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Examining The Impact Of Risk Management Strategies On Minimizing Delays And Cost overruns In Large-Scale Construction Projects

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ABSTRACT:

Construction projects in modern days are complex due to the potential challenges that can cause budget overshoot and project delays. The study aims to identify the effect of risk management solutions to reduce delays and cost overrun issues in large-scale construction projects. According to the findings of the previous literature, labour shortage is a major concern that causes delays and defects in the building process. Workplace safety training is vital for ensuring that the project is completed by following appropriate measures. On the other hand, collaboration and communication with all the stakeholders of the project is paramount to make effective decisions which is essential to meet the outcomes of the project in a successful way. However, risk management is important for ensuring the success of the project. Monitoring the risk management procedure is imperative to identify the potential challenge that can impact the overall project outcomes. Real-time monitoring tools can be used for identifying warning signs and following preventive measures.

Primary quantitative and secondary qualitative data are collected in this paper. The primary quantitative data is collected by organising a survey using Webropol. The survey link was shared with professionals from the construction industry. Total of 54 survey responses were received. Additionally, secondary data was collected from previously published academic journals and articles. Mixed data is used in the study to successfully meet the objectives of the research. According to the findings of the research paper, it is clear that effective risk management strategies are fundamental to avoid delays and cost overrun issues in construction projects. In this regard, companies need to monitor and evaluate the overall project functions in a suitable manner. Providing appropriate training to the employees associated with the project is also key for developing their skills and abilities in order to mitigate the risk. Additionally, multiple kinds of new technology can be used by the company for early detection of the possible risk in the project.

A risk management framework must be included for determining the possible risks in the construction project. Moreover, this study includes effective knowledge and meaningful insights about the project management procedure. Appropriate implementation of the risk monitoring process can help all the project stakeholders enhance risk preparedness and reduce the likelihood of any disruption. As a result, better project delivery can be ensured by the construction companies. In future, the research can be done in a more effective way by including primary qualitative data. Increasing the budget and the time for the research can help to collect more qualitative data for this research. Appropriate identification of the key elements of large-scale construction projects can help to follow sustainable approaches that can develop construction companies and provide them success.

KEYWORDS: Risk Management, Cost Overruns, Project Delays, Construction Projects. Mitigation Strategies, Large-Scale Project, Project Management

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Abbreviations

PMBOK	Project Management Body of Knowledge
ISO	International Organisation for Standardization
JIT	Just In Time
PMI	Project Management Institute
BIM	Building Information Modelling
CPM	Critical Path Method
FMEA	Failure Mode and Effects Analysis
LEED	Leadership in Energy and Environment Design
BREEAM	Building Research Establishment Environmental Assessment Methodology

1 INTRODUCTION

1.1 Introduction

Large-scale construction projects cause significant risks that can cause and delays. Therefore, it adversely impacts the project outcomes which is a major concern of the construction companies. Appropriate risk management strategies are crucial to mitigate, anticipate and manage the uncertainties in the whole project lifecycle. Due to the large scale and complexity issues in projects it failed in completing the projects in the allocated time within the project. The study aims to align how multiple risk management methods influence the reduction of cost overruns and delays. Determining the key risk factors as well as mitigation methods, the research focuses to provide detailed insights into developing the project efficiency.

1.2 Background

The “construction sector” is globally identified for the vulnerability of the risk associated with factors such as unforeseen site conditions, design changes and the fluctuating cost of the materials. All these risks can lead to budget escalations and project delays, especially in large-scale projects. Previous studies have highlighted that inadequate risk planning as well as response mechanisms are the main contributors to these failures.

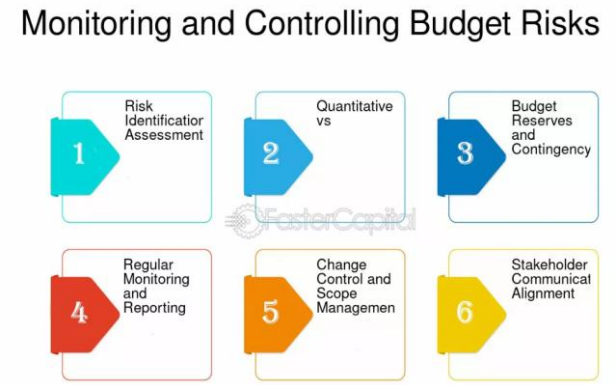

Figure 1. Budget risk control (Source: fastercapital.com, 2025)

The rising investment in infrastructure development and understanding the role of risk management is crucial for the success of the project (Jiang *et al.* 2021). The study is

“based on the existing literature” and new information for identifying the systemic risk identification process and strategies for improving the outcomes in “large-scale construction projects”. However, the current practices of project management provide a structural as well as proactive approach in order to identify the risks as well as an assessment strategy (Pomaza-Ponomarenko *et al.* 2023). There is a need to identify a well-defined as well as systematic approach to create a risk management framework which can influence the project performance. “The study seeks” to identify the gap by evaluating the effect of risk management strategies in reducing delays as well as causing overrun issues in large-scale construction projects.

1.3 Problem statement

“Large-scale construction” projects are associated by “cost overruns and delays” that pose major challenges for stakeholders including contractors, developers, governments and investors. Despite the advancements in project management techniques and tools, multiple projects fail to meet their initial budget and time expectations (Shabbir *et al.* 2023). The recurring challenges impact the economic viability of the projects and can undermine credibility and trust within the construction sector. The main contributing factor to the failures is the “inadequate application of risk management methods”. The risk in the construction ranges from regulatory changes and design errors. Furthermore, labour shortage is another challenge that can impact the project budget. In the opinion of Flyvbjerg (2021), sometimes material fluctuation is either poorly managed or underestimated by the project managers. Multiple studies have acknowledged the presence of risks in the construction process. Hence, there is a gap in determining the “effectiveness of risk management strategies” in cost overruns and mitigating delays in large-scale projects with complexity.

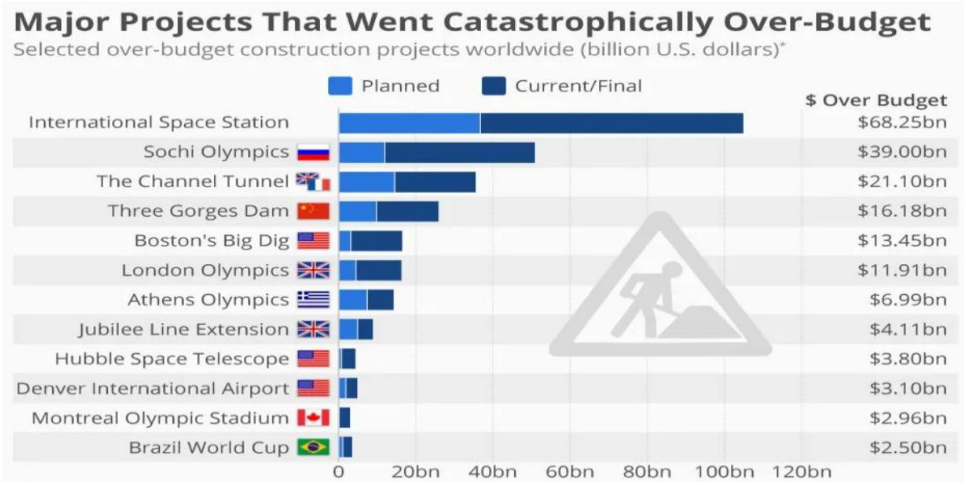

Figure 2. Overbudget projects (Source: McCarthy, 2018)

1.4 Rationale

Cost overrun and delays remain a persistent issue in the large-scale construction project that leads to financial losses as well as reputational damages. Risk management is identified as a critical part of the project's success (Shayan *et al.* 2022). However, mitigating all these challenges needs for the investigation process and the study is crucial for identifying the real-world practices in the risk management procedure. Examining the effectiveness of multiple strategies the study will provide crucial knowledge to the contractor's project manager and policymakers for developing their planning, reducing uncertainties and developing overall outcomes of the project in the construction industry.

1.5 Aim and objectives

Aim: "The aim of this study is to" analyse the effect of risk management solutions for reducing "delays and cost overrun issues" in large-scale construction projects.

Objectives

- To identify the reasons for cost overrun and delays in "large-scale construction projects"
- To suggest effective recommendations for construction project organisations, stakeholders as well as policymakers for developing risk management models and getting project outcomes

1.6 Research question

What is the effect of risk management solutions for reducing delays and cost overrun challenges in large-scale construction projects?

1.7 Scope of the study

This study will provide details regarding the “risk management methods” in “large-scale construction projects” which will ensure effective project outcomes. Hence, the main reasons for cost overrun and delays will be highlighted and discussed in detail by including primary and secondary data in this study.

1.8 Structure of the research

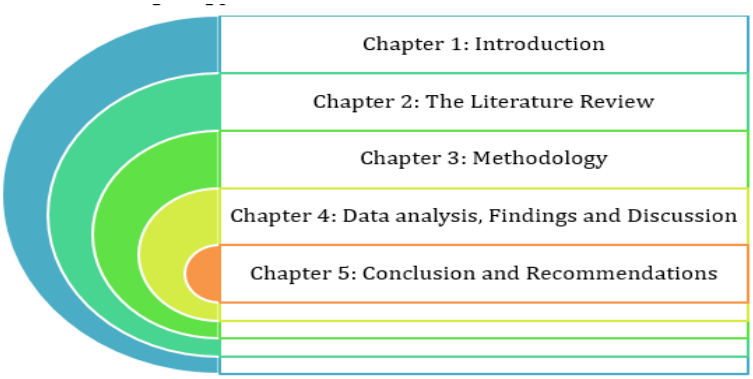

Figure 3.“Structure of the research” (Source: Researcher)

2 LITERATURE REVIEW

2.1 Introduction

Risk management is one of the fundamental aspects of project management, particularly for high-profile construction projects where uncertainties are the norm. These projects have numerous stakeholders, enormous resources, and extended timeliness, thus being susceptible to different uncertainties, including financial uncertainties, regulatory complexities, and sudden environmental uncertainties.

Proper risk management involves the identification of potential hazards, analysis of their impact, and implementation of preventive or mitigative measures (Rehman, 2024). For the Project Management Institute (PMI), systematic risk management improves the chances of success for projects by ensuring maximum quality of the decision-making process and the avoidance of disruptions. Modern construction projects are founded on risk assessment tools such as Building Information Modeling (BIM) and predictive analytics for the possibility of predicting future pitfalls and constructing stronger barriers against uncertainties.

Proper risk management processes enable project managers to foresee such problems and respond accordingly. For example, risk allocation in contracts, contingent planning, and computerized monitoring systems have enabled the minimization of financial and operational uncertainties. Application of risk management models such as the ISO 31000 and the PMBOK guidelines also improves the capacity of the project to manage the risk in the best possible manner. This review of the literature will summarize work already undertaken on risk management on construction sites, where priority will be given to the main risk factors resulting in delays and over budget.

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2.2 Understanding Risks in Large-Scale Construction Projects

2.2.1 Definition and Types of Risks

As per the study developed by qizi and Komilovich, (2024), financial risks on a construction project include cost fluctuations, insufficiency of funds, and unexpected costs on the overall budget. Financial risks can be initiated by inflation, fluctuating material prices, budgeting errors, or changes in interest rates. Ineffective financial management can lead to cash flow issues, and ultimately project delay or abandonment.

Iroha, Watanabe and Satoshi, (2024), shows in their study that, operational risks are inefficiencies in the project's performance, such as lack of labor productivity, safety, and inefficient use of resources . These risks primarily occur due to poor supervision, lack of team coordination, or inefficient training of employees. Inefficient communication between subcontractors and contractors also leads to delays, quality defects, and additional costs.

Construction activities entail compliance with local, country, and international regulations. Regulatory risk entails the procurement of licenses, compliance with environmental regulations, and compliance with safety regulations (Willis, 2024). Non-compliance can lead to fines, suspension of the projects, or suits.

Figure 4. Financial Risk (Source: Sorted, 2023)

Lima, (2024), conducted the study that shows, external threats are initiated by the unexpected parameters of weather, natural disasters, political unrest, and supply

disruptions. Environmental risks include floods, earthquakes, and temperature fluctuations that may impact the timing and readiness of the material.

2.2.2 Common Causes of Cost Overruns

As per the study of Moosazadeh et al., (2023), Inaccurate initial budgeting is among the causes of cost overruns. This is when the data are inaccurate, assumptions are unrealistic, or contingencies are not anticipated. Pessimistic estimates of the costs can make the project financially insufficient, whereby the project managers will be required to raise further financing or sacrifice quality in favor of keeping the costs to a minimum.

Ascari, Bonam and Smadu (2024), show in their study, that material prices are susceptible to fluctuation due to market forces, exchange rates, and global supply chain trends, particularly in the context of various economic cycles. Unpredictable surges in the price of materials such as steel, concrete, or timber can lead to gargantuan cost overruns, particularly in long-term projects with open-ended pricing. This risk could be mitigated through the application of fixed-price contracts.

As per the study developed by AlololeIbimAmadi (2023), sequential design modifications as a result of inadequate planning, client alterations, or regulatory approval issues can lead to cost overruns. Such changes necessitate additional work, labour, and materials, resulting in increased times and costs. Feasibility studies and stakeholder consultation prior to this may minimize such risks. On the other side, Nguyen et al., (2025), say that late procurement, ineffective selection of suppliers, and inept negotiation strategies can create excess costs. Mismanaged procurement operations cost more in terms of materials and services, and ill-defined contracts lead to conflict, claims, and financial loss. Terms and conditions stated correctly in contracts and supplier contracts can help contain costs within parameters.

Based on the study of Aslam and Baffoe-Twum, (2024), Poorly conceived project timelines result in enormous time overruns. All projects are bound to be condemned when unrealistic timelines, inaccurate estimation of the workload, and lack of contingency planning dominate. Utilization of improved scheduling tools like the Critical

Path Method (CPM) and Building Information Modeling (BIM) can boost the efficiency of operations and management of time.

One of the sectoral issues of the construction sector is also a lack of adequate skilled manpower, specifically for mega projects requiring specific skills. They all encompass high labor turnover, not training of the workforce, and union strikes, all of which can cause delays in work advancement (Maqbool et al., 2023). Reduced labor productivity due to an inappropriate environment of supervision, safety hazards, or motivation also causes delays. To ensure skilled and efficient labor, good planning, competitive wages, and extensive training programs need to be implemented.

As per the study of Rasshyvalov et al., (2024), it can be said that construction operations are based on the uninterrupted supply of equipment, machinery, and materials. Interruptions in the supply due to delays in shipment, geopolitical tensions, or manufacturer shortages can interfere with the work's progress. Failure to acquire the required materials forces the projects to delay and incur additional expenses. COVID-19 revealed the fragility of global value chains, which emphasized strategic purchasing, alternative sourcing, and inventory processes such as Just-in-Time (JIT) logistics for risk management. Unforeseen weather patterns like heavy rain, high temperatures, and catastrophes can cause severe danger to the schedule. Project schedules in hurricane, earthquake, or monsoon-risky areas need to incorporate weather-proof construction procedures and backup strategies (Bednarski, 2023). Labor efficiency, equipment efficiency, and quality of materials also vary with seasons. Schedules need to be adjusted with the help of forecasting tools by project managers to minimize the loss of schedule by the environment.

The study developed by NyagaGithae, Hagir and Alowo, (2024) shows that any delay in issuing permits required for the work, environment clearances, and government approvals can result in delays to the work. Any regulatory variations during work execution can result in design changes or additional compliances and thus cause delays and additional expenses. Incorporating the regulatory authorities and attorneys from the outset can prevent delays and regulatory intricacies.

2.3 Theoretical Frameworks in Construction Risk Management

The projects' risk management is within the control of the formal processes and structures for the definition, analysis, and reduction of uncertainty (Zhang, 2024). Conceptual models of risk deliver processes through which the disturbances are possible to be anticipated and managed by the project manager for the realization of the projects.

2.3.1 Risk Management Process in Construction Projects

Risk management throughout construction is achieved by the structured process of identification, evaluation, minimization, and monitoring. Effective risk management ensures uncertainties are dealt with before their effect across the project duration, cost, or quality.

Figure 5. Risk Management Process in Construction Projects (Source: RIB, 2024)

Risk identification is the initial process of risk management, which implies identifying risks that may impact the project (Zhang, Zhang and Gong, 2024). It includes the assessment of both internal and external elements, such as financial fluctuations, operational inadequacies, environmental factors, and regulatory needs. Techniques applied to this end are mostly brainstorming, expert views, examination of past data, and risk checklists.

Once risks have been established, they must be assessed based on their likelihood of occurrence and consequences. Their assessment employs qualitative as well as

quantitative methods, i.e., risk matrices and statistical analysis, to rank risks in order of their severity (Xue et al., 2024). Tools such as SWOT analysis and sensitivity analysis assist project managers in deciding exposures and finding priorities for required risk response. The dynamic and complex nature of large-scale construction projects has experienced a series of cost overruns over the years. According to researchers, AI-based models are able to better control uncertain, complex, and vulnerable relationships of risk-cost network of construction projects (Afzal *et al.* 2021). AI models can predict the potential risk associated with construction project.

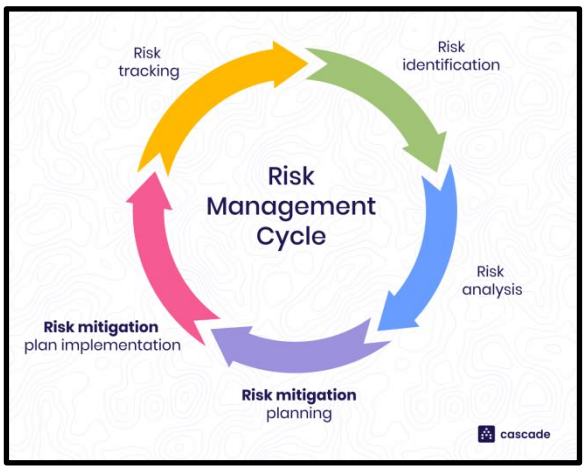

Figure 6. Risk Mitigation and Response Strategies (Source: Cascade Team, 2023)

The purpose of risk mitigation options is to reduce the probability or impact of the calculated risks. These strategies include risk avoidance (adapting arrangements for avoiding threats), risk reduction (taking preventive steps), risk transfer (applying contractual or insurance arrangements), and risk acceptance (evaluating and accepting the danger and then developing contingency plans) (Anderson et al., 2023).

Risk management is an ongoing procedure that is always incomplete and continuously needs to be monitored. This entails managing confirmed risks, acknowledging developing risks, and updating reaction plans throughout the project life cycle (Abrahams et al., 2024). Risk registration, performance reporting, and real-time monitoring tools are tools used by project managers to catch warning signs in time and institute preventive measures.

2.3.2 Existing Risk Management Models

The project work by Maria Clara Egie, (2024), Project Management Body of Knowledge (PMBOK) of the Project Management Institute (PMI) is a global standard for managing projects. PMBOK is a process of dealing with risk which are strongly emphasized. These are risk identification, qualitative and quantitative risk analysis, risk response planning, and risk monitoring and control. Moreover, through extensive planning, and integration of the risk process into the project management processes, PMBOK significantly increases the proactivity of risk management.

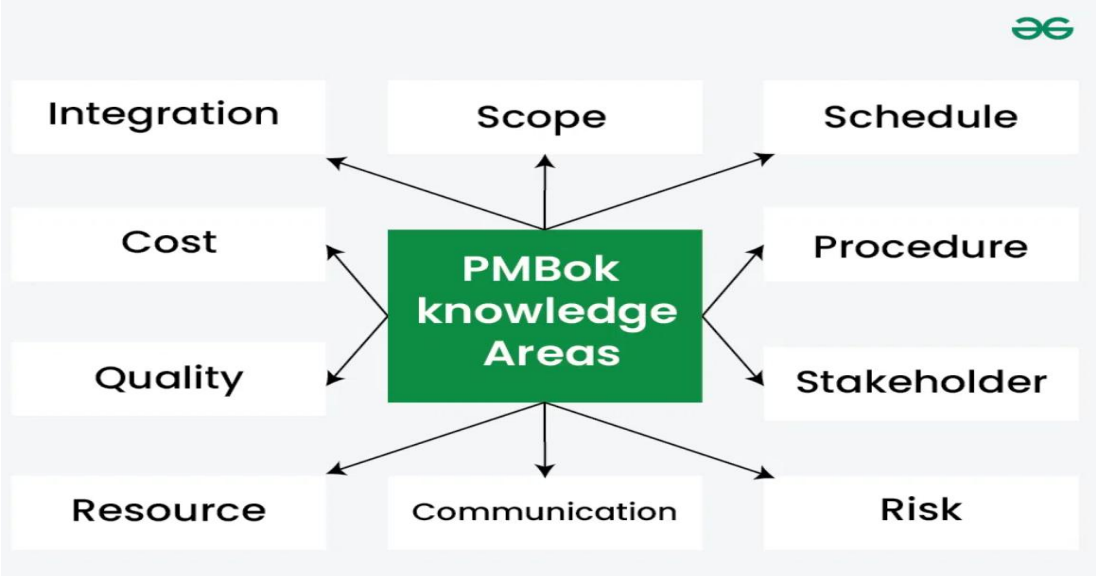

Figure 7. PMBOK Knowledge areas

The study conducted by ArіefRahmana, (2024), ISO 31000 is one global standard for risk management guidelines and principles that applies to all industries, including construction. The methodology is risk assessment-based through a systematic, transparent, and context-relevant process. This includes identification of risk, assessment of risk, treatment of risk, and monitoring. ISO 31000 enables combining risk management within the company decision-making process to such an extent that risk sensitivity is accepted in planning, taking, and fulfilling phases of a project. On the other hand, the BIM system is a technology that uses computer modelling to foster several stages of planning, simulation, execution, design, construction, and development

(Tabejamaat *et al.* 2023). The implementation of proper decision-making methodologies is crucial to address the challenges in construction projects.

FMEA is an official methodology that identifies possible points of failure within a system and prioritizes their effects. Within the construction field, FMEA is utilized for identifying design deficits, material deficits, and operation inefficiencies as they start, rather than allowing them to be full-fledged risks (Pathak et al., 2024). FMEA includes an examination of failure modes, effects, and ranking corrective actions. FMEA is universally applied within the fields of engineering and construction risk management for improvement in safety, reliability, and efficiency by managing failure points through a structured process.

F. Acebes et al., (2024) shows that, Monte Carlo Simulation is an analytical tool of quantitative risk analysis based on the use of probability distribution models to estimate probable project outcomes (F. Acebes et al., 2024). For construction risk management purposes, this method of simulation is applied to forecast cost fluctuations, schedule risks, and resource availability through the execution of multiple scenarios. Based on the analysis of hundreds of simulations, project managers can identify risk exposure and make informed judgments.

2.4 Strategies for Minimizing Cost Overruns and Delays

2.4.1 Proactive Risk Management Strategies

As per the opinion of Odejide and Edunjobi, (2024), the identification of risk in the early stages allows the project manager to provide for mitigation against disruptions. Predictive analytics, risk registers, and feasibility analysis allow business companies to identify probable risk costs and timing. Budget buffers, schedule buffers, and contingency plans can all be allocated through the application of contingency planning for dealing with the unforeseen. Building Information Modeling (BIM) enhances risk management by providing project data in real-time, collaborative work, and reduced construction errors. BIM allows project managers to model various scenarios and

improve resource assignment (Yilmaz et al., 2024). BIM also eliminates the need for rework as it detects design inconsistency before actual construction.

Value engineering looks for optimization of segments of the project for maximum utilization for minimal costs (Hamid, Sadik and Hasan, 2024). Value engineering quantifies the use of substitute materials, construction techniques, and design modifications for cost-saving opportunities without loss of quality. Cost-benefit analysis allows stakeholders to compare several solutions for the project and determine the most financially savvy solution for cost avoidance over-blow.

2.4.2 Financial and Contractual Risk Management

Diriye and Ogbazghi, (2024) provide their opinion at, fixed-price contracts provide certainty of budget but create discord when the cost of a project increases. Cost-plus contracts provide flexibility but necessitate strong cost-control processes. More recent variants such as the Guaranteed Maximum Price (GMP) contracts are being embraced by many for risk-sharing by the contractor and client vis-à-vis budget certainty. Inflation and fluctuating material prices can havoc on building budgets. Inflation provisions for contracts shield against inflation by fluctuating the price base against general standards (i.e., indexes of the cost of materials) (Abasolo and Montefrio, 2024). This shields the contractor from inflationary burdens while making the client budget-conscious.

In order to, promote efficiency and punctuality, most projects have adopted the incentive type where the contractors are incentivized for being finished on time or for coming in under budget for expenses (Pule, 2024). This promotes more productivity and does not encourage unnecessary addition of extra expenses.

2.4.3 Supply Chain and Procurement Strategies

Relying on a single supplier poses the threat of delays. Supplier diversification and finding backup suppliers guarantee the presence of building materials regardless of market volatility or political ties (Butt, 2024). Multiple supplier strategic relationships increase the resilience of the supplier base, reducing the threat of shortages. Just-in-

Time (JIT) inventory management maintains inventory-holding cost low and minimizes wastage by procuring only as needed. Though JIT is economical, its functioning requires tight coordination with suppliers (Bányai, 2024). Supply schedules also become mechanized with the implementation of RFID tracking and AI-based forecasting software.

Brandín and Abrishami, (2024) provide their opinion on digital technologies such as blockchain-based tracking platforms that render supply chains transparent. Blockchain provides a tamper-evident history for transactions, thus eradicating fraud and conflict. IoT sensors for logistics networks also ensure real-time tracking of materials, providing the capability of the project manager to estimate likely delays during delivery and implement necessary adjustments. Firms depend on suppliers to obtain 80% of components and materials (Cigolini *et al.* 2022). The temporary collaboration between organisations in construction supply chains shows how risks can hamper project performance. Procurement helps to effectively establish the conditions of supply chain.

2.4.4 Workforce and Labor Management

Labor shortages for skilled workers cause delays and defects in the building process. Worker training investment improves efficiency and reduces the degree of error (Habu and Oni, 2024). Workplace safety certification and workplace safety training of employees guarantee compliance with workplace regulations, reducing the incidence of workplace accidents that lead to delays in the building process. The application of technologies that automate the processes, including the application of 3D printing and robot bricklaying, assists in alleviating shortages of labor through increased efficiency (Dindorf and Wos, 2024). Off-site manufacturing, in which parts are fabricated and assembled at the site, shortens the duration of the projects and decreases wastage.

Subcontractor delays will cause the projects to be behind schedule. Having clear performance benchmarks and monitoring subcontractors through the contract terms will reduce delays (Heston, Wulandari and Fernando, 2024). In addition, online platforms, such as building management software, enable tracking of subcontractor

progress and communication among different sets of projects. AI and robotics possess the potential to solve issues in the construction industry by automating the unsafe and physically challenged roles (Faheem *et al.* 2024). Smart robots and AI can assume repetitive, impractical, and hazardous roles from workers on job sites. These technologies improve workforce productivity by managing difficult tasks.

2.4.5 Regulatory Compliance and Governance

Construction companies also have to comply with the law, the environment, health and safety regulations, and the zoning legislation. Government officials regulate the above legislations to prevent avoidable collapses, contaminations, and exploitation of workers (Ononogbo et al., 2024). Having experts from the outset ensures easy handling of complex legislation alongside compliance without additional costs.

Detailed documentation of permits, contracts, and compliance reports reduces exposure under the law. The regular internal audit enables the project managers to identify non-compliance even before the regulatory audit (Yang et al., 2023). Electronic compliance management software such as web-based tracking systems mechanises the maintenance of the records and enables timely regulatory filing.

Green building codes demand energy efficiency design, waste minimization, and the use of eco-friendly materials. LEED and BREEAM certification ensures green building. Implementation of green technologies such as the utilization of solar panels and recyclable materials not only simplifies compliance but also ensures higher value to the project in the long term, and to the environment at large.

2.5 Case Studies and Real-World Applications

Risk management has been the deciding factor of mega-project success and failure. Successful projects illustrate the advantage of soundly planned risk management, whereas failed ones reveal the cost of bad planning and mitigation.

One of the finest examples of effective risk management is the development of the Burj Khalifa building in Dubai (Bakhtyar, Saleh Ahmmad and Horvath-Kalman, 2023). As the

tallest building in the world, the tower had several probable risks like adverse weather conditions, engineering problems, and material supply problems concerning the availability of resources. The construction project went on as expected, however, by embracing cutting-edge Building Information Modeling (BIM) capabilities, careful planning for contingency measures, and well-coordinated interfaces with the supply chain.

Conversely, the Berlin Brandenburg Airport (BER) is a perfect case of the ill effects of amateur risk management, that resulted in cost overrun and delay. Originally slated for delivery in 2011, due to design issues, poor coordination between contractors, and regulatory gaps, it finally opened in 2020, nine years late and billions of dollars over budget (Gemünden et al., 2024). The Big Dig is another case of poor risk management with costs going through the roof, safety issues. The organisational craziness from an initial budget estimate of $2.6 billion to over $14 billion.

2.6 Conceptual Framework

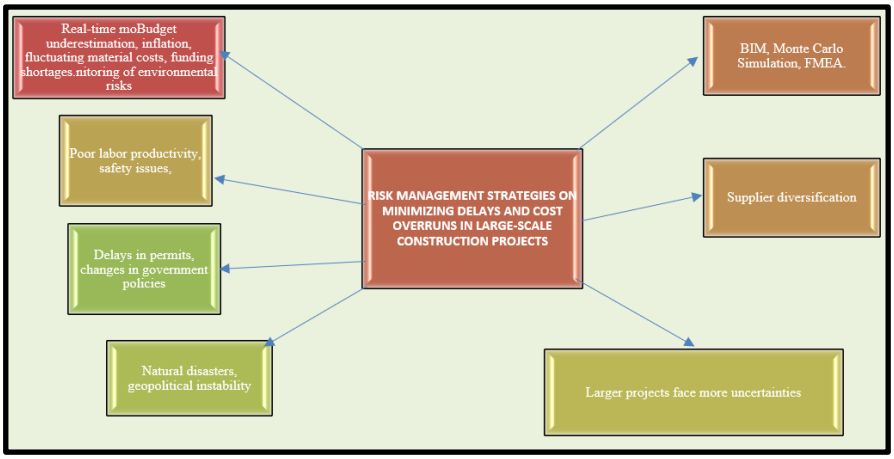

Figure 8. Conceptual Framework (Source: Self-Created)

This Framework introduces risk management techniques within the conceptual framework that aims to avoid cost overruns and delays in megaprojects. It outlines some of the risks — underestimation of costs, inflation, supply chain disruption, labour productivity, regulatory delay and environmental risk. That makes more complicated projects riskier, since they are more complex. On the other hand, various optimum

approaches like supplier diversification, advanced modelling techniques (BIM, Monte Carlo Simulation, FMEA), and real-time surveillance are deployed to reduce these threats to the metal level. As a result of these preventive measures, construction managers are able to improve project efficiency, costing and timely deliveries, leading to successful execution and ensuring financial and operational risks are mitigated to the extent possible.

2.7 Literature Gaps in Construction Risk Management

Construction is changing at a rapid rate, and new technology is coming into the market that is revolutionizing risk management. Machine learning and artificial intelligence are changing the practice of risk prediction by undergoing minute histories of mega projects for cost overrun and delay. AI simplifies decision-making by predicting risk according to trends, simplifying security check, and resource allocation, and thereby eliminating uncertainty in large projects.

2.8 Conclusion

Successful risk management is the only way to avoid delays and cost escalation in mega projects. The critical findings shape the role of financial uncertainties, supply chain failures, regulatory problems, and labor inefficiencies for successful projects. Official risk standards such as the incorporation of the application of ISO 31000 and PMBOK, and the deployment of AI, BIM, and blockchain technologies make the projects successful and less uncertain. Case studies indicate proactive planning, contingent action, and open communication as key determinants for risk reduction.

Shared project forecasts through predictive analytics, electronic monitoring systems, and the social practice of adopting green that will significantly enhance informed decision-making and risk management for both stakeholders and construction managers. The project stability will further improve through the adoption of the practice of using performance-based contracts, workforce training projects, and diversification of the supply base.

3 METHODOLOGY

3.1 Introduction

The methodology chapter helps in outlining the design of the research, data collection and analysis method which can be used for analysing the impact of strategies associated with risk management in decreasing the delays and cost overruns in construction projects which occur large-scale. A structured methodology helps in assuring that the research properly follows and maintains a systematic approach which helps in enhancing both validity as well as reliability of the findings. This study uses a mixed method approach which involves qualitative as well as quantitative data for gaining better understanding about the practices related to managing risk in the construction industry. The primary data will be gathered with the help of surveys by targeting the industry professionals who will provide the measurable and valuable insights about the effectiveness of strategies related to risk mitigations. On the other hand, the secondary data has been collected through academic journals, government publications and industry reports. This research study is aimed to offer effective recommendations for enhancing the managing strategies associated with risk in the construction industry by adopting a structured approach.

3.2 Research onion

A well-structured framework which can be used for providing appropriate guidance in order to develop a research methodology is known as research onion (Gamag, 2025). This framework involves different layers and each of them represents the major aspects of the research procedures which involves research philosophy, approach, strategy, choice, data collection technique and time horizons. This framework helps in designing the methodology in a systematic manner by making effective and informed decisions at every level. As a result, using the research onion in the research study will be significant as it has the ability to provide a logical structure in order to select the most prominent methods of the research. Following the research onion helps in assuring proper consistency as well as coherence in the study. As a result, a decrease in the errors associated with the methodology can be observed.

Moreover, it also helps in aligning the design of the research with the objectives of the research study and enhances the reliability as well as the validity of the findings. This framework is also used for fostering transparency which enables proper justification for selecting a particular choice for methodology (Gamage, 2025). Further, it enhances the flexibility which helps the researchers to implement effective methods on the basis of the scope of the study. Therefore, using the framework of research onion is beneficial to develop a methodology in a systematic manner.

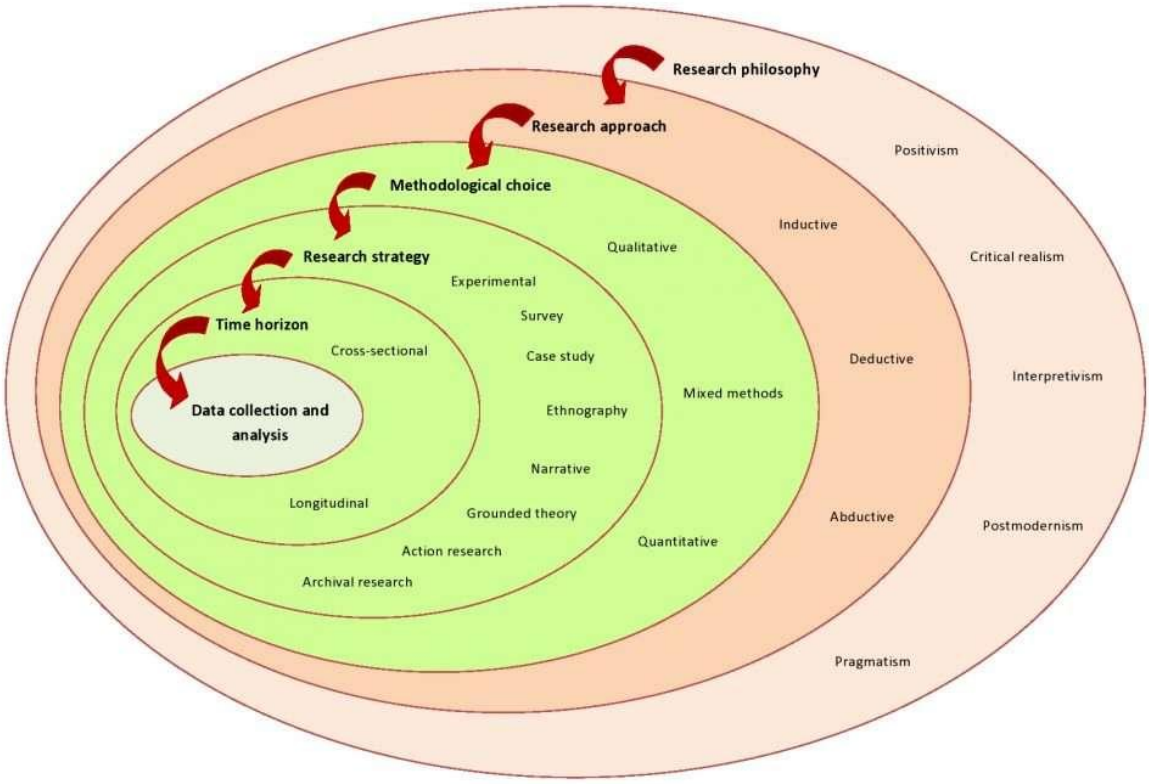

Figure 9. Research Onion (Source: Aesa, 2020)

3.3 Research philosophy

The beliefs and assumptions which underlie the search and provide guidance for developing the knowledge in a research study is research philosophy (Brownand Dueñas, 2020). Research philosophy helps in defining how data needs to be gathered, analysed and interpreted on the basis of perspective differences about reality and knowledge. The major types of research philosophy involve positivism, interpretivism, realism and pragmatism philosophy. However, this research study employed positivist research

philosophy. According to the opinion of Botha(2025), positivism philosophy is used on the basis of the principles which state that knowledge needs to be derived with the help of observable and measurable. This approach helps in assuring the reliability as well as objectivity of the research findings. Following the positivism research philosophy helps the research study to pay more attention to the statistical analysis of the primary data collected through the survey responses. This helps in assessing the effectiveness of the strategies associated with the risk management in decreasing the delays as well as cost overruns in the construction industry.

3.4 Research design

The overall plan which helps in outlining how a research will be conducted, involving the methods utilised for collection data, analysis and interpretation is known as research design (Tomaszewski*et al*. 2020). This helps in assuring that the research follows a well-structured approach which allows both validity as well as reliability of the findings. The types of research design which can be observed involves exploratory, descriptive and explanatory which serves different objectives of the research. The study utilises mixed method research design which involves sport qualitative as well as quantitative research approach. The quantitative aspect involves survey responses which helps in collecting numerical data about the strategies associated with risk management in a construction project.

On the other hand, the qualitative aspect involves secondary data which are collected through academic sources for gaining deep information about risk management frameworks. This particular combination helps in conducting a comprehensive analysis of the topic with assured both contextual as well as statistical understanding. It is said by Harrison*et al*. (2020) that mixed method Research design helps in enhancing both depth along with accuracy of the research as it provides different perspectives. However, significant limitations of this approach can be observed as it takes more time for collecting and analysing the data.

3.5 Research approach

The strategy which guides how the data is gathered, analysed and interpreted the study is known as research approach. Research approach helps in structuring the process war

of research in order to ensure both logical reasoning as well as valid conclusion. The primary type of research approach which can also involve detective and inductive research approach. This study employs a deductive research approach which tests the existing theories by gathering and analysing the data (Casula*et al*. 2021). This research approach is used as it involves the existing theories , with risk management and applies them to the construction project at large scale. This research starts with reviewing the developed risk management frameworks and then tests its effectiveness by utilising both primary as well as secondary data.

One of the major benefits of utilising deductive approaches is that it offers a clear direction from general theories to a particular observation, making the procedure of the research more systematic and objective (Naeem*et al*. 2024). It also helps in improving the reliability and validity of the findings by allowing for measurable results. Hence, utilising the deductive research approach is more suitable for this research study as it helps in ensuring both logical and evaluation based on evidence about the strategies associated with risk management.

3.6 Research strategy

The overall plan which helps in outlining how the data of a study will be collected and analysed for achieving the objectives of research study is known as research strategy (Ghanad, 2023). It helps in ensuring that the research follows a well-structured and logical sequence which helps in making the findings of the study more reliable and valid. This study utilises survey based research strategy in order to collect primary data and secondary data analysis for collecting qualitative information. The survey will be conducted among the industry professionals for collecting quantitative data about the effective practices associated with risk management.

On the other hand, the secondary data will be collected from reputed academy journals, reports and industrial publications. Utilising survey based research strategy along with secondary data helps in collecting broad data from different sources which assures comprehensive information. Therefore, selecting this research strategy helps in ensuring a well-structured and balanced analysis of the risk mitigation practices.

3.7 Research choice

The selection of methods which can be used for collecting and analysing the data in a research study is known as research choice (Mweshiand Sakyi, 2020). It helps in determining whether a research study will follow a quantitative, qualitative or mixed method approach. The research choice highly relies on the objectives of a research study, nature of data and the requirement for depth. The study utilises mixed method research choice as it involves both quantitative as well as qualitative technique. According to Amin*et al*. (2020), mixed method research choice helps in assuring comprehensive understanding by maintaining reliability and validity of the numerical data along with contextual information. The quantitative data involves the survey responses with well-structured and close ended questions which helps in collecting data about risk management strategies in the construction industry. However, the qualitative aspect involves analysing the secondary data which are sourced from academic journals in order to provide deep information about the theoretical frameworks.

3.8 Research procedure and technique

Research procedure helps in outline the procedures which are used step by step for conducting a research study (Kittur, 2023). Whereas, a particular method which is used for collecting data and analysing it is known as research technique. A well-structured and defined research procedure and technique is important for ensuring both accuracy as well as consistency in findings. This study utilisers both primary data collection as well as secondary data collection research procedure. The primary data collection process involves structured questionnaires and distribution of the survey questions through Webropol to the industry professionals for collecting quantitative information about risk management strategies. The sample size of the survey was targeted to 54 , derived from the population size of 62 with a confidence level 95 % and 5 % Margin of Error.

The secondary data collection involves analysing and reviewing the academic journals and industry reports for analysing the frameworks associated with risk management. Quantitative data will be analysed by using descriptive statistics with graphical representation. However, the qualitative data will use thematic analysis for identifying

the patterns and trends of the data. As a result, this research procedure will help in providing a structured result.

3.9 Data collection method

Data collection is considered as an important aspect of research collecting relevant insights for addressing the objectives of a study. The two main methods for collecting data involve primary data collection which obtains firsthand information and secondary data collection which depends on existing sources. This study involves a mixed Data collection method approach. The primary data will be collected with the help of a survey which is distributed through Webropol to the industry professionals in the construction sector. The survey will involve well-structured and close ended questions for obtaining quantitative information about the effectiveness of risk management practices in decreasing cost overrun and delays. The secondary data will be collected from the academic journals and industrial reports which will help in ensuring a deep understanding about the existing frameworks related to risk management and their practical implementation. It is said by Harrison*et al*. (2020) that utilising mix method data collection helps in allowing comprehensive analysis as it combines both numerical data as well as contextual information.

3.10 Data analysis

The procedure which is used for analysing the collective information for identifying the patterns, trends and the relevance of the information towards the objective of the study is known as data analysis (Nassauerand Legewie, 2021). This research utilises both quantitative as well as qualitative analysis methods. The quantitative data which is collected through survey will be analysed by utilising the descriptive statistics which involves distribution of frequency and graphical representation in order to identify the major trends in strategies related to risk management. Thematic analysis will be used for analysing the qualitative data which is collected from secondary resources for identifying the major themes which are related to this mitigation as well as deposit efficiency will be interpreted. This particular data analysis approach helps in ensuring proper understanding about the effectiveness of risk management in the construction

industry. The measuring parameters are cost overrun and delay durations in construction projects. The following hypotheses will be tested in the result.

H0: “Effective risk management strategies can not mitigate delay and cost overrun in construction projects”

H1: “Effective risk management strategies can mitigate delay and cost overrun in construction projects”

3.11 Ethical consideration

This study achieved all the ethical standards throughout which involves conducting responsible research, protecting the rights of the participants and maintaining the integrity of data. This study follows all the ethical guidelines by taking informed consent from every participant of the survey which ensures that the participants are aware about the purpose of the study. The confidentiality will also be maintained by anonymising the responses and the data will be stored securely. The participants will have the right to withdraw themselves at any stage without any significant consequences. The measures related with data protection will also be followed appropriately in order to prevent unauthorised access. In addition, the secondary data sources will be cited appropriately in order to maintain the academic integrity.

3.12 Summary

The methodology chapter utilises a mixed method approach which involves both quantitative survey along with qualitative secondary data in order to analyse the strategies associated with risk management in construction projects. It follows a deductive approach along with descriptive statistical as well as thematic analysis. However, the ethical considerations will be followed which involve informed consent, confidentiality and data protection for ensuring the reliability and integrity of the research.

4 DATA ANALYSIS AND FINDINGS

4.1 Introduction

This chapter highlights the analysis and the discussion of the data that are collected by mixed method strategy. All the objectives of the research are focused in order to create the questionnaire that has been distributed among the selected number of participants working in the construction regions. However the responses of the participants are discussed in the section below. An appropriate discussion is provided that includes all the major themes generated by the researcher based on the common facts and ideas presented by the authors regarding the research topic.

4.2 Quantitative data analysis

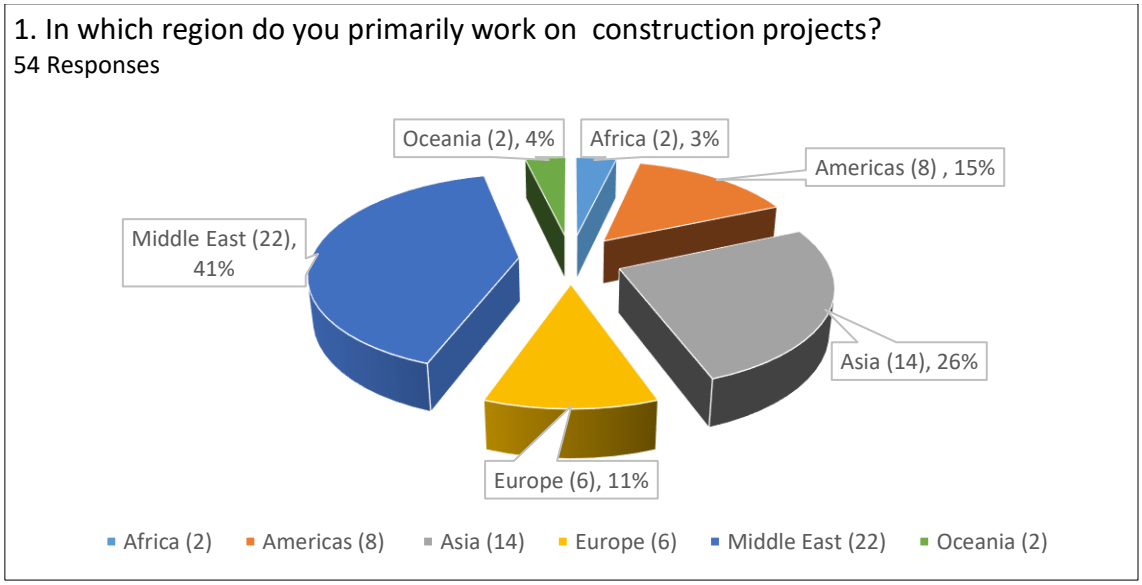

Figure 10. Region of construction projects (Source: MS-Excel)

This is the first survey question where 54 participants were asked about the region of their work. 22 participants work in the Middle East, and only 2 respondents work in Oceania. 2 other respondents work in Africa, and 14 respondents work in Asia.

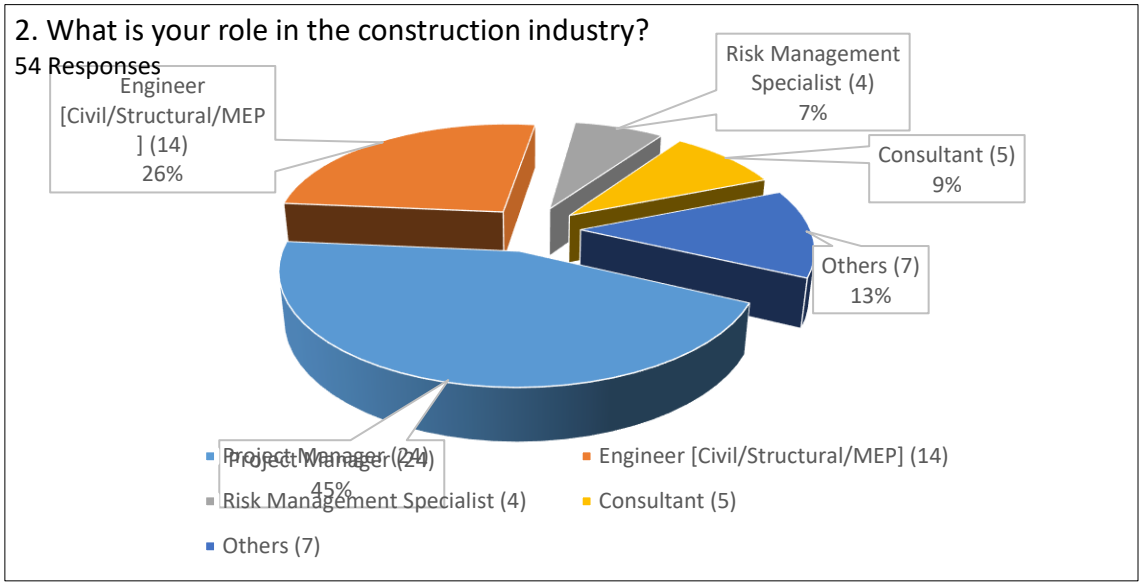

Figure 11. Role in construction projects (Source: MS-Excel)

Among 54 survey respondents, 24 work as project managers. 14 work as engineers, and 4 work as risk management specialists. The respondents have diverse job roles, and they are able to carry out their responsibilities appropriately. 7 respondents are engaged in other job roles such as project control managers, program managers, and reliability experts.

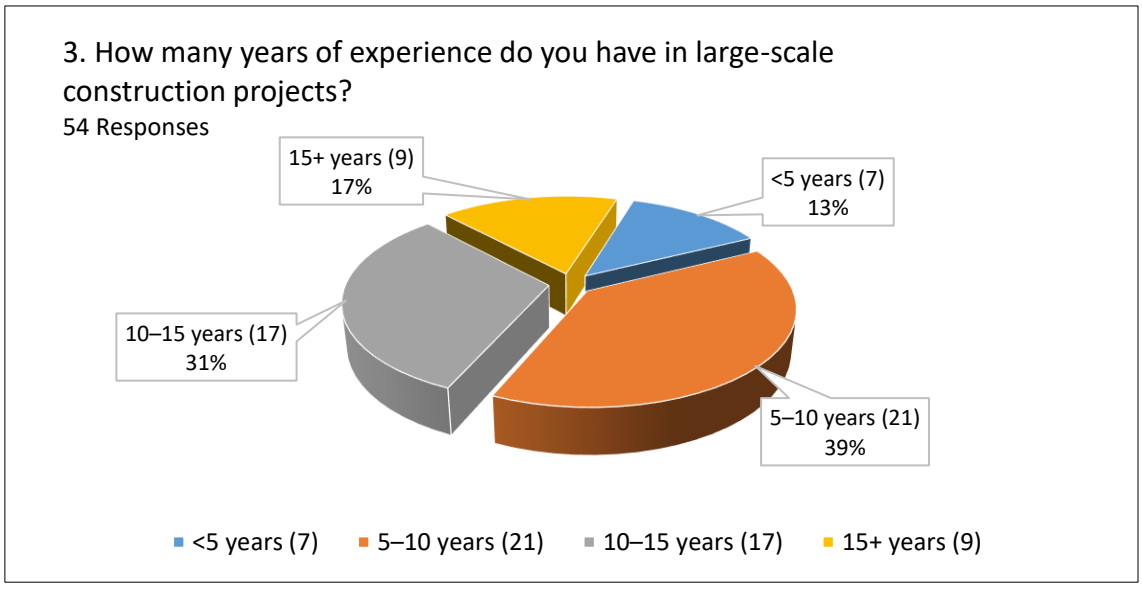

Figure 12.Experience in construction projects (Source: MS-Excel)

The 54 survey respondents have different work experience in construction projects. For example, only 7 respondents have less than 5 years of experience. 21 respondents have

5 to 10 years of experience. 17 respondents have 10-15 years of experience, and 9 respondents have more than 15 years of experience.

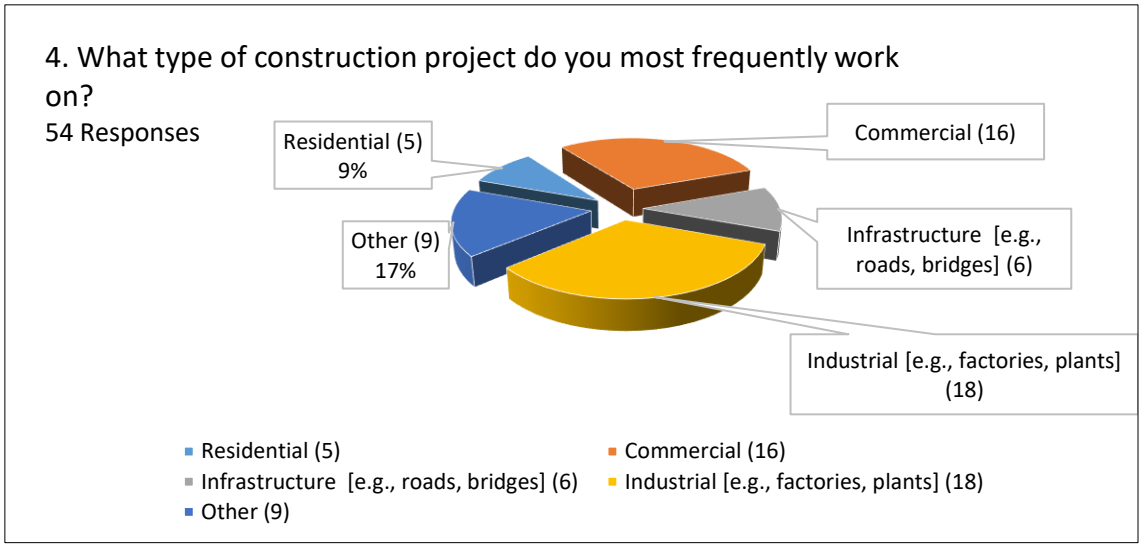

Figure 13. Types of construction projects (Source: MS-Excel)

The survey participants are experienced in working on different types of construction projects, such as residential, commercial, industrial, infrastructure, healthcare, and energy sector projects. 18 respondents are working on industrial construction projects, 16 are working on commercial construction projects, 5 are working on residential projects, and 9 are working on other construction projects.

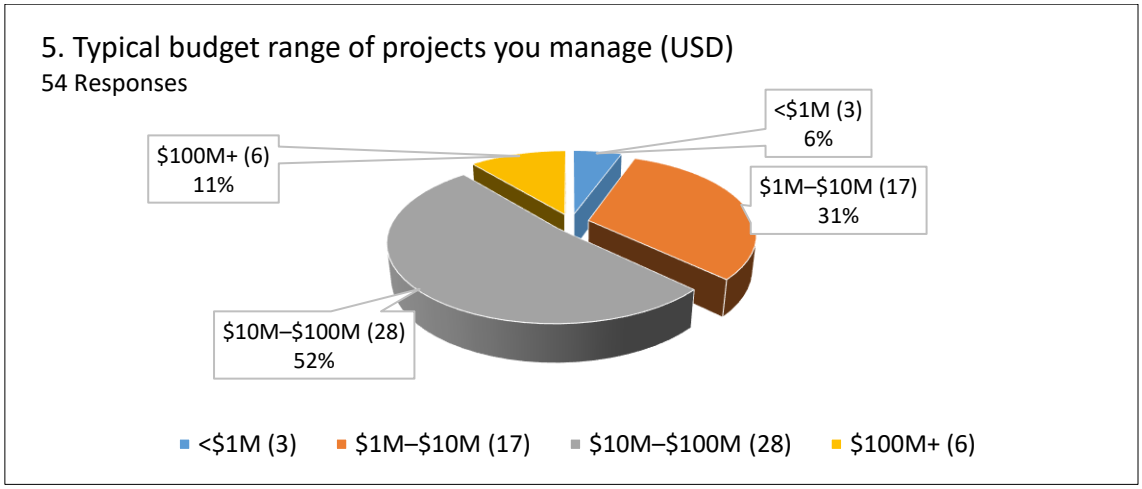

Figure 14. Budgets of construction projects (Source: MS-Excel)

Among 54 respondents, only 3 have worked on projects with less than 1 million USD. 6 respondents are experienced in working on projects with more than 100 m USD. 28 are experienced in working on projects with 10-100 m USD.

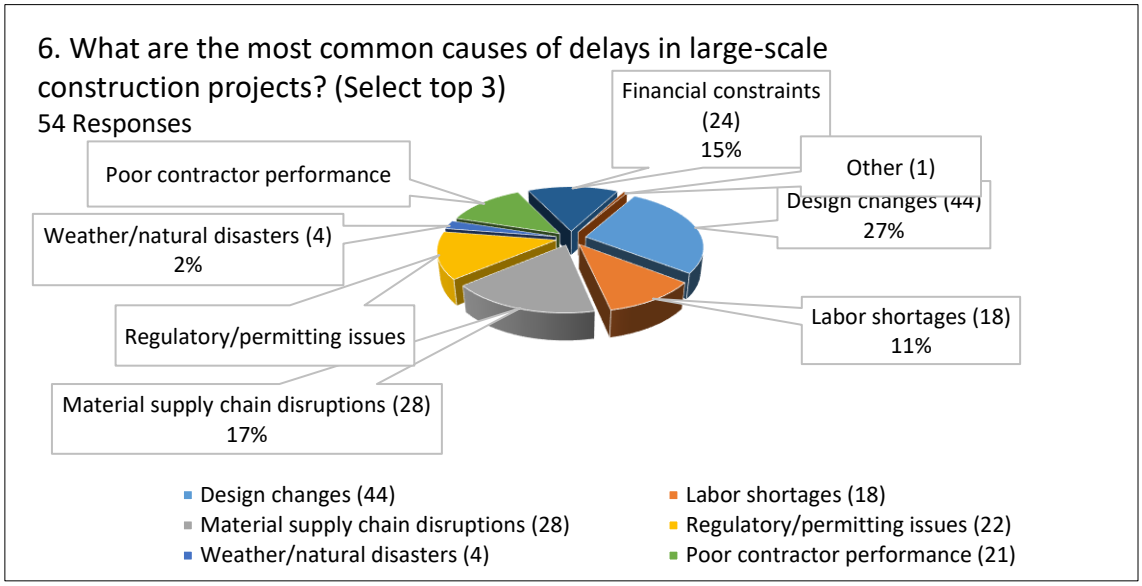

Figure 15. Delays in construction projects (Source: MS-Excel)

The most common causes of delays in large-scale construction projects are design changes, labour changes, material supply chain disruptions, permitting issues, poor contractor performance, financial constraints, and regulatory changes.

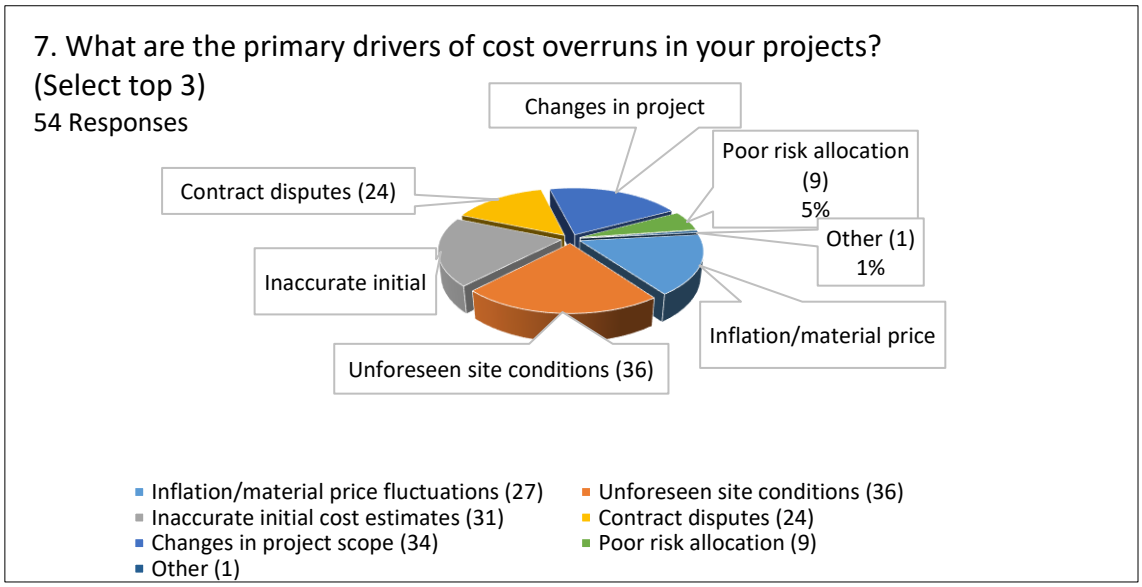

Figure 16. Drivers of cost overrun in construction projects (Source: MS-Excel)

Some primary drivers of cost overrun in construction projects are inflation and material price fluctuation, unforeseen site conditions, inaccurate cost estimates, contract disputes, changes in project scope, poor risk allocation, and others. Among 54

candidates, 27 respondents opined that material price fluctuations are mainly responsible for cost overruns.

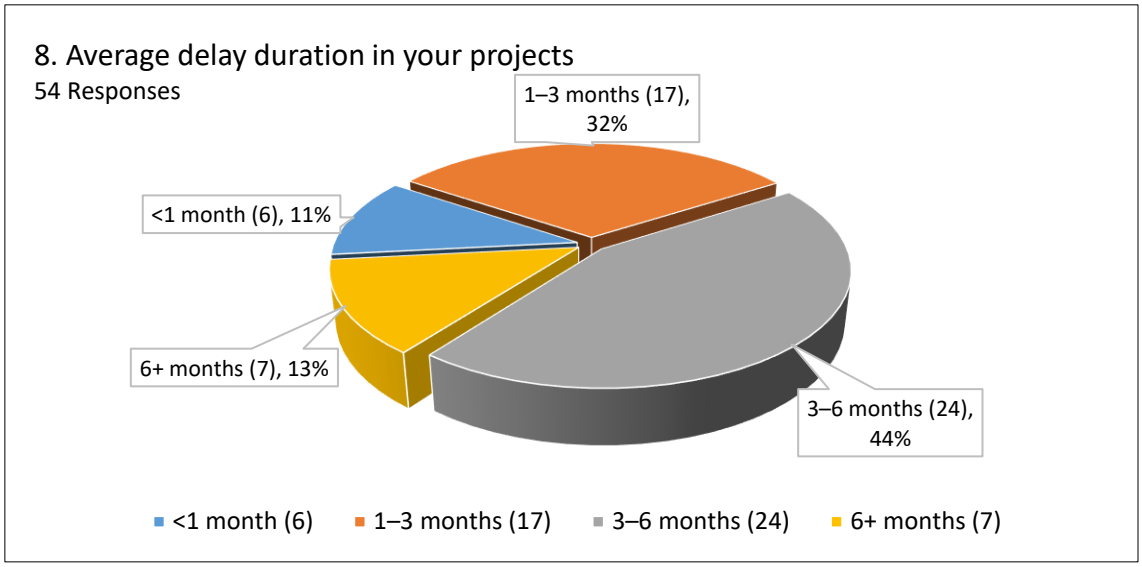

Figure 17. Delay duration in construction projects (Source: MS-Excel)

Among 54 candidates, 7 respondents have experienced an average delay duration in construction projects for more than 6 months. 24 respondents have experienced a delay duration of 3 to 6 months.

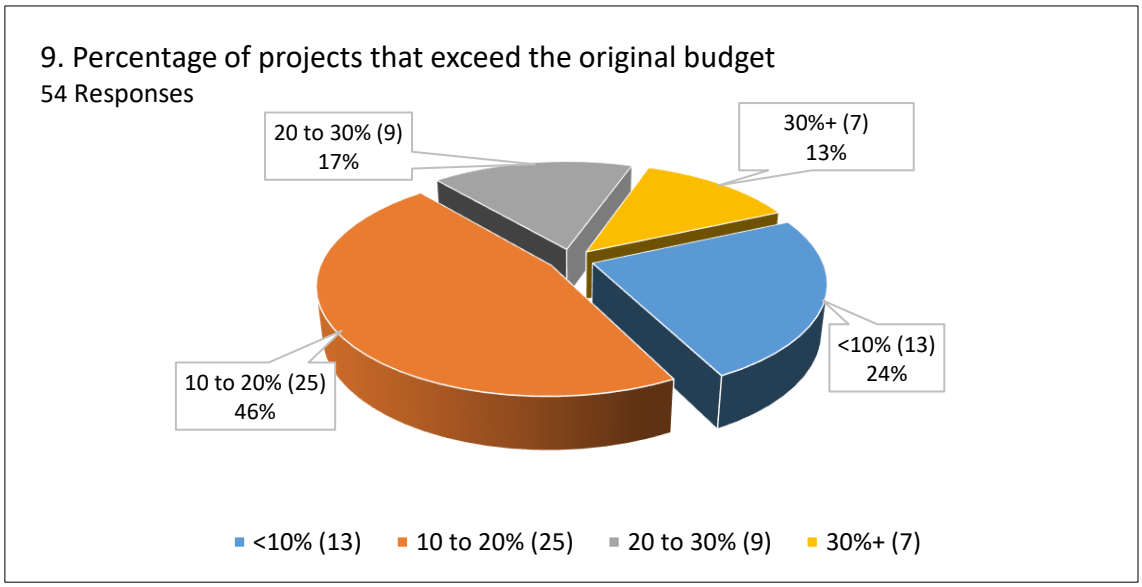

Figure 18. Construction projects exceeding original budgets (Source: MS-Excel)

Among 54 respondents, 7 people have seen that more than 30% of construction projects have exceeded the original budgets. Only 9 respondents have found that 20 to 30% of construction projects exceed the original budget.

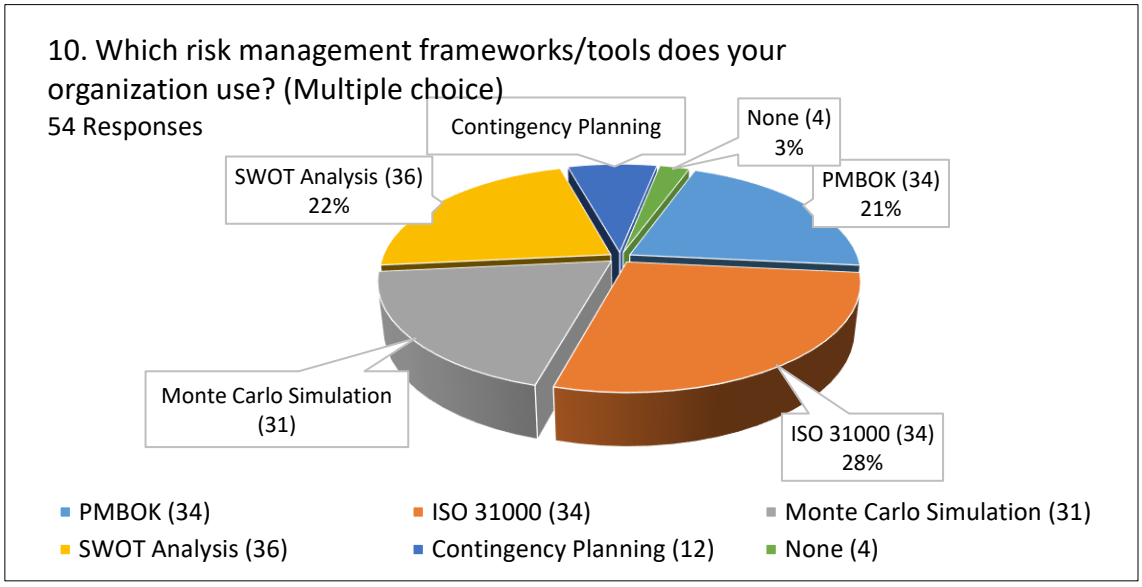

Figure 19. Risk management frameworks in Construction projects (Source: MS-Excel)

Some of the major risk management frameworks used in construction projects are PMBOK, ISO 31000, Monte Carlo Simulation, SWOT analysis, contingency planning, and others. 4 respondents opined that their projects do not use any type of risk management frameworks.

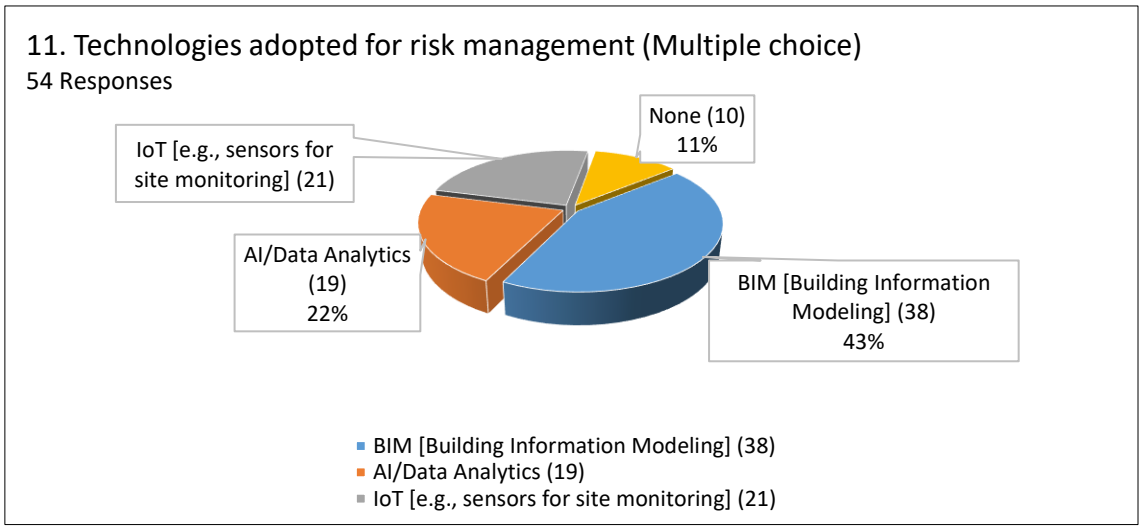

Figure 20. Technologies adopted in Risk management in Construction projects (Source: MS-Excel)

Some of the major technologies used in construction projects are BIM, AI, Data Analytics, IoT, and others. Among 54 respondents, 10 admitted that their project does not use any type of technologies for risk management.

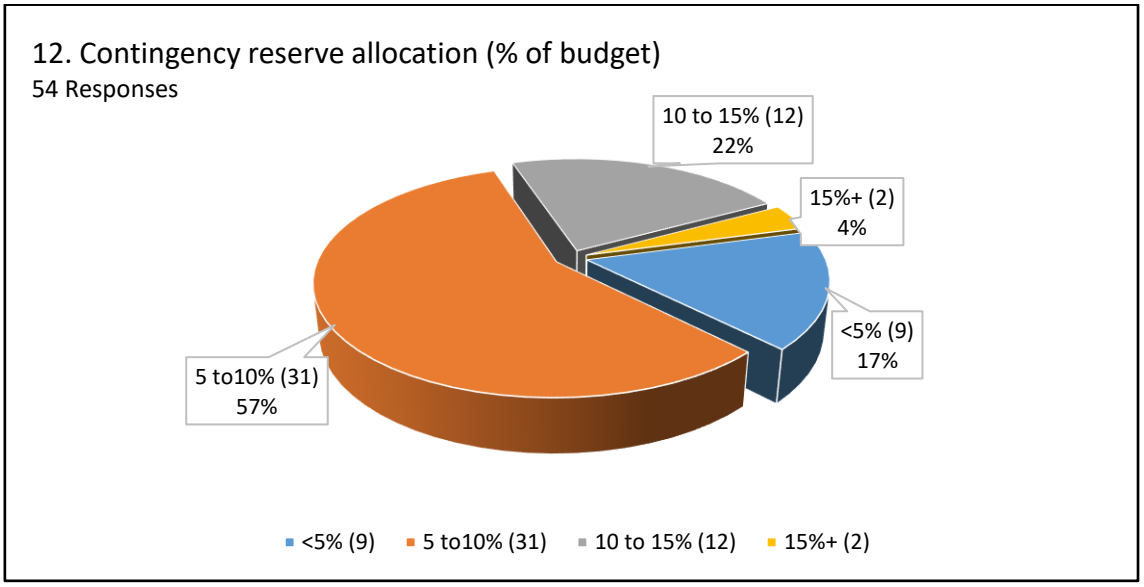

Figure 21. Contingency reserve allocation in Construction projects (Source: MS-Excel)

Among 54 respondents, 9 admitted that their projects reserve less than 5% as a contingency fund. Only 2 respondents revealed that their projects reserve more than 15% as a contingency fund. Only 12 respondents opined that their projects reserve 10-15% as contingency fund.

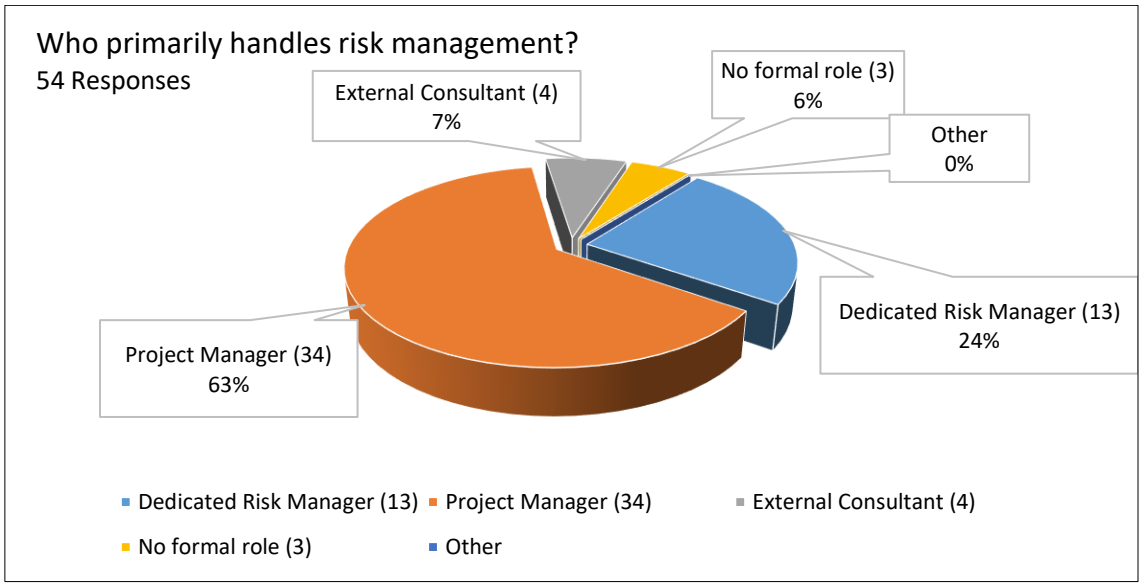

Figure 22. Handling risk management (Source: MS-Excel)

People responsible for handling risk management are risk manager, external consultant, project manager, and others.

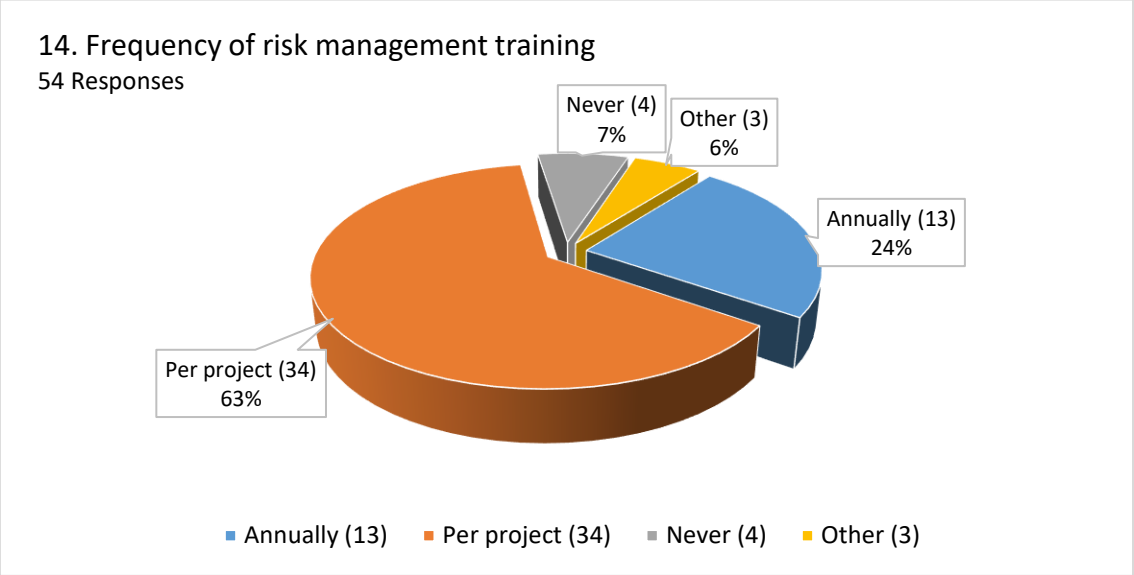

Figure 23. Risk management training (Source: MS-Excel)

13 respondents revealed that risk management training takes place annually whereas 4 admitted that risk management training have never took place in their projects.

Table 1. Q15.Effectiveness of Risk Management Strategies (Source: MS-Excel)

How effective are your organization's current risk management strategies in mitigating delays? (Scale: 1–5)					
Min value	**Max value**	**Average**	**Median**	**Sum**	**Standard Deviation**
2.0	5.0	3.1	3.0	167.4	.9

From the above table, it can be found that the selected minimum value is 2 and the maximum value is 5. The value of the Median value is 3.0, Average 3.1 and standard deviation is 0.9.

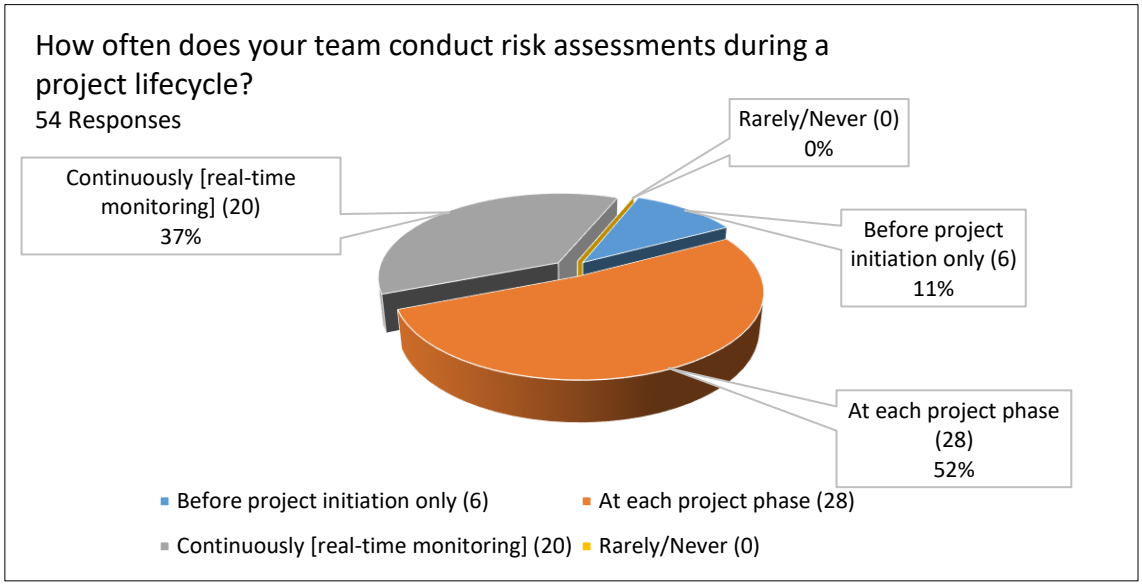

Figure 24. Risk Management during project lifecycle (Source: MS-Excel)

6 respondents mentioned that risk assessment is conducted before the project initiation. 20 respondents revealed that they continuously assess risk during the project lifecycle.

Table 2. Q 17 Impact of regulatory changes (Source: MS-Excel)

Impact of regulatory changes on timelines: (Scale: 1–5)					
Min value	**Max value**	**Average**	**Median**	**Sum**	**Standard Deviation**
2.0	5.0	3.5	3.0	189.0	.9

The above table shows that the value minimum 2 and maximum 5 with average 3.5 and standard deviation is 0.9, which means regulatory changes have a high perceived impact on the project timeline.

The last 2 questions are open ended questions where respondents expressed their opinion on risk mitigation strategies and key improvements in risk management.

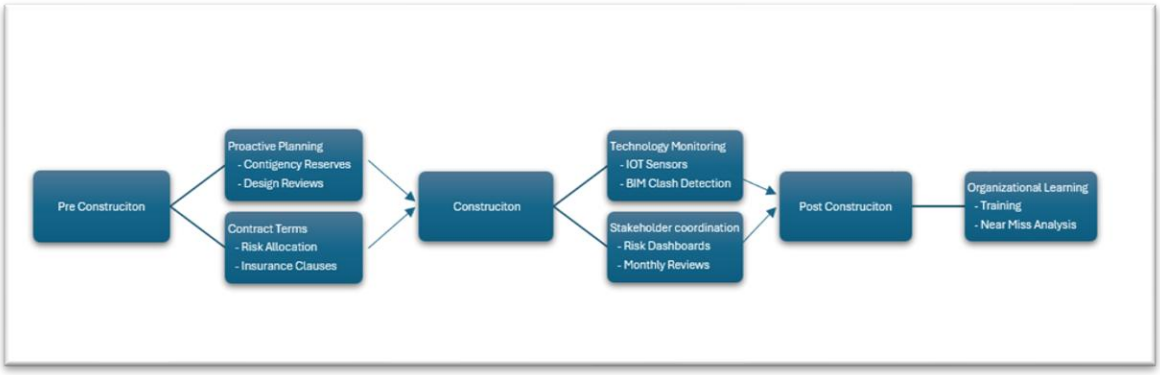

Figure 25. Risk Management and Mitigation (Source: MS-Excel)

The analysis of 54 expert responses identified few key themes for improving construction risk management, with early and integrated risk planning being the most frequently cited (44%), emphasizing thorough pre-construction assessments and dynamic risk registers. The critical relevance of technology adoption, indicated at 39%, was reinforced. An emphasis was made on promoting risk-aware culture (28%) and adopting accurate contract management (28%) to eliminate gaps in behavior and contracts, in addition to calls for designated contingency resources (22%) and minimising regulatory issues (11%), particularly in situations where extended permit delays compromise project schedules. After all, the research highlights the benefits of an agile, data-driven and collaborative mindset when enhancing the risk management process in a construction project.

Table 3. Impact of regulatory changes (Source: MS-Excel)

Comparison of Risk Management Improvements (Q1) and Mitigation Strategies (Q2)			
Category	**Q1 Focus: Systemic Improvements**	**Q2 Focus: Actionable Mitigation**	**Key Shift**
Planning	Early risk identification	Contingency buffers	Detection → Preparedness
Technology	BIM adoption	Real-time IoT monitoring	Design tool → Execution aid
Contracts	Scope clarity	Equitable risk allocation	Drafting → Enforcement
Training	Annual risk modules	VR safety simulations	Theoretical → Experiential
Unaddressed Risks	Regulatory delays	Climate change impacts	Regional → Global
Note. Q1 data from responses to *"key improvements for risk management"*; Q2 data from *"mitigation strategies"* comments.			

4.2.1 Regression Analysis of the survey results

From the survey results, few variables were analysed using regression analysis. Testing carried out as simple regression and multiple regression. For simple regression, Projects that exceeded the actual budget v/s contingency reserve allocated and Delay v/s Risk Management trainings were tested.

4.2.1.1 Projects that exceeded the actual budget v/s Contingency reserve allocated:

Var X

Percentage of projects that exceed the original budget

	n	Percent
<10% (13)	13	24.1%
10 to 20% (25)	25	46.3%
20 to 30% (9)	9	16.7%
30%+ (7)	7	13.0%
Total Respondents	54	

Var Y

Contingency reserve allocation (% of budget)

	n	Percent
<5% (9)	9	16.7%
5 to10% (31)	31	57.4%
10 to 15% (12)	12	22.2%
15%+ (2)	2	3.7%
Total Respondents	54	

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.950554652
R Square	0.903554147
Adjusted R Square	0.85533122
Standard Error	3.066507902
Observations	4

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	176.1931	176.1931	18.73702	0.049445348
Residual	2	18.80694	9.403471		
Total	3	195			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	5.154013015	2.463412	2.092225	0.171512	-5.445194764	15.75322	-5.44519	15.75322
X Variable 1	0.618221258	0.142822	4.328628	0.049445	0.003709891	1.232733	0.00371	1.232733

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*
1	10.71800434	2.281996
2	24.31887202	0.681128
3	12.57266811	-3.57267
4	6.390455531	0.609544

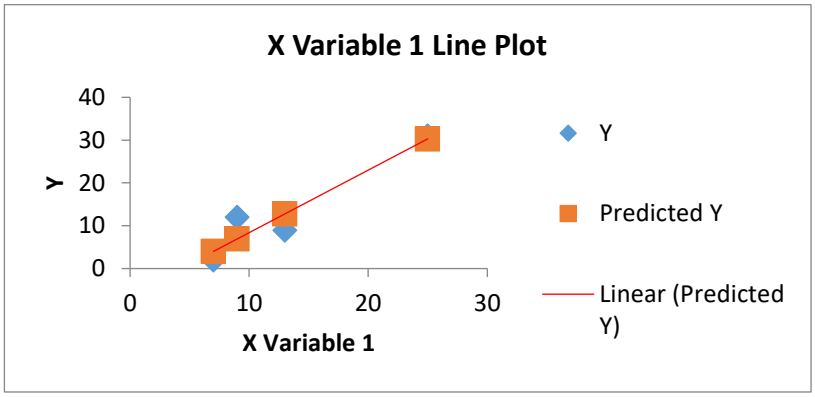

Figure 26. Simple Regression Analysis 01

4.2.1.2 Analysis between Delay v/s Risk Management training

Var X

Frequency of risk management training

	n	Percent
Annually (13)	13	24.1%
Per project (34)	34	63.0%
Never (4)	4	7.4%
Other (3)	3	5.6%
Total Respondents	54	

Var Y

Average delay duration in your projects

	n	Percent
<1 month (6)	6	11.1%
1–3 months (17)	17	31.5%
3–6 months (24)	24	44.4%
6+ months (7)	7	13.0%
Total Respondents	54	

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.118771089
R Square	0.014106572
Adjusted R Square	0.478840143
Standard Error	17.49628273
Observations	4

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	8.760180995	8.760181	0.028617	0.881229
Residual	2	612.239819	306.1199		
Total	3	621			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	10.81221719	18.13766842	0.596119	0.611577	-67.2279	88.85231	-67.2279	88.85231
X Variable 1	0.199095023	1.176927339	0.169165	0.881229	-4.86481	5.263005	-4.86481	5.263005

RESIDUAL OUTPUT

Observation	*Predicted Y*	*Residuals*
1	12.00678733	0.99321267
2	14.19683258	19.80316742
3	15.59049774	-11.59049774
4	12.20588235	-9.205882353

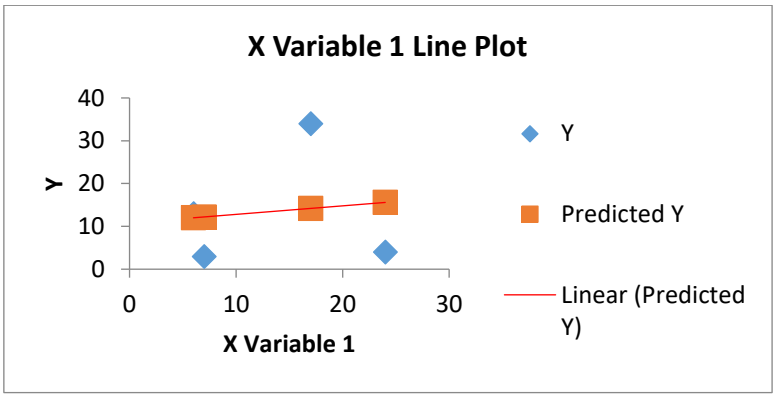

Figure 27. Simple Regression Analysis 02

While conducting multiple regression the results were not correlating and large discrepancies were noticed. Due to the aggregated nature of the quantitative survey data, A direct statistical test of the hypotheses (e.g., by correlating individual risk management effectiveness scores with individual project delay/cost outcomes) was not possible. These are mentioned in the limitation section.

A correlation matrix is created to assess the strength and direction of a relationship between the variables. Considering the dependent variables Project Exceed budget, Average delay. Budget and staff experience as control variables and other variables as independent variables.

Table 4. Correlation matrix-Annotated (Pearson correlations)

	Budget	*Proj Exceed Budget*	*Experience of Staff*	*Avg Delay*	*Reserve Allowance*	*Freq.of Training*	*Freq.of Risk Management*	*Risk assessment*
Budget	1.000***							
Proj Exceed Budget	0.10529455	1.000***						
Experience of Staff	0.793***	0.644***	1.000***					
Avg Delay	0.996***	0.187867287	0.829***	1.000***				
Reserve Allowance	0.409**	0.951***	0.842***	0.482***	1.000***			
Freq.of Training	0.03662283	0.997***	0.600***	0.118771089	0.927***	1.000***		
Freq.of Risk Management	0.03662283	0.997***	0.600***	0.118771089	0.927***	1.000***	1.000***	
Risk assessment	0.744***	0.740***	0.950***	0.798***	0.910***	0.690***	0.690***	1.000***

Additionally, the significance of the correlations (*p<0.1, **p<0.01, ***p<0.001) is marked in the matrix.

Table 5. Condition Index

Eigenvalue	Condition Index
7.557733134	1
3.037087762	1.577491782
0.071845771	10.25640522
3.62E-32	1.45E+16

The condition index is used to assess whether the predictor variables in a regression model are too highly correlated, which can lead to unstable coefficient estimates and inflated standard errors.

4.3 Qualitative Data Analysis

Theme 1: the reasons for cost overrun and project delays in large scale construction project

Cost over run as well as delays are the major challenge in large scale construction projects. A lot of integrated factors can contribute to these issues like frequent design modification, poor planning of the projects, in accurate cost allocation, procurement delay and scope changes. The major causes include delayed approval from the authorities and inadequate site investigation. On the other hand Durdyev (2021) mentioned that lack of skilled labors and poor communication among the stakeholders can also be a major issue that can cause delays and cost overrun in the large-scale

construction projects. However the environmental constraints can also cause major challenges. Determining the causes is crucial for designing appropriate strategies during the project life cycle.

Theme 2: the risk management methods for resolving uncertainties during the project and developing cost control

As indicated by Pomaza-Ponomarenko *et al.* (2023) risk management is crucial for mitigating all types of uncertainties in a project and also developing cost control measures. However effective methods include risk identification, mitigation strategies and response planning. The tools such as risk breakdown structure and sensitivity analysis can be used widely in order to identify the potential threats effectively. Moreover, integrating all these tools for the project planning and the execution process allows to anticipate the risk as well as ensure informed decision making for controlling the cost and the schedule.

Theme 3: effect of risk management strategies in developing overall efficiency and reducing project disruptions

Risk management strategies can significantly develop the efficiency of the construction projects (Parsamehr*et al.* 2023). All these strategies ensure that the potential disruptions are recognised in the early phases and dealt with by following appropriate measures. Reducing the likelihood of all the crisis driven responses is essential to manage the risk of the project management in an effective way. On the other hand Mizrak (2024) explained that response strategies as well as regular risk review are crucial for better and smooth operations of organisations. A protective risk culture is essential for timely communication and fosters accountability among all the team members within a project. All these practices are essential for improving the task execution process and also boost the confidence of all the stakeholders. As a result the overall stability of the project can be ensured by following the strategy. On the other hand, timely delivery of the results is expected within the budgetary limits if all the risk management strategies are followed by the organisation.

Theme 4: Strategies for construction project firms for developing risk management methods and better project outcomes

According to the understanding of all the management practices and the risk factors it can be stated that multiple suggestions are important to be followed. Construction organisations need to adopt a structured risk management framework which is integrated from the initial planning phase and followed throughout the project life cycle (Sami Ur Rehman *et al.* 2022). However, capacity building by certification and appropriate training in project management is essential for successful integration of the risk management strategies. Hence all the team members in a project need to encourage each other to follow appropriate management strategies. The stakeholders of a project need to enhance collaboration and coordination by using different kinds of communication platforms as well as real time reporting tools (Marion and Fixson, 2021). All the policy makers need to support the industry wise risk monetary process through the introduction of standard regulations. Conducting appropriate audits can help in improving the risk management strategies of the project management organisations. Analysis technology can be used for adopting innovation in organisations. All these combined efforts can successfully ensure efficient, resilient as well as successful outcome of the projects.

4.4 Discussion

The issues of project delay and cost overrun are the major concerns in the construction sector. A lot of factors contribute to the major issue including accurate cost estimation, poor planning and delay in procurement (Durdyev, 2021). There are some external factors like labour shortage, inflation, lack of skills and regulatory challenges that are also impactful on the budget and the timeline of the project. All these disruptions can be formed if lack of communication is found between the stakeholders associated with the project (Parsamehr*et al.* 2023). Hence it is crucial to develop the communication and collaboration during the design and the execution phase of the project management. However, educating risk anticipation during the early stage can cause the overall project

to delay. In order to address all these uncertainties it is crucial to follow a risk management strategy for developing the model construction management procedure. The second objective of the research was focused on determining the effective risk management methods. According to the findings of the study it has been identified that appropriate assessment identification and control measures can help in improving the overall project management strategies.

Figure 28. Budget risk in project management (Source: fastercapital.com, 2025)

The tools such as profitability impact matrices, risk breakdown structure as well as simulations like Monte Carlo analysis can help in improving the potential disruptions. However all these practices can allow the project teams to detect the issues of the project management and maintain financial discipline during the project life cycle. Major role for improving the operational efficiency as well as reducing the disruption in the project. Hence it is important to identify as well as mitigate the risks (Mizrak, 2024).

Figure 29. Impact of budget risk (Source: fastercapital.com, 2025)

Strategies like mitigation and avoidance are important to be followed. Regularly checking the risk and stakeholder communication can help in improving the overall decision making process in order to ensure smooth execution of all the project management phases (Eyieyien*et al.* 2024). However the overall product activity of the project can be increased and the downtime can be reduced by following appropriate project management methods.

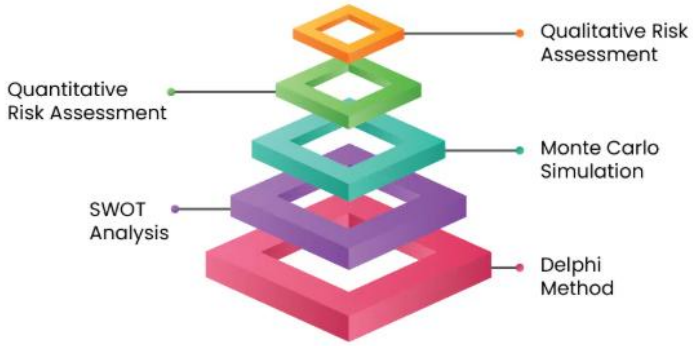

Figure 30. Project risk management methods (Source: geeksforgeeks.org, 2025)

The development of a risk management framework needs appropriate involvement between all the stakeholders who are directly or indirectly associated with the project. However all these stakeholders include consultants, construction firms, policy makers and contractors. In order to support the industry wide adoption of appropriate practices the study suggests appropriate risk management training programs and standardised

procedures. The use of digital tools for risk identification and control can also help to improve the project management methods in the construction sector (Pomaza-Ponomarenko *et al.* 2023). How ever the policy makers needs to create appropriate guidelines for mandating risk assessment practices in private and public sector projects. Different kinds of collaborative platforms can be helpful for fostering the risk culture across the construction region.

4.5 Summary

The study has highlighted the necessity of a systematic risk management process for addressing the time related and cost related challenges in the large scale construction project. However application of a structured model as well as cross functional collaboration between all the stakeholders of the business can help in improving the project outcomes (Goyal, 2021). This is important for achieving better accountability and efficiency of project management activities. Hence all the major hierarchy and the stakeholders of the project needs to improve the project outcomes and minimise disruption by effectively communicating with the project team regarding the risk management procedures.

5 CONCLUSION

5.1 Conclusion

The results of the research have highlighted that the contingency fund is a major issue for the large-scale projects. A lot of companies failed in applying the risk management strategies which caused major challenges in the project. Moreover the study has highlighted that the tools like profitability impact metrics, risk breakdown structure and simulations can help to improve the overall project outcome. Appropriate training needs to be provided to all the employees associated with the project management department in order to identify the possible risks that can impact the quality of the project.

5.2 Linking with objectives

Objective one

The first objective of the research paper was to the reasons for the cost overruns and delays in large-scale projects. This objective is successfully met in the data analysis chapter where primary quantitative and secondary qualitative data are provided. The primary data has discussed the opinion of the employees working in the construction companies. On the other hand, the secondary data has revealed that the poor planning process and frequent design modifications are the major issues that can cause project delays and cost overrun issues. An additional lack of skilled labourers is also a major challenge that is faced by the companies.

Objective two

The second objective of the research was to provide effective recommendations for the construction project companies, stakeholders and policy makers for developing the risk management models to get effective project outcomes. The findings of the theme four of thematic analysis has highlighted that construction companies need to follow a structured risk management framework for the initial planning process. More details about this objective can be found in the recommendations section of this chapter.

5.3 Recommendations

In order to reduce the delays and cost overrun challenges in the large scale construction project it is crucial for the stakeholders' companies and policy makers to follow a proactive as well as structured approach of risk management. Hence the strategies that can be followed by the companies are as follows.

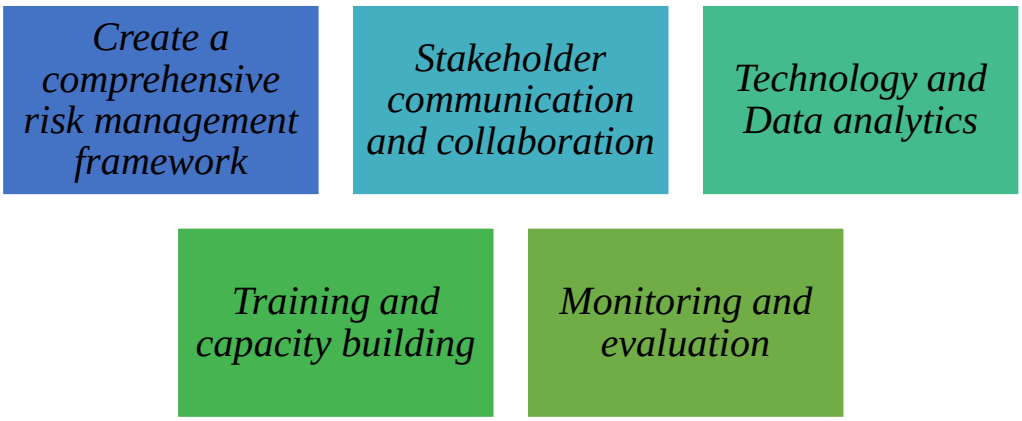

Figure 31. Recommendations (Source: Self-created)

Create a comprehensive risk management framework*:* Organisations from the construction industry need to implement a standardized risk management framework which covers the total life cycle of the project from feasibility to handover. This model needs to include all the possible risks and they are mitigation strategies.

Stakeholder communication and collaboration: Developing communication among all the stakeholders including the supplier's contractor's client and regulatory bodies is essential. A risk sharing mechanism needs to be established by a collaborative decision making process which can help in managing the uncertainty as well as meet the expectations.

Technology and Data analytics: The use of modern technical tools like Building Information Modelling (BIM) and digital project management tools are essential for detecting the early warning signals. AI based risk analysis platforms can be used for

simulating the potential risk impact on the project while the real time data is essential for developing accuracy in the forecasting as well as decision making process.

Training and capacity building: Companies need to provide appropriate training for all the engineers, project manager's as well as risk officers for using the predictive Data analytics, risk management tools and project control system. A workforce which is trained and has appropriate knowledge can better anticipate all the possible risks and respond in an appropriate manner.

Monitoring and evaluation: Risk management needs to be a dynamic process and companies must adopt a regular project audit process for the appropriate assessment of the risk and refine the mitigation strategies for the project.

5.4 Limitations and Future scopes

The study includes both the primary and the secondary data which enhance the quality of the results. However, the lack of primary qualitative data is the major limitation of the research paper. Due to the aggregated nature of the quantitative survey data, A direct statistical test of the hypotheses (e.g., by correlating individual risk management effectiveness scores with individual project delay/cost outcomes) was not possible. It was not able to statistically prove or disprove these hypotheses with the current data.

In future, an interview can be conducted with the employees and managers working in different construction companies. The interview session will include some open-ended questions that will be asked of the participants regarding the risks they face while handling large-scale projects and the mitigations applied by their project managers to resolve the issues. Hence the study can be done in a more effective manner in future by including primary qualitative data.

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Appendices

Appendix 1. Survey questionnaire

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Master Thesis- EXAMINING THE IMPACT OF RISK MANAGEMENT STRATEGIES ON MINIMIZING DELAYS AND COST OVERRUNS IN LARGE-SCALE CONSTRUCTION PROJECTS"> Master Thesis- EXAMINING THE IMPACT OF RISK MANAGEMENT STRATEGIES ON MINIMIZING DELAYS AND COST OVERRUNS IN LARGE-SCALE CONSTRUCTION PROJECTS">

Master Thesis- EXAMINING THE IMPACT OF RISK MANAGEMENT STRATEGIES ON MINIMIZING DELAYS AND COST OVERRUNS IN LARGE-SCALE CONSTRUCTION PROJECTS

Privacy Notice

This survey is part of a Master's thesis study. Participation is voluntary, and your responses are handled confidentially under the EU General Data Protection Regulation (GDPR) (EU 2016/679).
Data is collected only for research purposes and will be anonymized and deleted after the thesis is completed. You have the right to access, correct, or delete your data.
By continuing, you consent to the processing of your responses for this study.

Section 01: Demographic Information

1. In which region do you primarily work on construction projects?

- ◯ Africa
- ◯ Americas
- ◯ Asia
- ◯ Europe
- ◯ Middle East
- ◯ Oceania

2. What is your role in the construction industry?

- ◯ Project Manager
- ◯ Engineer (Civil/Structural/MEP)
- ◯ Risk Management Specialist
- ◯ Consultant
- ◯ Others _____

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3. How many years of experience do you have in large-scale construction projects?

- ○ <5 years
- ○ 5–10 years
- ○ 10–15 years
- ○ 15+ years

4. What type of construction project do you most frequently work on?

- ○ Residential
- ○ Commercial
- ○ Infrastructure (e.g., roads, bridges)
- ○ Industrial (e.g., factories, plants)
- ○ Other _____

5. Typical budget range of projects you manage (USD)

- ○ <$1M
- ○ $1M–$10M
- ○ $10M–$100M
- ○ $100M+

Section 02: Risk Factors and Delays

6. What are the most common causes of delays in large-scale construction projects? (Select top 3)

- ☐ Design changes
- ☐ Labor shortages
- ☐ Material supply chain disruptions
- ☐ Regulatory/permitting issues
- ☐ Weather/natural disasters
- ☐ Poor contractor performance

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☐ Financial constraints

☐ Other _____

7. What are the primary drivers of cost overruns in your projects? (Select top 3)

☐ Inflation/material price fluctuations

☐ Unforeseen site conditions

☐ Inaccurate initial cost estimates

☐ Contract disputes

☐ Changes in project scope

☐ Poor risk allocation

☐ Other _____

8. Average delay duration in your projects

○ <1 month

○ 1–3 months

○ 3–6 months

○ 6+ months

9. Percentage of projects that exceed the original budget

○ <10%

○ 10–20%

○ 20–30%

○ 30%+

Section 3: Risk Management Practices

10. Which risk management frameworks/tools does your organization use? (Multiple choice)

☐ PMBOK

☐ ISO 31000

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- ☐ Monte Carlo Simulation
- ☐ SWOT Analysis
- ☐ Contingency Planning
- ☐ None
- ☐ Other _____

11. Technologies adopted for risk management (Multiple choice)

- ☐ BIM (Building Information Modeling)
- ☐ AI/Data Analytics
- ☐ IoT (e.g., sensors for site monitoring)
- ☐ None
- ☐ Other _____

12. Contingency reserve allocation (% of budget)

- ○ <5%
- ○ 5–10%
- ○ 10–15%
- ○ 15%+

13. Who primarily handles risk management?

- ○ Dedicated Risk Manager
- ○ Project Manager
- ○ External Consultant
- ○ No formal role
- ○ Other _____

14. Frequency of risk management training

- ○ Annually

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- ○ Per project
- ○ Never
- ○ Other _____

15. How effective are your organization's current risk management strategies in mitigating delays? (Scale: 1–5)

16. How often does your team conduct risk assessments during a project lifecycle?

- ○ Before project initiation only
- ○ At each project phase
- ○ Continuously (real-time monitoring)
- ○ Rarely/Never

Section 4: Recommendations & Challenges

17. Impact of regulatory changes on timelines: (Scale: 1–5)

18. What key improvements would enhance risk management in construction projects?

_____
_____
_____
_____
_____

19. Additional comments on risk mitigation strategies.