Developing of Construction Project Risk Analysis Framework by Claim Payout and its Application

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Abstract: The growing size and complex process in construction project recently leads to increase risk and the losses as well. Even though researchers have identified the major risk indicators, there is lack of comprehensive and quantitative research for identifying the relationship between the risk indicators and economic losses associated with construction projects. To address this shortage of research, this study defines risk indicators and create a framework to assess the influence of economic losses from the indicators. An insurance company's claim payout record was accepted as the dependent variable to reflect the real economic losses. Based on the claims, we categorized the causes and results of accidents. To establish framework, built environment vulnerability indicators and geographical vulnerability indicators were employed as the risk indicators. A Pearson correlation analysis was adopted to validate the relationship with loss ratio and risk indicators. Consequently, this framework and its results may offer significant references for under writers of insurance companies and loss prevention activities.

Keywords: Loss Prediction Model / Building Construction / Risk Indicator / Claim Payout

I. INTRODUCTION

The rising size and complex process in construction project recently leads to escalate the risk and the losses as well. Although researchers have identified the major risk indicators, there is shortage of comprehensive and quantitative research for identifying the relationship between the risk indicators and economic losses associated with construction projects. To address this shortage of research, this study will define risk indicators and create a framework to assess the influence of economic losses from the indicators.

As shown in Table 1, many studies have been accomplished to analyze the losses and establish frameworks for risk assessment. However, they have not employed real financial loss and several vulnerability classifications, nor have there been a research dealing with multiple construction projects.

Furthermore, major insurance companies have developed risk assessment tools to define and estimate the risk for various type of construction projects. The purpose of the tools are to estimate the risk and decide the premium founded on the risk. For instance, Swiss Reinsurance Company has developed Project Underwriting Management Application (PUMA) and Muinch Reinsurance Company has established Munich Re Engineering Expert Tool (MRET). Nevertheless, the tools are not able to use to define the weight of the risk indicators, since the damage functions are hidden.

Hence, there is a need to fill the gap in the study by establishing a framework to develop risk assessment tools for construction projects.

TABLE 1. Previous studies

Researcher	Contents
Lee (2014)	Developed a mathematical assessment model to estimate near-misses of construction worker
Park (2011)	Established a risk assessment model based on the analysis of risk indicators for bridge construction
Kang et al (2010)	Conducted risk indicators weight analysis for overseas plant projects based on the matrix method
Choi (2010)	Analysed occurrence and cause of accident ink railway construction
Yoo (2010)	Investigated risk indicators for medium small and medium construction projects

II. RESEARCH OBJECTIVES AND METHODS

The objectives of this study are: 1) to make categories regarding cause of the accident and result of accident, 2) to define risk indicators to develop a framework.

Ⅲ. DATA DESCRIPTION

To reveal the financial damage, insured loss payment was employed as the dependent variable. We adopted an insurance company's claim payout record from 1994 year to 2015 year. The amount of claim payments is decided by the inspection of the adjuster and engineer, since the payouts reflect the real economic loss. Hence, the loss payment should be a great source to disclose the financial loss.

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Ⅳ. FRAMEWORK

Based on the analysis of the loss record, we developed the framework. On the basis of the result of the analysis, we made categories to identify the construction project as shown in Table 2. Table 3 and 4 show the category of accident causes and results respectively. The causes of accidents were categorized based on the twelve specific items, including theft, failure of Construction, fire & Explosion, natural hazards (tropical storm, heavy snow & cold wave, lighting, flooding), carelessness of worker, vibration & noise & dust, failure of machine, electric accident, and etc. The results of accidents were classified based on the liability characteristics, which indicate whether the accidents were associated with third party liability, objective liability, and life liability.

Table 5 and 6 describe the dependent variable and the risk indicators individually. The dependent variable, the ratio (KRW/KRW), is the value of the claim payout (KRW) divided by the total sum of insured (KRW). The risk indicators are the risk categories related to geographical location, constructability, project scale, project period, and method of construction.

TABLE 2. Category of construction projects

No.	Category of Construction Project
1	Bridge
2	Harbor
3	Railroad
4	Road
5	Site-Building
6	Tunnel
7	Water related
8	Plant
9	Building

TABLE 3. Category of accident causes

No.	Category of Accident Cause
1	Theft
2	Failure of Construction
3	Fire & Explosion
4	Tropical storm
5	Heavy snow & cold wave
6	Lighting
7	Carelessness of worker
8	Flooding
9	Vibration & Noise & Dust
10	Failure of machine
11	Electric accident
12	Etc.

TABLE 4. Category of accident results

No.	Category of accident results
1	Third party liability
2	Objective liability
3	Life liability

TABLE 5. Description of the dependent variable

Variable Name	Unit	Description
Loss Ratio (Claim Pay out / Total Sum of Insured)	% (KRW/KRW)	Loss ratio of each construction project

TABLE 6. Description of the risk indicators

No.	Risk Category	Risk	Risk Factors	Risk Indicators	Unit
1	Geographical Location	- Wet risk from river and sea - Decline of constructability by physiographic condition - Flooding - Loss of slope	- Condition of location	Location	1~5
				Elevation	m
2	Constructability	- Occurrence of safety accident - Fault construction - Material theft - Increasing of claim from the third party - Fire	- Rank of contract and sales - Safety management Plan - Combustible material treatment	Rank of ENR	
3	Project Scale	- Increasing the complexity	- Risk depend on the project scales	Max. length, width, span length	m
				Total sum of insured	KRW
				No. of floors	
				No. of underground	
4	Project Period	- Increasing the complexity - Construction delay	Project Period	Project Period (Total Months)	Mo.
5	Method of construction	- Risk from the using special construction method -Increasing the construction of difficultly	Structure type	Structure type	

V. VALIDATION

We selected 100 random samples from the payouts and conducted a Pearson correlation analysis to validate the relationship with loss ratio and risk indicators as shown in Table 7. The dependent variable, ratio, was transformed by a natural log. The location, elevation, and no. of underground are the indicators with insignificant relationships with the loss ratio. However, the ENR, ln(TSI), no. of floors, and project period are the indicators with significant relationships with the loss ratio. The ENR have only a positive coefficient; the indicator have a positive correlation with the loss ratio. Whereas the ln(TSI), no. of floors, and project period have negative coefficients; those variables have a negative correlation with the loss ratio.

TABLE 7. Result of Pearson correlation

Pearson Correlation	Ln(Ratio)	
	Coefficient	Sig. (2-tailed)
Location	.183	0.109
Elevation	.025	0.826
ENR	*.227	0.046
Ln(TSI)	**-.619	0.000
No. of Floors	**-.307	0.007
No. of Underground	-.187	0.104
Project Period	*-.233	0.040

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

VI. CONCLUSIONS

Owing to the increasing size and complex process in construction project, the risk and losses of construction projects has been exponentially increased. However, since researchers have mainly identified the major risk indicators, there is lack of comprehensive and quantitative research for identifying the relationship between the risk indicators and economic losses associated with construction projects. To address this lack of research, this research created a framework to assess the influence of economic losses from the indicators. A Pearson correlation analysis was adopted to validate the relationship with loss ratio and risk indicators. We found that the risk indicators, e.g., ENR, ln(TSI), no. of floors, and project period, are the indicators with significant relationships with the loss ratio. Therefore, we would be able to use the significant indicators in the framework.

The framework we established in this study can be utilized by construction companies and insurance companies to analyze the cause and result of accident and loss prevention activities using risk indicators. However, this study only addressed a correlation analysis and framework; therefore, future study should develop a loss prediction model for building constriction risk using statistical analysis based on the indicators and framework.

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