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ASSESSMENT OF QUALITY RISK FACTORS DURING THE CONSTRUCTION PHASE OF THE BICONSI TOWER PROJECT

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Abstract: *Project performance is assessed using various criteria. Quality is one of the typical triangle criteria used to assess the performance of any office building project. However, office projects in Vietnam have faced numerous quality risks, particularly during their construction periods. This can cause the building projects to be delayed and over budget. As a result, identifying quality risk factors throughout the construction phase of office projects is essential. Therefore, this paper applies the analytical hierarchy process to prioritize critical risk factors affecting project quality during the construction phase of the Biconsi Tower project in Vietnam. The research results show that the five top risk factors affecting the quality of the Biconsi Tower project from most to least impact are as follows: (1) inspection and approval work are not in accordance with regulations and procedures, (2) lack of coordination between project stakeholders, (3) poor quality design documents and drawings, (4) poor construction methods, and (5) poor quality input materials.*

Keywords: *Construction Management, Construction Phase, Quality Risks, Risk Management, Project Management*

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1. Introduction

Every office building project is different in terms of construction complexity and the amount of on-site construction. They have constructed not only on-site but also the complexity of construction methods. Furthermore, weather and environmental conditions will impact the progress of construction projects. Risks are unavoidable in office building projects, and multiple

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risk factors can affect building quality during construction. As a result, construction projects may be delayed or go over budget. Therefore, it is critical to identify quality risk issues throughout the construction phase of office building projects. This paper adopts the analytical hierarchy process (AHP) method to prioritize significant risk factors affecting project quality during the construction phase of the Biconsi Tower project in Vietnam. The research results show that the five top risk factors affecting the quality of the Biconsi Tower project with decreasing impact levels are as follows: (1) inspection and approval work are not in accordance with regulations and procedures, (2) lack of coordination between project stakeholders, (3) design documents and drawings are of poor quality, (4) construction methods are unsatisfactory, and (5) the input materials are of poor quality.

2. Research background

Quality is one of the standard triangle criteria used to measure the success of any office building project (Anderson, 1992; Atkinson, 1999). Construction quality encompasses the safety, long-term viability, technical, and aesthetic criteria of construction work conducted according to construction standards and in harmony with the surrounding environment (Arditi & Gunaydin, 1997; Nguyen, 2019; Nguyen et al., 2018; Nguyen, 2015; Wanberg et al., 2013). Construction projects have always been exposed to various unforeseeable risks, particularly during the construction phase of office projects. The following table summarizes ten critical quality risk factors of the Biconsi Tower project in Vietnam based on a survey of research publications and in-depth expert interviews (Arumsari et al., 2018; Chan & Tam, 2000; Dehdasht et al., 2017; Do et al., 2017; El-Sayegh & Mansour, 2015; Eybpoosh et al., 2011; Gan et al., 2017; Hussain et al., 2019; Kassem et al., 2020; Likhitruangsilp & Ioannou, 2009, 2012; Likhitruangsilp et al., 2016; Liu et al., 2017; Naderpour et al., 2019; Nguyen & Nguyen, 2020; Nguyen et al., 2021; Perrenoud et al., 2016; Rustom & Amer, 2006; Siraj & Fayek, 2019; Subramanyan et al., 2012; Tadayon et al., 2012; Tam & Chan, 2000; Tamošaitienė et al., 2021; Viswanathan et al., 2020; Xu et al., 2010; Zavadskas et al., 2010; Zeng et al., 2007; Zou & Zhang, 2009):

Table 1. Risk factors affecting the construction quality of the Biconsi Tower project

	Risk factors affecting construction quality of the Biconsi Tower project
GI	Risk factors impacted by the main contractor or subcontractors
R1	Unskilled construction workers
R2	Incompetent main contractor and subcontractors
R3	Poor construction methods
R4	Pressure to shorten the schedule for early handover
R5	Installation of equipment not following the manufacturer's catalog or instructions
GII	Risk factors impacted by other project stakeholders
R6	Poor quality input materials
R7	Poor quality design documents or drawings
R8	Poor quality construction survey
R9	Lack of coordination between project stakeholders (i.e., owner vs. contractor, main contractor vs. subcontractor, etc.)
R10	Inspection and approval work is not in accordance with regulations and procedures

3. Research Methodology

The AHP is one of the most popular multi-criteria decision-making methods. Invented in 1980 by Professor Thomas Saaty, AHP is a theoretically robust, advanced calculation method that enables individuals or groups to assess, analyze and make selections among given options. It also helps to solve complex problems. AHP aims to quantify the priority of a given set of factors or alternatives on a scale based on the decision maker's judgment, emphasizing the importance of the decision-makers' intuitive judgment and consistency by pairwise comparison during the decision-making process. Four primary principles are used in formulating an AHP model (Saaty & Vargas, 2012):

1. Analyze and establish the hierarchical structure of the problem,
2. Calculate priorities,
3. Synthesize, and
4. Measure inconsistencies.

The capacity to evaluate the criterion that does not meet the measurable requirement is a benefit of the AHP approach over other methods. That is, it does not need to directly quantify the value of a criterion but rather evaluate it on a scale (see Table 2). In reality, the evaluator only estimates the true value of elements in the pairwise comparison matrix by assigning it a value from the nine-point scale. Furthermore, AHP has the advantage of calculating the degree of discrepancy in expert opinion through the consistency ratio computation. A consistency ratio of less than 10% is regarded as acceptable in most cases. Because of the above advantages, this study applies AHP to risk factors affecting the construction quality of the Biconsi Tower project based on the opinions of five construction experts.

Table 2. The fundamental Saaty AHP scale

Ranking scale	Comparison
1	Equally preferred
2	Equally to moderately preferred
3	Moderately preferred
4	Moderately to strongly preferred
5	Strongly preferred
6	Strongly to very strongly preferred
7	Very strongly preferred
8	Very to extremely strongly preferred
9	Extremely preferred

Source: Van Nguyen et al. (2016)

4. Results and Discussion

The Biconsi Tower project is being constructed in Phu Loi Ward, Thu Dau Mot City, Binh Duong Province. The total land area is 7,984.6 m², with a total floor area for construction phase 2 (including basement and roof) of 48,381.3 m². The height of the building is estimated at 70 meters. The Biconsi Tower is a grade 1 project and has 19 floors (two basements, five podiums, 14 floors of towers, and roof floors) with a construction area of 2,488 m². The prospective design of the project is shown in Figure 1.

Figure 1. The prospective design of the Biconsi Tower project

The ranking of risk factors affecting the quality of the Biconsi Tower project in the construction phase using the AHP method shows that the five risk factors with the highest scores are (1) the inspection and approval work are not in accordance with regulations and procedures (R10 = 0.213), (2) the lack of coordination between project stakeholders (R9 = 0.175), (3) poor quality design documents and drawings (R7 = 0.130), (4) poor construction methods (R3 = 0.095), and (5) poor quality input materials (R6 = 0.093) (see Table 3).

Table 3. Risk factors affecting the construction quality of the Biconsi Tower project

Risk factors affecting the construction quality of the Biconsi Tower project		**Overall weight**	**Rank**
GI	*Risk factors impacted by the main contractor or subcontractors*		
R1	Unskilled construction workers	0.088	6
R2	Incompetent main contractor and subcontractors	0.069	7
R3	Poor construction methods	0.095	4
R4	Pressure to shorten the schedule for early handover	0.023	10
R5	Installation of equipment not following the manufacturer's catalog or instructions	0.059	8
GII	*Risk factors impacted by other project stakeholders*		
R6	Poor quality input materials	0.093	5
R7	Poor quality design documents or drawings	0.130	3
R8	Poor quality construction survey	0.055	9
R9	Lack of coordination between project stakeholders (i.e., owner vs. contractor, main contractor vs. subcontractor, etc.)	0.175	2
R10	Inspection and approval work is not in accordance with regulations and procedures	0.213	1

Inspection and approval work not in accordance with regulations and procedures is the risk factor most affecting the quality of the Biconsi Tower project. Acceptance or inspection work is known as a measure of construction quality management. The result will be a good quality project if it is performed carefully. In contrast, project delays may be extensive if the quality check is not guaranteed, as costly remediation will be required. The inspection and acceptance work not being in accordance with the specifications is very common due to the subjective psychology and lack of depth of the construction technicians who directly inspect the work. To overcome this, the Biconsi Tower project should conduct acceptance testing according to the

technical step-by-step process and increase the frequency of daily monitoring and inspection. The contractor's technician-in-charge and supervisor must always follow the process or not underestimate any stage or construction task, no matter how small. In addition, it is necessary to train technicians with expertise in quality inspection and supervision and with the ability to read and understand drawings and master technical standards for each construction work before conducting acceptance. The technicians must also promptly notify and guide the contractor when detecting errors.

The second most important risk factor affecting the quality of the Biconsi Tower project is the lack of coordination between project stakeholders (i.e., owner vs. contractor, main contractor vs. subcontractor, etc.). Good coordination between project stakeholders is crucial for timely information exchange, especially when the owner requests changing design drawings. If this coordination is insufficient, it will lead to the construction work not matching the owner's requested changes, which will lead to rework. For example, this poor coordination may result in the need for a structural part of a project to be added to the main structure or be demolished and reworked. This issue affects the quality of the remaining components of the building and leads to increased costs and delays in the project schedule. To limit this risk, it is necessary to establish a coordination process between the project stakeholders before construction implementation. In that process, the schedule of periodic briefings must be specified, and a list of tasks assigned to each project stakeholder for for a successful project. In addition, communication and the exchange of information between the parties must be enhanced, including from the owner to the supervisor, from the supervisor to the contractors, and from the main contractor to the sub-contractor via a variety of methods such as mail, dispatch, e-mail, telephone, fax, and social media.

The third-ranked quality risk for the Biconsi Tower project is poor-quality design documents or drawings. Concrete constructions, for example, are not built on their whole but require drilling and filling when design problems are discovered, resulting in a significant reduction in overall quality. As a result, the contractor may be forced to demolish a portion of the project, potentially impacting the remaining construction work. To manage this risk, when a construction manager is unsure whether the design drawings are of poor quality or contain errors, they should quickly request another unit to inspect them. Furthermore, throughout the construction phase, site supervision must be strengthened and coordinated between all key project stakeholders, including the supervising consultant, the construction company, and the owner.

Conclusion

This study assists the quality manager of construction contractors who require a foundation for identifying and assessing potential risks that may arise during the construction phase. The research results show that the five top risk factors affecting the quality of the Biconsi Tower project in order of decreasing impact are (1) inspection and acceptance work not in accordance with regulations and procedures, (2) lack of coordination between project stakeholders, (3) poor quality design documents and drawings, (4) poor construction methods, and (5) poor quality input materials. Based on this prioritization of risks, construction managers could either prevent dangers or provide methods to manage them in the current project and future projects of similar scope. This will also help managers minimize the time and effort required to complete the construction project.

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