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Article

Risk management strategies in large-scale infrastructure projects: A financial perspective

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Abstract: The successful execution of large-scale infrastructure projects is essential for economic growth and societal development, but these projects are too often beset with financial risks. The main financial risks related to infrastructure projects, including cost overrun, funding uncertainty, currency fluctuation, and regulatory change are examined in this research. The study identifies and assesses the magnitude and frequency of these risks by combining surveys and analysis of financial reports. The findings show that current risk management strategies, including hedging, contingency funds, and public-private partnerships, are often unsuitable to respond to the specific needs of financial uncertainties. The research suggests the need for an all-encompassing financial risk management framework that relies on real-time data analysis and a cocktail of risk assessment tools. Additionally, the development of strategic tailored approaches to address financial risk recovery depends on proactive stakeholder engagement. This research complements the existing literature on risk management in infrastructure projects by highlighting the financial dimensions of risk management and suggesting future research on advanced financial tools and technologies. Ultimately, large-scale infrastructure project sustainability and success contribute to economic stability and societal well-being can only be achieved through effective financial risk management.

Keywords: financial risk management; infrastructure projects; cost overruns; funding uncertainties; risk mitigation strategies; public-private partnerships

1. Introduction

Infrastructure large-scale projects including transportation, energy, and water management play an important role in economic growth and societal development. The Global Infrastructure Hub (2020) estimates that global infrastructure investment needs will total $94 trillion by 2040, fuelled by urbanization, population growth, and the transition to more sustainable development (Hub, 2021). In addition to improving public services, these projects generate jobs, catalyze local economies, and foster trade. Nevertheless, the complexity and size of these projects expose them to different financial risks that may compromise their implementation and general benefits. Of course, these challenges are navigated with financial risk management. There are risks associated with a project that can blow up your project budget or timelines like cost overruns, budget uncertainties, and material price fluctuations. According to studies, nearly 30% of infrastructure projects budget for overruns (Flyvbjerg et al., 2002). As

a result, effective understanding and management of financial risks is pivotal to achieving timely and cost-effective delivery of infrastructure projects, and thus, financial risk management is a major focus in the planning and execution of infrastructure projects. Although financial risk management is extremely significant in infrastructure projects, few of the existing approaches tackle the specific financial risks that occur during the execution of a project. Inadequate funding mechanisms, unpredictable market conditions as well as misalignment of stakeholder interests are common challenges that cause significant financial strain on projects (Hrytsenko et al., 2021). In addition, despite the number of proposed risk management frameworks, there has been little study on the large-scale infrastructure risk factors and the effectiveness of the current strategies in managing the same. Existing literature addresses either operational risks or case studies but lacks empirical data to support the proposed risk management strategies (Odeck, 2015). Thus, there is a clear research gap in the complete understanding of the financial risks of infrastructure projects and the development of appropriate strategies to tackle these problems. Several key theories and concepts of risk management form a basis for the identification, evaluation, and embossing of risks in different environments. Another main framework is the Risk Management Process, which includes risk identification, risk analysis, risk evaluation, risk treatment, monitoring, and review (Syahputri et al., 2020). Financial risks are of particular importance in infrastructure projects which are characterised by large investments and long-time horizons.

The Financial Risk Theory holds that organizations experience different financial risks capable of causing their performance and stability to drop. This theory considers risks as market risk, credit risk, operational risk, and liquidity risk, all of which have different effects on infrastructure projects (Global Association of Risk Professionals, 2007). Market risk, for example, refers to changes in interest rate or currency exchange rate, while credit risk means contractor's or shareholder's default. Additionally, the Agency Theory describes the conflicts of interest in project financing and management and thus the necessity of appropriate risk-sharing mechanisms among project stakeholders to ensure their interests are aligned (Eisenhardt, 1989). The underlying theory for these problems is complex and highlights the coordination of diverse stakeholder interests in infrastructure financial risk management.

Research objectives & hypothesis

The primary objectives of this study are:

1) What are the financial risks to the successful delivery of infrastructure projects?
2) What are the largest financial risk factors in large-scale infrastructure projects?
3) What are the most effective strategies for reducing financial risk in infrastructure development?

Based on these objectives, the following hypotheses are proposed:

Hypothesis 1: The most significant financial risks in executing large-scale infrastructure projects are cost overrun, funding uncertainty, and material price fluctuations.

Hypothesis 2: However, the current financial risk management strategies, such as hedging, contingency funds, or public-private partnerships are not effective enough to mitigate the financial risks associated with large-scale infrastructure projects.

Hypothesis 3: Real-time risk assessment and proactive stakeholder engagement as part of a comprehensive data-driven financial risk management framework can reduce the effect of financial risks on infrastructure projects.

Based on the theoretical framework of Financial Risk Theory, including market risks, credit risks, operational risks, and liquidity risks, along with Agency Theory which emphasizes risk sharing amongst different stakeholders, these hypotheses are developed. These will drive the analysis and interpretation throughout this study.

2. Materials and methods

2.1. Research design

This research was quantitative in design, utilizing surveys and financial report analysis to evaluate financial risk management strategies in large-scale infrastructure projects. The quantitative approach involves a systematic measurement and statistical assessment of the risk frequencies and magnitudes, which are based on primary sources (surveys) and secondary sources (financial reports). The motivation was to select a design with which to obtain empirical data that could then be used for objective analysis and the drawing of reliable conclusions about the prevalence and impact of various financial risks and their mitigation strategies within the infrastructure sector.

2.2. Data collection methods

To examine financial risk management in large-scale infrastructure projects, this study used a mixed methods approach whereby surveys and financial report analysis were the main sources of primary data. A survey was carried out among professionals involved in infrastructure projects, specifically financial managers, project managers, and risk analysts involved in infrastructure projects in a structured and self-administered manner. The survey included close-ended and open-ended questions to identify the different financial risks experienced in their projects, estimate how often and how much these risks occurred, and assess the efficiency of the risk management strategies being applied. The financial risks were quantified on a Likert scale from 1 to 5, from low impact to high impact, and respondents provided qualitative insights into the challenges of financial risk management. Respondents' demographic data will include age (25–34, 35–44, 45–54, 55+), gender (male, female, other), profession (financial manager, project manager, risk analyst, etc.), experience in years (5–10 years, 10–20 years, 20+ years), sector (transportation, energy, urban development, etc.) and geographic location (Europe, North America). The survey analysis will integrate this information to also gain greater knowledge of the variations of financial risk management strategies utilized by individuals with different demographic groups and professional experiences. The data was collected over three months, allowing for quantification of specific risks and their prevalence.

Secondary data was also collected by reviewing financial reports of several large-scale infrastructure projects initiated no later than 2020 and completed by the end of 2023, including audited financial statements, project balance sheets, cash flow statements, and risk disclosures. The frequency and magnitude of cost overruns, variations in interest rates, the effect of exchange rate variations on international

projects, and unexpected regulatory costs that caused delays in the project were the key data points of these reports. The combination of survey and financial report data enabled a more complete picture of financial risks, informed by a historical perspective of financial trends, to contribute to the study of financial risk management in infrastructure projects.

2.3. Sampling and participants

A purposive sampling method was used to select participants for the survey, participants having direct knowledge and experience in financial risk management in large infrastructure projects. The survey was distributed to 70 financial managers, 50 project managers, and 30 risk analysts in 150 professionals from public and private sector infrastructure projects across Europe and North America, ensuring its variety of regional risk factors and risk management strategies while ensuring the dataset is diverse. The participants were selected from projects funded by three main sources: publicly funded projects supported mainly by government agencies for public infrastructure such as transportation networks and energy facilities; privately funded projects financed by corporations or investors for commercial infrastructure such as private energy facilities and toll roads; and public-private partnerships (PPPs) where public and private sector investment is combined to deliver projects like highways and railways to realize both public benefits and private profits.

To participate, participants had to have at least five years of experience managing financial risk in infrastructure projects. To have a broad view of risk management practice, participants were sourced from a range of projects (transportation, energy, urban development). Six large-scale infrastructure projects of over USD 500 million were selected for financial reports. These include London Crossrail, California High-Speed Rail, and Dubai Creek Tower. These projects are expensive and risky projects, with a high level of financial risk. The set of projects spanned across sectors, types of funding, and geographic locations to generate a broad dataset. Data was limited to include only projects with accessible, detailed financial reports to ensure data accuracy.

2.4. Data analysis techniques

The collected data were analyzed using a combination of statistical analysis and financial ratio analysis:

Statistical Analysis of Survey Data: Survey responses were summarized using descriptive statistics, including frequency distributions, mean, and standard deviation. The relationships between project characteristics (such as sector and funding structure) and the occurrence or impact of certain risks were examined using inferential statistics, such as chi-square tests, were used. This analysis showed trends in financial risk exposure by type of infrastructure project.

Financial Ratio Analysis of Reports: The financial reports were considered to calculate key financial ratios and metrics such as cost overrun ratio, debt-to-equity ratio, and exchange rate sensitivity. These ratios allowed us to quantify the actual financial impacts of identified risks. For instance, the cost overrun ratio (actual cost/planned cost) was used to measure how close projects stayed to budget forecasts,

while the debt-to-equity ratio was used to identify a project's sensitivity to interest rate fluctuations.

2.5. Ethical considerations

We made sure that we collected and handled data ethically and therefore the study is ethical. Participants were fully aware of the objectives of the study, data usage, and anonymity measures, and were provided with informed consent. The responses were anonymized data kept confidential and secure, and no identifying information was released. Cross-checking financial data with public records and resolving ambiguities through consultation with financial sources were used to uphold data integrity. The research employed these practices to maintain high integrity and respect for participant privacy throughout the research process.

3. Results

3.1. Identification of key financial risks

Using survey responses and financial report analysis, these were identified as the most common and impactful key financial risks in large-scale infrastructure projects. (**Table 1**).

Table 1. Identification of key financial risks in large-scale infrastructure projects.

Risk Type	Description	Frequency (% of Projects Affected)
Cost Overruns	An unplanned increase in project costs which results in budget overrun.	72%
Funding Challenges	Inadequate funding sources, either in securing or maintaining.	64%
Currency Fluctuations	The effect of changes in foreign exchange rates on project budgets.	48%
Regulatory Changes	The impact of sudden regulatory or policy change on financial implications.	50%
Interest Rate Variability	Borrowing costs vary when long-term financing is sought.	45%
Material Price Volatility	Changes to material costs that affect project forecasts.	58%
Credit Risk	The risk that a contractor or subcontractor defaults affects project finances.	38%

3.2. Risk assessment findings

Table 2. Risk assessment findings for financial risks in infrastructure projects.

Risk Type	Risk Magnitude (Impact Rating: 1–5)	Frequency (% of Projects Affected)	Survey-Based Insights
Cost Overruns	4.5 (High)	72%	60% of respondents indicated cost overruns due to inaccurate initial budgeting.
Funding Challenges	4.0 (High)	64%	Projects with single-source funding reported higher risk.
Currency Fluctuations	3.8 (Moderate-High)	48%	Significant in projects with > 20% expenses in foreign currency.
Regulatory Changes	3.5 (Moderate-High)	50%	Regulatory changes led to unanticipated project delays.
Interest Rate Variability	3.2 (Moderate)	45%	High exposure for projects financed over extended timelines.
Material Price Volatility	3.9 (High)	58%	55% of respondents reported the impact of steel and cement price surges.
Credit Risk	3.1 (Moderate)	38%	Higher incidence of credit issues with multiple subcontractors.

The risk magnitude (impact rating) and frequency of occurrence are given in **Table 2** based on the analyzed data.

Figure 1 contains a risk-type analysis of large-scale infrastructure projects, in terms of the frequency of occurrence as well as the magnitude of the impacts. The impact of each risk on project success is rated on a scale of 1 to 5 and the percentage of projects affected by each risk. The most significant one is the cost overrun with the highest impact rating of 4.5 and having an impact on 72% of the projects; which signifies, that one of the biggest challenges there, is the constraint of a budget. Rating coming fourth with a score of 4.0 and affecting 64% of projects, funding challenges follow closely with the need for reliable funding sources. Moderate-high risks were identified for currency fluctuations (3.8), regulatory changes (3.5), and material price volatility (3.9) which all have the potential to seriously disrupt project planning and execution. Moderate impacts are presented by interest rate variability and credit risk, which are rated 3.2 and 3.1, respectively, and need to be considered in financial management and contractor reliability. Collectively, these results highlight the need to appreciate and mitigate the many risks involved to increase the probability of project success.

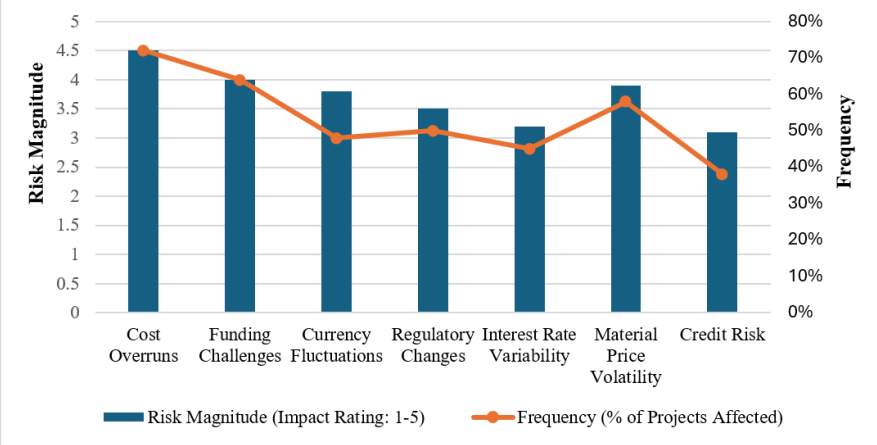

Figure 1. Assessment of risk magnitude and frequency in large-scale infrastructure projects.

Financial risk also includes regulatory changes because they can lead to unforeseen costs (compliance expenses; redesigns) that directly add cost to the project budget. Also, these changes can cause delays and further increase the financial burdens, justifying their inclusion as a financial risk in this study.

3.3. Statistical and analytical findings

Results of the data analysis are summarized by the following statistical findings which indicate the correlation and impact of certain financial risks on project budgets and timelines. Models and visual representations supported these insights. **Table 3** shows key risk findings: project scale was correlated with cost overruns (R^2 = 0.72), single source funding increased risk frequency (p < 0.05), and over 20% foreign expenses increased currency risk (R^2 = 0.68). Delays increased by 45% due to regulatory risks, and returns were affected by 20% due to interest rate variability. Multiple subcontractors (R^2 = 0.52) increased credit risks.

Table 3. Statistical and analytical findings on financial risks in infrastructure projects.

Risk Type	Statistical Model/Analysis	Key Findings
Cost Overruns	Linear Regression Analysis ($p < 0.01$)	Strong positive correlation between project scale and frequency of cost overruns ($R^2 = 0.72$).
Funding Challenges	Chi-Square Test	A statistically significant association between single-source funding and risk frequency ($p < 0.05$).
Currency Fluctuations	Regression Analysis ($R^2 = 0.68$)	Projects with >20% foreign expenses showed higher vulnerability to currency fluctuations.
Regulatory Changes	Descriptive Statistics	45% increase in project delays directly linked to regulatory risks in emerging markets.
Interest Rate Variability	Monte Carlo Simulation	20% impact on net project returns under high-interest conditions.
Material Price Volatility	Paired *T*-Test	Significant impact ($p < 0.05$) of material price surges on projects without escalation clauses.
Credit Risk	Pearson Correlation ($R^2 = 0.52$)	Higher credit risks were observed in projects with multiple subcontractors, highlighting exposure risks.

4. Discussion

This study's results reinforce several key financial risk factors that dramatically impact large-scale infrastructure projects. Interestingly, cost overruns were the most common risk, being present in 72% of the projects studied. This is consistent with findings from previous research that budget excesses are usually caused by inaccurate initial budgeting and unexpected project complexities (Flyvbjerg et al., 2002). Moreover, the frequency of funding challenges (64%) increases with the growing difficulty in sustaining a stable source of funding, especially in projects funded by public sources, given the economic uncertainty (Bing et al., 2005). Currency fluctuations and material price volatility also had a big impact on project finances (48% and 58%, respectively). These risks expose infrastructure projects to the global shift in the economy and the importance of hedging and flexible contracting for effective risk management (Beckers et al., 2013). This study's findings support earlier research on financial risk management in infrastructure projects. For example, Akintoye and MacLeod (1997) did a study on a critical risk factor of cost overruns, as this study also shows. This study extends previous literature by combining a comprehensive survey approach with financial report analysis to create a dual perspective on risk assessment that has not been explored in previous research. Furthermore, although previous research has concentrated on qualitative evaluation of risk management techniques, this work also quantitatively assesses the impact and frequency of financial risks, providing valuable input to the study of risk dynamics in large-scale projects (Serpell et al., 2015).

This study provides insights that can be used to guide financial practices among stakeholders in large-scale infrastructure projects. For example, the high prevalence of funding challenges implies that stakeholders should look at diversifying their funding sources to reduce funding risks from dependence on a single funding source. A financial solution will involve the use of swaps and options, to manage the currency fluctuations and, hence, protect the project's budget from instability caused by volatile exchange rates (Shibani et al., 2022). Additionally, the results suggest employing flexible contract mechanisms to manage the volatility of material prices. This might

include adding escalation clauses in the contract which allow for the adjustments of the rate throughout the contract to meet market conditions, similar to similar scenarios as well as data showing that revising a rate under such circumstances reduced budget impact (Khalef et al., 2021). This study contributes to the literature but should be viewed with some caveats in mind. Second, the sample size of 150 professionals may not cover the whole group of infrastructure stakeholders, which implies the findings may not be well generalizable. Moreover, self-report survey data is reliant on, and results may be magnitude affected by, response bias with respondents underreporting negatives or risks. In addition, the analysis is limited to financial risks and does not include non-financial factors like political and environmental risks that could also affect project success. Several avenues for future research in understanding financial risk management in infrastructure projects are suggested. An area that is potentially of interest is the study of new financial risk management instruments, including those based on machine learning and data analytics, to better forecast and minimize financial risks (Garcia et al., 2022). Other studies, such as longitudinal studies that track the evolution of risk outcomes over time, can give us insights into which management strategies are more effective and how the long-term effect of different strategies on project success. Further, the correlation between stakeholder engagement and risk management results could be interesting to know, as, more often than not, the effectiveness of communication between project participants is considered central to risk avoidance success (Prebanić et al., 2023).

The distribution of financial risks within project management methodologies (e.g., Scrum and Waterfall) could be another area for future research. Neatly enough, these methodologies are flexible and exert leverage on financial as well as other risks through their structure during the project lifecycle. It might also help to understand their influence on risk outcomes to improve the financial risk management practices of infrastructure projects.

5. Conclusion

The role of financial risk management in large-scale infrastructure projects and the range of financial risks that can jeopardize their successful execution were explored in this research. The research recognized the cost overrun, funding uncertainty, the fluctuations of currency, and regulatory changes as the key financial risks that heavily determine the project outcome. Analyzing current risk management strategies further confirmed that approaches such as hedging, contingency funds, and public-private partnerships are being used; however, they have not been as effective as desired and are not sufficiently targeted to address the specific financial risks associated with infrastructure projects. The results highlighted the need for a holistic financial risk management framework that goes beyond the current risks and also looks ahead to tomorrow's threats. They encourage stakeholders to adopt more robust strategies that incorporate empirical data and real-time risk assessment tools to manage uncertainties better. In addition, incorporating state-of-the-art technologies, like data analytics and machine learning, in financial risk management will offer additional gains in how we identify and mitigate risk.

Lessons for future projects are presented in this study, with a focus on the importance of developing a tailored and dynamic risk management framework that responds to the dynamic nature of risks inherent in large-scale infrastructure. Contingency funds and hedging are worthwhile, but insufficient to manage currency fluctuations and regulatory change risk. Specific financial instruments should be developed for these risks in future efforts, especially in international projects.

Technologies like predictive analytics and machine learning can power real-time financial risk monitoring—all this can lead to improved forecasting and more proactive management of the challenges that emerge. This study bridges theory and practice by integrating Financial Risk Theory and Agency Theory to provide a framework for the limitations of current strategies and the potential of data-driven solutions. These findings can be used by policymakers to improve risk-sharing mechanisms and regulatory frameworks, to enable more sustainable infrastructure projects.

Although much was learned, this study recognized several limitations, namely the use of qualitative data and the possibility of regional differences in financial risk management practice. Expanding on this research in the future, additional longitudinal studies are needed to monitor how effective different financial risk management strategies are relative to one another and how they apply in other geographical contexts over time. Furthermore, the development of the field will be dependent on the examination of how innovative financial tools and technologies may be integrated to enhance the sustainability of infrastructure projects. Finally, large-scale infrastructure projects require a proactive, nuanced approach to financial risk management to be successful. Stakeholders who give priority to financial risk management can guarantee that these projects do not just reach the expected ends but also make a positive impact on sustainable economic growth and societal development.

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References

Akintoye, A. S., & MacLeod, M. J. (1997). Risk analysis and management in construction. International journal of project management, 15(1), 31-38.

Beckers, F., Chiara, N., Flesch, A., Maly, J., Silva, E., & Stegemann, U. (2013). A risk-management approach to a successful infrastructure project. Mckinsey Work. Pap. Risk, 52(2013), 18.

Bing, L., Akintoye, A., Edwards, P. J., & Hardcastle, C. (2005). The allocation of risk in PPP/PFI construction projects in the UK. International Journal of project management, 23(1), 25-35.

Eisenhardt, K. M. (1989). Agency theory: An assessment and review. Academy of management review, 14(1), 57-74.

Flyvbjerg, B., Holm, M. S., & Buhl, S. (2002). Under estimating cost in public work project. Journal of the American planning association, 30, 31-44.

Garcia, J., Villavicencio, G., Altimiras, F., Crawford, B., Soto, R., Minatogawa, V., ... & Yepes, V. (2022). Machine learning techniques applied to construction: A hybrid bibliometric analysis of advances and future directions. Automation in Construction, 142, 104532.

Global Association of Risk Professionals. (2007). Financial risk manager handbook. John Wiley & Sons.

Hrytsenko, L., Boiarko, I., Tverezovska, O., Polcyn, J., & Miskiewicz, R. (2021). Risk-management of public-private partnership innovation projects. Marketing i menedžment innovacij, (2), 155-165.

Hub, G. I. (2021). Infrastructure monitor 2021. Annual Report. Available online: https://cdn. gihub. org/umbraco/media/5171/global-infrastructure-hub_2022-infrastructure-monitor-report-plus-esg-section_fa_2203. pdf (accessed on 1 March 2023).

Khalef, R., El-Adaway, I. H., Assaad, R., & Kieta, N. (2021). Contract risk management: A comparative study of risk allocation in exculpatory clauses and their legal treatment. Journal of Legal Affairs and Dispute Resolution in Engineering and Construction, 13(1), 04520036.

Odeck, J., Welde, M., & Volden, G. H. (2015). The impact of external quality assurance of costs estimates on cost overruns: empirical evidence from the Norwegian road sector.

Prebanić, K. R., & Vukomanović, M. (2023). Exploring stakeholder engagement process as the success factor for infrastructure projects. Buildings, 13(7), 1785.

Serpell, A., Ferrada, X., Rubio, L., & Arauzo, S. (2015). Evaluating risk management practices in construction organizations. Procedia-Social and Behavioral Sciences, 194, 201-210.

Shibani, A., Hasan, D., Saaifan, J., Sabboubeh, H., Eltaip, M., Saidani, M., & Gherbal, N. (2022). Financial risk management in the construction projects. Journal of King Saud University-Engineering Sciences.

Syahputri, H. Y., & Kitri, M. L. (2020). Enterprise risk management analysis of group XYZ based on ISO 31000: 2018 framework. Asian Journal of Accounting and Finance, 2(3), 1-12.