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Exploring the impact of risks on road construction quality: an AHP model study

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ABSTRACT

The construction industry plays a role in the development of countries. The progress of this industry mainly depends on the quality of construction works, which is closely related to the longevity of the work. A risk assessment of construction quality is a comprehensive assessment of the level of risks and the construction contractor faces during the construction process. Risk factors affect the quality of work in the aspect of labor, equipment and machinery, material, constructional technology, environment, etc. Based on these factors, the authors build an index system to evaluate the quality of works according to experts. Quality is one of the factors to evaluate the success of construction projects. The level of success of the construction industry depends on many quality performances. The method used in this article is the analytical hierarchical method (AHP) for quantitative analysis, which has the function of comparing and selecting alternatives without requiring big data, etc. This method will also be chosen to satisfy the set of criteria. Based on the principle of comparing pairs of criteria, the AHP method analyzes, evaluates, synthesizes, and answers the question "Which criterion affects the quality of the work during the construction process?". This study is conducted to scrutinize the factors that harm construction projects. The results of the study evaluating over 15 criteria show that the influencing factor due to equipment and machinery assessed has the greatest influence on the quality of the work.

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1. Introduction

A construction project is an extremely complex process, including many activities and many factors affecting the quality of work such as design, materials, machinery, topography, engineering geology, hydrogeology, meteorology, construction technology, operation mode, technical measures, and management system. According to (Cao, 2010), quality is the symbol of human civilization and with the progress of human civilization, quality control will play an incomparable role in business and other activities. It can be said that without quality control, there is no economic benefit. He also emphasized that quality control is a process used to ensure a certain level of quality in a product or service. The basic objective of quality control is to ensure that the products, services, or processes provided meet specific requirements and are reliable.

Quality is one of the key factors for the success of construction projects. The quality of the construction project is also the success of the project, which can be seen as the fulfillment of the expectations (satisfaction) of the project participants. Quality, cost, and time have been recognized as key customer-related factors. However, for the majority of projects, cost and time parameters are important factors before project construction. Here the authors emphasize more attention to quality. Quality in the construction industry is generally associated with customer satisfaction and the implementation of a quality management system is an important tool for consistently and reliably managing the goal of customer satisfaction. A quality management system (QMS) can be implemented at the organizational level or the project level.

For the implementation of quality management in construction projects, the concepts of quality planning (defining quality standards), quality assurance (evaluating the overall results of the project), and quality control (monitoring of specific project results) are in the quality management process.

Construction projects are complex due to difficult construction sites, labor changes for each site, the influence of weather, and a higher possibility of errors (Tafazzoli, 2017). As a result, many risks arise during the different phases of the project and have an outsized impact on the time, cost, and quality of the entire project (Zou et al., 2007). The risk of delay has many impacts such as increasing costs, prolonging construction time, interrupting construction, reducing work quality, etc. (Mahamid et al., 2012). Therefore, risk control in a construction project has been part of the basis of management in construction projects for decades (Choudhry et al., 2014).

The main concerns for construction projects today are affected by several risks and limitations such as environmental conditions; efficiency and productivity of machinery and equipment; input materials and engineering geological conditions (Szymański, 2017). These factors cause delays and increase costs, reduce quality, and endanger safety (González et al., 2013).

The risk of construction progress has a great negative impact on the parties involved in the project (Abd El-Razek et al., 2008). Frequent delays in implementation will affect many employees of the investor as well as the contractor. The units participating in the project affected by the delay include investors, construction contractors, design consultants, supervision consultants, labor issues, equipment and machinery, materials, etc. Related to the project (Gündüz et al., 2013). Other delay factors such as government delays, lack of funding, errors in work, inappropriate planning, etc. (Larsen et al., 2016).

Different researchers conduct different studies on risk. However, the problems are still quite common and require an initial decision mechanism for risk assessment (Xu et al., 2018). The risk assessment helps to quantify the level of risks to minimize their impact. Therefore, managers need to emphasize the mechanism of scheduled risk decision-making (González et al., 2013). The assessment mechanism should consider risk throughout the construction lifecycle. Risk assessment in construction projects improves quality, and safety reduces costs, and increases stakeholder satisfaction.

The construction phase is a major stage of the construction investment process to turn the "on paper" work into an existing one, the construction process has a direct and decisive influence on the quality of the work and quantity of construction work. Quality control activities of construction contractors during construction play a very important part in ensuring and improving the quality of work. Establishing a model of a comprehensive quality management system applied to the construction process proved to be an effective and sustainable solution to help contractors improve construction quality management, contributing to improving construction quality. high-quality construction works. In the framework of the article, the authors introduce the method of hierarchical analysis (AHP - Analytical Hierarchy Process) to select and evaluate the level of factors affecting the quality of road construction.

Through synthesis and analysis, the research team found that there are many previous authors (Mahamid et al., 2012; Larsen et al., 2016; Abd El-Razek et al., 2008; Tafazzoli, 2017; Gündüz et al., 2013; González et al., 2013; Zou et al., 2007; Szymański, 2017; Choudhry et al., 2014) has only stopped at research related to financial risks when using AHP method and has not paid attention to construction quality. Therefore, the research team has chosen to study the factors affecting the quality of the works by the AHP method based on the case study of the factors affecting the quality of road construction.

2. Contents and methods of hierarchical analysis

AHP is one of the multi-objective decision-making methods proposed by (Saaty, 1980) - an Iraqi-born mathematician in 1980. AHP is a quantitative method, used to sort the decision alternatives and choose the one that satisfies the given criteria. Based on the pairwise comparison principle, the AHP method can be described with 3 main principles, namely analysis, evaluation, and synthesis. Applied to the assessment of road construction quality, AHP will show the influence of the evaluation criteria on the quality of road construction by comparing pairs of influencing factors.

The AHP method has many advantages over other multi-objective decision-making methods as follows (Saaty, 2008):

- AHP focuses on determining the importance of each criterion, which is the weakness of many multi-criteria decision-making methods; Therefore, AHP can easily be combined with other methods to take advantage of each method in problem-solving such as the SWOT matrix method.

- AHP can check the consistency of the decision maker's assessment.

- The hierarchical analysis process is easy to understand, can consider many sub-criteria simultaneously with groups of criteria, and can combine analysis of both qualitative and quantitative factors.

In the world, the application of AHP in decision-making is quite popular, especially in decisions related to socioeconomic and especially technical issues.

2.1. A sequence of conducting a hierarchical analysis to select alternatives

AHP is performed according to the following steps:

Step 1. Determine the priority for the criteria.

With n criteria as shown in Figure 1, we make a square matrix of level n as shown in Table 1.

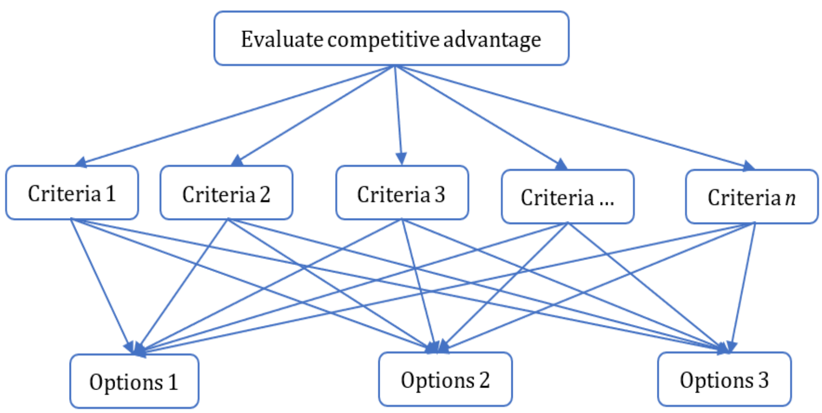

Figure 1. Diagram describing the problem of hierarchical analysis (Saaty, 2008).

Table 1. Square matrix of priority values for each pair of criteria.

	C_1	C_2	C_3	...	C_n
C_1	1	1	1/3		1/7
C_2	1	1	1/5		1/5
C_3	3	5	1		1
...					
C_n	7	5	1		1

Then we proceed to compare the criteria in pairs and fill in the priority of the criteria in Table 1 (and a_{ij} values, with i running in rows and j running in columns). The pairwise priorities of the criteria are looked up in Table 2, which have positive integer values from 1 to 9 or the reciprocal of these numbers. Assuming criteria C_1 has a priority equal to ¼ criteria C_3, then criterion C_3 will have a priority equal to 4 times criteria C_1. We record in Table 1, the row corresponding to C_1 and column C_3 the value ¼, the corresponding row C_3, and column C_1 the value 4.

Table 2. Evaluation of pairwise criteria based on priority.

Language variable	Language variable code	The corresponding triangular fuzzy numbers	Inverse triangular fuzzy number
Very good	1	(1, 1, 3)	(1/3, 1/1, 1/1)
Good	3	(1, 3, 5)	(1/5, 1/3, 1/1)
Rather	5	(3, 5, 7)	(1/7, 1/5, 1/3)
Least	7	(5, 7, 9)	(1/9, 1/7, 1/5)
Very poor	9	(7, 9, 9)	(1/9, 1/9, 1/7)

It can be seen that the inverse matrix is symmetric diagonally from left to right.

Step 2. Calculate the weights for the criteria.

After completing the matrix, the evaluator will calculate the weights for the criteria by dividing the value in each cell by the total value of cells by column, the obtained value is assigned to the calculated cell itself. maths. The weight of each criterion C_1, C_2, C_3,..., and C_n will be equal to the average of the values in each horizontal row (Table 3). The result gives us a matrix of 1 column and n rows.

Table 3. Weight matrix for selection criteria.

	C_1	C_2	C_3	...	C_n	Weight
C_1	W_{11}	W_{12}	W_{13}		W_{1n}	W_1
C_2	W_{21}	W_{22}	W_{23}		W_{2n}	W_2
C_3	W_{31}	W_{32}	W_{33}		W_{3n}	W_3
...						
C_n	W_{n1}	W_{n2}	W_{n3}		W_{nn}	W_n

The advantage of the AHP hierarchical analysis method is that it uses the consistency ratio to check the consistency of the expert's assessment, ensuring the science in the assessment. The consistency ratio (CR) is determined as follows:

$$CR = \frac{CI}{R} \quad (1)$$

Where: CI (consistency index) - the consistency index:

$$CI = \frac{\lambda_{max}}{n-1} \quad (2)$$

With λ_{max} - the eigenvalue of the comparison matrix (eigenvalue), calculated as follows:

$$\lambda \sum_{i=1}^{n} W_i \sum_{j=1}^{n} a_{ij}{}_{max} \quad (3)$$

n - the number of elements to be compared in pairs in one calculation, which is the size of the calculation matrix; RI (random index) - random index, RI - determined from a given table of numbers (Table 4), including 15 criteria.

Table 4. Random index with selection criteria considered.

n	1	2	3	4	5	6	7	8
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41
n	9	10	11	12	13	14	15	
RI	1.45	1.49	1.15	1.54	1.56	1.57	1.59	

Step 3. Calculate the priority of the alternatives according to each criterion.

In this step, the authors calculate for each criterion, the calculation method is the same as Step 1 and Step 2, but the data included in the evaluation is the result of comparing the priority of the options considered according to each criterion. Thus, the evaluator has to perform n matrices for n different criteria. As a result, we have n matrices of 1 column m rows. Consistency ratio checks should also be performed to ensure that the results obtained have adequate confidence.

Step 4. Scoring for options and options.

This is the final step in the evaluation and planning process. We concatenate the *n* matrix - column *m*-row matrix resulting from Step 3 into an *m*-row *n*-column matrix. Multiplying this matrix by a column of *n* rows as the result of Step 2 results in a matrix of *m* rows and columns. The resulting matrix will indicate the best option to choose, the one with the highest result value.

2.2. A solution to apply the AHP method to assess the quality of road construction

Based on the basis and content of the AHP method, the article proposes the process of applying the method to assess the quality of road construction Figure 2.

3. A case study in the Le Cong Thanh, Phu Ly, Ha Nam road works

Project: Construction of Le Cong Thanh Road - Ha Nam Province (Project Management Board of Nam Cao University Urban Area, 2020)

- Vertical axis D1.

Starting point: Km0 intersects with NH38 (Km83+622-QL38) next to the 110 kV power station in TT. Dong Van, Ha Nam, Vietnam

End point: Km7 + 566.28 intersects with the new National Road 21b (Km56 + 919.81 - National Road 21b) in the hamlet of North, Tien Hiep commune, Duy Tien district.

Length of line 1: 7.57 km.

Length of line 2: 2.1 km.

Based on analyzing actual conditions, input and output factors, experts have selected criteria to evaluate the quality of road construction. There are a variety of criteria that can be suggested, depending on specific conditions. To illustrate the research, the paper only considers 5 main criteria groups and 15 sub-criteria groups as shown in Table 5.

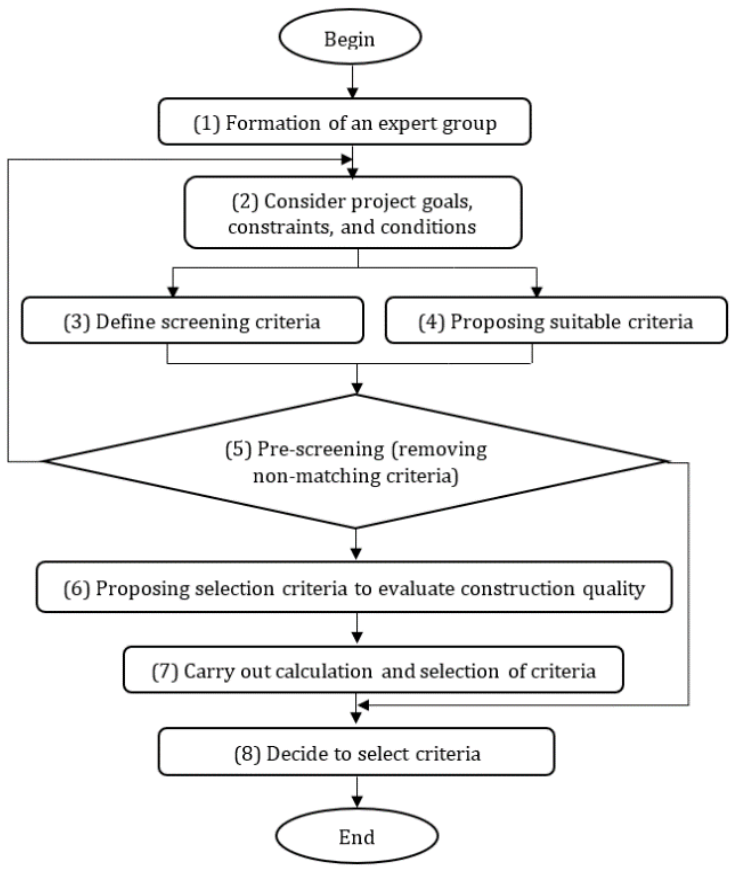

Figure 2. Process of applying the AHP method to select and assess the quality of road construction.

Table 5. Project quality risk assessment index system in the construction phase.

Rating Index	Number one	Number	Second index	Level				
				1	2	3	4	5
C	C_1 Labor index	1	C_{11} Level of compliance of the manager					
		2	C_{12} Level of the operator qualification standard					
	C_2 Material Index	3	C_{21} Material standards					
		4	C_{22} Material attribute status					
	C_3 Index of machinery and equipment	5	C_{31} The degree of compliance with the quality of machinery and equipment					
		6	C_{32} The rationality of the selection of machinery and equipment					
		7	C_{33} Machine operator standards					
	C_4 Construction method index	8	C_{41} The rationality of the construction technology diagram					
		9	C_{42} Advanced and reasonable construction technology and construction methods					
		10	C_{43} The rationality of construction methods and construction engineering measures					
	C_5 Environmental index	11	C_{51} The natural environment of the construction site					
		12	C_{52} Quality assurance index of construction contractors					
		13	C_{53} The quality management system of construction contractors					
		14	C_{54} Economic and technical conditions					
		15	C_{55} The working environment of a construction site					

4. Results and Discussion

The result of pairwise comparison according to Step 1 gives the data in Table 6, calculated data obtained from expert opinion (assumption)

We proceed to calculate the data of the problem according to the AHP method. The weights of the criteria are shown in Table 7 (Saaty, 1980).

We can calculate (with the number of criteria is 15, RI = 1.59 "Table 4") according to the formula (1, 2 and 3) we get:

λ_{max} = 17.066; CI = 0.148; CR = 0.093 (9.283%) < 10% satisfactory

Similarly, to calculate the priority of each alternative according to each criterion, we set up the corresponding matrices of 15 different criteria, and we weight the options according to different criteria as Table 8.

Multiplying the two matrices of Table 8 and Table 9, we have the following result (Table 10):

The results of Table 10 show that criterion C_3 (Index: Machinery and equipment) is more specific than criterion C_{32} (Sub-Index: The rationality of the selection of machinery and equipment) and has a large weight. In other words, customers are the criteria that have the greatest influence on the quality of road construction. Therefore, the parties involved in the road construction project need to check and choose accordingly to improve the quality of construction.

In addition, according to the results of Table 10, the indicators of C_2 material also need to be checked before being put into use, which is also the factor that greatly affects the quality of road construction.

Through this, the Investor can forecast other factors affecting the quality of road construction to make recommendations and inspect during the construction process, reminding the supervision consultant and the absolute construction contractor, to pay attention to the image indicators on the quality of road construction.

Table 6. Pairwise comparison of criteria.

Criteria	Sub-criteria	C_1		C_2		C_3			C_4			C_5				
		C_{11}	C_{12}	C_{21}	C_{22}	C_{31}	C_{32}	C_{33}	C_{41}	C_{42}	C_{43}	C_{51}	C_{52}	C_{53}	C_{54}	C_{55}
C_1	C11	1	2.600	2.333	2.667	2.133	2.667	2.333	1.933	1.867	2.000	2.267	2.467	2.400	2.267	2.333
	C12	0.385	1	2.600	2.333	2.667	2.133	2.667	2.333	1.933	1.867	2.000	2.267	2.467	2.400	2.267
C_2	C21	0.429	0.385	1	2.600	2.333	2.667	2.133	2.667	2.333	1.933	1.867	2.000	2.267	2.467	2.400
	C22	0.375	0.429	0.385	1	2.600	2.333	2.667	2.133	2.667	2.333	1.933	1.867	2.000	2.267	2.467
C_3	C31	0.469	0.375	0.429	0.385	1	2.600	2.333	2.667	2.133	2.667	2.333	1.933	1.867	2.000	2.267
	C32	0.375	0.469	0.375	0.429	0.385	1	2.600	2.333	2.667	2.133	2.667	2.333	1.933	1.867	2.000
	C33	0.429	0.375	0.469	0.375	0.429	0.385	1	2.600	2.333	2.667	2.133	2.667	2.333	1.933	1.867
C_4	C41	0.517	0.429	0.375	0.469	0.375	0.429	0.385	1	2.600	2.333	2.667	2.133	2.667	2.333	1.933
	C42	0.536	0.517	0.429	0.375	0.469	0.375	0.429	0.385	1	2.600	2.333	2.667	2.133	2.667	2.333
	C43	0.500	0.536	0.517	0.429	0.375	0.469	0.375	0.429	0.385	1	2.600	2.333	2.667	2.133	2.667
C_5	C51	0.441	0.500	0.536	0.517	0.429	0.375	0.469	0.375	0.429	0.385	1	2.600	2.333	2.667	2.133
	C52	0.405	0.441	0.500	0.536	0.517	0.429	0.375	0.469	0.375	0.429	0.385	1	2.600	2.333	2.667
	C53	0.417	0.405	0.441	0.500	0.536	0.517	0.429	0.375	0.469	0.375	0.429	2.600	1	2.600	2.333
	C54	0.441	0.417	0.405	0.441	0.500	0.536	0.517	0.429	0.375	0.469	0.375	0.429	0.385	1	2.600
	C55	0.429	0.441	0.417	0.405	0.441	0.500	0.536	0.517	0.429	0.375	0.469	0.375	0.429	0.385	1

Table 7. Weight of criteria when comparing pairs.

Criteria	Sub-criteria	C_1		C_2		C_3			C_4			C_5					Weight
		C_{11}	C_{12}	C_{21}	C_{22}	C_{31}	C_{32}	C_{33}	C_{41}	C_{42}	C_{43}	C_{51}	C_{52}	C_{53}	C_{54}	C_{55}	
C_1	C11	0.140	0.279	0.208	0.198	0.140	0.153	0.121	0.094	0.085	0.085	0.089	0.083	0.081	0.072	0.070	0.127
	C12	0.054	0.107	0.232	0.173	0.176	0.123	0.139	0.113	0.088	0.079	0.079	0.076	0.084	0.077	0.068	0.111
C_2	C21	0.052	0.041	0.089	0.193	0.154	0.153	0.111	0.129	0.106	0.082	0.073	0.067	0.077	0.079	0.072	0.099
	C22	0.052	0.046	0.034	0.074	0.171	0.134	0.139	0.103	0.121	0.099	0.076	0.063	0.068	0.072	0.074	0.089
C_3	C31	0.066	0.040	0.038	0.029	0.066	0.149	0.121	0.129	0.097	0.113	0.092	0.065	0.063	0.064	0.068	0.080
	C32	0.052	0.050	0.033	0.032	0.025	0.057	0.135	0.113	0.121	0.091	0.105	0.079	0.066	0.060	0.060	0.072
	C33	0.060	0.040	0.042	0.028	0.028	0.022	0.052	0.126	0.106	0.113	0.084	0.090	0.079	0.062	0.056	0.066
C_4	C41	0.072	0.046	0.033	0.035	0.025	0.025	0.020	0.048	0.118	0.099	0.105	0.072	0.090	0.075	0.058	0.061
	C42	0.075	0.056	0.038	0.028	0.031	0.022	0.022	0.019	0.045	0.110	0.092	0.090	0.072	0.085	0.070	0.057
	C43	0.070	0.057	0.046	0.032	0.025	0.027	0.019	0.021	0.017	0.042	0.102	0.079	0.090	0.068	0.080	0.052
C_5	C51	0.062	0.054	0.048	0.038	0.028	0.022	0.024	0.018	0.019	0.016	0.039	0.088	0.079	0.085	0.064	0.046
	C52	0.057	0.047	0.045	0.040	0.034	0.025	0.019	0.023	0.017	0.018	0.015	0.034	0.088	0.075	0.080	0.041
	C53	0.058	0.044	0.039	0.037	0.035	0.030	0.022	0.018	0.021	0.016	0.017	0.088	0.034	0.083	0.070	0.041
	C54	0.062	0.045	0.036	0.033	0.033	0.031	0.027	0.021	0.017	0.020	0.015	0.014	0.013	0.032	0.078	0.032
	C55	0.060	0.047	0.037	0.030	0.029	0.029	0.028	0.025	0.019	0.016	0.018	0.013	0.015	0.012	0.030	0.027

Table 8. Weight of alternatives according to criteria.

	Weight of options according to criteria														
	C_{11}	C_{12}	C_{21}	C_{22}	C_{31}	C_{32}	C_{33}	C_{41}	C_{42}	C_{43}	C_{51}	C_{52}	C_{53}	C_{54}	C_{55}
C_{11}	0.056	0.076	0.068	0.077	0.062	0.077	0.068	0.056	0.054	0.058	0.066	0.071	0.070	0.066	0.068
C_{12}	0.058	0.074	0.068	0.076	0.063	0.076	0.068	0.058	0.057	0.060	0.067	0.071	0.070	0.067	0.068
C_{21}	0.060	0.073	0.068	0.074	0.064	0.074	0.068	0.060	0.058	0.061	0.067	0.071	0.069	0.067	0.068
C_{22}	0.062	0.073	0.069	0.074	0.066	0.074	0.069	0.062	0.061	0.063	0.068	0.071	0.070	0.068	0.069
C_{31}	0.064	0.072	0.069	0.072	0.066	0.072	0.069	0.064	0.063	0.065	0.068	0.070	0.069	0.068	0.069
C_{32}	0.066	0.071	0.069	0.071	0.068	0.071	0.069	0.066	0.065	0.066	0.069	0.070	0.070	0.069	0.069
C_{33}	0.067	0.069	0.069	0.069	0.068	0.069	0.069	0.067	0.066	0.067	0.068	0.069	0.069	0.068	0.069
C_{41}	0.067	0.066	0.067	0.066	0.067	0.066	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067	0.067
C_{42}	0.067	0.064	0.065	0.063	0.066	0.063	0.065	0.067	0.067	0.066	0.065	0.064	0.065	0.065	0.065
C_{43}	0.067	0.062	0.064	0.062	0.066	0.062	0.064	0.067	0.068	0.067	0.065	0.063	0.064	0.065	0.064
C_{51}	0.069	0.062	0.065	0.061	0.067	0.061	0.065	0.069	0.070	0.069	0.065	0.063	0.064	0.065	0.065
C_{52}	0.071	0.061	0.064	0.060	0.068	0.060	0.064	0.071	0.072	0.070	0.065	0.063	0.063	0.065	0.064

Weight of options according to criteria															
	C_{11}	C_{12}	C_{21}	C_{22}	C_{31}	C_{32}	C_{33}	C_{41}	C_{42}	C_{43}	C_{51}	C_{52}	C_{53}	C_{54}	C_{55}
C_{53}	0.073	0.060	0.065	0.059	0.069	0.059	0.065	0.073	0.075	0.072	0.066	0.063	0.064	0.066	0.065
C_{54}	0.075	0.059	0.065	0.058	0.070	0.058	0.065	0.075	0.077	0.073	0.067	0.062	0.064	0.067	0.065
C_{55}	0.077	0.058	0.065	0.058	0.071	0.058	0.065	0.077	0.080	0.075	0.067	0.062	0.064	0.067	0.065

Table 9. Weight of options according to criteria.

Criteria	Weight	Criteria	Weight
C_{11}	0.127	C_{41}	0.061
C_{12}	0.111	C_{42}	0.057
C_{21}	0.099	C_{43}	0.052
C_{22}	0.089	C_{51}	0.046
C_{31}	0.080	C_{52}	0.041
C_{32}	0.072	C_{53}	0.041
C_{33}	0.066	C_{54}	0.032
		C_{55}	0.027

Table 10. Results of the importance of the criteria weight of options according to the criteria.

Criteria	Index	Plan	Sub-stats	Weight
C_1	Labor index	C_{11}	Level of compliance of the manager	0.06629
		C_{12}	Level of the operator qualification standard	0.06678
C_2	Material Index	C_{21}	Material standards	0.06682
		C_{22}	Material attribute status	0.06779
C_3	Index of machinery and equipment	C_{31}	Quality compliance of machinery and equipment	0.06786
		C_{32}	The rationality of the selection of machinery and equipment	0.06862
		C_{33}	Machine operator standards	0.06817
C_4	Construction method index	C_{41}	The rationality of the construction technology diagram	0.06656
		C_{42}	Advanced and reasonable construction technology and construction methods	0.06503
		C_{43}	The rationality of construction methods and construction engineering measures	0.06461
C_5	Environmental index	C_{51}	The natural environment of the construction site	0.06529
		C_{52}	Quality assurance index of construction contractors	0.06542
		C_{53}	The quality management system of construction contractors	0.06639
		C_{54}	Economic and technical conditions	0.06660
		C_{55}	The working environment of a construction site	0.06728

5. Conclusions

Based on the aforementioned analysis, it becomes evident that effective management of construction quality, specifically in road construction, as well as in construction projects as a whole, necessitates close coordination among investors, contractors, design consultants, and supervision consultants, These stakeholders should establish and implement suitable criteria to evaluate the quality of construction. By employing the AHP method, the assessment of road construction quality proves to be appropriate and gives results that are completely consistent with the current actual construction conditions.

By comparing and evaluating each pair of criteria on the priority of selection considering each criterion, the results are convincing. This article just stops at the level of simple evaluation with few illustrative comparison criteria. When there are more comparison criteria one can use more specialized software for comparison.

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Contribution of authors

Thanh Trung Dang - methodology, writing a manuscript; Phong Duyen Nguyen - computational model, analysis of the result and editing the manuscript; Minh Tuan Tran - computational model validation, editing the manuscript.

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