

## An Overview on Tools for Assessment of Cost Overrun Factors in Construction Projects

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### Abstract

This study investigated the significant reasons for cost overruns in construction projects, the critical success factors, and various tools that are helping to avoid cost overruns. This study aims to determine the significant factors that make a project successful or fail. The factors that cause cost overrun and the tools that can be used in the cost overrun projects in Pakistan's construction industry so that future efforts can be directed to mitigate them. Numerous reasons for cost overruns in the global construction sector were realized after a comprehensive literature study. The top ten cost overrun variables identified were fluctuating raw material prices, expensive machinery, lowest bidder cost, poor project management, poor cost control, delays between design and procurement phases and inappropriate cost estimation methods. Questionnaire surveys, structure equation modelling, the Delphi method, regression-based model, statistical assessment, fuzzy-analytical network processing, fuzzy artificial neural network, and fuzzy simulation have been widely used and dominated the literature because they can quantify the intricacy and unpredictability of the cost overrun factors. A statistical method was determined to estimate the ranking of cost overrun factors. Therefore, the objective of the present literature study is to conduct a thorough analysis of the literature about the fundamental causes of cost overrun factors and various cost-controlling techniques used. This is done by focusing on articles published in highly reputable journals in the last decade.

## 1. Introduction

The hidden changes in the project result are increasing the overall cost and budget of the project. This hidden cost is known as overrun. Poor cost performance has therefore been regarded as one of the most critical problems in Pakistan projects [1]. The factors that have a success/failure on a project's result are called attributes. These attributes focus on people, resources, technology, working conditions, systems, and assigned tasks [2]. It is often regarded as successful when a construction project is finished on schedule, without cost overruns, and in line with specifications. The three factors have been utilized in literature studies to assess project performance [2], [3]. The iron triangle refers to these three requirements in project management. Some studies have employed other factors to gauge the success of projects, including stakeholder satisfaction, safety performance, and conflict resolution [1], [4]. This literature shows that project financing is the primary factor that should be considered, and a practical plan can avert the risk of cost overrun. It also shows that a good management project eliminates the project's risks.

Cost overrun in the construction plans can be based upon a different number of factors as there is no particular cause or reason. A study established that the delays occurred due to additional work and changes required at the last minute, and pricing fluctuations were the reason for the cost overrun. Lack of expertise in site workers, defects in the building, and incomplete drawings were known as failure factors worldwide [5]. The literature study identified the following critical failure factors: disagreements among project participants, ignorance and a lack of knowledge, the presence of poor project-specific characteristics and a lack of cooperation, unfavourable socioeconomic and climatic conditions, reluctance to make timely decisions, aggressive competition at the tender stage, and a lack of time for bid preparation [2]. The project's timely and cost-effective completion is the primary objective shared by the customer and the contractor. Due to the enormous aggregates that are held up and cause a delay in completion, costs would increase [3].

Success can be achieved when the project is completed within the time and reasonable budget and for the proposed cost. As long as the project's cash flow management during the implementation stage, proficiency in coordinating the project resources, and project controls are satisfactory, and there would be no cost overruns that can hurt the worker. This requires high capability, knowledge, and experience [5], [6]. According to the survey results, poor communication between the respondents and the contractor's financial limitations were the most crucial cost overrun factors [7]. *Fuzzy logic* is an analytical computing method designed to present vagueness and standardize fuzziness. It also makes it easier to get a definite conclusion based on unclear, vague, noisy, and missing input. This research demonstrates that the tools help avert cost overruns like fuzzy logic and other tools for building information modelling (BIM) [1].

To the best of the author's knowledge, the most critical variables various techniques for reducing cost overruns and factors influencing the success or failure of construction projects. This review paper investigates the cost overrun factors and cost-controlling strategies mentioned in the literature. To do this, publications over the previous twenty years that were published in respected journals underwent a thorough review process to compile all available data on the causes and methods of cost overruns. The causes of success and failure are covered first. Then, the essential variables and methods are examined. Finally, numerous approaches for cost overrun are investigated.

## 2. Success/failure of construction projects

Gates et al. [8] found that schedule delays, frequent design changes, additional work and changes requested by the owner at the last minute, flaws in the design, insufficient planning and timelines, fluctuations in the prices, changes in the owner's scope of work, drawing that were incomplete or detailed designs at the time of presenting. Lack of expert site staff, construction defects, and failure in work are the major causes of cost overruns in construction projects worldwide. Herrando et al. [9] observed that they should have considered the significance of the project planning process, lack of experience executing a complicated task, poor design capacity, and frequent design changes. Cost overruns in the construction phase of projects have reportedly been attributed to factors including "insufficient site management and monitoring, slow decision-making, and client-initiated variations". The estimator and the parties that are involved in the construction project must be able to identify the cost overruns element.

Khodeir et al. [10] reported a quantitative questionnaire survey to analyze project failure factors. Their study revealed poor risk management, budget overruns, poor communication management, schedule delays, and poor estimation practices as the top five failure factors. According to studies by Alsolami [2] and Odeck [11], cost overrun-related factors and contractors' site management were critical factors affecting cost performance. According to Paraskevopoulou et al. [12], clear and realistic project goals, project planning, the project manager's competency & relevant experience the project management, the competency of the project management, clear and precise goals of the client, the project's value, complexity, and uniqueness, the project manager's experience, and the client's ability to make timely decisions are the top-ranking CSFs for construction projects. The three factors have been utilized in literature studies to assess project performance.



Figure 1. Importance of cost in iron triangle

In the future, the evaluation of success or failure in construction projects will be enhanced through various approaches. Advanced data analysis techniques, including artificial intelligence and machine learning, will play a crucial role in analyzing vast amounts of project-related data. By identifying patterns and predicting potential issues, these technologies will enable proactive measures to prevent failures and optimize project success. Additionally, there will be a greater emphasis on improved risk management, with the development of more sophisticated risk assessment models that consider a broader range of factors and incorporate real-time data. Effective stakeholder engagement and communication strategies will also be prioritized, recognizing the significance of involving stakeholders throughout the construction process to ensure project success. By addressing these areas, future work aims to enhance project evaluation methodologies and contribute to more successful and efficient construction projects.

## 3. Different Cost overrun factors

Paraskevopoulou et al. [12] studied that showed the cost and time management of construction projects that revealed the primary sources of cost and time overrun, which included changes in design, risks and doubts, wrong estimations of task time and length, complications, and poor performance of subcontractors. Sepasgozar et al. [13] studied the most important aspects determining building cost project features, attributes of the contractors, and conditions of the external market, according to research on the factors that influence the construction cost of Industrialized Building Systems (IBS) plans. Shah et al. [14] revealed that variations in material prices, cash flow and financial experiments faced by contractors, a lack of site labour, lack of communication between different parties, improper planning and arrangement by contractors, and frequent design changes are the factors that have the most negligible impact on the project's construction costs.

Herrando et al. [9] studied that the cost of building includes the cost of materials and labour. The survey's top three concerns include fluctuating raw material prices, unstable manufacturing material costs, and high machinery costs. Alsolami [2] studied that prices may fluctuate virtually daily, and they sometimes do. In many circumstances, these quick changes make it difficult for suppliers to commit to a single fixed pricing. Dikmen et al. [6] studied several reasons construction projects exceed the budget. Each factor of a cost overrun occurs at a different pace and has a distinct effect on the final project cost. While some specific factors appear, their impact on cost may be less severe. According to the literature study, several variables influence cost overruns in the construction industry. The top 10 factors are identified below:

Table 1. Identified Cost Overrun Factors

Author	Year	Factors	Findings
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Khodeir et al. [10]	2019	Inadequate Estimation	Inaccurate cost estimates result in financial loss and increased claims and disputes. The Client will be in a financial crisis if the project estimate is insufficient.
Amini et al. [3]	2022	Inflation	The cost of materials, equipment, and labor varies due to inflation. Change in market prices of construction materials leads to loss if price adjustment terms are not considered in the project cost.
Wyke et al. [15]	2023	Improper Planning	Inadequate planning of the project, poor management experience, and adequate resources will result in faster project progress and longer project completion time, which increases indirect project costs.
Shehu et al. [16]	2014	Frequent Design Changes	Allot adequate time and resources for precise budget and schedule estimates in the preconstruction stage. Changes in design in the construction phase could lead to cost overrun.
Zhong et al. [17]	2022	Poor site management and supervision	Inexperienced subcontractors may make expensive errors and delay projects. Proper micro-level Management of the resources deployed on-site will result in early project completion and will avoid an increase in the budget.
Yun et al. [18]	2022	Inadequate Resources	If deployed at the site, inadequate equipment, tools, and plants will lead to delays. The project will suffer cost overruns.
Alekhyia et al. [1]	2022	Unforeseen Site Conditions	The unforeseen site conditions involve risks like revolution, pandemic, thunderstorms, fire earthquakes, and other force majeure actions; when they do happen, projects typically experience significant delays and cost overruns.
Alsolami [2]	2022	Inadequate Design	The preliminary design will disrupt the progress during the execution and end in cost overruns.
Araskevopoulou et al. [12]	2022	Contractual claims	Initiating unnecessary contractual claims by both parties of the contract will affect the end delivery of the project. It may lead to cost overrun if claims were valid and their cost needed to be considered in the initial estimate of the project.
Wang et al. [19]	2022	Non-BOQ items	Various Non-BOQ items are incurred due to site requirements and other factors for which no budget is allocated in the initial estimate. Execution of Non-BOQ Items will always lead to cost overrun via variation orders.

In the future, further research and work on identifying and addressing cost overrun factors in construction projects will be crucial. One aspect of future work involves examining the role of project planning and design in cost overruns. By analyzing historical data and conducting comprehensive studies, researchers can identify common design-related factors that contribute to cost overruns and develop strategies to mitigate them. Additionally, enhancing risk management practices will be essential in addressing cost overruns. Future efforts may focus on developing robust risk identification and mitigation strategies, leveraging historical data and lessons learned from past projects. This could involve the use of advanced analytics to assess project risks, simulate various scenarios, and implement effective risk response plans.

#### 4. Tools for Assessment

Cost control is a comprehensive set of cost analysis methods and managing techniques to improve cost efficiency using various techniques. Shah et al. studied that [14] construction risks and complexity are still assessed based on expert opinion. Therefore, the information for risk has quantitative. The chance of occurrence and severity of the risk are the starting points for measuring project risk and complexity, which are then converted into quantitative metrics to address the interdependencies for project cost [6]. These quantitative tools are built using various linear and non-linear methods. Non-linear probabilistic because the majority of construction projects display stochastic behaviour. According to the literature, several tools identify cost overruns factors to make construction sustainable. The top 9 tools are identified.

Khodier et al. [10] analyzed fuzzy approaches that have been widely used as hybridized techniques for construction risk assessment during the last ten years. They are very effective in stimulating the vulnerabilities faced in experts' judgments. Some questions about network interdependency have been highlighted by using structural equation modelling. Wang et al. [19] recommended that these approaches have limited uses in construction projects where system complexity and unpredictability are significant. A short discussion of probabilistic methods and their use in construction projects.

In the future, there will be continued efforts to develop and refine tools for assessing construction projects. These tools will aim to provide a comprehensive and standardized approach to evaluating various aspects of a project's performance. One area of future work involves the development of advanced performance measurement frameworks that consider not only traditional metrics such as cost and schedule but also factors like sustainability, quality, and stakeholder satisfaction. These frameworks will help project stakeholders gain a holistic view of project performance and enable more informed decision-making.

Table 2. Assessment of different tools for literature review

Author	Year	Tools	Advantage/Disadvantage
Dikmen et al. [6]	2022	Questionnaire Survey (Expert Judgment)	Data can be sent fast, and coming back time can be reasonable and can instantly connect with the audience. Online surveys are free of cost. Laying may be a problem. Respondents do not provide honest replies.
Khodeir et al. [10]	2019	Fuzzy Synthetic Evaluation	Fuzzy synthetic evaluation offers benefits in managing complex evaluations with various criteria and levels. Fuzzy logic cannot be used to answer all problems in a single, organized way and relies on human knowledge.

Herrando et al. [9]	2023	Structural Equational modelling	The modelling of measurement errors and unexplained variances are benefits of using SEM. SEM has several drawbacks, including selecting and utilizing variables.
Shah et al. [14]	2022	Delphi-SWARA method	Delphi is beneficial for creating estimations or forecasts. Lowers noise among group members based on other rankings by offering regulated feedback. There is no right or incorrect answer produced.
Ammar et al. [4]	2022	Regression Based Model	Regression models provide an algebraic equation, correlation coefficients, and other statistical metrics. Regression models become less reliable as variables rise and do not handle nonlinearity. The user must consider different variables to enhance the regression model.
Awodie et al. [5]	2023	Fuzzy group decision-making approach (FGDMA)	Factors causing cost overruns are assessed as the fuzzy probability of the independent risk. FGDMA computes the defusing scores of the non-conformities. The limits of expert assessments are addressed by disobeying scores by connecting them to relevant fuzzy numbers.
Shoar et al. [20]	2022	Computer Based Contingency Estimation	The contingency estimating system was developed utilizing contingency estimation modelling to solve a cost overrun. This system is based on the study of the present state of contract modification requests and the findings of the identification and analysis of risk.
Sepasgozar et al. [13]	2022	Statistical Method (Relative Importance Index)	The project risk variables were ranked using the relative relevance index technique. Reliability and correlation coefficient tests were also conducted.

## 5. Conclusion & Future Recommendation

This review paper examines the most critical factors contributing to cost overruns in the construction industry in developed countries, as reported in articles published in highly reputable journals in the last two decades. The current effort is to compose all published information related to factors, tools and techniques used in cost overrun. Based on this literature research, the following are the conclusions:

- Construction industry experts should constantly conduct accurate planning, estimating, management, and cost control in their projects to achieve sustainability.
- The most crucial aspects were the requirements of scope, cost, time, quality, resources, and management. Furthermore, unrealistic expectations, lack of resources, and lack of executive backing are the leading causes of project failures.
- By providing new tools for organizing, interpreting, and presenting data sets, statistical analysis often enables users to do more detailed analyses.

This study examined the factors that influence cost overruns, the ranking of these factors, and techniques that will be used in cost control to achieve sustainability in construction projects, which can help minimizing the impact cost overruns.

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## Declaration of Conflict of Interests

The authors declare that there is no conflict of interest.

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