they said that defective design may cause rework, and consequently these conditions could lead to cost overruns.

These findings were confirmed by the work of Ogunlana *et al.* (1996) which showed that most project delay (on 75% of the projects studied) was caused by incomplete design. Moreover, it was found that unqualified or shortages of personnel involved in project design due to work overload in the firm designing the project were recognised as the most important reasons causing defective construction drawings. Santoso *et al.* (2003) added that in Indonesia, the limited design fee allocated by the owner would cause the designer to provide an incomplete design.

Delayed payments on contract

In this survey, a considerable number of contractors had difficulties obtaining regular progress payment from the owners. This problem was also faced on construction projects in Ghana, where the most critical problem faced by contractors was monthly payment difficulties for the completed work (Frimpong *et al.* (2003).

As has already been mentioned, most of the projects were classified as commercial building projects and were financed by the private sector. Most of the funds to finance the projects would likely be borrowed from banks, with the remaining funds earned when the projects were partially sold out or rented in advance. According to Santoso *et al.* (2003), owners will manage their cash flow effectively by minimising cash out and maximising cash in when funds are borrowed from banks. If they fail to generate funds, they will postpone project progress payment to the contractors to minimise cash out.

Several of the projects studied had bad experiences on delayed payments, especially for the commercial projects funded by the private sector. According to the contractors surveyed, delayed progress payments would affect their project's cash flow as a result of delayed income. Contractors usually have limited capital for executing a project and when the capital provided is exceeded, consequently, the contractors may postpone payments to subcontractors and suppliers. As a result, they will also reduce their performance. These multiple problems will eventually cause construction delays.

Weather condition

Located along the equator, Indonesia has two seasons, “wet” and “dry”. Normally, the “wet” season is between October to March, when the survey was conducted and the “dry” session is between April to September. In the wet session, heavy rain is a common occurrence.

As reported earlier, most of the projects surveyed were in the early stages and this means that the works being undertaken were foundation work or construction of the building structure. Such activities would undoubtedly be affected by rain. Project managers whose buildings included basements said that their basements were flooded and they needed extra time and equipment to dewater them. Most of the concreting works for the structures were also affected by heavy rain and occasionally, concreting was postponed.

Another impact of weather was that rivers with sand quarries were flooded and affecting the availability of sand. This also resulted in the bad quality of sand because too much mud was blended in with the sand. This situation would inevitably cause a shortage of sand in the local market stock, and lead to construction delays.

Defective construction work

According to the project managers interviewed, defective works were caused by unskilled labour, lack of supervision, changes in design, incorrect construction methods and unordered sequences of work. These defective works required extra budgets to complete or repair them. Clearly, this factor would cause construction cost overrun. This finding was supported by a survey conducted by Love and Li (2000) which found that rework in construction projects caused 2.40% to 3.15% extra costs above the initial contract price.

Most of the rework can be done alongside the main schedule without impeding it and this may be why defective construction work was seen as an important factor when considering cost, but not when considering time.

CONCLUSIONS

The survey conducted on the 22 building projects showed that the most critical risk factors affecting both project time and cost were similar. They were: high inflation/ increased price, design change by owner, defective design, delayed payments on contract, weather condition and defective construction work. Most of these risk factors cannot be controlled or managed by the contractors and yet contractors working on most Indonesian construction contracts will be expected to accept the risks relating to inflation, delayed payments, defective construction work and to take some responsibility for adverse weather conditions. Quite what risks a contractor working in Indonesia will have to accept, however, it is not easy to say, as different owners adopt their own contract forms. It would be clearly be wise for any contractor working in this are to check how these most important risks are apportioned for contracts on which he intends to bid.

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