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CASH FLOW FORECASTING IN INTERNATIONAL CONSTRUCTION PROJECTS THROUGH FINANCIAL AND PROJECT RISK ANALYSIS

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Abstract
Construction firms have endeavored to forecast project cash flow at the initial stage of a project that quite relates to the payment contract terms and their financing schedules such that the cash borrowed and the final net-profits can be accurately measured. There are, however, diverse risk factors influencing project cash flow, especially in case of international projects that are often confounded by external as well as internal uncertainties. In this research, risk factors that can affect the cash flow are classified into two categories; financial risks and project characteristic risks. The former that is derived from the external economic conditions such as exchange rate, cost escalation, interest rates is analyzed through the stochastic method with the support of Monte-Carlo Simulation. Then, the project characteristic risks such as project-specific condition, weather and climate, resource delivery conditions are evaluated through the utility curves to represent the personal risk attitudes because the people are inclined to respond differently to the same risk amounts based on their risk perceptions. As a validation purpose, the results of cash flow forecasting conducted by the proposed algorithm are compared with the actual project cash flow. Through the proposed approach, construction firms are expected to better decide the optimum level of cash contingency and to foresight the probable net-cash at completion in more accurate and practical way.

Keywords
International Construction, Risk Analysis, Risk Attitude, Cash flow, Contingency

1. Introduction

It is an essential procedure to review the soundness of business feasibility and profitability with an analysis on the expected cash flow at the stages of project planning. Especially, in case of international construction projects that encompass different political, economic, and cultural features, the reliable and accurate prediction on the business feasibility has an important meaning to successfully perform the project and secure the profit. This study proposes a method to forecast a project cashflow close to the real outcome and takes the risk response attitude into account, which represents different disposition to the severity of various kinds of risks that may occur during execution of international construction projects.

Based on the prediction of a cash flow, a method to estimate the adequate cash contingency is also proposed from the contractors' viewpoints. To accomplish this objective, this study begins with the comparison of risk-free cash flow with those fluctuated by financial variables that affect the project cash flow to identify any variation of the whole project cash flow. Beyond the impact of the financial variables, it is important to include other risks related to increase of cash such as project specific condition, weather, geographical location, resource delivery conditions. An affect of these project-driven characteristic risks is analyzed and applied to the cash flow so as to determine the degree of impact and any probable deterioration to the stability of cash flow. Finally, this study presents the framework to estimate the differential contingencies upon the degree of risks on a basis of the project scale and personal risk attitude of the decision maker.

2. Risk Analysis of the Project Cash flow

2.1 Risk-free Cash flow

In general, the construction companies have acquired the expected progress curve from the firm's cash management program and experiences of similar projects at the planning stage. They usually forecast the cash flow based on the progress curve of a project by reflecting the fixed variables such as advanced payment ratio and retention ratio described in the contract terms. In addition, they evaluate the financial feasibility through investigating the traditional practice of cash-in from the owner and cash-out by the contractor. In this process, time lags in accordance with the contractual payment conditions and credit times given by suppliers or venders have great impact on the shape of cash flow. This paper defines the risk-free cash flow upon the assumption that the project is completed as initially planned; thereby it normally excludes the impact out of contractor's controllability. Figure 1 illustrates the whole procedures of risk analysis proposed by this study.

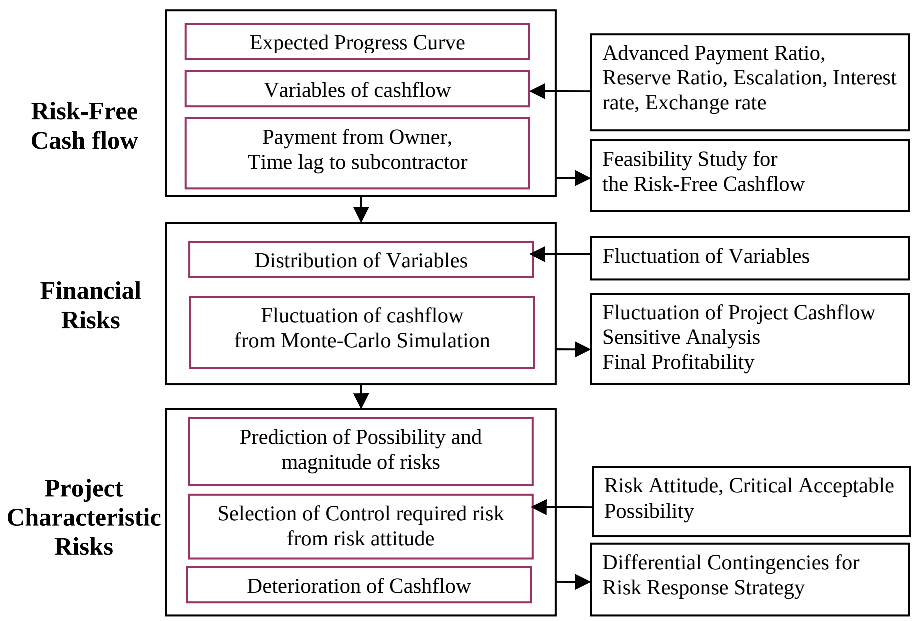

Figure 1: Risk Analysis Procedure

Table 1 summarizes the variables influencing a project cash flow, specifically for an actual case used in this study. This case project is an electric power plant project in Brazil accomplished by one of the Korean construction companies. The risk-free cash flow, as shown in Figure 2, is generated from the financing plan submitted to the commercial bank in order to get the performance bond at the time of bid acceptance. The construction company had estimated that they would earn 8 % of profit as to the whole contract amount, US$ 11,856,000. This final profit was presumed to be based on the risk-free cash flow without any reflection of probabilistic variable such as price, exchange rate, and interest rate (discount rate).

Table 1: Deterministic Variables Influencing Cash flow

Contract Amount (US$)	148,208,000	**Construction Duration**	34 Months (1999 ~ 2003)
Budget (92%)	136,352,000	**Initially Expected Final Profit (US$)**	11,856,000(8%)
Time Lag of Payment(Month)	1	**Tax Rate**	Involved in Management expenses (1%)
Exchange Rate (US$/Real)	1.825	**Partial Payment Plan Of Advanced Payment**	At once in the first month
Escalation	Only applied to local currency	**Retention Ratio**	5 %
Ratio of Advanced Payment	13.7%	**Limitation of Retention**	To the end of construction

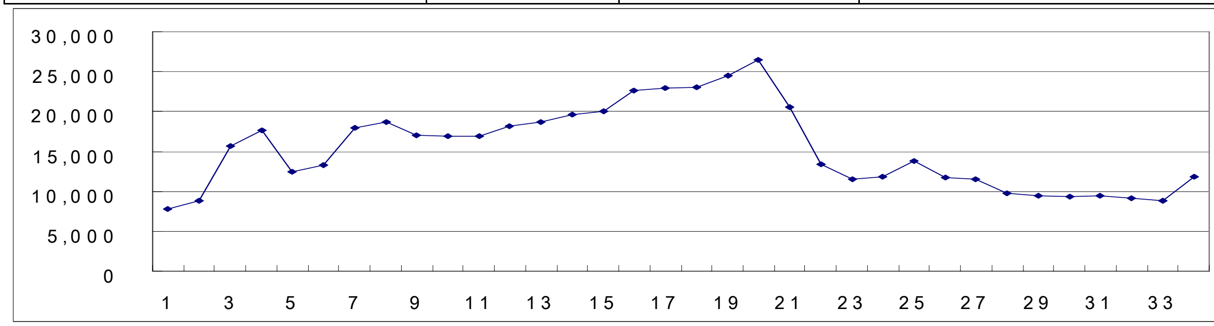

Figure 2: Risk-Free Cash flow of Case Project

2.2 Financial Risk Analysis

Since it is clearly stated in the contract terms that the escalation could be compensated only for the portion of the local currency (6.3 %), it is impossible to get such a satisfactory compensation against the damages due to the escalation of this case project. However, the material cost has the largest portion of the total cost with around 67 % and is largely influenced by an interest rate. In order to predict the interest rate, this study uses the data estimated by the Central Bank of Brazil.

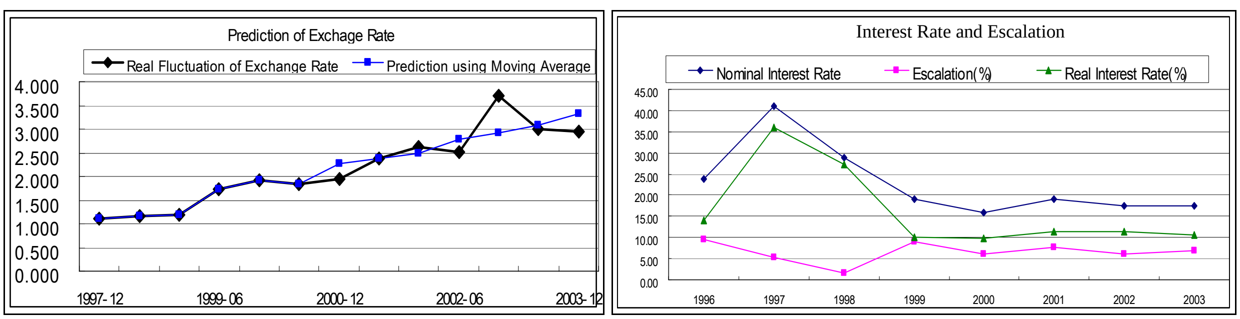

Figure 3: Prediction of Financial Variables

Rather than real interest rate, the nominal interest rate is used because the influence of escalation is separately considered. The nominal interest rate in Brazil as of year 2000 was substantially at the high level with 15.8 % and accordingly, it was assumed that such a high level of interest would be continuously maintained during the exception of a project as predicted by the Central Bank of Brazil (Refer to Fig. 3). The present value of the time of construction planning stage could be discounted tremendously due to a big impact to the cash flow and final profit. The exchange rate had been also rapidly increased during the project period, which produced a bad influence upon the profitability of the local currency portion that occupying 6.3 % of the whole contract payment. On the other hand, such an increase of exchange rate was rather favorable to the profitability since contractor established an expenditure plan to pay costs (i.e., material, outsourcing, labor cost) by 12.4 % of local currency. It makes it possible to appropriate the local construction cost by exchanging dollar into the local currency. The exchange rate during the construction is predicted through the time series analysis from the past 30 months, and its comparison to the real fluctuation is shown on Figure 3.

Table 2: Distribution of Financial Variables

Financial Variables	6 Months.	12 Months	18 Months	24 Months	30 Months	34 Months
Exchange Rate (Std. Variation)	2.275 (10%)	2.389 (10%)	2.491 (15%)	2.784 (15%)	2.929 (20%)	3.087 (20%)
Escalation (Std. Variation)	7.7% (0.77%)		6.0% (0.9%)		7.0% (1.4%)	
Nominal Interest Rate (Std. Variation)	19.10 (0.95%)		17.50 (1.75%)		17.60 (2.64%)	

Table 2 summarizes the forecasts of financial variable's variations and fluctuations. While the exchange rate is predicted every six months, the escalation and interest rate are on the annual base. All of the variables are represented as the probability density function in shape of normal distribution according to an accuracy of the prediction. As a result of the Monte Carlo Simulation, - an application of these distributions of financial risks according to the calculation algorithm of the cash flow - the cashflow has a distribution as shown on Figure 4. As a result, the final profit is reduced to an average of $9,486,140, and the profit rate decreases by 1.6 % ($2,271,000) from 8 % of a risk-free profile (see Table 3).

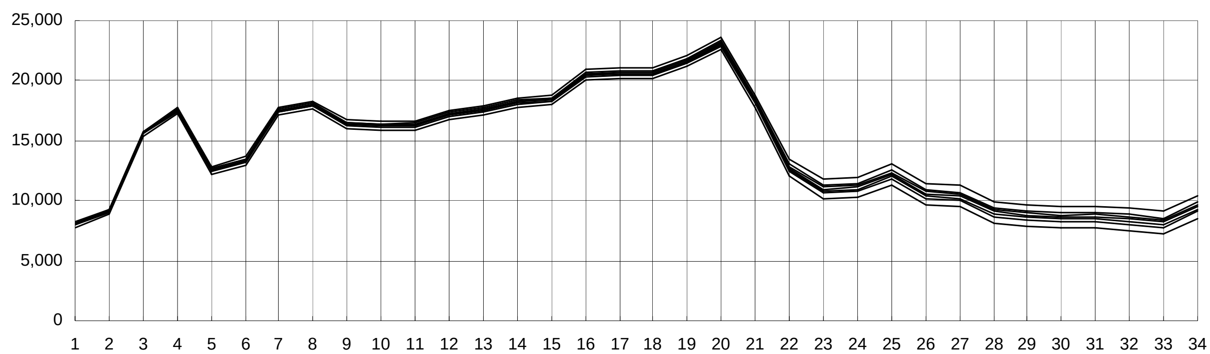

Figure 4: Fluctuation of Cash flow Associate with Financial Risk Analysis

Table 3: Result of Financial Risk Analysis

Index	Final Profit(US$)		Profit Rate(%)	
Mean	9,486,140		6.4%	
Std. Variation	554,127		0.4%	
Distribution	+90%	8,560,347	+90%	5.78%
	mean	9,486,140	mean	6.40%
	-90%	10,354,939	-90%	6.99%

3. Project Characteristic Risk Analysis

The analysis of financial risks takes into consideration only external economic situation and contract particulars. The project characteristic risks are possible factors in relation to the internal features on top of the financial risks. These kinds of risk factors can be identified by expert's estimations in terms of their possibility and amount of loss. While the financial risks are incorporated into cash flow by a mathematical algorithm, the project risks are considered as itemized impacts on individual basis. These losses are finally used to calculate the adequate level of contingency by adding to the result of the financial risk analysis. In this process, risk attitudes should be considered so that the differential thresholds to the risk amounts and reasonable contingencies can be estimated on the basis of the degree of risk.

3.1 Identification of The Project Characteristic Risk

The project risks related to the cost increase of this case are summarized on the Table 4. We identified the project risks - normally cannot be covered by the financial risk analysis, on the basis of the estimations of practical expert groups as well as the individual reports on the probable cost increases. The occurrence possibility of each project risk was predicted using a 7-point same scale.

Table 4: Prediction of Project Characteristic Risk

Risk Prediction	Cost Increase (US$)	Possibility of Occurrence (0~7)	Conversion to (0~100) Scale
Increase of Material Cost	290,000	6	85
Increase of Freight	556,000	7	100
Additional Expenses caused by delayed design	85,000	3	43
Increase of Labor Cost	63,000	4	57
Management Expenses of Branch Office	1,148,000	3	43
Reserved Fund for Warranty	450,000	3	43
Additional Expenses caused by Consortium	225,070	2	29
Additional Expenses Caused by Owner Interference	900,300	4	57
Additional Expenses Caused by Equipment Secure	450,150	5	71

3.2 Selection of Significant Risks for Management

From a contractor's viewpoint, it is more effective to consider the managerial priority of the risks rather than to control all of them, and it is required to consider the recognition of risk attitudes on the severity of the risk impacts. The risk attitude refers to a frame to present the degree of influence on decision making using numerical values that change in the form of nonlinear patterns, and it uses the utility function to represent those curves specifically (Kahnemann and Tversky, 1979).

The utility refers to a degree of influence on the personal judgment against the certain amount of loss (or "degree of worry"). Figure 5 represents a certain shape of the utility curve when the loss increases. The pattern of utility curve shapes psychological features and takes on a different pattern along with the characteristics of the decision maker's or company's perceptions on the risk amounts. The larger the amount of damage, the bigger the magnitude of utility (worry) is. In other cases, if the manager is content to prepare response strategies to any risk along with the expected amount of loss, he/she will consider even a small possibility when the damage amount is significant. For example, the expected damage amount of US$290,000, which is relatively low comparing to other risk factors, the decision maker might not feel any big worry on even a high possibility with 80%. However, in case of a large amount of damage such as US$ 1,148,000, the manager might feel worry from even a low level of possibility such as 20 % and be willing to allocate the contingency for the response strategy to the improbable but high influential risks.

This paper defines the 'Critical Acceptable Possibility (CAP)' as a minimum span to select the meaningful risk variables that are included in the cash flow. Since there is a general tendency to take into consideration a small possibility when the amount of loss is large, the CAP curve is likely to be inversely proportionate to the utility curve (figure 5). Accordingly, if a possible utility score is represented in 100 points scale and a magnitude of utility for a loss at L1 is represented U1, it can be noted that he/she has a CAP with a degree of (100 – U1) for a loss of L1. Stated another way, if a probability of a ‘R1’ risk that causes ‘L1’ loss has larger CAP than (100-U1), the ‘R1’ risk is to be selected as a management/control target to evaluate the consequential impacts on the cash flow and to make a response strategy required to mitigate the risk damages.

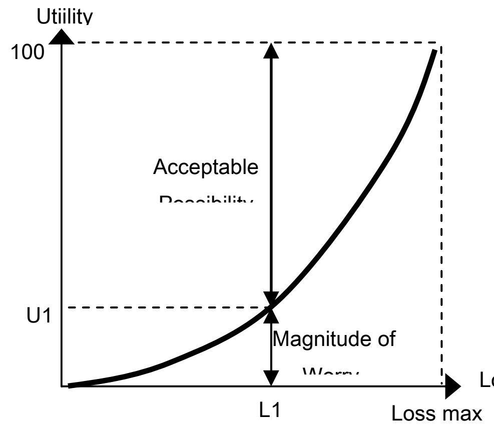

Figure 5: Concept of Critical Acceptable Possibility

The proposed method can effectively reflect the decision maker’s risk attitude. For example, when construction firm has risk-taking attitude, it is natural for a decision maker not to take into consideration some of the risks that have low possibility or low magnitude of loss. On the other hand, when the decision maker has risk-avoid attitude, he/she intends to control more risk zones (I to VI in Figure 6) with more care and attention.

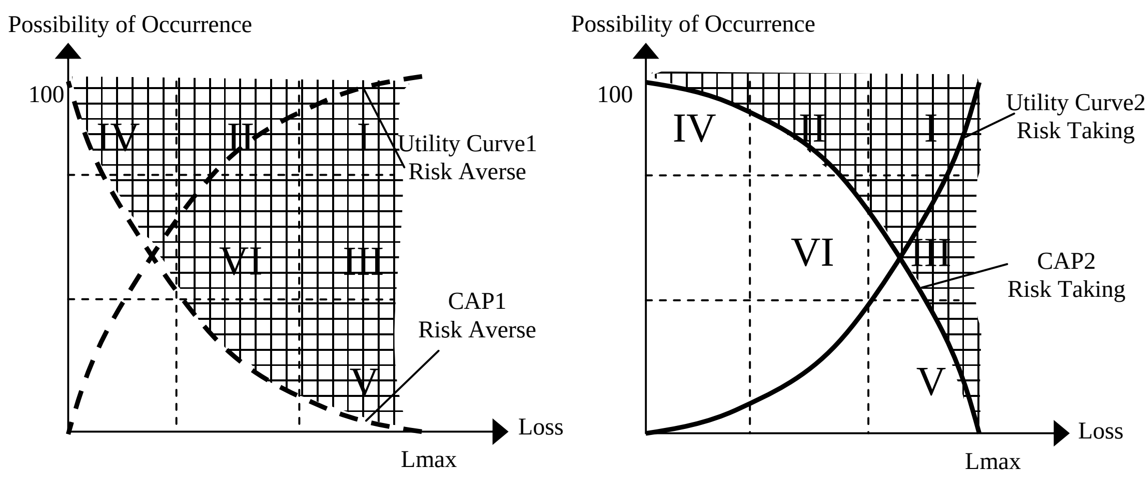

Figure 6: Different Risk Thresholds According to Risk Attitudes

Because the case project was the first experience performed in Brazil, it is assumed that the company has risk-avoid attitude that gives a big worry about a risk with less loss. Figure 7 illustrates a CAP curve obtained from risk-avoid utility curve and the characteristics of each project risk. As a result, six risk factors out of total nine project risks that are positioning on the higher range than CPA curve are considered being essential risks to be incorporated into the cash flow forecasting.

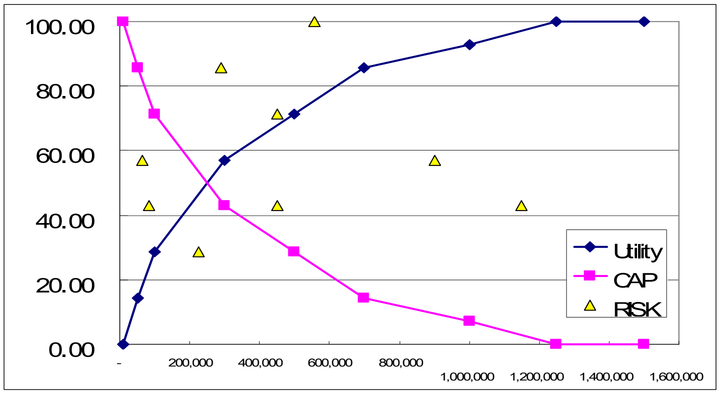

Figure 7: Selection of Significant Risks for Management in Case Project

3.3 Application to the Cash flow

It is possible to predict the final profitability by applying the amount of loss and possibility of the selected risks to the cash flow. However, an existing analysis method using the expected monetary value (EVM) calculated by [probability × cost magnitude] is not reasonable for the construction project because it is often not possible to estimate the statistical objective probability of risks through accumulation of the historical data due to the unique characteristics of construction work. Rather, it is more practical to use a meaning of possibility for the risk factors upon subjective judgment of the responsible experts. In addition, if it once occurred, this type of risk deteriorates the cash flow that was initially predicted regardless of the probability. Stated another way, in the sense of cash management, whole increase of cost from a specific risk should add to the negative cash side rather than does a portion of cost increase multiplied by its probability.

In order to address this problem, this study applies a method to distribute the amount of loss to the cost accounts relate to the risk. For example, the increases of material cost and transportation cost have a strong relation to the supply and demand of materials, so such predicted amount of loss of the risk is distributed to the monthly expenditure schedule for material cost. Based on the proposed approach, this study calculates the present value at the initial stage of a project to analyze the project feasibility including the additional expenses due to the risks. This tool makes it possible to forecast the final cashflow curve as shown on Figure 8. Table 5 also shows the deviation of a profit rate due to this negative effect to the cash flow.

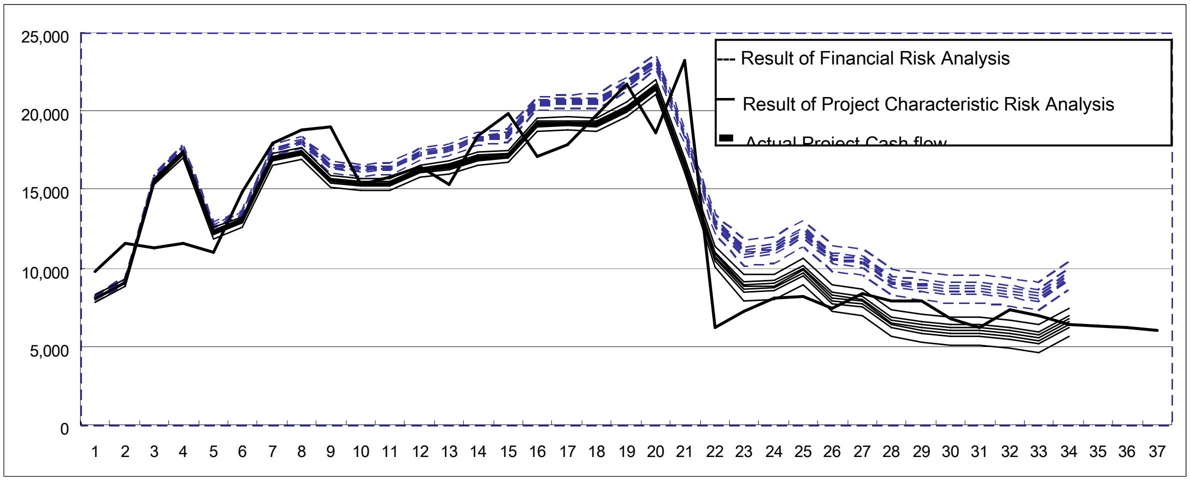

Figure 8: Comparison between Cash flow Forecasting and Actual Outcome

Table 5: Result of Project Characteristic Risk Analysis

Index	Estimated Final Profit (US$)		Profit Rate (%)	
Mean	6,544,434		4.42%	
Std. Variation	573,377		0.4%	
Distribution	+90%	5,618,642	+90%	3.79%
	mean	6,544,434	mean	4.42%
	-90%	7,413,233	-90%	5.00%

3.4 Comparison with actual outcome

Even though the project was initially planned to complete within 34 months, its completion was extended by 2 months due to a delay in site handover. The actually-earned profit was reported to be 4.06 % of the total contract amount, showing a small difference from 4.42% that was estimated through a financial as well as characterized project risks. Since the difference is occurred mainly from the delay of a completion due to the unforeseeable fire accident which was beyond the liability of contractors. If it would be compensated, the variation could be additionally reduced.

4. Summary and Conclusion

This study analyzed the risks influencing on the project cash flow by categorizing those risks into the financial risks that stems from fluctuation of the external economic circumstances and the project-related risks that internally generated from the unique characteristics surrounding a project. Additionally, this study proposed the method designed for calculation of differential contingencies along with the marginal degree of risk tolerances by reflecting the firm's risk attitude, Through the proposed algorithm, construction firms are expected to better decide the optimum level of cash contingency and to foresight the probable net profit in more accurate and practical way.

However, the evaluation of the risk occurrences and selection of prioritized risks targeting for management are still based on the subjective and psychological judgments. Future researches will concentrate on developing more effective cash flow management system with a well-founded prediction rationale for the possibility of risks and their expected damages. Also, more CPA cases will be surveyed on the basis of various financial situations and strategies of the company as a practical guideline to address the issues of risk attitudes in cash flow management.

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