

Integration of Technology Risk Management in Engineering Projects for Project Success

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ABSTRACT

Risk management in engineering projects, particularly those involving technology, is a very important element to ensure the success and smooth running of the project. Risks relating to the use of technology can potentially disrupt project objectives, such as delays, additional costs, or reduced quality. It is important for organizations to identify, analyze, and manage these risks effectively. This research examines approaches that can be applied to mitigate technology risks in engineering projects, including risk identification techniques, risk analysis, and possible mitigation measures. With the implementation of structured risk management, organizations can reduce potential losses and increase the chances of project success. The research also discusses the importance of evaluation of the technology used in the project and effective communication between stakeholders. With proper mitigation measures, technology risks can be controlled, allowing projects to achieve their desired goals more efficiently.

INTRODUCTION

In recent years, risk management has become an important aspect of managing engineering projects, mainly due to the increasing complexity and uncertainty associated with such projects. Engineering projects often involve advanced technologies and processes that require the integration of various elements, resulting in higher potential risks. Risk management is key to identifying, analyzing, and mitigating potential risks that may arise. With the right approach, organizations can reduce the negative impact of unforeseen risks and ensure smooth project execution (Khatatbeh, 2016).

Based on engineering projects, the risks faced stem from external factors such as market fluctuations or regulatory changes, and also from internal factors, including technology design, system failures, or delays in material procurement. Projects developing advanced infrastructure, like renewable energy or large constructions, require risk evaluation to anticipate potential technical issues. Ghaffari (2013) noted that effective risk management in engineering projects depends on the ability to anticipate and respond to unforeseen changes, often driven by technological innovation.

One of the key issues faced in engineering project risk management is the uncertainty in identifying and assessing risks associated with new technologies. Engineering projects often involve unproven or first-time technologies, which can add complexity to risk assessment. For example, the application of technology in infrastructure development involving advanced IT systems or the use of new materials can present high uncertainty in terms of system performance and integration. This makes it difficult for project managers to determine appropriate mitigation measures at the planning and execution stages (Mills, 2017).

Risk mitigation approaches in engineering projects often lack the flexibility to accommodate rapid changes in technology or market dynamics. In some cases, the risk management implemented may not be able to respond quickly enough to emerging risks during the implementation phase of the project, especially when the project deals with fast-evolving technological innovations (Hillson, 2018). This lack of adjustment to change can lead to ineffectiveness in managing risks that could actually be potentially detrimental to the overall success of the project.

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It is important to review and improve risk management approaches in engineering projects given the rapid development of technology and the challenges faced by organizations in dealing with risks related to new technologies. The inability to identify and address technical risks can lead to failures in project execution, which can further affect the cost, time and quality of the final project deliverables. Successful risk management in engineering projects relies heavily on the ability to adapt quickly to changing technology and dynamic market conditions. The risks must be addressed in a proactive and planned manner to ensure project success and operational sustainability (Bhadange & Khedikar, 2018).

The purpose of this research is to understand effective ways of identifying and analyzing technology-related risks in engineering projects. By focusing on mitigation techniques that can be applied at the planning and implementation stages, this study aims to develop an approach that is more adaptive and responsive to changing technology and project dynamics. This research is expected to provide insights to improve the success of engineering projects through more effective risk management.

RESEARCH METHOD

The literature study approach to reviewing risk management in engineering projects focuses on collecting and analyzing relevant information from various existing literature sources, such as books, journals, industry reports, and case studies. The process begins with a search for sources that discuss risk management theory and its application in engineering projects involving advanced technology. This literature study aims to gain a deeper understanding of the various approaches that have been applied in the past, as well as to identify knowledge gaps that may exist in risk management, especially regarding new, rapidly evolving technologies (Zhao et al., 2018). By utilizing existing literature sources, this approach can provide useful guidance in forming a theoretical basis for further analysis of the application of risk management engineering in engineering projects.

This approach allows the researcher to sift through more relevant and credible information, as well as to analyze and compare existing findings in various related studies, whether conducted in industry or academia. Through literature analysis, various risk management techniques and models that have been applied in different types of engineering projects can be examined in more depth. This approach also allows researchers to gain a broader understanding of how external and internal factors,

such as technological changes or regulatory factors, can affect risk management approaches in engineering projects (Chien & Chen, 2020). By examining these various sources, this research can make an important contribution in suggesting best practices in risk management of engineering projects involving high technology.

RESULT AND DISCUSSION

Risk management in engineering projects is a very important element in ensuring the success of a project, especially when it involves the use of advanced technology. On engineering projects that are often large in scale and high in complexity, the uncertainties that come with implementing technology can increase the potential for project failure if not managed properly. This approach allows projects to anticipate potential technical, operational, and managerial issues that may arise during the implementation process. It is important for organizations to have a structured approach to identifying, analyzing, and managing risks associated with technology. In this case, project managers must be able to anticipate various problems that may arise and plan appropriate mitigation steps to minimize negative impacts on project success (Muriana et al., 2017). With careful risk management, the chances of a successful engineering project with advanced technology can be significantly increased.

For this reason, the research on how to manage technology risk in engineering projects is very relevant. Not only to avoid potential financial losses or delays, but also to ensure that the technology implemented can deliver optimal results in accordance with project objectives. Careful risk identification and analysis of potential threats lay the foundation for more effective mitigation measures. With proper risk management, organizations can minimize the negative impact of technology on the project and keep the project on track to achieve the desired goals (Ibeh et al., 2017). The importance of collaboration between engineering and risk management teams cannot be overlooked either, as this synergy will strengthen mitigation strategies and increase the chances of overall project success (Kayis et al., 2008). Solid collaboration enables a more comprehensive understanding of risks and more integrated and responsive solutions. This collaboration creates an environment where innovation can flourish, allowing teams to respond quickly to changes and challenges that arise during the project lifecycle (Chen et al., 2012). This is key to the success of complex engineering projects that rely on advanced technology.

The risk management process in engineering projects is a complex and structured activity, which aims to anticipate and mitigate the impact of technological risks that can occur during the project lifecycle. This process relies on the use of risk management tools, and involves effective communication between stakeholders, the use of proven technologies, and continuous evaluation of project progress. All of these steps aim to create an ecosystem that is more responsive to technology risks that can arise suddenly, while ensuring that any challenges can be addressed with appropriate mitigation measures. This whole process, if done right, will create a more resilient, adaptive, and responsive project management ecosystem. With an understanding of technology risk management, organizations can improve the overall performance of engineering projects (Shahzad & Safvi, 2008).

Identifying, analyzing, and managing technology-related risks in engineering projects requires a comprehensive and systematic approach. The first process in risk management is risk identification, which involves mapping out the potential risks that may arise during project execution. Based on technology, these risks are often related to hardware or software failures, incompatibility of new technologies with existing systems, or unexpected technical limitations (Kwak et al., 2018). Identifying these risks requires collaboration between project managers, engineers, and technologists to ensure that all aspects of the technology used in the project have been thoroughly considered. One effective approach is through brainstorming methods or group discussions, where various stakeholders can reveal potential problems that may arise (Hillson, 2017). This collaboration also helps avoid individual bias and improves accuracy in recognizing project-specific risks.

Once risks have been identified, the next step is to analyze those risks to assess their probability and impact on the project. Risk analysis involves measuring the severity of each risk's impact and the probability of that risk occurring. One frequently used method for risk analysis is the risk matrix, which categorizes risks based on two main dimensions: probability and impact. This helps project managers to prioritize risk handling. Other techniques such as sensitivity analysis and failure analysis can be used to dig deeper into how certain technologies can affect the course of the project (Müller et al., 2019). In engineering projects involving technology, these analyses are important to ensure that potential technical failures will not hinder the achievement of project goals.

After the analysis stage, the next step is risk mitigation planning. Managing technology risks in engineering projects requires planning and implementing appropriate mitigation measures to reduce the probability and negative impact of the identified risks. One commonly used approach to risk mitigation is the development of a contingency plan, which includes alternative solutions in the event of unforeseen technology issues. The use of proven technologies that have a good track record is also an important mitigation strategy, as it can reduce the uncertainty associated with adopting new, unproven technologies in the field (Gulati, 2019). In this case, project managers need to conduct an evaluation of the credibility and reliability of the selected vendor or technology provider to ensure that the products and services they offer meet the required quality standards.

Managing technology risks in engineering projects also involves implementing a sound risk management system, which includes conducting regular risk monitoring and control. This includes overseeing the implementation of technology in the project and ensuring that all identified risks are addressed in accordance with the mitigation plan that has been developed previously. In this case, the project manager needs to work closely with the technical team to ensure that each phase in the technology implementation is done correctly and according to plan. The implementation of an effective monitoring and control system can help identify potential technical issues early on and allow for adjustments before they escalate (Aven, 2018). This system also serves to oversee whether mitigation procedures are effective and as expected.

Effective communication between the project team and relevant stakeholders also plays an important role in technology risk management. Clear and open communication allows stakeholders to share relevant information about potential technical risks, as well as ensuring that appropriate solutions can be taken quickly if problems occur. This timely and relevant information enables more responsive and strategic decision-making, so that risks can be anticipated or addressed before they develop into bigger problems. Good communication can also help ensure that the entire project team understands their role in risk mitigation and knows what needs to be done if technology risks arise (Aven, 2018). Project managers should ensure that there is a forum for regular discussion of existing risks, as well as updates on the status of risk management, to minimize negative impacts to the project. Engineering projects can have a greater chance of managing technology risks by maintaining active and structured communication.

It is important for organizations to have human resources who have adequate skills and understanding of the technology used in the project. The technologies used in projects are often complex and evolving, requiring a deep understanding from team members. Training and skill development in technology is needed to ensure that project team members can handle technical issues effectively. When project personnel have the appropriate technical skills, they can more quickly understand system requirements, adapt work processes, and collaborate more efficiently. These skills also enable them to assess the impact of technological changes on project objectives. In some cases, specialized training on the technology to be used in the project can help the team to be better prepared to face challenges that may arise during the project (Lichtenstein et al., 2020). By improving the technical capabilities of the team, organizations can reduce potential risks caused by a lack of technical knowledge or skills.

Technology risk management also involves the use of project management tools or software that can assist in identifying and monitoring risks. These tools are often equipped with the ability to track project progress, identify emerging issues, and provide recommendations for risk management in real-time. Effective use of risk management software allows project teams to mitigate risks faster and more efficiently. The tool can also assist in creating risk reports that are easily accessible to all relevant stakeholders, thereby increasing transparency in risk management (Wallmüller, 2002). Utilizing technology in risk management not only improves operational efficiency but also strengthens collaboration between team members, allowing them to work in a more coordinated manner and be responsive to changes (Tsiga et al., 2017; Jarrah et al., 2022). With an integrated system, teams can more easily share information and solutions, thus creating a proactive work environment in facing project challenges (Samad & Ikram, 2006).

Although technology offers a variety of tools and approaches that can be used to manage risk, no one approach can guarantee success in all situations. It is important for project managers to be able to adapt and select appropriate mitigation strategies related to the project and the technology being used. The selection of the right technology and relevant mitigation strategies can greatly determine the success of a project, especially in engineering projects involving advanced or new technologies (Bannister et al., 2018). In some cases, inappropriate selection of mitigation approaches can worsen the situation and increase project risks.

In some engineering projects involving technology, the uncertainty associated with technology risk can often be exacerbated by external factors, such as regulatory changes or market competition. This kind of risk often cannot be controlled by the project manager directly, but should still be anticipated from the start of planning. In managing technology risk, it is also important to consider external factors that can affect project success. Project managers need to understand how changes beyond their control, such as changes in government regulations or fluctuations in raw material prices, can affect the course of the project and change the priority of risks to be managed (Couto et al., 2020). By considering external factors thoroughly, project managers can increase the project's resilience to unforeseen disruptions and keep the project's goals within reach despite changing external conditions.

The importance of evaluating the technology used in the project cannot be ignored. This evaluation process includes an assessment of the suitability of the technology to the technical and operational needs of the project, including its ability to solve the specific problems encountered. This evaluation aims to assess whether the applied technology fits the needs of the project and provides added value that is proportional to the costs and potential risks involved. In some cases, seemingly sophisticated and attractive technologies may not fit the specific needs of the project, and may risk adding complexity without providing significant benefits. Careful evaluation of the technology used in the project is a crucial step in effective risk management (Gulati, 2019). This process not only helps in identifying the best technology options, but also supports more informed decision-making in managing risks.

The development of a risk management policy that includes technology risk is a strategic element in the implementation of engineering projects. Technology risks can arise from various aspects, such as system failure, integration incompatibility, and cybercrime. For this reason, the preparation of risk management policies involving technology risks must be done carefully. Organizations need to have clear guidelines on how technology will be applied in the project, as well as mitigation measures to be taken in case of problems. This includes the creation of standardized procedures to be followed when facing technical and technological issues. With a comprehensive risk management policy, organizations can minimize potential problems associated with the application of technology in engineering projects (Hillson, 2017). The policy also ensures that the entire project team follows the same procedures in managing technology-related risks.

Identifying, analyzing, and managing technology relate with technology in engineering projects is a task that requires a holistic and continuous approach. Through careful identification, in-depth analysis, and effective mitigation, organizations can minimize the negative impact of technology risks on project success. Proper implementation of mitigation strategies, good communication, as well as regular evaluation of technology are key to reducing risks and increasing the likelihood of success of complex and challenging engineering projects (Smith, 2014). With this kind of continuous and comprehensive approach, organizations are not only able to reduce the negative impact of technology risks, but also increase the chances of overall success of engineering projects, especially those that are complex and challenging.

Overall, technology risk management in engineering projects plays a very important role in ensuring that the project runs smoothly and successfully. In many cases, the technology used can provide great potential benefits, but it also carries risks that cannot be ignored. It is important for project managers to have a solid understanding of the various risks that may arise related to the technology being used. This awareness is the basis for building a comprehensive technology risk management system. With the right approach, such as careful risk identification, in-depth analysis, and effective risk management, organizations can minimize potential losses and ensure that projects can be completed according to expected quality standards (Ward & Chapman, 2011). Good technology risk management shapes a work culture that is more adaptive and responsive to change, creating a project environment that is more stable, scalable, and prepared for future complexities.

The implementation of a structured risk management system, the use of proven technologies, and clear and regular communication between stakeholders are the keys to success in managing the risks of engineering projects involving technology. Evaluation of the technology used in the project must be carried out periodically to ensure that the technology is suitable for the project objectives and can function properly under the conditions encountered during the project. This evaluation includes the technology's performance, level of reliability, as well as suitability to the changing needs of the project. Regular evaluations allow organizations to immediately adjust strategies or make improvements before bigger problems occur. With the right mitigation strategy, technology risks can be better controlled, so that project success can be achieved more optimally.

Finally, technology risk management in engineering projects is not just about avoiding problems, but rather managing existing uncertainties in an effective and proactive manner. In the context of often complex and dynamic engineering projects, technology risks cannot be completely eliminated. The success of a project largely depends on the ability to deal with emerging challenges, adjust strategies, and make improvements quickly and appropriately. With a culture of data-driven decision-making and regular risk evaluation, projects can not only survive disruptions, but also thrive through continuous learning and improvement. By applying sound risk management principles, organizations can increase the probability of engineering project success and ensure that technology risks will not hinder the achievement of set goals. Risk management is not only a control tool, but also a strategic component in achieving the long-term success of engineering projects.

CONCLUSION

Risk management in engineering projects, especially those involving technology, is important to ensure the smooth and successful running of the project. Risks arising from the use of advanced technology, be it hardware or software, can pose significant challenges to project success. These risks can arise from various sources, such as hardware system failure, software instability, imperfect system integration, and cybercrime. With the right approach, such as careful risk identification, in-depth analysis, and structured risk management, technology risks can be controlled and mitigated. Good management reduces potential losses and helps in achieving project objectives in accordance with the time, cost, and quality that have been set. Technology risk management is not only a form of protection against possible failure, but also a strategic tool to ensure that the project achieves its main objectives.

For this reason, it is advisable for organizations involved in engineering projects to continuously improve managerial capacity in terms of risk management, especially those related to technology. The application of appropriate risk management tools and techniques, as well as continuous evaluation of the technology used, will assist in minimizing potential unforeseen risks. Effective communication between all stakeholders and an understanding of the technology being used are also key elements in successful technology risk management. With these steps, organizations can ensure that projects run smoothly and can achieve predetermined goals without being disrupted by uncontrollable technology risks.

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