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THE ROLE OF RISK MANAGEMENT IN IMPROVING THE EFFICIENCY OF CONSTRUCTION PROJECT IMPLEMENTATION

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Abstract: The study aimed to investigate the role of risk management in improving the efficiency of construction project implementation, through a comprehensive study that highlights the importance of adopting risk management systems as a basis for achieving high performance in projects. The research addresses the basic stages of risk management, starting from identifying potential risks and assessing their impact, to developing mitigation strategies and continuous monitoring throughout the project life cycle. The research highlights how these measures contribute to reducing unexpected costs, limiting time delays, and ensuring the application of quality and safety standards, which enhances confidence among stakeholders and investors. In addition, the study reviews the multiple challenges facing construction projects, such as material price volatility, environmental and regulatory challenges, as well as technical and social factors that may hinder achieving the desired results. The study also addressed the risk mitigation hierarchy that guides taking preventive steps starting with eliminating or replacing the risk, through the use of engineering and administrative controls, with suggestions for future research that include expanding the sample scope, integrating modern technologies such as artificial intelligence and the Internet of Things in risk management, and conducting long-term international comparative studies to improve current models.

Keywords: Risk management, construction projects, implementation efficiency, construction challenges, modern construction techniques, environmental sustainability.

Introduction

Risk management in construction projects is one of the key factors that determine the success and continuity of the project (Etezady, 2016; Lu, 2020). Due to the complex and diverse nature of construction projects, the risks that may be encountered vary greatly, from financial challenges to technical issues, time delays, and environmental risks (Fourie et al., 2010; Guidetti et al., 2022). To ensure that the desired objectives are successfully achieved, it is essential to adopt effective strategies to manage these risks. Risk management in construction projects is a systematic process that aims to identify, analyze, and evaluate the risks that may affect the project, and then take the necessary measures to deal with them. This includes developing strategies to manage risks and planning to deal with potential problems before they turn into real crises (Belas et al., 2021; Wolkowski, 2021). The main goal of risk management is to reduce the impact of potential risks on the project, which contributes to achieving the desired results on time and within the specified budget. One of the most important modes of production is the project production mode. Building houses, buildings, bridges, roads, manufacturing aircraft and ships, establishing factories, writing doctoral theses, preparing graduation projects by students in various specializations, and developing new products are just examples of different projects (Choi et al., 2016). We often hear and read about huge programs implemented by countries or international organizations, where

each program contains a number of different projects (Höglund et al., 2021; Skipper & Hanna, 2009). For example, projects to combat poverty or projects to develop mathematics curricula, for example, or any other science (Sajjad et al., 2015; VanHoy, 2021). The success of any of these projects depends primarily on the existence of effective management that plans and monitors the project activities, schedules its activities correctly, and takes the necessary measures to expedite the completion of some activities to meet the commitment to complete the project on time. The role of management is not limited to a specific stage of project implementation, but rather begins from the beginning of the project and does not end until the end of the project. Here, management must determine all the requirements for each activity, as well as parallel activities, i.e. those implemented together at the same time (Ali & Beh, 2019). It is also necessary to identify potential bottlenecks and obstacles to address or avoid them, as well as determine a timeline or sequence for completing each activity and its start and end dates, with an organized distribution of material and human resources among them. Among the important duties of management are analyzing the deviations that occur, preparing control reports, and then taking the necessary corrective measures to correct the situation. Completing the project with the least risks is a common general goal for all projects of all types (Ali & Beh, 2019; Butler, 2000; Okate & Kakade, 2019).

Method of processing and analysis:

The researcher adopted the office method and theoretical analysis enhanced by forms that help in conceptual framing and formulating ideas clearly due to the lack of sufficient documented case studies of different projects that can support the applied aspect of the role of risk management in improving the efficiency of implementing construction projects(Oppong et al., 2017). The current study is enhanced by practical cases to give this theoretical framework greater support, but this does not diminish the importance of the subject and the necessity of raising the problem due to its importance to everyone working in project management and improving the efficiency of implementing construction projects (Gbadamosi et al., 2018).

Literature Review

Construction projects are a fundamental pillar of economic and urban development in any country, as they contribute to building infrastructure, providing housing, and developing public facilities. However, these projects face significant challenges resulting from their technical complexity, long implementation periods, and multiple parties involved, in addition to being affected by external factors such as economic fluctuations, weather conditions, and legislative requirements (Cho, 2017; Zeng & Li, 2022). In this context, risk management emerges as a vital tool to enhance implementation efficiency, avoid failure, and ensure that objectives are achieved within the specified timeframe and budget (Young et al., 2021). Risk management is considered one of the basic knowledge required in project management as well as managing the company's operations in general, and it is one of the critical factors in the success of the project because it ensures that risks are properly monitored and mitigated to avoid becoming problems, and risk management is a concept that is used in all industries in all sectors, so each industry has set its own risk management standards, but the general ideas of the concept usually remain the same regardless of the sector (Bromiley et al, 2014). Project risk management is one of nine parts of project operation, which indicates a strong relationship between risk management and project success, as the concept of (RMPs) is called risk management processes, as it is a systematic integrated approach to managing the company as a whole and not at the department level (PMI - Project Management Institute, 2000) based on the total commitments in a way that helps management achieve its goals

by identifying and estimating the total risks that affect the value of the facility and the implementation of the strategy at the company level in order to manage those risks (Kaplan and Mikes, 2012). Therefore, understanding and managing risks is essential for organizations and projects to identify potential problems and address them proactively, make informed decisions, and allocate resources. Effectively, and protection from negative events, by adopting a systematic and organized approach to risk management, organizations can enhance their ability to achieve goals, improve performance, and ensure long-term sustainability (Al-Zaabi and Al-Jaghbir, 2019). Through this topic, we will address two requirements, the first of which addresses the nature of risk management in terms of the concept and the relationship between risk management and uncertainty, in addition to the relationship with the current business environment, and identifying the risk environment, while the second requirement addresses the nature of risk management in terms of the concept, objectives, principles, roles, risks, and finally the reasons and challenges of the ineffectiveness of risk managemen (Abualrejal et al., 2017; Li & Yu, 2013; Serpella et al., 2014)t.

Risk Management Concept

A risk in any project can be defined as an uncertain event or circumstance that results in a negative or positive impact on the project objective (PMBOK, 2002, P127). Every risk has a cause and a consequence. For example, the cause may be the limited qualified workforce available for the project or the unsuitability of this workforce for the tasks assigned to it. Thus, the result or consequence will appear clearly in the additional cost or the defect in the work schedule and the length of the implementation period or the quality of implementation. As for the project conditions that can lead to the occurrence of risks, the most important of them are mismanagement or inefficiency or reliance on external participants in implementing the project who cannot be monitored and their performance controlled (Seok et al., 2015). There are some known risks, which are those risks that have been diagnosed and analyzed and can now be planned for, unlike unknown risks that cannot be managed, although project managers can deal with them by implementing general contingency plans based on past experience gained through the implementation of previous projects. There are risks that are considered opportunities, which are risks that threaten the success of the project but are accepted when they are balanced against the rewards that will result from them(Crail, 2006; Etezady, 2016). An example of this is accelerating and adopting a quick schedule for project activities, as there is a great risk of not completing them on time and at a high cost, but in return there are great benefits that result from the time gained. The risk management plan means reporting on how to prepare to deal with the risk and the approaches to address it and identifying and coordinating activities. This planning process is very important because it clarifies the subsequent steps that will be taken to determine the level, type and extent of the clarity of the risk in the project and thus the proper treatment of it (Wideman, 2004, p. 145). The first step in preparing the risk management plan is planning meetings, which are held to mature the plan(Serpella et al., 2014). These meetings are usually attended by the project manager, project team leaders, and anyone in the project who has the authority to address some aspects of the risk in the project, as well as the main beneficiaries of the project and anyone who is needed. The plan to be prepared will show how to diagnose risks, the qualitative and quantitative analysis of these risks, as well as the methods of responding to each risk, the implementation process and the type of control that will be exercised throughout the project life cycle. Risk is also known as those unexpected events that may occur in the future under conditions of uncertainty and cause unexpected results that usually negatively affect goals or interests. It is

the total risk, which includes systematic and unsystematic risks. It refers to the possibility of facing negative consequences or undesirable events that may affect the achievement of goals or the success of a project, activity or organization. It also represents a state of uncertainty and the possibility of damage or loss associated with specific procedures, decisions or positions (Al-Aroud, 2023). Risk in any project can be defined as an uncertain event or circumstance that results in a negative or positive impact on the project objective (PMBOK - The Project Management Body of Knowledge, 2002). Risk is a specific circumstance that, if it occurs, there is a possibility of an adverse deviation from the expected and desired result (Hamad, 2008). The Hazard Mitigation Hierarchy is a structured framework used in occupational health and safety to identify and implement preventive measures in a gradual manner according to their effectiveness in reducing or eliminating hazards. This hierarchy ranks measures from most effective to least effective, helping to protect workers and reduce risks systematically. Each level of the hierarchy It is as shown in the following figure1)NIOSH 2010 – 2015) is explained below:

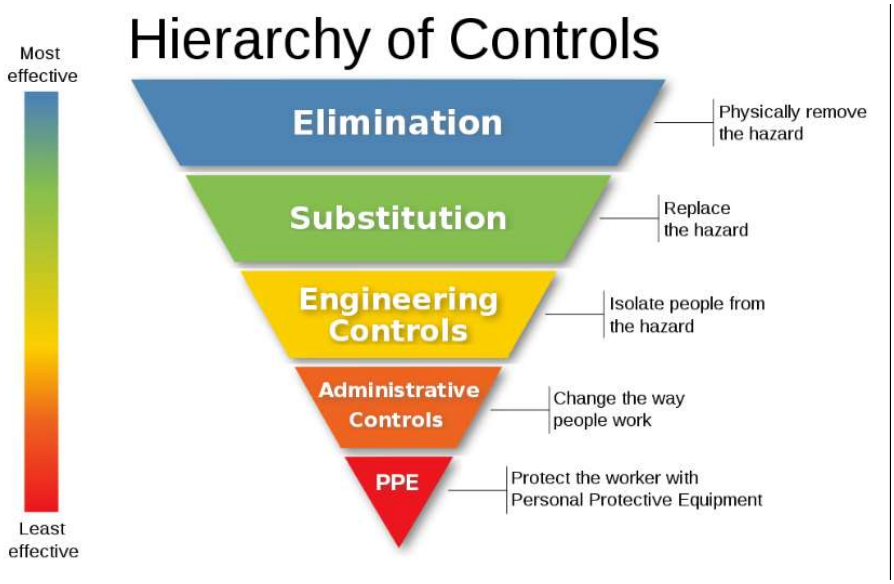

Figure1: risks systematically
Source: NIOSH Strategic Plan Outline 2010-2015, National Institute for Occupational Safety and Health.

Remove the hazard:

Removing the hazard from its source is the best way to protect it, as the hazard is eliminated entirely rather than trying to control it. In the context of construction projects, this may include redesigning a process or selecting a work site that is free of environmental or physical hazards that may threaten the safety of workers(Ho & Ng, 1994).

Replace:

If the hazard cannot be eliminated, replacing it with a less hazardous substance or process is a good option. For example, replacing a hazardous chemical with one that has a lower health impact or using new technology equipment that reduces the risk during implementation (Ionita & Patriciu, 2014).

Engineering Controls:

These include modifying the physical or process environment to reduce exposure to the hazard. In construction projects, protective barriers, ventilation systems, or engineering designs may be used to reduce exposure to hazards from heavy equipment or hazardous materials. Engineering controls are solutions that rely on physical changes to provide a safer working environment.

Administrative controls:

These measures focus on changing worker behaviors and organizing work processes to reduce risks. This includes establishing strict policies and procedures, setting precise schedules, and providing training and educational programs to improve risk awareness and emergency procedures. It also includes organizing working hours and reducing continuous exposure to risks.

Personal Protective Equipment:

Personal protective equipment is the last resort in the hierarchy, used when other measures are not sufficient to reduce risks to acceptable levels. This equipment includes helmets, goggles, special shoes, and other protective tools. It is important to emphasize that relying on PPE alone is not the best option unless there are no more effective options, and it should be used as an addition to other measures, not as a substitute for them.

This hierarchy shows the importance of taking preventive steps starting from the complete elimination of risks and ending with the use of personal protective equipment as a last resort. Thus, the system helps in achieving a safe and organized working environment, which contributes to protecting workers and improving the efficiency of implementation processes in construction projects (Bendo & Mitchell, 2017; Huang & Hu, 2015).

The importance of construction projects and their challenges

Construction projects are considered one of the most important investments that support economic growth, as they attract local and foreign capital and contribute to increasing productivity and providing job opportunities (Awalekar et al., 2019; Bendo & Mitchell, 2017; Huang & Hu, 2015; Okate & Kakade, 2019; Terouhid & Ries, 2016). For example, developing infrastructure such as roads and bridges is essential to facilitate the movement of goods and services between cities and rural areas, which leads to stimulating local and international trade. Construction projects also contribute to raising the standard of living of the population by creating adequate housing, hospitals, schools and entertainment centers that meet the needs of the community. Providing effective public transportation services also contributes to reducing traffic congestion and improving the urban environment. In addition, by creating public facilities, green spaces and parks, construction projects contribute to creating a cohesive community environment that enhances social interaction and integration among community members. This reflects the interest of government agencies and investors in developing communities on solid and sustainable foundations. In addition, adopting modern technologies in implementing construction projects such as geographic information systems (GIS), 3D modeling and digital project management systems enhances the ability to plan, implement and monitor, which leads to improving the quality of implementation and reducing costs (Karimi & Rahimi, 2020). These projects also encourage research and development in the fields of engineering, materials and technology, which contributes to raising the level of innovation. With the increasing environmental awareness, construction

projects are seeking to apply sustainability standards in the design and implementation of projects, such as the use of environmentally friendly materials and the application of energy-saving and recycling techniques. This approach contributes to reducing negative environmental impacts and achieves a balance between urban development and the preservation of natural resources. Despite the great importance of construction projects, they face many challenges that may affect their success and the achievement of their goals. The most prominent of these challenges can be summarized as follows (Dulaimi, 2022; Hussain & Huei Xian, 2019; Jahankohan & Mirmohammadsadeghi, 2018; Johnson & Babu, 2020; Karimi & Rahimi, 2020):

High costs and price volatility:

Controlling costs is one of the biggest challenges in construction projects. The prices of raw materials and labor are affected by global and local economic factors, which leads to sudden changes in the budgets allocated to projects. In addition, the volatility of energy and building materials prices may lead to exceeding planned costs, which requires periodic review of financial plans and the implementation of effective budget management strategies.

Time delays and schedule:

Time management is one of the most important factors that determine the success of a project, as any delay in implementing the project stages leads to negative effects on the overall schedule and delivery of the project on time. Delays are usually caused by supply chain issues, unexpected changes in project requirements, or external factors such as adverse weather conditions or logistical problems.

Technical and technological challenges:

Construction projects face technical challenges related to the complexity of engineering design and the application of modern technologies. It is necessary to use modern programs and technologies for planning and monitoring, but this requires additional investments in training and technology. Lack of technical expertise can also lead to design or implementation errors that affect the quality and safety of the project.

Environmental and regulatory risks:

Construction projects are subject to strict regulatory procedures related to environmental and health safety. These projects require obtaining licenses and permits from the competent authorities, and changes in environmental laws or policies may complicate the implementation process. Moreover, the impact of the project on the local environment, such as noise and air pollution, requires the implementation of advanced preventive measures to ensure compliance with international and local standards.

Risk management and coordination of different parties:

Given the complex nature of construction projects that involve many parties such as contractors, consultants, and regulatory authorities, coordinating work between them represents a major challenge. Effective risk management systems must be in place to monitor progress and address issues as they arise. This requires regular risk assessments and the development of contingency plans to deal with any emergency that may affect the workflow.

Qualitative risk analysis

Qualitative risk analysis typically involves assessing the likelihood of a risk occurring based on its subjective characteristics and the impact it could have on the organization using pre-defined rating scales. The impact of a risk is often rated into three levels: low, medium, or high(Etezady, 2016). The likelihood of a risk occurring can also be expressed in the same way or rated as a probability of occurrence, ranging from 0% to 100%. As the PMI-RMP® Risk Management Professional course syllabus states, the qualitative risk analysis process involves several interrelated steps, as shown in the attached figure. The process begins with gathering the necessary inputs, such as the project management plan and risk register. Appropriate tools and techniques, such as expert judgment and risk likelihood and impact assessment, are then used to analyze and assess the risks. Finally, project documents, such as the risk register and risk report, are updated based on the results of the analysis, as shown in the following figure (Etezady, 2016; M. Badubi, 2017; Owusu-Boadi, 2019):

Figure2: Quantitative risk analysis (https://bakkah.com/ar/knowledge-center/risk-management-projects)

Quantitative risk analysis uses numerical models and attempts to allocate a specific amount of money to adverse events, representing the potential cost to the organization if that event occurs, as well as the probability of the event occurring in a given year. In other words, if the expected cost of a major cyber-attack is $10 million and the probability of an attack occurring during the current year is 10%, then the cost of this risk would be $1 million for the current year.

The Relationship Between Risk Management and Project Management

Risk management is a pivotal element in enhancing the efficiency of construction project implementation, as it provides an analytical and methodological framework for dealing with potential challenges that may negatively impact schedule, costs, and quality of implementation. This process relies on identifying and assessing risks early, enabling teams to develop contingency plans that contribute to reducing negative impacts and transforming risks into opportunities to enhance performance. The risk management process also includes several stages, starting with identifying all potential risks that the project may face, such as supply delays, climate change, technical risks, and occupational safety risks (Etezady, 2016). At this stage, various analysis tools are used, such as SWOT analysis (strengths, weaknesses, opportunities, threats) or cause and effect analysis to identify critical points that may affect the project's progress. Each risk is then evaluated in terms of its likelihood of occurrence and impact on the project, allowing for prioritization of dealing with it according to its degree of severity(Etezady, 2016; Fourie et al., 2010; Gauche et al., 2017; Wu & Cheng, 2018). The next stage includes developing risk mitigation strategies, where preventive and proactive measures that can be applied are identified. For example, this may include adjusting implementation schedules, securing additional resources to cover emergencies, or even using modern technology to monitor progress and manage risks on a regular basis. This approach also helps ensure effective communication between all stakeholders in the project, which enhances transparency and trust and contributes to making decisions based on accurate data. On the other hand, risk management is a means of improving implementation efficiency by integrating it into the overall project planning process (Islam & Barghouthi, 2017; Moustaghfir et al., 2020). By applying risk management principles, resources can be redistributed more effectively, and weaknesses in design and implementation can be identified before they occur. This process also allows investors and stakeholders to be reassured that the project is being managed to the highest standards of quality and safety, which contributes to improving business relations and enhancing mutual trust. Risk management is also increasingly important in construction projects due to the complex and multifaceted nature of these projects. Construction projects often face challenges related to coordinating activities between specialized teams and dealing with market variables and local and international legislation (Belas et al., 2021; Guidetti et al., 2022). Hence, the vital role of risk management in providing continuous monitoring mechanisms and periodic updating of the strategies followed, so that they remain compatible with the changing circumstances that may affect the project. Thus, risk management contributes to reducing the gaps between plans and implementation reality, leading to higher levels of operational efficiency. The application of risk management systems is based on international standards such as ISO 31000, which provides detailed guidance on how to apply best practices in this field. This standard is based on a comprehensive risk assessment that includes all aspects of the project, which enhances the management team's ability to make quick and informed decisions (Belas et al., 2021; Guidetti et al., 2022; Höglund et al., 2021; Sajjad et al., 2015; Skipper & Hanna, 2009; VanHoy, 2021). Moreover, digital technologies such as project management software and data analysis tools can play a major role in improving the accuracy of risk prediction and monitoring the implementation of preventive measures (Al-Sayed et al., 2022; Al-Shammari, 2021). Thus, risk management appears as an indispensable strategic tool for improving the efficiency of construction project implementation, as it contributes to mitigating potential risks and transforming them into opportunities for improvement and innovation. Through advance planning, effective communication, and the use of modern technologies, construction projects can achieve a balance between achieving set goals and dealing with unexpected challenges (Abdul Ganiyy et al., 2017; Hayes et al., 2015; Nygard et al., 2021). This integrated approach not only helps avoid financial

and time losses, but also enhances the quality of implementation and establishes a professional work culture based on analysis and prevention (Okate & Kakade, 2019).

Conclusion

In light of the comprehensive analysis presented on the importance of construction projects and the challenges associated with them, we find that risk management is the fundamental pillar that ensures the success and sustainability of the implementation of these projects. Construction projects represent the vital engine of economic and social development, and play a pivotal role in improving the quality of life by providing an integrated infrastructure that meets the growing needs of society. However, the complexity of these projects and the multiplicity of their parties make them vulnerable to many risks that may negatively affect the schedule, budget, and quality of implementation. On the economic level, construction projects contribute to stimulating growth by creating direct and indirect job opportunities, and enhancing local and foreign investments. However, the volatility of raw material prices and changing market conditions pose a major challenge that may lead to exceeding planned costs. Here, the role of risk management emerges in developing flexible financial plans based on periodic analysis of price fluctuations and identifying alternative strategies to address any unexpected changes, which contributes to maintaining budget stability and achieving expected returns. From the technical side, technological development in the construction sector has led to the use of advanced tools such as 3D modeling, geographic information systems, and digital project management tools (Crail, 2006; Seok et al., 2015). These technologies improve the accuracy of planning and monitoring workflow, but they require significant investments in training and upgrading technological infrastructure. Hence, the importance of adopting risk management strategies that include assessing technological readiness and ensuring that human cadres are able to deal with these technologies effectively, ensuring maximum benefit from them and avoiding errors that may lead to delays or increased costs. In terms of the environment and regulation, international and local standards impose significant challenges on construction projects in terms of compliance with environmental legislation and safety standards. Failure to comply with these standards may lead to the project being halted or financial penalties being imposed that affect its economic feasibility. Therefore, implementing risk management systems becomes essential to identify environmental risks and develop proactive strategies to mitigate their impact, such as adopting environmentally friendly building materials and applying energy-saving technologies, which contribute to reducing negative impacts and protecting natural resources. Time challenges are also a major factor threatening the success of projects, as delays resulting from problems in supply chains or urgent design modifications can lead to project delivery being postponed, which negatively affects confidence among investors and stakeholders. To address this aspect, careful planning and periodic assessment of time risks are effective tools in ensuring that the project adheres to the specified schedule, in addition to developing alternative plans that contribute to overcoming obstacles without radically affecting the workflow. The social and political aspect cannot be overlooked, which adds another dimension to the challenges of construction projects. Changes in government policies, social conflicts, and even local community reactions can directly affect the success of the project. Hence, the importance of transparency and continuous communication between all parties appears, as this helps in building mutual trust and avoiding any friction that may prevent achieving the desired goals. Global experiences show that risk management is not just a precautionary measure, but rather a comprehensive strategy that contributes to transforming challenges into opportunities for innovation and improvement. By applying the hierarchy of risk reduction, starting from removal and replacement to the use of engineering and administrative controls and finally personal

protective equipment, the best solutions can be identified to minimize risks to the minimum possible. This integrated approach is an effective tool in improving implementation efficiency and ensuring the achievement of quality and safety standards. The future of the construction sector requires the adoption of renewed policies based on innovation and technology while simultaneously taking into account economic, environmental and social aspects. All stakeholders – from governmental and private institutions – must work in close coordination to develop integrated risk management systems that contribute to enhancing operational efficiency and project sustainability. Investing in this field is an investment in a promising future that ensures comprehensive development and improving the quality of life for future generations.

Limitations and future research

This study aimed to understand the role of risk management in improving the efficiency of construction project implementation. However, it was not without some limitations that should be noted, in addition to providing suggestions for future research that could contribute to the development of knowledge and practices in this field, as the study relied on a limited set of available data and sources, whether from previous studies or from industrial reports. This has affected the generalization of the results to a wider range of construction projects, as the difference in work environments and local legislation may lead to a diversity of results when applying the same methods in different geographical and economic contexts. Despite attempts to collect diverse data, the number of projects included in the study was relatively limited. The focus was also on specific projects in specific sectors, which may limit the comprehensiveness of the results and make it difficult to generalize them to all types of construction projects, whether large or small, governmental or private. The research also relied heavily on secondary sources such as academic and professional reports and articles. Despite the accuracy of these sources, relying on them may lead to data gaps or continuous updates that may not be sufficiently integrated into the study, affecting the freshness and credibility of the results in light of the rapid changes witnessed by the construction sector. The study recommends expanding the scope of the research to include wider samples of construction projects in different regions and countries. Field studies can be conducted that combine quantitative and qualitative data to provide a more comprehensive and accurate view of the impact of risk management on implementation efficiency. Diversifying the sectors included in the research (residential, commercial, industrial) will also help in drawing more general results and achieving a deeper understanding of the role of risk management in improving implementation efficiency and developing better practices that are in line with modern requirements. Investing in this future research not only contributes to enhancing the industrial and operational performance of construction projects, but also represents a step towards achieving environmental, social and economic sustainability in light of ongoing global changes.

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