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Risk Management Techniques in Construction Projects: Development and Assessment of an Innovative Framework

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Abstract: Professional and trade skills are required for handling the construction related projects; Construction industries of the present day however lack useful information concerning different practices, patterns and trends involved in risk management. Considering this, the present study focuses on the aforementioned variables of risk management by quantitative analysis specifically in the domain of construction industry. This study has used IBM's SPSS (Statistical Package for Social Sciences) version 25.0 to analyze the results. This study is an initiative to assess the impact of risk management in the construction sector of Jordan. It will assist the construction sector for exploring the limitations with respect to integrate effective risk management. A sense of competition will be developed through a comparison of risk factors of construction projects among the project stakeholders such as contractors should enhance their risk management practices.

Key words: Construction, Jordanian construction projects, risk assessment, risk treatment.

1. Introduction

Construction is a high-risk market with a weak track record in risk management [1]. Construction is a dangerous business, and construction project operations are much riskier [2]. In the building sector, project performance is primarily determined by the degree of risk [3]. The amount of risk rises as the number of contracting partners, such as vendors, subcontractors, manufacturers, operators, and designers, grows [4]. Risk assessment practices may reduce this degree of risk [4, 5]. Construction projects come in various sizes (small, medium, and large), posing a risk of differing degrees of effects [6]. Frequently, the risk is not adequately addressed, and as a result, the sector suffers from low products [4].

The majority of the infrastructure schemes, due to their size, have large budgets, resulting in significant financial losses, which are caused by the different uncertainties associated with such megaprojects [7]. Failures of this kind had to be detected and mitigated. Risk assessment encompasses the whole method of identifying and mitigating risks [8]. Various scholars have developed a variety of risk assessment systems. Iqbal et al. [4] created a risk assessment system to report the importance of multiple categories of risks and the usefulness of risk management strategies used in construction projects. Aleshin [5] proposed a plan for realistic risk management advice to joint ventures in Russia, which defined, categorized, and evaluated risk incidents. Choudhry and Iqbal [9] described and prioritized typical risks in the construction industry and risk management strategies to resolve those risks, the current state of risk management system adoption in organizations, and obstacles to successful risk management.

Wang et al. [2] proposed a risk management framework, with significant emphasis on identifying

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techniques, processes, and risk evaluation processes for effective mitigation measures. Moreover, the Alien Eyes' Model, a risk model that indicates hierarchical degrees of risk and the affected relationship between the threats, was implemented. From the contractor's perspective, Shen [10] introduces a risk management model for identification of significant risks and their mitigation plans. Furthermore, the use of analytical methods to determine essential risks in the Hong Kong construction industry is limited. Li and Tiong [11] proposed a robust risk management model for identifying and assessing risks in a joint venture project. This model is useful for identifying important risk factors and providing a means to quantify the identified risk in a joint venture project. Project management is concerned with the application of expertise, resources, strategies, and information about project tasks while having the central objective of the project stakeholders' aspirations in mind [6].

The construction industry is one of the most overlooked industries [12]. The identification and management of risks is an essential aspect of project management. The consistency of a method related to the probability of various consequences is known as risk [13]. Risk is an occurrence that affects the organization's goals that can impact the organization's efficiency in terms of low production, high results, and a budget rise [14, 15]. Danger management is regarded as the most critical aspect of construction management implementation [16]. It primarily focuses on the project's triple constraints (time, expense, and quality) and project integration, connectivity, HR (human resources), and the procurement process. It also aids in creating future project visions by recognizing risks and uncertainties [17]. It is defined as a mechanism that aims to identify and evaluate all risks to which the project is exposed to make an accurate decision on coping with the risk [18-20].

According to the findings, many researchers have conducted risk management studies, but Jordan has made very little or no attempt. Many projects in Jordan's construction sector are not finished on schedule or under budget due to insufficient risk management activities. In the building industry, there is also a great need for workers to be trained and educated on risk management practices. This study aims to provide a mechanism to examine risk management strategies and their consequences to produce potential gains for Jordanian construction projects. This research focuses on the risk control practices used by contractors in Jordan's construction industry. The study's primary goals are as follows;

- to study, classify, and rank risk management strategies;
- to recognize and prioritize project performance factors in the construction industry;
- to extend successful risk management skills to construction projects;
- to analyze the relationship between effective risk management and the progress of construction projects in Jordan.

The main goal is to assist contractor companies in managing their future and ongoing contracts by focusing on risk management practices and assessing risk management's impact on construction project performance. The below is a breakdown of the research: Section 2 covers the basics of risk assessment, including concepts and past procedures. Section 3 outlines the present study's theoretical approach, which leads to Section 3's suggested risk management system. The risk management strategies for the current research are described in Section 4. It also contains the results and a review, followed by Section 5, which concludes the analysis.

2. Literature Review

2.1 Risk Identification

Organizations and scholars have identified or referenced many risk assessment frameworks over the years to include a systemic approach to risk. Nonetheless, comprehensive risk assessment can be broken down into three steps: detection, review, and reaction

behavior and controls. According to some scholars, the risk identification process identifies the threats that could harm the company and its programs and recognize their characteristics [8]. It is also known as the method of predicting what will happen and how it will happen [21].

On the other hand, other scholars consider the risk assessment step to be either one of the most critical phases in the risk management process [22] or perhaps the most challenging and appropriate [23]. High life cycle nature, scale, complexity, place, the various parties involved, and familiarity with the performer's work to be done are all factors and key characteristics listed by Ghani [24]. The constant climate change, direct exposure to hazards, the high pressure involved in cost and schedule enforcement, and the sophistication of construction technology are all listed by Zeng et al. [25]. Shen [10] also emphasizes one of the main characteristics: the vast number of individuals of varying desires and skills that must manage a wide range of interrelated tasks. Variability in cost, time, and quality output goals, as well as the uncertainty associated with different issues such as lack of clarification due to the actions of actors involved, as well as a lack of data and detail, are all identified as significant factors in Chapman and Ward's [26] analysis.

2.2 Risk Assessment

Cost and budget overruns and consistency and usability issues are all too common in software development programs [27]. Kwak and Stoddard [27] concentrate on project risk assessment by establishing a clear corporate framework and culture. Warkentin and Willison [28] and Doherty and King [29] address how active threats arising from organizational culture, configuration, and market processes affect technological product development problems, resulting in a wide variety of possible trouble spots. According to a survey, managerial issues are responsible for 65% of project delays. Alter and Ginzberg [30] concentrated on topics related to the information system's corporate recognition and application. They concluded that every system's implementation would be fraught with managerial instability. While the articles mentioned above have focused on operational problems that affect project risks, other aspects such as project-specific, human resource-based, or related to the general context in which the project will be executed have been overlooked. This seems to imply that software project creation is a high-wire act. As a result, risk management from a holistic perspective is critical in software project creation, especially in long-term software projects [31]. Boehm's model [32] proposes a detailed series of measures and recommendations to control the risk associated with software development. Boehm [32] developed a set of risk-management strategies for each of the top ten risk items. The risk management strategies included in this set were: benchmarking, designing costs, incremental development, instrumentation, building morale, pre-scheduling, reusing software, compatibility analysis, cost-benefit analysis, estimating schedule, modeling, checking references, simulation, mission analysis, prototyping, team building, competitive design, inspections, and task analysis. However, the model does not allow for continuous project performance enhancement by updating evolving risk profiles in software projects.

2.3 Risk Treatment Strategies

If negative consequences occur as a result of unavoidable situations, risk incidents detract from project goals. Risk assessment aims to investigate all facets of project management in depth such that all controllable incidents have a course of action or risk avoidance. A constructive strategy, also known as a feedback approach, refers to risk reduction steps taken after risk incidents occur and may be thought of as the start of contingency planning. A proactive or feed-forward strategy, on the other hand, refers to steps taken in response to the likelihood of a dangerous occurrence happening similar to insurance [3, 33]. To

escape danger, minimize the probability of risk, reduce the effect of chance, pass risk, or maintain risk, a mixture of these two methods is used in risk management [34]. After that, using the techniques renders a risk query mechanism, and can be devised and placed on the process model through interactive or collaborative interfaces to collect quantitative and qualitative data. Decision support mechanisms based on the methods are likely to be used to assess risk. Risks that are worth exploring further because they have a high likelihood of happening, having a high potential effect, or contributing to new opportunities are first pursued and handled. This entire risk management process is collective and involves gradual input from all stakeholders within the organization and a strategic project management approach.

3. Methods

The analysis technique used in this study starts with a basic knowledge of risk control. Risk assessment, its methods, and recent risk management findings became the subject of a literature review. A questionnaire (5-point Likert scale) was created based on a literature analysis and dialogue with construction industry top management. It was divided into three sections: the respondent's basic description, questions about the risk management investigation goals, and questions about the performance criteria. Two hundred seventy respondents from the target population completed the questionnaires through field ties (handwritten responses in a face-to-face meeting). Contractor companies identified with the JGTD (Jordan's Government Tenders Directorate) made up the target population. These companies are classified as C1, C2, C3, C4, C5 and C6 based on their tendering cap. This study concentrated on construction projects such as bridges, buildings, roads, flyovers, dams, and infrastructure. Moreover, project managers, senior site managers, planning engineers, deputy project managers from different constriction companies were included as the target population in this study.

Various respondents are working on multiple initiatives that fall under different JGTD registration groups. The two firms with the categories C1 and C2 obtained the most samples, with 34.4 percent and 32.2 percents, respectively. Furthermore, 58.5 percent of the people who provided data were extremely experienced (> 20 years of experience). Based on their previous knowledge, it can be assumed that the information gathered is accurate and credible. 35.6 percent and 21.5 percent of the comments received from deputy project managers and project managers, respectively, attest to the data's accuracy and reliability. Furthermore, infrastructure ventures accounted for 41.1 percent of the samples, with 47.1 percent of the projects costing > 30 million JD.

The suggested risk management system is presented here with significant emphasis on the risk management process (risk recognition, risk evaluation, and response) and the problem-solving of the detected and evaluated threats (risk treatment). In addition to project completion, the risk assessment period must be implemented as predicted in the report. Using risk identification methods, the risk occurrence is identified [6, 8, 16].

- Examining the source and effect of risk [18, 35, 36].
- Using risk response strategies to assess and respond towards the risks [8, 9, 15].
- Using risk treatment strategies to deal with the risk event's risks and opportunities [8, 37, 38].
- Using the risk assessment cycle to help the contractor companies in succeeding on different projects.

Contractors are a significant stakeholder in the construction ventures in Jordan. The contractor is responsible for using the entire budget and scope and is also responsible for maintaining its timeline. Over the life cycle of building projects, the contractor is the only one of the stakeholders that have to deal with different risks [38, 39].

The researcher used IBM's SPSS (Statistical Package for Social Sciences) version 25.0 to analyze

the results. Estimating the sample population means, rating of techniques based on their means, and similarity analysis are all part of the analysis. The study's findings were deemed meaningful at the 0.05 level and particularly significant at the 0.01 level. The rating in this analysis was dependent on the mean of a population sample. The survey population's mean values were used to rank risk assessment strategies and project performance variables. Means with a higher value were ranked first, while those with the lowest value were ranked second. The Spearman rank correlation test, denoted by the symbol, was used to determine the nonparametric intensity in interaction or path between two variables depending on the measurement scale (r-Rho). If there was no relationship between the variables, the null hypothesis (H0) for this test was justified. If the finding was statistically crucial at the 0.05 level or highly significant at the 0.01 level, it was rejected. The impact of risk management's effectiveness on the success of a project was tested by finding the correlation between effective risk management and project success.

4. Results

An overview of successful analysis of applied techniques is provided by risk management technique implementation with the comprehension of project success. It further offers a correlation analysis indicating the association between obtained benefits and applied technique. This section discusses results for application of three phases.

Risk identification techniques were computed and structured from most often used to less often used, on the basis of their means. Additionally, participants have identified the extent of usage on scale of 1 to 5, on which 1 showed never used and 5 represented always used. Table 1 indicates the ranking of risk identification techniques on the basis of their means for examining the procedure of effective risk management. Lesson learnt from the past project was ranked most often used by participants among the risk identification techniques and ranked 1st on the basis of its mean. Nominal group techniques were ranked 12th in this group as they were less important. Risk identification is the preliminary footstep of risk evaluation, which encompasses the identification and categorization of possible risk factors conducted related to construction projects. Questionnaire surveys, historical information, interviews, workshops, and brainstorming were the widely used approaches that help in identifying the risks.

Risk response and risk assessment techniques were computed and structured from most frequently used to less frequently used on the basis of their means.

Table 1 Risk identification techniques.

Techniques	R
Mind mapping	4
Brainstorming	9
System or process flow charts	11
Lesson learned from the past project	1
Strength, Weakness, Opportunities, and Threats (SWOT) analysis	8
Nominal group techniques	12
Checklist analysis	6
Cause and effect diagrams analysis	5
Risk review meetings	2
Root cause analysis	10
Expert judgment	7
Delphi technique	8
Scenario analysis	11
Interviews	3

Table 2 Risk assessment and risk response techniques.

Techniques	R
Work Breakdown Structure (WBS) & expert judgment	1
Business contingency plan	2
RMP (risk management plan)	3
Qualitative & quantitative analysis	3
Risk urgency assessment	4
Cost-benefit analysis	5
Consultation with experts & meetings	6
Prioritizing the risk	7
Risk index method & expected monetary value	8
Data gathering and representation techniques	9

Additionally, participants were asked for responding to classify the extent of usage on a scale of 1 to 5. The ranking of effective risk management is shown in Table 2. Expert judgment and WBS was the most frequently used technique and ranked 1st on the basis of mean. In addition, the least important technique was data gathering and representation technique, which was ranked 9th in this group. The risks identified are computed in the risk evaluation process via statistical analysis either quantitative or qualitative. Moreover, other effective tools to evaluate the potential risk and to minimize the likelihood of avoiding the risk event are lesson learned and WBS. Additionally, WBS determines the type of design needed for building a project and undertakes the resources through which work is conducted.

Risk treatment techniques were computed and structured from most often used to less often used. Additionally, the findings have shown the ranking of risk treatment techniques for investigating the process of effective risk management undertaken by any organization during projects. Table 3 shows risk treatment techniques in construction projects. The most often used risk treatment techniques include decision-making and mitigating the negative risk, based on the mean. The effect of risk can protect the project if the risk is avoided. Moreover, the risk of the project can be reduced by modifying the management plan entirely. In this regard, the best resources should be selected that should be allocated for minimizing the time of completion, or the risk for accomplishing project objective.

Project success factors were computed and structured by most frequently used to less frequently used on the basis of its means. Additionally, participants were asked to identify the level of usage on a scale of 1 to 5, on which 1 represented never used and 5 represented always used. Table 4 shows the means and ranking of project success factors on the basis of their means examining the criteria of project success. The most important project success factor was "no complaints and claims" and ranked 1st on the basis of its mean. On the contrary, the least important project success factor was "completion of the project throughout schedule". The examination of project success factors refers to the point at which majority of construction projects are undertaken successfully when the project baseline is accomplished and targets captured and when all the technical specifications are fulfilled.

Table 3 Risk treatment techniques.

Techniques	R
Decision making	1
Variance & trend analysis	7
Mitigating the negative risk	1
Reserve analysis	4
Accepting the positive risk	5
Exploiting the positive risk	3
Avoiding the negative risk	2
Transferring the negative risk	6
Sharing the positive risk	7

Table 4 Project success.

Techniques	R
No complaints and claims	1
Overall project quality objectives meet based on baseline and targets	7
Confirm all technical specifications	1
Fulfill all quality standards	4
Fulfill scope/no changes in scope	5
The project is within the planned budget	3
Completion of project within schedule	2

5. Conclusion

An innovative framework is presented in this study for risk management in the construction sector of Jordan. In this regard, a survey-based study was carried-out, which intended to examine the risk management practices utilized in construction projects in Jordan. This study is an initiative to assess the impact of risk management in the construction sector of Jordan. It will assist the construction sector for exploring the limitations with respect to integrate effective risk management. A sense of competition will be developed

through a comparison of risk factors of construction projects among the project stakeholders such as contractors should enhance their risk management practices. This initiative triggers the evolutionary procedure to change the perception of all contractors for investing in risk management practices for effective productivity.

The study indicates several elements of risk management practices by examining the insights of the major contractors in the construction industry. The findings of the study offer an opportunity to assistant project managers, senior key members, and project managers of a project for ensuring current and upcoming projects by following risk management techniques. Highlighting the outcomes from an initial perspective is that the level of risk identification procedures used in the construction sector of Jordan is low.

Author Contributions

Khatatbeh A. A. conducted the research, analyzed the data, prepared the manuscript and approved the final version.

Conflict of Interest

The author declares no conflict of interest.

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