Determining the risks of the process construction in border areas

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ABSTRACT

In all phases of the project, there are always events and conditions occurring that directly or indirectly affect the implementation of the project, causing the project to fail to achieve the target of the proposed project subject. Such events and conditions are called project risks. The more human society develops, the more diverse, rich, and complex human activities become. Therefore, risks are increasingly complex and have negative impacts on people's lives. Construction work is a special product. Therefore there are more and more risks that are hidden in the construction process. Especially when projects are placed in remote, mountainous, or border areas, the risks become more complex and diverse. Hence, if risks are identified quickly and accurately, managers can reduce the level of risk in the process. Then, people can also suggest some solutions to reduce the risks. The goal of this paper is to propose and evaluate the risk factors of the construction process in the border district, Quang Nam Province, by applying the Exploratory Factor Analysis (EFA) method. This study tried to collect data analyze qualitative and quantitative risk factors. The results showed that the collected survey data is meaningful.

1. Introduction

The construction field contains a variety of risks that only occur with a one-time probability; however, they have a great impact on the project. There is no doubt that there are risks repeatedly occurring with many different projects. In 1901, Allan Herbert Willett introduced the concept of "risk," he described the risk as an unspecified and undesirable event or phenomenon (Willett, 1901). Clearly, risks appear in almost every field, such as risks in banking and financial investment activities, risks in the design and construction of traffic and construction works, risks in transportation, transfer materials, machinery, equipment, etc.

Following the extended view, the risk is emphasized the positive or negative outcomes of the occurrence of a risk. The risk can be calculated by the probability, the frequency of occurrence of the risk multiplied by the degree of loss, damage, or gain caused by the risk. Today, when considering an issue, researchers and managers tend to consider both positive and negative aspects. Actually, this shows an optimistic view of management science.

Construction investment projects are activities related to abandonment for new construction, expansion, or renovation for the purpose of developing, maintaining and improving

the quality of works, products, or services in a certain term. It can be said that one of the main characteristics of a construction investment project is an uncertain and potentially risky environment.

Risk management is a process of identifying, assessing, and ranking possible risks. And then, people can give several effective measures, choose necessary resources, and put them into a real project to limit, monitor, and control the likelihood of occurrence of risk or the effects of unforeseeable events (Dinh & Nguyen, 2016). Therefore, risk management is an important task in construction management that helps contractors proactively identify, evaluate, control, and minimize the negative impacts of risks on the project.

In the world, there are a lot of scientists such as Barnes (2006), Cooper (1999), Chapman (2001, 2011) who contributed to great achievements in the process of risk management research. Chapman and Ward (1997) showed the process, technique, and project information in project risk management. The authors presented that risks are the factors causing deviations from the proposed plan, and they proposed nine stages of risk management of the methodology: definition, objective, assessment, structure, ownership, estimate, evaluate, exploit and manage. Flanagan and Norman (1993) research on risk management in construction showed that the construction industry is subject to more risks and uncertainties than other fields. In this study, the authors presented that the risks had both positive and negative factors, and the risk management process included 04 steps: identity, classify, analyze and react to risks.

Moreover, Ang, and De Leon (2005) analyzed uncertainties about risk decisions in technical infrastructure projects. The authors proposed a framework for risk-handling methods in technical infrastructure projects. Tran and Molenaar (2014) applied risk analysis strategies to help decision-makers evaluate and select the design-build delivery method consistently and defensibly. This article studied 39 risk factors related to the design-build delivery selection process. Ranjbar, Ansari, Taherkhani, and Hosseini (2021) developed a novel risk analysis framework for construction projects based on Building Information Modeling Analysis. Another research team proposed the risk factors affecting the main execution activities associated with global roadways construction projects (Issa, Marouf, & Faheem, 2021). Issa, Mosaad, and Hassan (2019) evaluated and selected the construction projects based on risk analysis. This study presented a new strategy based on identifying multiple criteria that affect construction projects to help contractors in evaluating and selecting suitable construction projects.

In Vietnam, there are a lot of works researching risk management we should mention. For example, Do Thi My Dung studied risk factors as well as the construction management process and assessed the necessity of risk management during project implementation (Do, 2014, 2019). Besides, Le, Le, and Do (2015) clarified the theory of both risk and risk management of construction investment projects. The study evaluated the correlation relationship of one variable with others to assess the risks after identifying them in the process of risk management of Barret pile construction in Ho Chi Minh City. Trinh (2014) studied the theoretical basis of risk, risk management standing from many parties including investor, consultant, contractor, community to see which subject bore the risks and what risks were. She also proposed three risk management solutions towards the state risk management, including risk mitigation group, project risk management according to the cycle, and risk management system. Pham and Nguyen (2011) showed that the construction of basements of high buildings contained many risks and caused great consequences. This study presented and ranked forty-two risk factors affecting this process.

To be honest, understanding the factors that can bring disadvantages to a project plays an important role. Understanding the possible risks will help people avoid unnecessary damage;

therefore, planning to prevent the risk before it occurs is necessary. Currently, in Vietnam, there are few studies identifying the risks during the implementation of construction investment projects in border areas, mountainous or remote areas. Obviously, in the process of construction investment, risks are always hidden. However, the risks become more complicated in the remote border areas and need to be minimized more. At the same time, there are also very few studies evaluating and analyzing the correlation between risk factors. Therefore, in this study, the authors want to focus on researching the risks factors in the process of construction concerning remote border areas. The authors chose several border districts of Quang Nam like Dong Giang, Nam Giang, Tay Giang, etc., making research areas.

The main goal of the paper is to identify risk factors affecting the implementation phase of construction investment projects in border districts, Quang Nam province. The exploratory Factor Analysis (EFA) method is used to quantify these risk factors. The rest of this study is organized as follows. Section 2 describes the method that is used in the study. Section 3 validates the result and discussion. Section 4 analyzes the risk factors affecting construction investment projects, and the final part is the conclusion presented in Section 5.

2. Methodology

This study used the Exploratory Factor Analysis (EFA) method to build and test the group of risk factors affecting the project implementation process in border districts - Quang Nam Province.

Thanks to existing studies on domestic and foreign risks and based on consulting experts, the authors found that there are four main factors that cause risk factors affecting the stage of investment project implementation construction in several border districts, Quang Nam Province. They are investors, contractors, sub-contractors, and consultants. The authors built a survey with 15 influential variables (Table 1). Risk factors are assessed according to the Likert scale (Likert, 1932) with 05 ratings as follows: (5) very strong influence, (4) strong influence, (3) moderate influence, (2) weak influence, and (1) very weak effect.

Table 1

Coding the scale of risk factors

No.	Risk factor	Encode
I	Investor	INV
1	The equity was distributed insufficiently and timely	INV1
2	The management department lacked professional capacity	INV2
3	The lack of management responsibility	INV3
II	Contractor	CONT
4	Occupational safety at construction sites	CONT 1
5	The lack of devices	CONT 2
6	Low skilled labors	CONT 3
7	Poor construction management and supervision	CONT 4
8	The difficulty of finance	CONT5
9	Delaying in the acceptance of completed items	CONT6
III	Sub-Contractor	Sub-CONT

No.	Risk factor	Encode
10	Delaying in material supply	Sub-CONT 1
11	Suppling low quality materials	Sub-CONT 2
12	Poor or insufficient abilities	Sub-CONT3
IV	Consultant	CONS
13	Mistakes in design document	CONS1
14	Supervision consultant did not accept inspection timely	CONS2
15	Supervision consultant lacked professional capacity	CONS3

Source: Data analysis result of the research

The influential variables in this study were conducted based on survey results from many people who have been directly involved in construction investment projects in border districts - Quang Nam including investor, investor project management consultants, supervision consultants, construction contractors, subcontractors, etc. Data collection methods were carried out by methods such as interviews, direct questionnaires, and email directly.

EFA factor analysis has the following steps.

Step 1: Build and test the quality of the scale;

Step 2: Exploratory factor analysis EFA;

(1) Test the appropriateness of the model and the correlation of the observed variables;

(2) Test the explanatory level of the observed variables;

Step 3: Multivariate regression analysis.

3. Result and discussion

3.1. Evaluate the quality of the scale by using Cronbach's Alpha coefficient

Cronbach's Alpha helped to test the coherence as well as the correlation between observed variables. In addition to this, Cronbach's Alpha helped to eliminate unsatisfactory observed variables. According to the research (Nunnally & Bernstein, 1994), the criteria for selecting factors is that Cronbach's Alpha coefficient is from 0.6 or more and observed variables in each group with the total correlation coefficient is not less than 0.3. Table 2 summarizes the results of the quality analysis of the scale using Cronbach's Alpha coefficient.

Table 2

Cronbach Alpha coefficient results

No.	Variable	Cronbach's Alpha
1	Investor	0.610
2	Contractor	0.793
3	Subcontractor	0.651
4	Consultant	0.743

Source: Data analysis result of the research

Table 3

Correlation coefficient of the total of the observed variables results

No.	Factor	Featured variable	Corrected Item - Total Correlation
1	Investor	INV1	0.409
		INV2	0.452
		INV3	0.397
2	Contractor	CONT 1	0.599
		CONT 2	0.504
		CONT 3	0.626
		CONT 4	0.470
		CONT5	0.643
		CONT6	0.445
3	Sub-Contractor	Sub-CONT 1	0.516
		Sub-CONT 2	0.563
		Sub-CONT3	0.320
4	Consultant	CONS1	0.550
		CONS2	0.661
		CONS3	0.502

Source: Data analysis result of the research

From this result, it is shown that all scales satisfied the requirements. Hence the authors went on analyzing the EFA factor in step 2.

3.2. Analyze EFA factor

3.2.1. Check model suitability

EFA exploratory factor analysis is considered suitable when the following conditions are satisfied:

(a) Value $0.5 < KMO < 1$;

(b) Bartlett test has statistical significance (Sig. < 0.05);

(c) Factor loading ≥ 0.5 (Nunnally & Bernstein, 1994).

From the survey data, throughout the analysis steps, the results are summarized in Table 3 and the factor rotation matrix in Table 4.

Table 4

KMO and Bartlett's Test

KMO (Kaiser-Meyer-Olkin Measure of Sampling Adequacy)		0.687
Bartlett's Test of Sphericity	Approx. Chi-Square	454.361
	Degree of Freedom (df)	105
	Level of significance (Sig.)	0.000

Source: Data analysis result of the research

From Table 4, the KMO value had 0.687, the discovery factor is appropriate with the actual data. Bartlett's test with the additive Sig. Value is 0.000, which is lower than 0.05. Therefore, risk factors have a linear relationship with the degree of influence on construction investment projects in the study area.

Based on the results in Table 5, it is found that most of the observed variables have factor loading factors being higher than 0.5. Thus, the obtained results satisfy the statistical conditions, showing that the obtained values are appropriate and yield practical significance.

Table 5

Factor matrix

	Factor			
	1	**2**	**3**	**4**
CONT 5	.801			
CONT 3	.768			
CONT 1	.708			
CONT 2	.654			
CONT 6	.646			
CONT 4	.595			
CONS 2		.885		
CONS 1		.802		
CONS 3		.708		
Sub-CONT 2			.836	
Sub-CONT 1			.824	
Sub-CONT 3			.579	
INV 1				.757
INV 2				.746
INV 3				.697

Source: Data analysis result of the research

3.2.2. Test the level of explanation of observed variables

The level of explanation of variables in the study is determined through the total value of extracted variance. From Table 6, the total value of extracted variance is 58.871% which is higher than 50%. This parameter means that 58.871% of the change in the level of impact on the project implementation phase is explained by the observed variables stated in the model.

Table 6

Total Variance Extracted

Factor	Initial Eigenvalue			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative (%)	Total	% of Variance	Cumulative (%)	Total	% of Variance	Cumulative (%)
1	3.149	20.990	20.990	3.149	20.990	20.990	3.029	20.193	20.193
2	2.248	14.984	35.974	2.248	14.984	35.974	2.068	13.787	33.980
3	1.922	12.812	48.787	1.922	12.812	48.787	1.960	13.064	47.045
4	1.513	10.084	58.871	1.513	10.084	58.871	1.774	11.826	58.871
5	.963	6.423	65.294						
6	.794	5.292	70.586						
7	.699	4.663	75.249						
8	.659	4.392	79.641						
9	.607	4.049	83.690						
10	.557	3.714	87.403						
11	.503	3.355	90.758						
12	.438	2.921	93.679						
13	.359	2.391	96.071						
14	.313	2.083	98.154						
15	.277	1.846	100.000						

Source: Data analysis result of the research

3.3. Regression analysis

To evaluate the relationship between risk factors and the level of influence, the authors conducted the regression analysis method. In this study, the multivariable linear regression model was determined as follows:

$$\text{Project risk} = \beta 0 + \beta 1.\text{Investor} + \beta 2.\text{Contractor} + \beta 3.\text{Sub-Contractor} + \beta 4.\ \text{Consultant} \quad (1)$$

The results of tested regression coefficients are shown in Table 7. Through the results of the calculation of regression coefficients, all four risk groups have a statistical significance of 95% or more. Thus, the regression equation is:

$$\text{Project risk} = 0.220\ \text{Investor} + 0.572\ \text{Contractor} + 0.325\ \text{Subcontractor} + 0.377\ \text{Consultant} \quad (2)$$

Table 7

Coefficient result

Independent variables	Normalized regression coefficient (β)	Accreditation (t)	Statistical significance level (.Sig)
Constant	0		
Investor	0.220	3.636	.000
Contractor	0.572	9.522	.000
Sub-Contractor	0.325	5.421	.000
Consultant	0.377	6.217	.000

Source: Data analysis result of the research

All the variables investor, contractor, sub-contractor, and consultant have a positive relationship with the variable of risk management. To evaluate the degree of influence of the independent variables, the authors determine the normalized regression coefficient. The regression results show that the contractor has the greatest influence in the four risk factors affecting the project, followed by the consulting unit, subcontractor, and investor. Obviously, in the process of construction, the contractor is the most important factor and has a crucial effect on the project. Figure 1 shows the importance of risk factors during construction in the research areas.

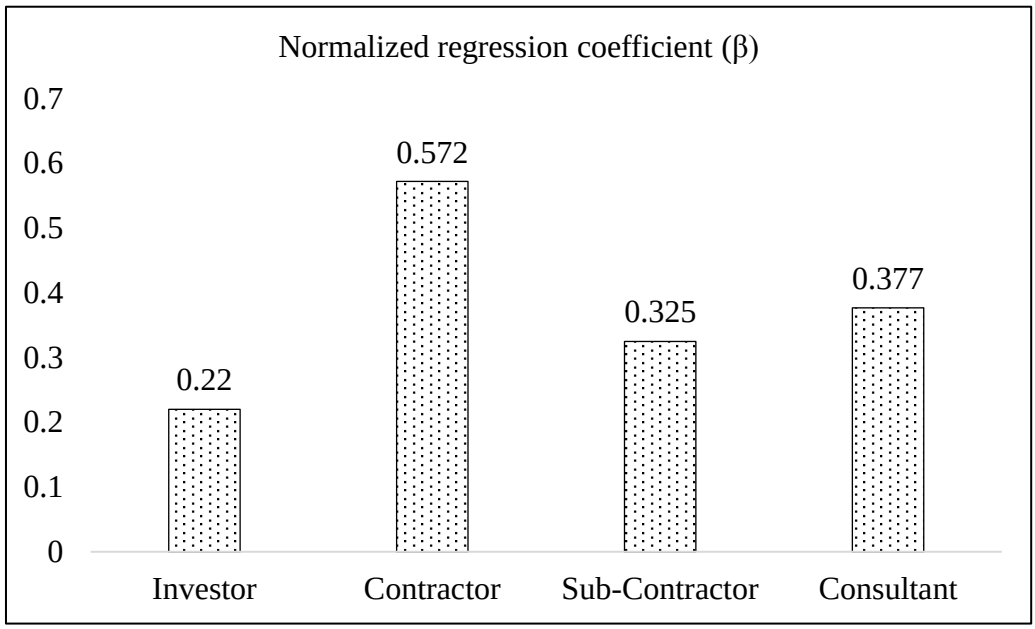

Figure 1. The importance of risk factors

4. Analysis of risk factors affecting construction investment projects

Creating a perfect and sustainable construction project needs many different factors, from the stage of ideation, design to the implementation process. Particularly, the contractor plays an extremely important role in the process of creating the success of a project.

In the group of contractor risks, we found that the cost factor is mentioned first. Obviously, for projects in several border areas, it will probably be carried out before the equity is allocated to the investor. To be honest, most of the projects in the study area are funded by the state budget. Hence it is possible that the investor is quite passive in deciding when the equity will be allocated, leading to the initial advance or payment to contractors being delayed. The reason is that legal procedures caused delays in the supply of equity. Another reason we can mention is that the difficulty of funding comes from the contractor. Therefore, the contractor needs to plan cost measures to ensure the equity supply process during the project implementation period, specifically the construction phase.

The next risk factor from the group of contractors mentioned by experts is poorly skilled labor. It is clear that a team of professional and skilled workers will give high work efficiency. At the same time, construction in remote border districts may affect the psychology of the living environment; therefore, in the working process, labor productivity will also be affected.

Through the collected survey data, for the construction area in border districts - Quang Nam, the potential risk coming from consultants is also quite high. In the process of construction

of a work, the people that play the most important role affecting the entire quality of construction works is the construction supervision consultant. Hence, the supervision consultant must have good technical qualifications, many years of experience and work for large construction projects, honesty, integrity, and objectivity to bring the best benefits to the investor.

In the subcontractor risk group, the element of poor-quality raw material supply is mentioned first. Certainly, with a remote geographical location, the supply of materials with both quality and being on time is an issue that needs to be resolved from the beginning between the main contractor and the subcontractor. Group of investor risk factors is mentioned last by experts. Because this is the construction phase, the investor accounts for a lower proportion compared to other groups of factors. However, the role of the investor at any stage is also very important.

Honestly, getting the quality of construction buildings requires the participation of investors, contractors, subcontractors, suppliers, and consultants. Each project participant must have the personnel and perform specific quality management activities. The investor needs to set requirements for quality and progress have the person participate in the quality inspection during the construction process. In addition to this, the investor must organize the acceptance test to mark the completion of the quality of the work. Contractors need to have tools to check and monitor the construction performance closely so that they can detect design errors early in order to have a timely repair plan and avoid rebuilding, which is a huge waste of money.

Obviously, a project which would like to be completed as planned, cost savings, and quality assurance required close, rhythmic and continuous coordination of the involved parties. Just one party does not cooperate or work irresponsibly; it will affect the chain of projects being stopped and delayed. Therefore, during the construction process, it is necessary to have regular and continuous exchanges of the involved parties so that the parties can understand each other, grasp each other's situation and promptly handle any problems. A total solution for the parties is a software system that helps to exchange information continuously in order to promptly solve when any work arises.

5. Conclusion

In this paper, the authors have proposed an EFA model to identify risk factors during the implementation of construction investment projects in several border districts - Quang Nam. The author proposed a process to identify risk factors during the construction process in the study area. Particularly, the authors identified the risk factors, gave the survey design, collected data, analyzed and processed data, determined the frequency as well as degree of risk of factors, and listed of risk factors.

Through the analysis of survey data, the study presented the importance as well as the correlation between risk factors. The paper also proposed some solutions to minimize risks during construction in the study areas. The study attempted to use quantitative analysis techniques to identify risk factors. However, because the study areas are borderline, data collection was difficult. In the future, the author wishes to collect more data with new and more diverse risk factors for better results.

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