Research some key risk factors in construction

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Abstract. The construction investment project is a collection of activities related to abandonment, expansion or renovation to develop, maintain or improve the quality of work or product or service for a while. One of the main characteristics of a construction investment project is the uncertain environment (potentially high risks). According to the statistics of the Department of State Inspection of Vietnam about the quality of construction works every year, about 0.28% ÷ 0.56% of construction projects have problems. To account for the above issues, there are many reasons related to the investors, designers, contractors, even objective conditions. Therefore, the analysis and giving exact causes of risks are of very high practical significance, and this is also an important basis for devising measures to minimize harm or prevent risks happening. This paper, therefore, attempted to assess the current use of risk management in Vietnam construction projects by an empirical survey. However, within the scope of this paper, the authors conduct a survey to assess some main risk factors, thereby building a relationship between risk management and factors by questionnaires combined with statistical processing methods. At the same time, from a research perspective on risks, it is considered in terms of forecasts and is preventable.

1. Introduction

Risks are unexpected events that cause damage to human life, materiality, health, and life. However, this concept is changed according to the meaning of each object of interest, for example, in different industries and fields, the risk of having different definitions is suitable for their particular properties. From many authors' studies around the world, the concept of risk management can be defined as follows: “Risk management is a process of identifying, evaluating and ranking possible risks. through which effective measures and necessary resources are selected and put into practice to limit, monitor and control the occurrence and / or impacts of events. forecast.” Risk analysis and management are an important part of the decision-making process in construction industry. Construction industry and its clients are widely associated with high degree of risks due to the nature of micro-, meso- and macro-environments particular to construction (Zavadskas et al. 2010a); however, construction industry has poor reputation in coping with risks as many projects fail to meet deadlines and cost targets (Shevchenko et al. 2008).

In the field of Vietnam construction safety, risks are often perceived as negative [1]. A building is considered safe if its actual risk level is within the range of acceptable values. The marginal values of this region are two risk standard values: the risk of standard failure - the value that allows risk for newly constructed buildings; and the risk of damage to the permissible limit - the risk value when the work being exploited is reached, must be repaired and strengthened [2]. But when those risks are over-allowed they will cause a certain impact and many cases of risk will grow to a high level and have a major impact on a project that we often call effective impact of the project, socio-economic efficiency. Understanding the development process of risks will help us to anticipate their effects on project...
efficiency and quickly devise measures to minimize, overcome and prevent before risks develop to the stage. cause impact. In terms of risk management, it is important to consider the following issues:

– the origin of risk context;
– identify and allocate processes (Hanna et al. 2013). This paper of author discusses the risk assessment and allocation model, including its accompanying tools, followed by a legal research discussion that will help parties to better understand construction contracts; and the legal terms that often cause misallocation of risk with severe consequences, [3].
– analyse information (Zavadskas et al. 2010a, 2010b). This paper presents applicability of grey theory techniques for defining the utility of an alternative. A case study of the assessment of contractors’ competitive ability was used to demonstrate the applicability and the effectiveness of the proposed approach, [8].
– analyse the flexibility of results (Jaskowski, Sobotka 2012; Ustinovičius et al. 2010; Kapliński 2008);
– risk assessment and evaluation (Markmann et al. 2013; Skinner et al. 2014). The research of authors concentrates on man-made risks in global supply chains which are particularly uncertain in terms of type, location, and affected supply chain partners and can, therefore, be classified as inherently “wicked” issues. They illustrate that Delphi's research makes a fivefold contribution to risk analysis, [4].
– treatment;
– function or process of risk (Zavadskas et al. 2010a; Kapliński 2009b, 2013). The study of the authors mentions risk assessment of construction projects. The assessment is based on multi-attribute decision-making methods. The risk evaluation attributes are selected taking into consideration the interests and goals of the stakeholders as well as factors that influence the construction process efficiency and real estate value, [6], [7], [8].
– monitoring and communication of risks associated with any activity (Xianbo et al. 2014). This study aims to investigate the resource allocation, effectiveness, impact and understanding of construction PRM in Singapore, [5].

2. Risk factors in construction
2.1. Identify the factors
The impact of risks can be different at each stage of the project and different at work in each phase. Within the scope of the paper, the author only takes into account the overall perspective of the project to consider the factors affected. Based on the results of domestic and international studies [1], [2], [4], the author proposes the risk factors for construction as shown in Table 1 as follows:

| No | Variables | Risks type |
|----|-----------|------------|
| 1  | R1        | Shortage/delay of material supply |
| 2  | R2        | Inaccurate schedule |
| 3  | R3        | The winning price of the project is low |
| 4  | R4        | Site clearance works are slow and asynchronous |
| 5  | R5        | Errors in the experimental work |
| 6  | R6        | Poor performance of contractors |
| 7  | R7        | Poor professional ethics of contractors and supervision consultants |
| 8  | R8        | Construction does not comply with standards and technical processes |
| 9  | R9        | Defective design |
| 10 | R10       | Exchange rate fluctuation and inflation |
| 11 | R11       | Economic depression |
| 12 | R12       | Survey of geological and hydrological are still lacking |
| 13 | R13       | The level and experience of project managers is limited |
| 14 | R14       | Poor competence and productivity of labor |
2.2. Research methodology

The research used a questionnaire to evaluate the risk in the construction industry in Vietnam. The questionnaire-based survey was used as the main source of data collection. The questionnaire was prepared following a thorough literature review and in-depth interviews with experienced professionals in this industry for questionnaire finalization.

The authors then prepared the questionnaire using the Likert-type scale with five points. Respondents were required to use the Likert Scale (1–5) to indicate their perception of the significance of each risk: “1” for the lowest significance and “5” for the highest risk significance. The questionnaires are distributed to 500 respondents in some major corporations in Vietnam, as results received about 200 valid feedbacks from contractors, clients. The results were tallied, tabulated and treated statistically. Finally, the results were interpreted and the findings and conclusions were drawn.

3. Reliability Analysis

To test the reliability of each research paradigm in the model as measured by established observable variables, it is necessary to use the Cronbach Alpha and coefficients of total variables. The results from the data collected for each research concept are as follows:

It can be seen in Table 2 that 24 dependent variables in the study that ensure reliability and relevance. Based on standard analysis of Alpha Cronbach coefficient, in which > 0.7 is an acceptable result with new studies.

|   |   |   |
|---|---|---|
| 15 | R15 | Poor quality of material and equipment |
| 16 | R16 | Change government policies and regulations |
| 17 | R17 | Funding problem for projects |
| 18 | R18 | Payment delays |
| 19 | R19 | Construction organization methods are not guaranteed |
| 20 | R20 | Delays due to disputes with contractor |
| 21 | R21 | Unforeseen site conditions |
| 22 | R22 | Accidents/safety |
| 23 | R23 | Inaccurate estimation of quantities of work |
| 24 | R24 | Natural disasters |

Table 2. Reliability Analysis

| Case Processing Summary | N   | %  |
|-------------------------|-----|----|
| Cases                   | Valid | 199 | 99.5 |
|                         | Excluded<sup>a</sup> | 1 | .5 |
|                         | Total | 200 | 100.0 |

<sup>a</sup> Listwise deletion based on all variables in the procedure.

Reliability Statistics

| Cronbach's Alpha | N of Items |
|------------------|-----------|
| .726             | 24        |
4. Exploratory Factor Analysis

EFA is intended to help reduce the number of observation variables to less variables that still contain the main information of the entire dataset. Because factor analysis is a technique of interdependent analysis, there is no distinction between dependent and independent variables. Thus, this study conducted a factorial analysis with independent variable variables at the same time and the variables of the dependent variable. Analysis results are as follows:

4.1. EFA of dependent variable factors

The analysis results for the "Technical risk" dependent variable from the research data show that the KMO coefficient is greater than 0.5 (0.777), Bartlett's test has p-value less than 0.05 (0.000), large eigenvalue More than 1, the factor loading factor is greater than 0.5, the explanatory variance is greater than 50% (68.843%), the observed variables converge on a single factor as seen in Table 3. This shows that using factor analysis is appropriate, the dependent variable "RM" is a one-way scale.

**Table 3. EFA of the dependent variable factor**

| KMO and Bartlett's Test |       |       |       |       |
|-------------------------|-------|-------|-------|-------|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | .777  |       |       |       |
| Bartlett's Test of Sphericity |       | 3599.683 |       |       |
| Approx. Chi-Square df Sig. |       | 276   | 0.000 |       |

**Rotated Component Matrix**

| Component |       |       |       |       |
|-----------|-------|-------|-------|-------|
| R9        | .982  |       |       |       |
| R18       | .940  |       |       |       |
| R17       | .925  |       |       |       |
| R6        | .899  |       |       |       |
| R1        | .875  |       |       |       |
| R4        | .685  |       |       |       |
| R5        | .669  |       |       |       |
| R22       | .635  |       |       |       |
| R3        |       | .918  |       |       |
| R11       |       | .905  |       |       |
| R7        |       | .900  |       |       |
| R19       |       |       | .776  |       |
| R14       |       |       | .750  |       |
| R20       |       |       | .715  |       |
| R8        |       |       | .584  |       |
| R21       |       |       |       | .766  |
| R24       |       |       |       |       | .790  |
| R16       |       |       |       |       |       | .749  |
| R12       |       |       |       |       |       | .712  |
| R10       |       |       |       |       |       | .780  |
| R2        |       |       |       |       |       | .702  |
| R15       |       |       |       |       |       | .649  |
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 6 iterations.

4.2. Research model

From table 3, classify risk factors into 6 risk groups, as follows:

\[
\begin{align*}
\text{RG}_1 &= \text{mean (R9, R18, R17, R6, R1, R4, R5, R22)}; \\
\text{RG}_2 &= \text{mean (R3, R11, R7)}; \\
\text{RG}_3 &= \text{mean (R19, R14, R20, R8)}; \\
\text{RG}_4 &= \text{mean (R21, R16, R12)}; \\
\text{RG}_5 &= \text{mean (R10, R2, R15)}; \\
\text{RG}_6 &= \text{mean (R24, R23, R13)};
\end{align*}
\]

Risk management (RM) is a dependent variable that is assessed by those risk groups namely RG1, RG2, RG3, RG4, RG5, and RG6. Based on the study of influencing 6 risk groups, the author constructed the evaluation model as follows Fig.1:

![Figure 1. Research Model](image)

5. Analysis of correlations, regressions and test hypotheses

5.1. Correlation analysis

A correlational analysis is an analytical technique that shows the relationship between researched variables. If the correlation coefficient differs from 0, it shows that the research concepts have a real relationship, the positive correlation coefficient reflects the correlation and the negative correlation coefficient and the negative correlation reflects the opposite relationship, the correlation coefficient is in the range \(0 \leq |r| \leq 1\). The results get the correlation between researched variables in the range (Table 4). Verification of research hypotheses was performed at a 95% confidence level.

|          | RM     | RG1   | RG2   | RG3   | RG4   | RG5   | RG6   |
|----------|--------|-------|-------|-------|-------|-------|-------|
| RM       | 1      | .967""| .024  | .031  | -.003 | -.025 | -.030 |
| Correlation Sig. (2-tailed) | .000  | .736  | .663  | .962  | .721  | .674  |
| N        | 200    | 200   | 200   | 200   | 200   | 200   | 200   |
5.2. Overall regression analysis

The correlation analysis only shows that the variables can be related to each other without indicating the causal relationship between them. Theoretically, we know that the main risks influence the quality of construction. In other words, we view them as causal variables (independent variables) and the risk management is the result variable (dependent variable).

Overall regression function:

\[ RM = \beta_0 + \beta_1 RG_1 + \beta_2 RG_2 + \beta_3 RG_3 + \beta_4 RG_4 + \beta_5 RG_5 + \beta_6 RG_6 \] (1)

By using the least squares (OLS) to determine the regression coefficient \(\beta_i\). Validate the fit of the model using Adjusted R Square to determine the model's explanatory power in practice.

Running the model with SPSS software to get results analysis shown as Table 5:
Table 5. Regression analysis

| Model | R   | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-----|----------|-------------------|---------------------------|
| 1     | .670<sup>a</sup> | .942     | .940              | .166                      |

a. Predictors: (Constant), RG6, RG1, RG3, RG5, RG2, RG4

b. Dependent Variable: RM

ANOVA<sup>a</sup>

| Model | Sum of Squares | df | Mean Square | F       | Sig. |
|-------|----------------|----|-------------|---------|------|
| 1     | Regression     | 6  | 14.417      | 520.711 | .006<sup>b</sup> |
|       | Residual       | 193 | .028        |         |      |
|       | Total          | 199 |             |         |      |

a. Dependent Variable: RM

b. Predictors: (Constant), RG6, RG1, RG3, RG5, RG2, RG4

Coefficients<sup>a</sup>

| Model | Unstandardized Coefficients | Standardized Coefficients | t     | Sig. | Collinearity Statistics |
|-------|------------------------------|----------------------------|-------|------|-------------------------|
|       |                              |                            |       |      | Tolerance | VIF |
| 1     | (Constant)                  |                            |       |      | -3.844     | .000 |
|       | RG1                         | -.721                      | .197  |      | -3.844     | .000 |
|       | RG2                         | 1.146                      | .021  |      | 55.770     | .000 |
|       | RG3                         | .107                       | .027  |      | 3.957      | .000 |
|       | RG4                         | .024                       | .024  |      | .015       | .951 |
|       | RG5                         | -.085                      | .029  |      | -.034      | .265 |
|       | RG6                         | -.036                      | .025  |      | -1.424     | .156 |

According to Table 5, Sig. The coefficients β<sub>3</sub>, β<sub>4</sub>, β<sub>6</sub> are higher than the 5% significance level; meaning that these groups (RG<sub>3</sub>, RG<sub>4</sub>, RG<sub>6</sub>) do not affect much the quality of construction due to not statistical significance in this study. So these variables can be ignored. Otherwise, we can be seen Sig. of RG<sub>1</sub>, RG<sub>2</sub>, and RG<sub>5</sub> are less than the 5% significance level, the coefficients β<sub>1</sub>, β<sub>2</sub>, β<sub>5</sub> are statistically significant, meaning that three risk groups (RG<sub>1</sub>, RG<sub>2</sub>, RG<sub>5</sub>) affect the RM. Besides, the VIF index of almost variables is less than 7, which means not happening multi-collinearity.

- Validation of the regression function: due to Sig. (F) <0.05, so the regression function is appropriate. Regression equation using Beta Coefficients:

\[
RM = 0.969RG_1 + 0.77RG_2 - 0.44RG_5
\]

From (2) there are only three factors that affect RM (statistically significant at 5%) including GR<sub>1</sub>, GR<sub>2</sub> and NR<sub>s</sub>, while 3 variables GR<sub>3</sub>, GR<sub>4</sub>, GR<sub>6</sub> do not make an affect.

6. Discussion

Firstly, the risk management mentioned is considered in terms of impact on the construction project including 24 main impact factors detailed in Table 1. After evaluating the survey, 14 factors were
divided into 6 groups to build a relationship function with risk management variables, but only three risk groups affect, which is statistically significant.

Secondly, the study also showed that factors influencing risk management had different levels of influence. The RG1 including 8 factors is the group with the most influence, namely from equation (2) when $\beta_1 = 0.969$, means that when other factors are constant, when the RG1 increases 1%, the RM increases 0.97 and vice versa. Besides, in the RG1 group with the risk index (RI) detailed in Table 6, most of the factors are quite influential because the RI of all factors is high ranging from 3.79 - 4.21, especially the two factors R6 and R17 keep the largest risk influence in construction.

Table 6. Risk Index of RG1

| No | Risks type                      | RI  |
|----|--------------------------------|-----|
| 1  | Defective design               | R9  | 4.12 |
| 2  | Payment delays                 | R18 | 4.07 |
| 3  | Funding problem for projects   | R17 | 4.19 |
| 4  | Poor performance of contractors| R6  | 4.21 |
| 5  | Shortage/delay of material supply| R1  | 4.10 |
| 6  | Site clearance works are slow and asynchronous | R4  | 4.09 |
| 7  | Financial capacity of the contractor is not guaranteed | R5  | 4.01 |
| 8  | Accidents/safety               | R22 | 3.79 |

The RG2 including 3 factors is the group with the second influence, namely from equation (2) when $\beta_2 = 0.77$, means that when other factors are constant, when the RG2 increases 1%, the RM increases 0.77 and vice versa. Furthermore, all three factors have a risk index ranging from 3.62-3.63, the risk index of all factors are quite high, especially the two factors R3 and R7 have the same risk index (Table 7).

Table 7. Risk Index of RG2

| No | Risks type                              | RI  |
|----|----------------------------------------|-----|
| 1  | R3                                     | 3.63|
| 2  | The winning price of the project is low | R11 | 3.62|
| 3  | Poor professional ethics of contractors and supervision consultants | R7  | 3.63|
The RG5 also including 3 factors is the group with the third influence, namely from equation (2) when \( \beta_6 = -0.44 \) means that when other factors are constant, when the RG5 increases 1%, the RM decreases 0.44 and vice versa. Moreover, all three factors have a risk index ranging from 3.7-3.92 (Table 8), the risk index of all factors are quite high even higher than factors in the RG2. Especially, the factors R15 with the highest risk index in the group shows the fact that poor quality of material and equipment affect significantly for quality of construction.

**Table 8. Risk Index of RG5**

| No | Risks type                        | RI  |
|----|-----------------------------------|-----|
| 1  | Exchange rate fluctuation and inflation | R10 | 3.7 |
| 2  | Inaccurate schedule               | R2  | 3.86 |
| 3  | Poor quality of material and equipment | R15 | 3.92 |

7. Conclusions

Thus, after studying the impact risk factors, 14 strong influence factors have been found causing risks in construction, namely Poor performance of contractors, Funding problem for projects, Defective design, Shortage/delay of material supply, Site clearance works are slow and asynchronous, Payment delays, Financial capacity of the contractor is not guaranteed, Accidents/safety, Poor quality of material and equipment, Inaccurate schedule, Exchange rate fluctuation and inflation, Exchange rate fluctuation and inflation, Poor professional ethics of contractors and supervision consultants, and Financial capacity of the contractor is not guaranteed.

Based on these impact factors, stakeholders should devise more effective measures to manage risks to minimize unwanted impacts on a project in construction. This study is aimed at highlighting the main risks that Vietnam construction projects are facing. It also describes some significant factors of risk management.

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