International Research Journal of Innovation in Science and Technology

Role of Early Risk Identification in Reducing Project Delays and Cost Overruns

Nishant D. Patil[1], Kartavya M. Patil[2]

[1-2]Research Scholar, Vishwakarma Institute of Information Technology, Pune, India
Correspondence: [2]kartavya.22310506@viit.ac.in

Abstract

Project delays and cost overruns continue to affect construction, infrastructure, transportation, and information technology projects across the world. Studies conducted over the past two decades indicate that a large percentage of projects exceed planned cost and schedule targets due to inadequate planning, weak governance, and ineffective risk management practices. This paper presents a systematic review of the role of Early Risk Identification (ERI) in reducing project delays and cost overruns using published industry reports, project management studies, and global datasets from 2005–2025. The review examines the causes of project overruns, traditional and modern risk identification techniques, sector-specific evidence, and the growing role of technologies such as Artificial Intelligence (AI), Building Information Modelling (BIM), and digital twins in project risk management. The study also discusses behavioural and organizational barriers including optimism bias, weak stakeholder coordination, and delayed decision-making. The findings suggest that proactive risk identification significantly improves project performance by reducing schedule delays, improving cost control, and strengthening project governance. The paper concludes with practical recommendations for implementing structured ERI frameworks in modern project environments.

Keywords: Risk Identification; Cost Overrun; Project Delay; Project Risk Management; PMBOK; Predictive Analytics; AI in Project Management; Megaproject; Early Warning Systems.

1. Introduction

Project management failure is a widespread issue that knows no geographical or industrial boundaries. The inability to deliver projects on time and under budget translates into massive financial and organizational losses measured in multi-trillion dollars each year. Regardless of the continuous improvements in various project management methodologies, including Waterfall, Agile, or a combination thereof, the root cause of project overruns persists at a systemic level.

Statistics paint a clear picture. According to Flyvbjerg, analyzing a database of over 16,000 projects in 136 different countries, over 91.5% of the projects experience either cost or schedule overrun or both [1]. In other words, less than 1% of projects are delivered on time and budget without failing to achieve their stated goals [1]. This statistic was independently confirmed by McKinsey in its review of over 300 megaprojects worth more than $1 billion per project with 80% cost overruns and close to 50% schedule delays [2].

These numbers set out a convincing case for conducting further research: if overruns are so common, what sort of systematic measures can be taken by project managers to stop this from happening? This paper argues that Early Risk Identification (ERI), defined as the systematic process of detecting and analyzing potential project risks early in the project cycle, is one of the most effective approaches for improving project delivery performance.

The outline of the paper proceeds as follows: section two describes the global statistics on project failure rates. Section three describes ERI and its importance within the project life cycle. Section four discusses the causes of overruns. Section five estimates the advantages of ERI. Section six compares and contrasts conventional and contemporary risk identification techniques. Section seven analyzes the industry-specific evidence. Section eight looks at psychological barriers. Section nine explores frameworks and standards. Section 10 considers stakeholder communication. Section 11 outlines future directions. Section 12 discusses the limitations of the study, and Section 13 concludes with practitioner recommendations.

2. Scale of the Problem: Global Evidence (2005-2025)

The body of literature on project failure is plentiful and coherent. Here is some statistical evidence collected over the past twenty years, which serves as a base for this paper.

2.1. Performance of Megaprojects

Flyvbjerg's groundbreaking research, which first appeared in the Project Management Journal in 2014 and was further elaborated upon in his book 'How Big Things Get Done' in 2023, provides the most complete evaluation of megaproject performance. Based on a database of 16,000+ projects in 20 different sectors in 136 countries, including Olympics, nuclear reactors, railroads, bridges, and NASA missions, the results indicate significant levels of project overruns [1]:

Table 1: *Global Megaproject Performance Statistics and Overrun Evidence*

91.5%	**Global Failure Rate**	Go over budget, over schedule, or both (Flyvbjerg, 2023)
<1%	**On-Time & On Budget**	Delivered on time, on budget, with promised benefits
80%	**Megaproject Overrun**	Average cost overrun in 300+ billion-dollar projects (McKinsey)
50%	**Schedule Delay**	Average schedule delay in billion-dollar megaprojects (McKinsey)

On railroads, the typical overrun is 44.7% while ridership is overestimated by 51.4%. London's Jubilee Line extension was 80% above budget in real terms. Denver International Airport experienced a budget overrun of 200%. Boston's Big Dig project experienced an overrun of 220%, spending 22 billion on a 3.5 mile highway tunnel. The Canadian Firearms Registry was 590% above budget. The world's most notorious project failure in history, the Sydney Opera House, had a budget overrun of 1,400% [1].

2.2. Project Overrun Evidence by Industry

Construction: According to McKinsey & Company, there are $1.6 trillion in efficiency losses per year within the global construction industry due to overbudgeting where projects typically go 20-45% over-budget depending on the nature of the project. The United Kingdom National Audit Office reported that 70% of projects were over-budget on average with an overrun of 18% [3].

Information Technology: IT projects are by far the riskiest tail risks in any business. According to Flyvbjerg and Budzier (2022), 18% of IT projects experience budget overruns exceeding 50%. More importantly, for such projects, the mean overrun is 447% [4].

Transportation: A Florida DOT study (Choi et al., 2021) found that 61.1% of transportation projects resulted in cost overruns, 69.4% experienced delays, and 46.0% encountered both simultaneously [5]. In Jordan, Al-Momani (2000) documented delays in 81.5% of public infrastructure projects [6].

One-year delay correlation: Flyvbjerg's quantitative modelling demonstrates that on average, a one-year extension of the implementation phase correlates with a 4.64% increase in cost overrun percentage. For a project the size of London's $26 billion Crossrail, this equates to over $1.2 billion in additional cost per year of delay [1].

3. Defining Early Risk Identification in the Project Lifecycle

Early Risk Identification (ERI) refers to the systematic detection, classification, and documentation of potential threats to project objectives specifically cost, schedule, scope, and quality during the initiation and planning phases of the project lifecycle, before significant resource commitment has occurred.

The Project Management Body of Knowledge (PMBOK Guide, 7th Edition, PMI 2021) defines risk identification as an iterative process: 'Identify Risks is an iterative process because new risks may become known as the project progresses through its lifecycle' [7]. The PMBOK outlines six core risk management processes:

Table 2: *PMBOK Risk Management Processes (PMI, 2021)*

SN	Process	Description
1	**Plan Risk Management**	Define risk management approach, roles, and methodologies
2	**Identify Risks***	Detect potential risks using checklists, brainstorming, Delphi, SWOT, and document review
3	**Qualitative Risk Analysis**	Prioritize risks by probability and impact using risk matrix
4	**Quantitative Risk Analysis**	Numerically model risk effects via Monte Carlo simulation
5	**Plan Risk Responses**	Develop strategies: avoid, mitigate, transfer, accept
6	**Monitor & Control Risks**	Track identified risks, identify new risks, evaluate risk responses
**Denotes the focus of this paper.*		

The key distinction between ERI and reactive risk management lies in timing. In reactive models, risks surface during execution when change orders are already inevitable, contracts are binding, and the cost of correction is 10–100 times higher than prevention. In ERI, risks are surfaced during feasibility and planning, enabling design modifications, contract restructuring, and contingency allocation before any financial commitment crystallizes.

4. Root Cause of Project Delays and Cost Overruns

An investigation on 405 peer-reviewed literature (Buildings, MDPI, 2025) identified 66 interlinked cost overrun determinants in 69 impactful publications from 2000 to 2024 through Social Network Analysis, which had a network density of 0.987. It was observed that cost overrun determinants are strongly interconnected, meaning that addressing them individually may not be fully effective [8].

4.1. Design and Planning Issues

A 2025 research on 127 mega-projects in Indonesia (Ramadhan & Watty, 2025) utilizing Partial Least Squares Structural Equation Modelling (PLS-SEM) yielded the following impacts [9]:

Table 3: *Impact of Design Changes and Planning Errors on Project Performance*

56.5% / 40%	Design Changes	contribution to cost overruns / project delays respectively
34.5% / 23.1%	Planning Errors	contribution to cost overruns / project delays respectively

4.2. Economic and Other Environmental Factors

A study conducted by IJFMR (2025) on infrastructural projects within the Bangsamoro Autonomous Region used the Relative Importance Index (RII) method to determine the top three factors that contribute to cost overruns [10]:

- Rise in material expenses (RII = 0.902)
- Inflation and economic instability (RII = 0.873)
- Project under-pricing during the design phase (RII = 0.842)

4.3. Execution and Management Mistakes

According to a McKinsey analysis of 48 failed megaprojects, 73% of them experienced cost and schedule overruns due to poor execution practices. These mistakes involved incomplete designs, vague project scope, misguided attempts to cut corners, and faulty calculations of timeframes and risks. The rest of the 27% of project delays resulted from political factors like regime changes and new regulations [2].

According to George (2020), ineffective project governance, insufficient communication channels, and low institutional capacities have been consistent issues throughout post-failure analysis of project management failures in developed and developing countries [11].

5. Quantified Benefits of Early Risk Identification

The core empirical contribution of this paper is to demonstrate, with measurable data, the financial and schedule impact of ERI adoption. The following evidence is drawn from industry reports, academic studies, and global project databases.

***Table 4:** Reported Benefits of Early Risk Identification in Project Management*

27% to 8%	Cost Overrun Reduction	Average cost overrun in well-managed vs. unmanaged projects (2024 Industry Data)
65%	Failure Prevention	Potential project failures prevented through proactive risk management
28%	Delay Reduction	Average reduction in project delays through proactive mitigation
+20%	Value Realization	Higher project value realization in organizations managing both threats and opportunities

This estimate, derived from the 2024 project management industry survey, may vary depending on project scale, sector, and implementation environment. In high-risk scenarios, like large-scale IT transformations and international infrastructure development, the gap between the results of managed and unmanaged risk situations becomes much larger.

The Chunnel is an illustrative example in this respect. Its expenses exceeded the planned budget by 80 percent in the construction phase and 140 percent in the finance phase. The revenues proved insufficient to meet expectations and brought a $17.8 billion loss to the UK's economy. The independent investigation concluded that inadequate risk analysis and assessment during the project preparation phase were the primary cause of this result [1].

Projects that adopt systematic ERI approaches, such as the PMI Standard for Risk Management (2024), show a statistically significant improvement in their delivery results. The improvement is primarily attributed to proactive planning and mitigation measures. If the risks are identified early, the variety of possible actions is broad, and costs are minimal. If the risks become apparent later, there will be few ways to address them, and their resolution would require considerable resources.

6. Traditional vs. Modern Risk Identification Methods

6.1. Traditional Methods (2000–2015)

The conventional approaches to risk identification were based on expert judgment, workshops, and checklists. According to the PMBOK Guide (4th Edition, 2008), the following techniques can be used [7]:

- Document Reviews: review of plans, contracts, and project history data
- Brainstorming: a structured group idea generation approach aimed at identifying risk scenarios
- Delphi: iterative development of expert consensus to objectively assess risks
- Interviews: stakeholder interviews to uncover risks
- SWOT Analysis: identification of Strengths, Weaknesses, Opportunities, and Threats
- Assumptions Analysis: review and stress testing of project assumptions to identify underlying risks
- FMEA: combination of failure modes identification and their assessment based on the potential impact on project

These methods, however, have one significant drawback: they are all subjective in nature since they are based on the expertise of the involved experts. Recent research on hybrid AI-assisted risk assessment frameworks highlights that traditional risk identification methods are often limited by subjective expert judgment and qualitative evaluation approaches, which may reduce forecasting accuracy in complex projects [12].

6.2. AI and Data-Driven Methods (2015–2025)

The integration of big data, cloud computing, and machine learning has led to a shift in paradigm in the process of identifying risks. AI-based risk identification transitions from reactive pattern detection by people to proactive detection of threats based on algorithms designed to work with thousands of prior projects.

Recent studies on AI-assisted risk assessment frameworks indicate that machine learning and semantic analysis techniques can improve the identification and classification of project risks by analyzing historical project datasets and risk relationships [12]. The integration of NLP, historical data analysis, and probabilistic modelling enables faster and more consistent risk forecasting compared to traditional manual approaches.

Nowadays, deep learning neural networks such as CNNs and RNNs are being used to identify patterns in highly complex project data sets. These algorithms allow for dynamic forecasting of resource consumption and possible project delays, delivering tangible benefits over intuition-based risk management and ensuring project stability (Muller et al., 2024) [13].

Modern AI-assisted risk identification systems improve the accuracy and speed of project risk analysis by processing large volumes of historical project data and identifying hidden patterns associated with delays, resource shortages, cost escalation, and scheduling conflicts. Compared to traditional experience-based approaches, data-driven systems provide more consistent and scalable risk assessment capabilities, especially for large and complex projects.

7. Sector Specific Evidence

Different industries experience project delays and cost overruns in varying degrees depending on project complexity, governance structure, financial uncertainty, and technological requirements [18]. Table 5 summarizes major sector-specific findings reported in previous studies between 2000 and 2025 regarding project overruns and the importance of early risk identification practices.

Table 5: *Sector-Wise Evidence of Project Delays and Cost Overruns (2000–2025)*

Sector	Key Statistic	Source / Year	Implication
Construction	90% exceed budget; avg. 28% overrun	Flyvbjerg (2014); McKinsey (2020)	ERI during design prevents most scope creep
Infra. (Global)	$1.6 trillion annual inefficiency cost	McKinsey (2020)	Systemic ERI frameworks can save hundreds of billions annually
IT Projects	18% overrun >50%; avg. overrun = 447%	Flyvbjerg & Budzier (2022)	Requirements risk identification is critical in digital projects
Transportation (USA)	61.1% cost overrun; 69.4% delayed	Choi et al. (2021)	Multi-phase risk reviews required from feasibility stage
Rail Projects	Avg. 44.7% cost overrun	Flyvbjerg (2014)	Demand forecasting risk must be identified pre-approval
Public Sector (Jordan)	81.5% of projects delayed	Al-Momani (2000)	Governance-level ERI institutionalization needed
Construction (UAE)	50% miss schedule deadlines	Faridi & El-Sayegh (2006)	Contractor risk sharing mechanisms required early

8. Behavioral Barriers: Optimism Bias and Strategic Misrepresentation

Behavioral factors influencing project risk management should not be overlooked in complex projects.

The question here should not be about 'Why are the risks ignored?' but rather about 'Why do organizations not see their need to look for the risks?' In his book on the political economy of projects, Flyvbjerg introduces a concept called 'optimism bias,' based on Kahneman's Nobel Prize-winning Prospect Theory, which suggests that the proponents of a project, including its planners, would always assume low costs and high benefits because of their optimistic cognition [1].

Indeed, the behavioural dynamics at work here are strikingly reminiscent of banks issuing mortgages based on the incomes reported by applicants without any independent corroboration. The system of granting approvals for projects rewards optimism and penalizes honesty, just as the mortgage lending market did prior to 2008. As Flyvbjerg pointed out, 'you get rewarded for misrepresenting projects and you get punished if you are honest.'

From an ERI perspective, this behavioural dynamic has important implications for the process of risk identification, namely that the responsibility for the latter cannot be entrusted to those who stand to gain from the success of the project. It is therefore necessary for mandatory and independent reviews of potential risks to be conducted, just as financial audits are mandated. Some governments have implemented a structural solution in the form of reference class forecasting (RCF), wherein new cost estimates of projects need to be compared to the real-world outcomes of previous, similar projects.

According to Flyvbjerg, 'overruns have stayed high and constant for the 90-year period for which comparable data exist' and 'geography does not seem to matter – all countries and continents for which data are available suffer from overrun' [1].

9. Risk Identification Frameworks and Standards

Some of the internationally acknowledged guidelines that offer structured advice for implementing ERI are discussed below.

9.1. PMI Risk Management Standard (updated 2024)

The updated version from 2024 of the 'Risk Management in Portfolios, Programs, and Projects: A Practice Guide', published by PMI, serves as the global benchmark for the application of risk management processes in portfolios, programs, and projects under the enterprise risk management (ERM) model [14]. It stresses that ERI should be integrated into corporate culture and not merely considered a compliance exercise.

9.2. ISO 31000:2018

ISO 31000 is an international standard on risk management that can be applied universally across all sectors. According to the standard, risk is described as 'the effect of uncertainty on objectives' and requires risk identification to be comprehensive, systematic, and involve stakeholder participation. The risk identification cycle presented in ISO 31000 bears a striking resemblance to the approach adopted by PMI, whereby a single risk identification approach is insufficient.

9.3. FMEA and Monte Carlo Simulation Approaches

Failure Mode and Effects Analysis (FMEA) is widely used in engineering and project management for systematic identification and prioritization of potential risks based on severity, occurrence, and detectability factors [15]. The method provides a structured framework for identifying high-priority risks during the planning and execution phases of projects.

In modern project risk management, FMEA is increasingly combined with probabilistic techniques such as Monte Carlo Simulation (MCS) to improve forecasting accuracy. Monte Carlo methods enable project managers to simulate thousands of possible schedule and cost scenarios under uncertainty, thereby improving contingency planning and decision-making. Unlike deterministic estimation approaches, MCS captures variability in project duration, resource availability, and external risk conditions.

The integration of structured risk identification methods with quantitative simulation models provides a more comprehensive understanding of project uncertainty and supports proactive risk mitigation strategies in complex projects.

9.4. PRINCE2 and Agile Risk Approaches

The Risk Theme in PRINCE2 framework makes it clear that risk management must be taken into consideration in projects. In particular, at the initial project planning stage, a Risk Register and Risk Management Strategy are needed. Agile methods in IT projects deal with risk short sprint cycles that enable continuous re-identification and response. The convergence of Agile and risk management (Risk-Agile integration) is an emerging research area with growing practitioner adoption.

10. Stakeholder Coordination and Risk Communication

However, risks do not exist in documents; rather, they exist in the space between individuals, groups, and organizations. In order for ERI to be truly effective, it is not enough simply to identify risks technically. Risks must also be communicated in a structured manner among all relevant parties within a project.

The analysis of infrastructure projects' failure themes invariably shows three organizational failures: poor project control, inadequate communications, and low institutional capacity [10]. These are human and organizational issues, not technical issues. Documents that lie untouched in a project manager's computer hard drive offer no protection against the risks recorded in those documents.

Through empirical research, Guyolla (2023) showed that risk management, when used as an intermediary in construction projects, greatly increases the success rate of these projects. The intermediary role of risk management implies that risk-related information must be effectively shared between the various project parties.

Risk communication best practices include a Risk Register that is shared and cloud-based, available to everyone involved; weekly reviews of risks during the planning phase; risk escalation procedures for risks of high priority; and risk audits after the project.

The aviation industry provides a useful example of how structured communication systems and standardized operational procedures can significantly improve risk management outcomes over time.

11. Future Directions: AI, BIM, and Digital Twins

The following decade is set to witness a paradigm shift in risk identification, monitoring, and mitigation processes. Three streams of technology, including artificial intelligence, building information modelling, and digital twins, are combining to facilitate the transition towards risk surveillance through automation.

11.1. Predictive Analytics and Machine Learning

Through the application of machine learning on historical project data sets, the prediction of cost overruns and project delays is becoming increasingly accurate. The work of Ashtari et al. (2022) presents a machine-learning solution that provides significantly higher accuracy of cost overrun risks compared to traditional regression-based models. NLP technologies are currently used to detect emerging risks in project communications, meetings, and change order documents before they become evident in traditional risk reviews [13].

11.2. Building Information Modelling (BIM)

Through the integration of geometric, scheduling, and costing information into a 3D model, BIM facilitates the detection of risks through the process of spatial conflict resolution, constructability analysis, and quantity take-off verification. By detecting and resolving potential issues in the virtual world, BIM preempts actual risks on site altogether. Evidence suggests that there are 15-20% fewer RFIs in construction projects utilizing BIM, as each RFI corresponds to an instance of risk materialization.

11.3. Digital Twins

A digital twin refers to a dynamic virtual model of a physical project created using continuous information updates from Internet-of-Things (IoT) sensors and the project's data systems. With respect to ERI, digital twins allow for: dynamic monitoring of structural risks; automation of detection of deviations in planned versus actual progress; predictive maintenance scheduling; and modeling alternative strategies for handling risks. Though currently used mainly for the purposes of managing operational infrastructure, digital twins are also being increasingly utilized during construction phases, allowing for alerts when deviations occur. According to the Community-Led AI and Project Management Report by PMI (2024), there has been increased usage of AI by practitioners with positive impacts on the ability to identify risks early. Current trends suggest that, within the next decade, ERI may evolve from a periodic manual activity into a dynamic AI-assisted continuous monitoring process [17].

12. Limitations of the Study

This study is primarily based on secondary literature, published reports, industrial datasets, and previously documented case studies between 2005 and 2025. The paper does not include primary survey data or experimental project observations conducted directly by the authors. In addition, some industry reports and global datasets may use different methodologies for measuring project overruns and performance indicators. Therefore, the findings of this review should be interpreted as analytical and comparative observations rather than universally standardized measurements.

13. Conclusion and Recommendations

This review highlights the critical role of Early Risk Identification (ERI) in reducing project delays, cost overruns, and implementation failures across construction, infrastructure, transportation, and information technology projects. The findings from global studies conducted between 2005 and 2025 indicate that ineffective planning, delayed risk recognition, weak governance, and poor communication remain among the leading causes of project underperformance worldwide. The study demonstrates that organizations adopting structured ERI practices generally achieve better schedule control, improved cost management, stronger stakeholder coordination, and enhanced project resilience. Frameworks such as PMBOK, ISO 31000, FMEA, Agile risk approaches, and modern AI-assisted analytics provide systematic mechanisms for identifying and mitigating risks during the early stages of project development. In addition, emerging technologies including Artificial Intelligence (AI), Building Information Modelling (BIM), predictive analytics, and digital twins are transforming project risk management from a reactive process into a proactive and continuously monitored system.

The review further emphasizes that technical tools alone are insufficient unless supported by organizational transparency, effective communication, stakeholder participation, and independent risk evaluation mechanisms. Behavioural factors such as optimism bias and strategic misrepresentation continue to influence project decisions and often prevent realistic assessment of project uncertainty. Based on the reviewed literature, the following recommendations are proposed for improving project risk management practices:

Practitioner Recommendations

- Conduct structured risk identification sessions during project feasibility and planning stages before major financial commitments are made.
- Implement centralized and continuously updated Risk Registers accessible to all major project stakeholders.
- Utilize Reference Class Forecasting (RCF) and historical project benchmarking for realistic estimation of cost and schedule performance.
- Integrate AI-assisted predictive analytics and data-driven monitoring systems into project management workflows wherever feasible.
- Perform periodic independent risk audits for large-scale or high-risk projects.
- Encourage cross-functional stakeholder participation and transparent communication during risk assessment activities.
- Promote organizational learning through post-project risk analysis and documentation of lessons learned.

Future research may focus on empirical validation of ERI frameworks using real-world project datasets, comparative analysis across industrial sectors, and development of hybrid AI-based risk prediction models capable of dynamic project monitoring and decision support.

Conflict of Interest

The author(s) declare no conflict of interest regarding the publication of this manuscript.

Data Availability Statement

The data supporting the findings of this study are derived from published literature, industrial reports, and publicly available project management datasets referenced within the article. All relevant data supporting the conclusions are available within the manuscript and cited references.

Table and Figure Source Statement

All tables and summarized analytical content presented in this manuscript were compiled and prepared by the authors based on the reviewed literature, published reports, and referenced academic sources cited within the study.

Ethics Statement

This study is based entirely on secondary literature review and publicly available academic and industrial sources. No human participants, animal subjects, or confidential organizational data were directly involved in this research; therefore, formal ethical approval was not required.

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