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Evaluation of Critical Factors Leading to Cost Overrun in Building Projects using Structural Equation Modeling

by

Muhammad Hamza Zahoor

A thesis submitted in partial fulfillment for the degree of Master of Science

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This thesis is dedicated to ALLAH Almighty, my creator, strong pillar, Source of inspiration, wisdom, knowledge, and understanding.

CERTIFICATE OF APPROVAL

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(Muhammad Hamza Zahoor)

Abstract

The construction industry is complex due to the involvement of various stakeholders. Construction cost greatly influences project success and still is a major concern. Despite project management improvements, cost overruns persist due to poor cost control during design and implementation. Cost overruns in building projects have significant implications for the construction industry, affecting project schedules, budgets, and stakeholder relationships etc. For this purpose, various methodologies have been adopted by researchers to minimize the impact of cost overruns. In this research, Structural Equation Modeling (SEM) is used to identify the most critical factors leading to cost overruns in building projects.

The primary objective is to determine the most crucial factors to cost overruns. For this purpose, firstly a literature review is conducted to identify gaps and critical factors in the construction projects, then frequency analysis is used to identify the critical factors in the construction projects. Subsequently, a literature review is conducted to identify the critical factors in building projects after that a draft questionnaire is formulated and distributed to experts for evaluation. The Delphi technique aids in the identification of any issues with wording, format, and questions. Necessary changes to the questionnaire are made according to the feedback received by experts. Two rounds of the Delphi technique are applied to enhance questionnaire clarity for ensuring a smooth flow. The finalized questionnaire is then distributed to key industry personnel to gather their important rankings. Statistical Package for the Social Sciences (SPSS) is employed for statistical analysis. Respondents in the questionnaire survey are professional engineers. Various analyses, including reliability analysis, factor reduction analysis, correlation analysis, normality analysis, and non-parametric analysis, are performed on the shortlisted factors in building projects. Additionally, Based on the output of SPSS, AMOS software is utilized for structural equation modeling (SEM).

The statistical analysis confirmed the reliability of the respondents. As demographic analysis endorsed that the 47.8% held a Bachelor degree, 45.1% were contractor representatives and 63.7% of respondents had 5 years of experience. The response rate is 87%. The reliability analysis impact data statistic is 0.987, confirming the validity of the questionnaire. The Kaiser-Meyer-Olkin (KMO) value of 0.941 indicates a high level of adequacy in the sample. The Pearson correlation coefficient calculates the degree of linear association between variables. The Kolmogorov-Smirnov normality test reveals that the data does not follow a normal distribution. The Kruskal-Wallis test is used to examine perception levels among respondents. The statistical method known as structural equation modeling (SEM) examines intricate connections between observed variables and latent variables. A comprehensive Cost Overrun Indicators Framework is developed, analyzing three key aspects: Construction Disruptions, Execution Challenges, and Project Risks. This study highlights leading factors of cost overruns, including inaccurate cost estimation, design errors, inadequate planning, market fluctuations, design changes, detailed cost estimation, and project scope. The overall results of this study helped to develop strategies to minimize the impact of cost overruns in building projects.

Keywords: Cost Overrun, Construction Industry, Delphi Technique, Identified Factors, Questionnaire, SPSS

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Abbreviations

AIC	AAkaike Information Criterion
AFGI	Adjusted Goodness-Of-Fit Index
AMOS	Analysis of a Moment Structures
ANOVA	Analysis of Variance
BIM	Building Information Modeling
CBS	Cost Breakdown Structure
CCOF	Critical Cost Overrun Factors
CF	Critical Factors
CFA	Confirmatory Factors Analysis
CFCI	Critical Factors in Construction Industry
CFBP	Critical Factors in Building Projects
CFI	Comparative Fit Index
CO	Cost Overrun
COF	Cost Overrun Factors
COFBP	Cost Overrun Factors in Building Projects
COFCI	Cost Overrun Factors in Construction Industry
ECVI	Expected Cross-Validation Index
FGDMA	Fuzzy Group Decision-Making Approach
FSE	Fuzzy Synthetic Evaluation
GOFI	Goodness-Of-Fit Index
HTML	HyperText Markup Language
IFI	Incremental Fit Index

LCA	Life Cycle Assessment
NCP	Noncentrality Parameter
NFI	Normed Fit Index
PCFI	Parsimony Comparative Fit Index
PGFI	Parsimony Goodness-Of-Fit Index
PNFI	Parsimony Normed Fit Index
PRATIO	Parsimony Ratio
RII	Relative Index of Inequality
RMR	Root Mean Square Residual
RMSEA	Root Mean Square Error of Approximation
SEM	Structure Equation Modeling
SPSS	Statistical Package for the Social Sciences
SPSS	Step Wise Weight Assessment Ratio Analysis
TLI	Tucker-Lewis Index)
URL	Uniform Resource Locator

Chapter 1

Introduction

1.1 Background

Projects are short-term initiatives designed to provide a unique product, service, or outcome. Even though project management has seen tremendous advancements over the years, however, success rates still need to be acceptable [1]. The success rates of projects are rarely explicitly measured in studies, even though doing so is a crucial step in the management process because it allows for the development of tools, techniques, and management approaches, as well as the analysis of environmental factors that may assist in making projects successful with various characteristics [2]. The most critical project success criteria must be identified to measure the success rate for projects carried out in Rawalpindi and Islamabad and success rates to comprehend the underlying causes of their success or failure [3]. Different Pakistani cities may place a varied emphasis on certain elements. Consequently, this research aimed to assess the degree of completion of the projects in the second half of 2022. The study also aimed to determine the critical factors leading to cost overrun in building projects.

The building sector is distinct and intricate, with many players in all trends. It will not be unexpected if disagreements arise, given the number of parties engaged in the same project and the nature of the building project itself [4]. Cost is a significant component of the project budget and is used to determine the project's financial feasibility [5]. Swift modifications in project management involve quick adjustments to project scope or timelines without extensive assessment, impacting project deliverables and objectives. Project managers can optimize resource allocation and decision-making regarding project scope, schedule, and budget by having a clear understanding of the construction cost. Each construction project's success is heavily dependent on the cost of the building [6]. It is critical in budgeting, cost estimating, financial planning, contract negotiation, and project control [7]. Project managers must clearly understand the construction cost to make informed decisions and deliver the project on estimated budget [8]. Having a clear insight into the construction cost allows them to effectively allocate resources, mitigate potential financial risks, and ensure that the project remains within the estimated budget. By closely monitoring and analyzing the expenditure at each phase of the project, they can proactively identify any potential budgetary discrepancies and take necessary corrective measures. This research tries to compile the many costs that might cause construction projects that result in cost overruns.

One of the most severe issues is cost overrun, which may affect building sector projects. Minimizing this aspect is challenging since it is ultimately dynamic and multifaceted [9]. The main reason is that the construction industry consumes a lot of resources, which results in a shortage of those resources, fluctuating material pricing, equipment expenses, and unforeseen expenditures to affect many projects [10]. Therefore, they must constantly update their understanding to manage complexity and minimize the risks. The leading contributing cause to cost overruns in construction projects include a lack of supplies on the market and on the project's site, a cash flow issue during construction, changing orders, financial restraints, and a lack of expertise, inflation in material cost, inaccurate material estimating, improper planning, frequent design changes, unforeseen site conditions, contractual claims, non-boq items, project complexity and poor site management [7, 11]. Cost overruns are a common challenge in building projects and can occur for various reasons, such as changes in scope, unexpected site conditions, and poor project management. By focusing on cost overruns, researchers and practitioners can determine the root causes of this problem and develop effective strategies for mitigating the risks. Project managers can optimize resource allocation and decision-making regarding project scope, schedule, and budget by having a clear understanding of the construction cost. The most critical project success criteria must be identified to measure the success rate for projects carried out in Rawalpindi and Islamabad and success rates to comprehend the underlying causes of their success or failure [3]. This study highlights the most important factors that could result in cost overruns in building projects to reduce budget overruns in upcoming projects.

1.2 Research Motivation and Problem Statement

Every industry's primary goal is to complete projects on time and within the allocated budget. The construction sector is known to have a high incidence of cost overruns, which can be attributed to various reasons such as inaccurate cost estimates, changes in scope, delays and unforeseen market conditions, etc. Cost overruns can have significant consequences for project owners, including delays in project completion, reduced profits, strained relationships with stakeholders, and a negative impact on reputation. Effective cost management practices are essential for the success of building projects. By using structural equation modeling to evaluate the critical factors leading to cost overrun in building projects. Thus, the problem statement is as follows:

Cost overruns are a significant problem in the construction sector, and the high incidence of cost overruns in building projects can have severe consequences for project owners. Despite of efforts to improve the cost management practices, cost overruns continue to happen, and there is a necessity for more effective strategies to identify and manage critical cost overrun factors. Most project managers and contractors need help to keep cost under control on their building sites for various *reasons. Proposing the ongoing structural equation modeling-based building cost overruns, further study is required, which can provide a more comprehensive understanding of the complex relationships between different variables that contribute to cost overruns in building projects. Building projects are preferred because they have a more defined scope and schedule, making it easier to recognize and measure the most critical factors contributing to cost overruns. Three critical stakeholders, namely clients, contractors, and consultants, must be considered when identifying the cost overrun factors, underlying causes, and management obstacle.*

1.2.1 Research Questions

1. What are the critical factors leading to cost overruns in building projects?
2. What are the significant factors for cost overrun in Rawalpindi and Islamabad?
3. How can the impact of recognized cost overrun factors be reduced and the project owner ensure that the selected budget is reliable of delivering the project within budget?

1.3 Overall Objective of the Research Program and Specific Aim of this MS Thesis

The research aims to improve the cost management practices in the building projects by identifying the critical factors that contribute to cost overruns in residential building projects and developing the efficient management strategies for these factors. The research uses the structural equation modeling technique to evaluate the essential cost overrun factors leading to cost overruns in building projects.

This MS research work aims to evaluate the critical factors leading to cost overrun in building projects using the structural equation modeling. The results of this study will help the project managers in the building sector to manage the better *cost and improve the accuracy of cost estimates, ultimately leading to the success of building projects.*

1.4 Scope of Work and Study Limitations

The scope of this research is focused on evaluating the critical cost overrun factors affecting the cost overruns in building projects in Rawalpindi and Islamabad, Pakistan, focusing on recently completed residential buildings ranging from 4 to 7 storeys in height. The building types include B+G+2 or G+3 to B+G+5 or G+6. A questionnaire survey is administered online to all industry stakeholders to collect data for the research project. The goal is to collect at least 100 responses, with at least 70 of those being valid. The primary statistical method for analyzing the data is structural equation modeling (SEM). The software tools used for data analysis and modeling are SPSS and AMOS. Through this study, we hope to gain insights into the factors that affect the structural integrity of residential buildings in this region, which can inform future building planning, design and construction practices.

The study is limited to a specific geographic region, namely zone V of Islamabad and city Rawalpindi in Pakistan. A total of 54 critical factors leading to cost overrun in building projects are considered after shortlisting. The most developed cities in Pakistan and its provinces are Islamabad, Karachi, Lahore, Peshawar, Quetta, and Muzaffarabad. To start with, Islamabad is being selected. However, to cater large response (i.e., over 100 responses) planned societies within city Rawalpindi are also taken into consideration. The diverse pool of stakeholders is expected to provide a more realistic and comprehensive perspective, contributing to the accuracy and applicability of the research findings. The study is limited to residential buildings between 4 to 7 story, specifically B+G+2 or G+3 to B+G+5 or G+6, and not generalizable to other types of buildings. The goal is to collect at least 100 responses. However, 113 valid responses were received from stakeholders. The data for this study was collected online with all stakeholders during a specific period and may not reflect changes in the construction industry over time. The study relies on self-reported data from project managers and other stakeholders. The study may need to account for all the aspects contributing to cost overruns in residential building projects, and other reasons may be relevant in different contexts.

1.4.1 Rationale Behind Variable Selection

Cost overruns are a significant issue in the construction sector, and various factors contribute to this issue, including design changes and inadequate estimation. Building projects are often high-stakes endeavors; it is essential to understand the factors that drive cost overruns to improve project outcomes. Limited research has been conducted on cost overruns in the area of city Rawalpindi and Islamabad based on experience of stakeholders [12, 13]. However, published literature is least minimum. As cost overruns remain a major concern in the construction sector. This study helps to identify critical factors and rank them in order to reduce the impact of cost overruns in building projects to the least minimum extent in a comprehensive way. B+G+2 or G+3 to B+G+5 or G+6 residential buildings are famous for mid-rise construction. Building projects are preferred because they have a more defined scope and schedule, making it easier to recognize and measure the most critical factors contributing to cost overruns [14]. Additionally, building projects may involve a greater variety of stakeholders, including architects, engineers, contractors, and clients, which can create a more complex and dynamic environment for analyzing cost overruns [15]. Building projects often involve significant financial investments and cost overruns can significantly impact the project's economic viability [16]. Therefore, it's critical to recognize and address the causes of cost overruns to reduce financial risk and guarantee project success [17].

SEM is particularly well-suited for analyzing the complex relationships between variables. Building projects involve many variables influencing cost overruns, such as project scope, project size, project complexity, project management practices, and external factors [18]. SEM can help to identify the most significant factors of cost overrun by modeling the relationships between these variables and quantifying their impact. The value, "0.9," serves as a baseline standard to highlight the most influential factors contributing to cost overruns in building projects. This value selection enables a clear prioritization of critical factors, facilitating a comprehensive understanding of their impact within the building projects. SEM allows researchers to test hypotheses about the relationships between different variables [17]. This is useful for identifying the underlying causes of cost overrun and developing effective strategies to mitigate the risks. SEM applies to various research questions and can accommodate different data types, including categorical and continuous variables [19]. This makes it a flexible and scale-able method for analyzing cost overruns in building projects. SEM has a well-established theoretical and methodological foundation and has been widely applied in the social sciences. This ensures that SEM analyses are valid and reliable and can be used to make informed decisions about cost overrun in building projects [20].

Structural equation modeling (SEM) is more effective than other techniques like fuzzy logic, Delphi, and Building Information Modeling (BIM). SEM provides more comprehensive understanding of the underlying factors driving the outcome of interest. They can also perform complex statistical analyses, such as regression and structural equation modeling, providing valuable insights into the factors driving cost overruns [21]. A sample size of minimum 100 stakeholders can provide a sufficiently large and diverse group to ensure that the findings are representative of the broader population of stakeholders involved in building projects. This sample size also allows for statistical analysis, which can help to identify significant factors and relationships between variables [5]. By including 150 stakeholders from different roles and organizations involved in building projects, the study can capture a range of perspectives and experiences. This variation can help to identify other factors contributing to cost overrun and provide a more nuanced understanding of the problem. Therefore, this study aims to use SEM to identify the critical factors leading to cost overrun in building projects in Rawalpindi and Islamabad, Pakistan.

1.5 Novelty of Work, Research Significance and Practical Implementations

To the best of the author's knowledge, no research has been conducted on evaluation of critical factors leading to cost overruns in building projects using structural equation modeling in Rawalpindi and Islamabad. Thus, the current study is aimed to find the most vital factors influencing cost overruns using Structural Equation Modeling (SEM). The novel aspect could be using SEM to analyze complex relationships between variables and understand the underlying causes of cost overruns. Compared to traditional regression-based methods, this approach can provide a more comprehensive and in-depth evaluation of the critical factors.

This research addresses a significant problem by evaluating the critical factors contributing to cost overruns in building projects. The shortlisted factors are sequenced according to their ranking. This comprehensive sequencing system helps to identify the importance of factors and aids decision makers in least minimizing the impact of cost overruns. The research aims to improve the cost management practices in the building projects by identifying the critical factors that contribute to cost overruns in residential building projects and developing the efficient management strategies for these factors.

The research uses the structural equation modeling technique to evaluate the essential cost overrun factors leading to cost overruns in building projects. This study will help to develop more effective strategies for minimizing cost overruns in building projects in Rawalpindi and Islamabad, which can improve practice in the construction industry and contribute to the academic literature on cost overruns in building projects by providing an innovative approach to evaluating critical factors. The findings of this research are especially valuable for building projects in Pakistan.

1.6 Brief Methodology

This study identifies various factors that causes cost overruns and uses frequency analysis to pinpoint the most significant ones in construction projects. A literature review is being conducted to ascertain the critical factors contributing to cost overruns in building projects. After identifying the key elements leading to cost overruns in building projects, a pilot study is carried out, and a draft questionnaire is created. The draft questionnaire is distributed to Delphi experts for evaluation, aiming to identify issues related to wording, format, and questions. Based on the Delphi technique results, necessary modifications are made to the questionnaire. Two rounds of the Delphi technique are applied, enhancing questionnaire clarity and accessibility. Subsequently, the questionnaire is finalized, taking into account characteristics of the target audience such as education, organization, and experience in the construction industry. The Likert scale captures respondents' agreement or disagreement intensity with statements. The finalized questionnaire is distributed for evaluation. The questionnaire is used to gather the required data. Data analysis involves reliability analysis, factor reduction analysis, correlation analysis, normality test, as well as parametric and non-parametric tests. Amos is utilized for modeling. Conclusions are drawn, accompanied by future recommendations.

1.7 Thesis Outline

This thesis is divided into five chapters, which are as follows:

Chapter 1: Background, research motivation and problem statement, the overall objective of the research program and the specific aim of this MS thesis, the scope of work and study limitations, brief methodology, and thesis outline are all included.

Chapter 2: The background, success/failure factors of building projects, a classification of construction costs, and cost overruns analysis are all covered in this chapter.

Chapter 3: This chapter consists of the background, research design, data collection and data anlysis procedure

Chapter 4: This chapter covers results from evaluating critical factors in building projects using structural equation modeling.

Chapter 5: This Chapter covers project management guidelines and guidelines from the the construction industry.

Chapter 6: This Chapter analyzes the research findings to draw conclusions and make recommendations.

Bibliography

Chapter 2

Literature Review

2.1 Background

A cost overrun is one of the most severe concerns affecting the building projects. It is a dynamic and complicated component, so comprehensive mitigation is difficult [22]. The primary cause is that many projects encounter resource shortages, fluctuating material, equipment prices, unforeseen expenses, and accidents while the building is underway [23]. A construction endeavor represents a mission of significant importance and urgency, aiming to create a structure with predefined performance objectives articulated concerning quality, specifications, project completion date, allocated budget, and other constraints [24]. Cost overruns in building projects can be based upon different causes as there is no specific cause/reason [25].

2.2 Success/Failure Factors of Building Projects

The construction industry is vital to economic growth and development in countries, including Pakistan. The success and failure factors of building projects is crucial in the construction industry. It allows stakeholders to continually improve their project management practices, mitigate risks, control costs, and enhance client satisfaction. Despite not reaching its full potential, the construction sector remains a crucial area of interest for the nation. Its growth is pivotal for increasing national income and employment opportunities [26, 27]. Moreover, the construction industry is a key indicator of Pakistan's economic health. However, the construction industry is uniquely intricate compared to other sectors due to the involvement of numerous stakeholders. The collaborative nature of construction projects and their inherent complexities can lead to disputes and conflicts. Such disputes are counterproductive and detrimental to project success [28]. Thus, effective claims management and avoidance strategies are imperative, commencing well before project initiation and continuing until completion. Reviewing and analyzing project plans, specifications, and condition of contract at the outset can clarify ambiguities and identify potential areas of contention [29]. Identifying these factors, construction firms can gain a competitive edge, foster innovation, and ensure compliance with evolving industry standards while promoting sustainability and effective collaboration among stakeholders. By implementing cost control techniques and procedures during the project's execution, many issues that could later become the basis for claims can be minimized.

Critical success factors (CSFs) are essential elements or conditions that must be present for a project, initiative, and organization to achieve its objectives and goals. Critical success factors (CSFs) are essential for an organization or project to accomplish its mission. These factors are crucial activities that underpin a company's or organization's success. Success criteria are aligned with objectives and can be quantified using key performance indicators (KPIs). Implementing these crucial success factors with the help of tools. The concept of "success factors" was first introduced by D. Ronald Daniel of McKinsey & Company in 1961 [30]. John F. Rockart further refined it into critical success factors between 1979 and 1981 [31]. In 1995, James A. Johnson and Michael Friesen extended this concept to various sectors, including healthcare [32]. The critical success factor serves as the primary framework for achieving success in a company, tailored to individual departments where each role possesses its unique Key Success Area. It is crucial to distinguish critical success factors from success criteria [33]. The former focus on achieving success based on established standards and rules that must be meticulously followed to ensure superior service for clients [34]. The success of a construction project is influenced by a myriad of factors, encompassing those related to the project manager, planning efforts, contractors, consultants, and clients [28]. External factors such as government policies and the economic climate also play a role. Successful project planning necessitates considering all these factors and identifying critical success factors that have the most significant impact [26].

FIGURE 2.1: Success Factors of Building Projects [3].

Market price changes are indicative of the fluctuating prices of construction materials and resources within the broader market, impacting the overall project costs. In contrast, inflation represents the general increase in prices and the decrease in the purchasing power of currency over time. While market price changes specifically pertain to the construction industry's immediate resource costs, inflation affects the economy at large, influencing various sectors beyond construction. Understanding these essential success factors is pivotal for project success and effective planning, involving prioritizing these factors to develop a comprehensive project plan [35]. Building projects are inherently complex endeavors, and cost overruns are common occurrences within the construction industry. Building projects are complex and multi-faceted endeavors that require careful planning, execution, and management to ensure their success.

TABLE 2.1: Critical Success/Failure Factors in Building Projects [36].

Sr. No	Category	Factors
1	Macro Economic Factors	Fluctuation in raw material costs
2	Macro Economic Factors	Unstable prices for manufactured goods
3	Macro Economic Factors	Expensive machinery
4	Business and Regulatory Environment	Lowest bidder selection process
5	Management Factors	Ineffective project (site) management/ Ineffective cost control
6	Business and Regulatory Environment	Long time duration between the design phase and the time of the biding or tendering process
7	Business and Regulatory Environment	Ineffective/Inadequate cost estimation methodology
8	Management Factors	Additional work
9	Management Factors	Ineffective Planning
10	Business and Regulatory Environment	Inappropriate government policies

Despite the best efforts of project managers, building projects can sometimes fail to meet their objectives, resulting in cost overruns, delays, and reduced quality. Jin et al. [37] investigated that several variables can affect whether a building project is successful or unsuccessful, including project scope, budget, resources, and stakeholder involvement. Eash et al. [15] and Tariq and Gardezi [38] studied that clear project objectives and communicating them effectively to all stakeholders, comprehensive planning is essential to the success of a building project, including the identification of potential risks and the development of contingency plans. Having an adequate budget and ensuring that it is managed effectively is critical to the success of a building project. Effective stakeholder engagement and collaboration can ensure that the building project is completed successfully and to all parties satisfaction. Building projects are intricate undertakings often plagued by cost overruns, a prevalent issue in the construction industry. It highlights the impor-tance of figuring out why these overruns happen. Such understanding is pivotal for a multitude of reasons, including the necessity to adhere to project budgets, meet established timelines, allocate resources judiciously, manage and mitigate risks effectively, uphold client satisfaction, evaluate contractor performance, safeguard industry reputation, comply with regulations, stimulate innovation, and mitigate potential economic repercussions. Herrando et al. [17] investigated that poor plan-ning and lack of risk management, can lead to significant issues and failures during the construction stage. Awodi et al. [10] highlighted the significant role of accurate cost estimation in minimizing cost overruns. Their research emphasized the need for precise estimation techniques that consider various factors, including materials, labor, and unforeseen expenses, to create a more reliable budgeting framework for construction projects. Effective budget management must be needed to avoid cost overruns and delays, which can negatively impact the building project's success. Critical success factors (CSFs) are essential elements or conditions that must be present for a project, initiative, and organization to achieve its objectives and goals. Critical success factors (CSFs) are essential for an organization or project to accomplish its mission. These factors are crucial activities that underpin a com-pany's or organization's success. Success criteria are aligned with objectives and can be quantified using key performance indicators (KPIs). Implementing these crucial success factors with the help of tools. Lack of communication or ineffective communication between project stakeholders can lead to misunderstandings, un-foreseen changes to the project scope, such as change orders, can lead to significant cost overruns and delays investigated by Koulinas et al. [39]. By considering these factors and incorporating them into their project management practices, project managers can increase the likelihood of delivering high-quality projects that meet the needs and expectations of all stakeholders. Stakeholders can take proactive measures to mitigate these challenges, improve the overall success of construction projects and can proactively address these challenges and work toward enhancing the overall success and efficiency of construction projects.

2.3 Classification of Construction Costs

Classification of construction costs refers to the systematic categorization and breakdown of various expenses associated with a construction project. It involves grouping costs into specific categories or elements, such as labor, materials, equipment, permits and overhead. Client financial difficulties relate to the financial constraints faced by the party initiating the construction project, potentially affecting the project's funding and overall progress. This classification provides a structured framework for organizing, analyzing, and managing the financial aspects of construction projects. Construction expenses can be categorized into several categories, including direct, indirect, overhead, contingency, and financing costs investigated by Kamal et al. [40]. Awodie et al. [10] studied that direct costs refer to expenses directly linked to a particular project component, such as materials, labor, and equipment. At the same time, indirect costs are not directly related to the construction work but are necessary for the completion of the project, such as administration, insurance, and financing costs. Khodeir and Ghandour [19] studied that soft prices are not directly related to the physical construction of the project but are still necessary for its completion, such as design, permitting, and pre-construction costs. Overhead costs such as utilities, office space, and equipment rental are incurred to support the construction project. The classification of construction costs is vital for effective project management, accurate budgeting, informed decision-making, financial reporting, and compliance with regulations.

Classification of Construction costs are typically divided into different groups to provide a clear and organized breakdown of the project's financial components.

The importance of understanding and categorizing construction costs lies in its various benefits. Odeck [21] reported that contingency costs are costs that are set aside to cover unexpected events or changes during the construction process, such as cost overruns, changes in the scope of the project, or natural disasters, and financing costs are costs associated with securing financing for the construction project, such as interest, origination fees, and loan fees. This classification of construction costs helps project managers better understand the various types of costs they will encounter during the construction process and allocate their resources effectively to ensure the success of their projects.

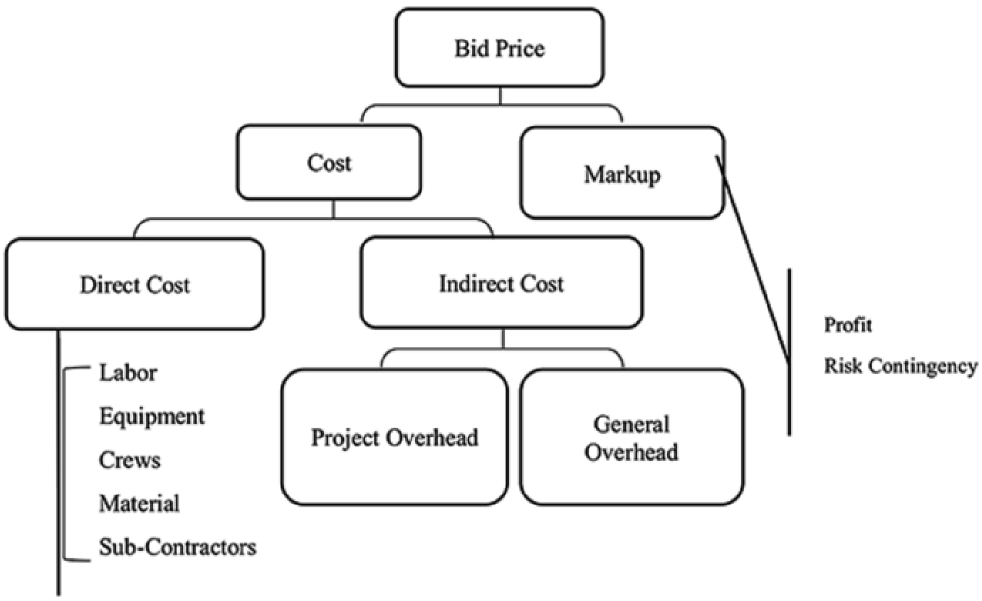

FIGURE 2.2: Classification of Construction Cost [41].

Despite the best efforts of project managers, building projects can sometimes fail to meet their objectives, resulting in cost overruns, delays, and reduced quality. Jin et al. [37] investigated that several variables can affect whether a building project is successful or unsuccessful, including project scope, budget, resources, and stakeholder involvement. Eash et al. [15] and Tariq and Gardezi [38] studied that clear project objectives and communicating them effectively to all stakeholders, comprehensive planning is essential to the success of a building project, including the identification of potential risks and the development of contingency plans. Having an adequate budget and ensuring that it is managed effectively is critical to the success of a building project. Effective stakeholder engagement and collaboration can ensure that the building project is completed successfully and to all parties satisfaction.

TABLE 2.2: Different Types of Cost involved in Building Projects.

Sr No.	Types of Cost	Explanation	Reference
1	Direct costs	Equipment, materials, and labour are all considered direct costs.	Khodeir and Ghandour [19]
2	Indirect costs	Administration, insurance, and overhead are examples of indirect costs.	Amini et al. [5]
3	Soft costs	Design, permit, and inspection fees are examples of soft costs.	Alekhya et al. [2]
4	Contingency costs	Contingency cost can be used to pay for extra expenses like cost overruns or unanticipated occurrences like delays due to bad weather or design modifications.	Dikmen et al. [11]
5	Fixed costs	Items like rent, salaries, and insurance fall under the category of fixed costs, which are frequently grouped with indirect costs.	Herrando et al. [17]
6	Variable costs	These are expenses that vary according to the volume of work done.	Awodie et al. [10]

2.3.1 Factors Influencing Cost Overrun

Factors influencing cost overrun in building projects are various conditions, events, or circumstances that can lead to project expenditures exceeding the initially budgeted cost. Prior research highlights the significance of managing swift modifications effectively to ensure project success and mitigate potential risks associated with abrupt changes. These factors can arise due to a multitude of internal and external variables. Inadequate project scheduling management refers to the inefficiencies in organizing and coordinating tasks within a project's timeline, leading to delays and disruptions in the construction process. On the other hand, inadequate planning encompasses broader deficiencies in the initial project strategy, including insufficient resource allocation, inaccurate cost estimation, and inadequate risk assessment. While both lead to project setbacks, inadequate planning contributes to fundamental flaws in the project's blueprint, while inadequate project scheduling management primarily deals with execution-related issues. Ivanovi et al. [42] and Cox et al. [43] investigated that inadequate planning and budgeting can lead to cost overruns as the project team may not have a clear understanding of the resources and materials required for the project, leading to underestimations and under budgeting. Paraskevopoulou et al. [23] studied that changes to the scope of work, such as adding new components or modifying existing ones, can significantly affect how much a project costs. Lapatin et al. [44] underscored the impact of proper project planning and risk assessment in reducing unexpected expenses.

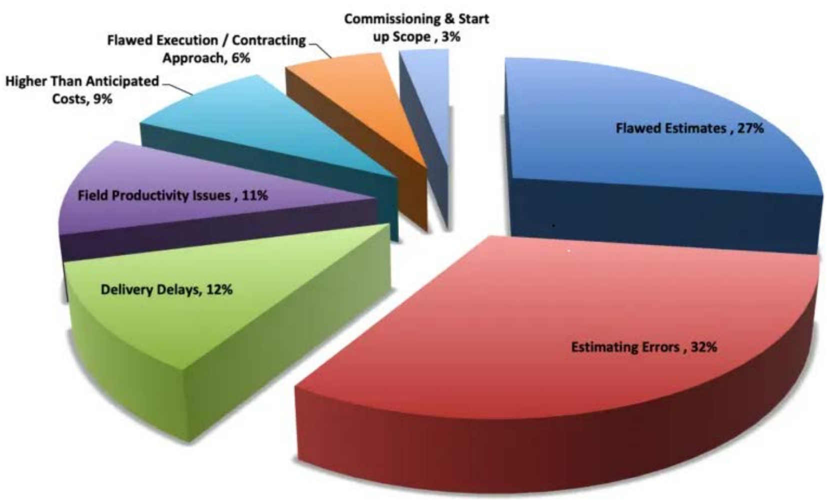

Figure 2.3: Factors influencing Cost Overrun[11].

Their study emphasized the importance of thorough risk identification and mitigation strategies during the planning phase, enabling project managers to anticipate potential challenges and allocate resources effectively to avoid cost overruns. Unexpected site conditions, such as poor soil conditions or the discovery of underground utilities, can result in unforeseen costs and delays contributing to cost overruns.

Yun et al. [45] investigated that improper contract management, failing to monitor and manage the work of subcontractors or suppliers adequately, can result in cost overruns as the project team may need help to control the quality and cost of materials and labor. A lack of experience and technical knowledge on the part of the project team can result in poor planning and budgeting decisions, leading to cost overruns. It enables the construction industry to proactively address these challenges and work towards more efficient and successful completion of projects.

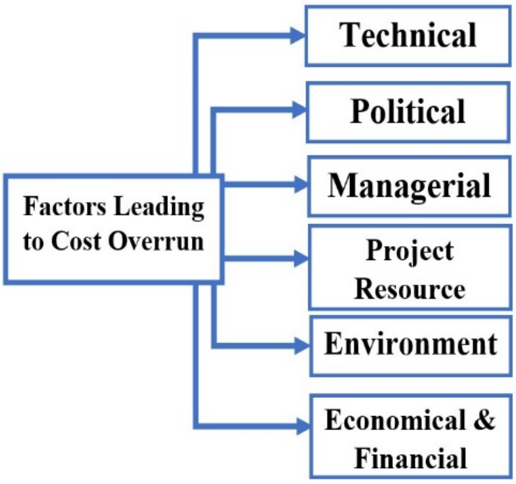

Figure 2.4: Classification of factors leading to cost overrun[7].

Factors influencing cost overrun in building projects are various conditions, events, or circumstances that can lead to project expenditures exceeding the initially budgeted or estimated cost. These factors can arise due to a multitude of internal and external variables at different stages of a construction phase. Cost is undeniably one of the most pivotal elements determining the success of a project. As highlighted by Sepasgozar et al. [46] in their research on Building Information Modeling (BIM), the project implementation phase is a critical juncture where substantial delays and cost overruns tend to materialize. As a result, factors like trouble making monthly payments, poor contractor management, trouble getting materials, poor technical performance, and an increase in material prices when building ground water projects in developing nations. Chadee et al. [47]

cited the issues of cost overrun, such as a delay in land acquisition, unforeseen issues with raw material supply, and unlawful encroachment on property as the cause of cost inflation. A thorough comprehension of the diverse factors influencing cost overruns in building projects is imperative for informed decision-making, risk management, budget control, client satisfaction, competitiveness, innovation, regulatory compliance, sustainability, and fostering effective collaboration among stakeholders. This understanding empowers the construction industry to proactively address these challenges and strive for enhanced efficiency and success in its projects, ultimately contributing to the industry's growth and credibility

2.4 Cost Overrun Analysis

Cost overrun analysis is a comprehensive examination and assessment of the factors that contribute to the deviation of actual project costs from the originally estimated or budgeted costs in a building project or any other type of project. It involves a systematic investigation into the reasons behind cost overruns, seeking to understand the root causes and implications of the financial discrepancies. Khodeir and Ghandour [19] emphasized the importance of effective communication among stakeholders to address issues promptly. Their research highlighted the necessity of clear and transparent communication channels to foster collaboration and ensure that concerns or challenges are promptly identified and resolved, thereby preventing potential cost overruns resulting from miscommunications. Shah and Chandragade [48] and wyke et al. [49] studied that previous researchers have used literature reviews to determine the essential factors that cause building projects' costs to exceed budget. Through a comprehensive review of the existing literature, researchers have identified several factors repeatedly mentioned as significant contributors to cost overrun. Eash et al. [15] emphasized the need for continuous monitoring and control mechanisms during the construction phase to manage expenses effectively. Their study stressed the importance of implementing robust monitoring systems that track budgetary allocations, resource utilization, and progress, allowing project managers to make timely adjustments and prevent cost overruns by addressing issues proactively.

Cost control is a comprehensive set of cost analysis methods and managing techniques to improve cost efficiency using various techniques. Some of the most common factors include project complexity, inadequate planning and scheduling, poor communication and coordination among project stakeholders, scope creep, changes in design or specifications, and external factors such as market conditions and regulatory changes. Yun et al. [45] investigated that the Delphi technique is a structured method for gathering and synthesizing expert opinions on a particular topic. In phase 1 of the Delphi technique, researchers identify a panel of experts with relevant experience in the study. These experts are then asked to provide their opinions on the critical factors contributing to building sector cost overrun.

The experts are invited to order the elements according to their perceived importance through questionnaires or interviews. Chadee et al. [16] reported that in phase 2 of the Delphi technique, the most crucial factors identified in phase 1 are further analyzed to develop a consensus among the expert panel. This phase involves a series of iterative rounds in which the experts are provided with feedback on the previous round's results and asked to revise their opinions. Jin et al. [37] focused on the influence of technological advancements in project management to streamline processes and reduce the likelihood of errors. Through this process, a consensus is reached on the critical factors that lead to cost overrun in the building sector. The results of the Delphi technique can be used to develop effective strategies for mitigating the risks of cost overrun in the building sector.

2.4.1 Comparison of Survey Tools

Comparison of online and physical surveys refers to the evaluation of data collection methods used to gather information or feedback from individuals or respondents. Online surveys are conducted over the internet, typically through web-based forms or questionnaires, while physical surveys involve face-to-face interactions with respondents using paper-based forms or interviews. Leu et al. [4] studied the first step in conducting a study on the evaluation of factors leading to cost overrun in the building sector. Shah and Chandragade [48] investigated that a pilot study can be used to identify any issues with the questionnaire design, such as unclear questions or response options. It can also be used to test the feasibility of the data collection methods, such as the mode of administration (e.g., online, in-person) and the timing of the survey. Comparing online and physical surveys is essential for making informed decisions about data collection methods.

Table 2.3: Different Survey Tools.

Sr. No	Nature of Survey	Target Audience	Response Rate	Valid Rate	Use of Software	Reference
1	Online and physical	58	82%	93%	AMOS	Rahman et al. 2022 [50]
2	Online and Physical	300	89%	-	IBM SPSS	Xie et al. 2022 [51]
3	Online and Physical	56	84%	-	IBM SPSS	Bhasvar et al. 2022 [52]
4	Physical	42	97%	97%	BN Model	Ashtari et al. 2022 [53]
5	Online	79	-	68%	IBM SPSS	Lee et al. 2022 [54]
6	Online and Physical	159	66%	-	MS Excel	Chadee et al. 2022 [47]
7	Snowball Sampling	87	87%	63%	MS Excel	Shah and Chandragade 2022 [48]

Online surveys offers numerous benefits for organizations and researchers. Firstly, online surveys are highly cost-effective, eliminating the expenses associated with printing, postage, and manual data entry. The questionnaire can be improved and finalized based on the pilot study's findings. This may involve revising the wording of questions or response options, adding or removing questions, or adjusting the survey administration methods. The literature review can identify relevant questions, which can then be organized into a structured questionnaire. The survey should include closed-ended and open-ended questions to collect quantitative and qualitative data.

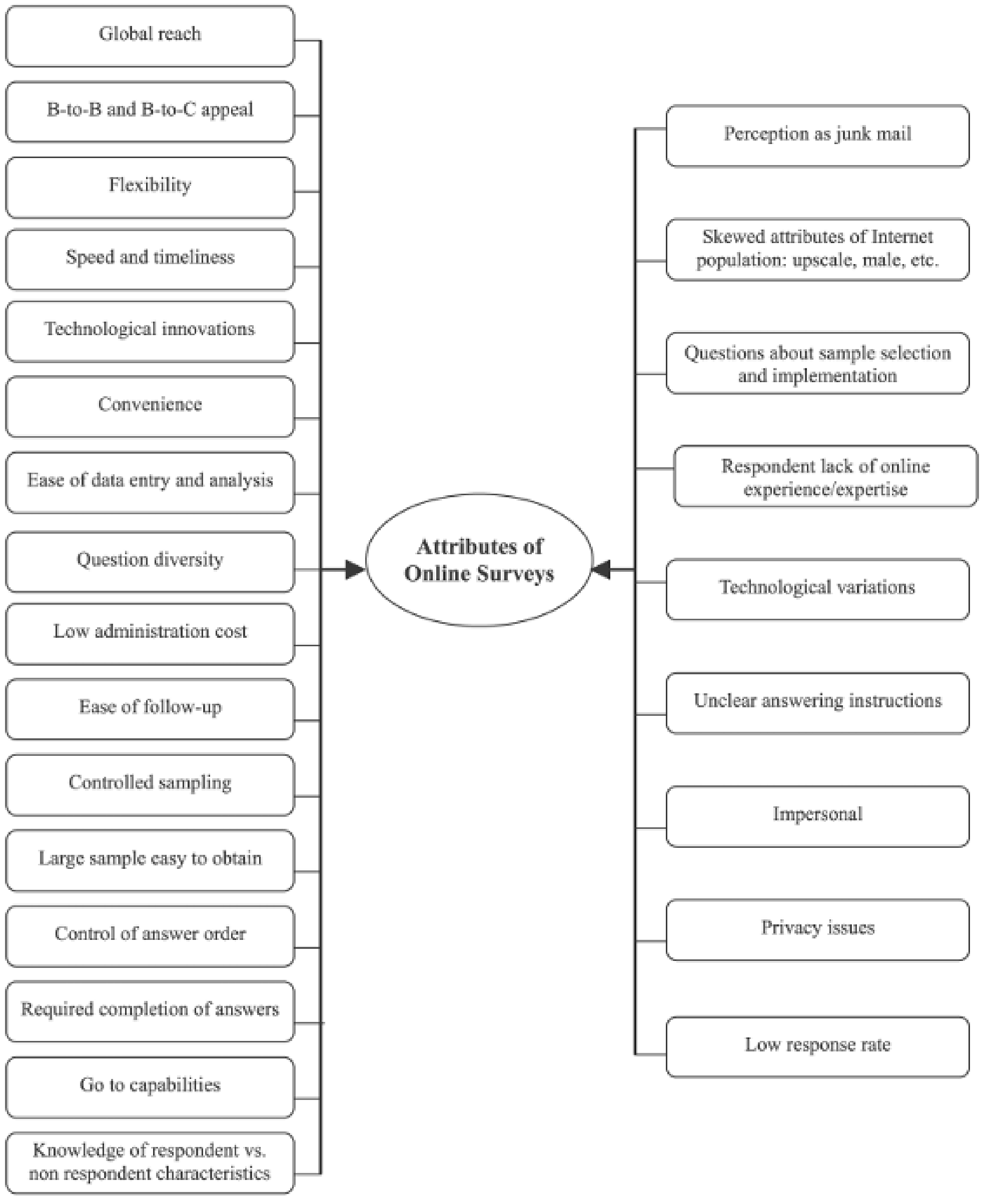

FIGURE 2.5: Attributes of Online Survey [47].

The questions should also be designed to cover a range of factors identified as significant contributors to cost overrun in building-based projects. Before administering the questionnaire to the total sample, a pilot study can be conducted to test the questionnaire's effectiveness. Additionally, they provide a platform for reaching a wider and more geographically diverse audience, ensuring a larger sample size and increased data accuracy. Online surveys also offer greater convenience to respondents, enabling them to participate at their own pace and from anywhere with an internet connection. Varouqa and Farooqi [55] investigated that online polls have a lot of flexibility. They can be conducted in various ways. Wang and Levinson [56] claim that the speed and global reach of the internet enable real-time interactions with geographically dispersed response groups and information servers. Broadband internet connections also make it simpler to transmit multimedia content, increasing the breadth and depth of online surveys.

2.4.2 Various Cost Overrun Techniques

Cost overruns are a significant challenge in construction projects, and identifying and analyzing the factors that contribute to them is crucial for successful project management. Various cost overrun analysis techniques, such as Delphi, SWARA (Step-wise Weight Assessment Ratio Analysis), FGDMA (Fuzzy Group Decision-Making Approach), BIM (Building Information Modeling), Fuzzy Logic, and Structural Equation Modeling, are employed to analyze, predict, and manage cost overruns in building projects. Several techniques are available in the literature to investigate the source of cost overruns studied by Afzal et al. [57]. Cost overruns are a significant challenge in construction projects, and identifying and analyzing the factors that contribute to them is crucial for successful project management. Various cost overrun analysis techniques, such as Delphi, SWARA (Step-wise Weight Assessment Ratio Analysis), FGDMA (Fuzzy Group Decision-Making Approach), BIM (Building Information Modeling), Fuzzy Logic, and Structural Equation Modeling, are employed to analyze, predict, and manage cost overruns in building projects. Several techniques are available in the literature to investigate the source of cost overruns studied by Afzal et al. [57].

TABLE 2.4: Various Cost overrun Techniques from Literature.

Sr No.	**Tools**	**Advantages/Disadvantages**	**Reference**
1	Structural Equation modeling	SEM allows researchers to test multiple, interrelated relationships between variables in a single model, making it possible to test complex, multi-variable theories.	Shoar et al. [41]
2	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.	Hassan et al. [58]
3	Expert Judgment	Data can be sent fast, and turnaround times can be reasonable and can instantly connect with audience. Online surveys are free of cost. Laying may be a problem. Respondents do not provide honest replies.	Shehu et al. [59]
4	Delphi-SWARA method	Delphi is beneficial for creating estimations or forecasts. By giving members of the group controlled feedback, it lowers noise based on other rankings. There is no produced right or wrong response.	Shah and Chandragade [48]
5	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 defuzzied scores by connecting them to relevant fuzzy numbers.	Xie et al. [51]
5	Building Information Modeling	BIM allows for improved collaboration between all stakeholders involved in a construction project. The implementation of BIM can be expensive. This may be a significant barrier for smaller construction firms.	Rachmawati et al. [60]
6	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.	Khodeir and Ghandour [19]

According to the Ayudhya [61], structural equation modeling (SEM) is a statistical technique that enables scientists to test numerous connected relationships between variables in a single model. Amini et al. [5] investigated the threshold value "0.9" in structural equation modeling (SEM), emphasizing the most critical factors contributing to cost overruns in building projects. By using this value, the crucial nature of the factors that significantly influence project budgets and highlights their substantial effect on project performance and outcomes. Previous researchers have utilized the threshold value of 0.9 in structural equation modeling (SEM) to discern the most critical factors reported by enders et al. [62] and cheung et al. [63]. This value selection assists in establishing a clear threshold for determining the most influential variables affecting the outcome under study. By employing this criterion, researchers can effectively identify and prioritize the factors with the most significant impact on the observed phenomena, facilitating a more comprehensive understanding of the underlying dynamics investigated by ding et al. [64]. The threshold value of "0.9" is determined based on the understanding that factors approaching a value of 1 signify the most significant factors. This standard is set to emphasize the prioritization of factors that hold considerable weight and influence in the context of the cost overrun reported by neumann et al. [65] and velayutham et al. [66]. The selection of criteria such as 0.9, 0.8, and 0.7 often serves to categorize and distinguish the performance levels of individuals in a structured manner reported by baumgartner et al. [67]. Hon et al. [68] studied that FSE uses fuzzy logic to assess the effectiveness of a construction project and the influence of different factors on cost overruns. This method has been used in previous studies to identify the most crucial factors leading to cost overruns, such as changes in project scope, lack of experience, and design errors. This framework facilitates a clearer understanding of the variations in performance and aids in the differentiation of high, medium, and average levels of cost overrun.

The use of various cost overrun analysis techniques, including Delphi, SWARA, FGDMA, BIM, Fuzzy Logic, and Structural Equation Modeling, offers several significant benefits in the construction industry. These techniques provide a systematic and data-driven approach to understanding the factors that contribute to cost overruns in building projects. They enable project stakeholders to identify and prioritize critical risk factors accurately. Mcleod [69] investigated that the

Delphi-SWARA method combines the Delphi and the Simple Additive Weighting And Ratio Analysis (SWARA) process. It is a multi-criteria decision-making technique that can identify and prioritize the factors affecting cost overruns in building projects. This method has been used in previous studies to identify the most critical factors causing cost overruns, such as inadequate project management, delays in project schedules, and unexpected changes in project scope. Rajarajeswari and Anbalagan [70] concluded that the fuzzy Group Decision-Making Approach (FGDMA) is a method that allows a group of decision-makers to work together to identify and prioritize the factors causing cost overruns. This method uses fuzzy logic to capture the uncertainty and ambiguity associated with decision-making in complex systems. Shoar and Chileshe [71] and Chan et al. [72] investigated that FGDMA has been used in previous studies to identify the factors causing cost overruns, such as lack of coordination among project team members, inadequate budget allocation, and poor project management. Ssegawa and Keakile [73] Building Information Modeling (BIM) is a digital representation of a construction project that allows stakeholders to visualize and simulate it before it is built. These techniques help in proactive risk management and cost control. By identifying potential cost overrun factors early in the project lifecycle, stakeholders can develop strategies to mitigate risks, reduce the likelihood of overruns, and allocate resources more efficiently. These techniques enhance decision-making. They provide quantitative and qualitative insights into cost overrun factors, allowing for well-informed decisions regarding project planning, budgeting, and resource allocation.

These techniques improve the accuracy of cost estimates. By incorporating expert opinions, multi-criteria assessments, and modeling, they lead to more precise initial cost projections, reducing the likelihood of budget discrepancies. Furthermore, these techniques promote collaboration among project stakeholders. They offer a structured framework for communication and consensus-building among experts, contractors, and clients, fostering a more transparent and cooperative project environment. Asiedu et al. [74] studeid that BIM can be used to identify potential sources of cost overruns and to optimize the design and construction process. BIM has been used in previous studies to identify potential sources of cost overruns, such as design errors, construction rework, and material waste. Chadee et al. [75] studied that the Relative Importance Index (RII) is a statistical method that can prioritize the factors causing cost overruns. Asiedu and Adaku [76] and Shamim and Islam [77] reported that RII involves calculating the relative importance of each factor based on a survey of stakeholders, such as project managers and contractors. The RII has been used in previous studies to prioritize the factors causing cost overruns, such as poor project planning, inadequate budget allocation, and insufficient risk management. The literature suggests several techniques for identifying and analyzing the factors affecting cost overruns in construction projects. These techniques include SEM, FSE, Expert Judgment, the Delphi-SWARA method, FGDMA, BIM, and the RII. Each process has advantages and disadvantages, and the best one depends on the project's requirements and available data. The use of these techniques contributes to the overall success and efficiency of construction projects. By effectively managing cost overruns, projects can be completed on time and within budget, leading to increased profitability, client satisfaction, and a positive industry reputation.

2.5 Summary

Cost overrun is one of the most severe concerns affecting building projects. Minimizing this aspect is challenging since it is ultimately dynamic and multifaceted. The primary reason is that the construction industry consumes a lot of resources, which leads to a shortage of those resources, fluctuating material pricing, equipment expenses, and unforeseen expenditures to affect many projects. Contractors face significant challenges in waste management, inadequate planning, and a lack of sustainability practices. Similarly, small-scale construction projects need more sustainability in the construction process, poor site management, and poor cost management issues, resulting in project delays and cost overruns. Various aspects related to cost overruns in the building sector are discussed in this chapter, including the factors influencing the success or failure of such projects, including project scope, budget, resources, and stakeholder engagement. The classification of construction costs is examined, distinguishing between direct and indirect costs, overhead costs, contingency costs, and financing costs. The causes of cost overruns are identified, such as inadequate planning, poor communication, changes in project scope, and unexpected site conditions. Different analysis techniques are discussed, including the use of structural equation modeling (SEM), fuzzy synthetic evaluation (FSE), expert judgment, Delphi-SWARA method, fuzzy group decision-making approach (FGDMA), and building information modeling (BIM). This chapter also discussed pilot studies and the refinement of survey methods for data collection. It concludes by emphasizing the importance of understanding and analyzing the factors causing cost overruns to enable effective project management and successful outcomes in building projects.

Chapter 3

Brief Methodology

3.1 Background

This chapter outlines the steps involved in conducting research and the tools and procedures chosen to achieve the study's goals. In this study, numerous factors contributing to cost overruns are identified, and a short list of the most important ones are included in construction projects. The methodology includes a rapid assessment of project requirements, stakeholder consultations, and agile planning to implement swift modifications efficiently. The literature review is conducted to recognize the most critical factors affecting cost overruns in residential building projects. After analyzing factors from the literature review, we narrow our focus to those directly pertinent to building projects. Consider the target audience's characteristics, such as age and experience, then develop a list of questions. After that, organize the questionnaire to help improve its flow and make it simpler for participants to complete. Write out the questions and response options and format the questionnaire precisely. The Likert scale is used to measure the opinions and perceptions. This helps identify any problems with the wording or format of the questions and any technical issues. Based on the pilot study, make any necessary changes to the questionnaire. The questionnaire is used to collect the required data. Reliability analysis, Factor Reduction Analysis, correlation analysis, Normality Analysis and the choice of parametric or non-parametric tests are used for data analysis, and AMOS is used for modeling. The evaluation and data analysis process involves various statistical techniques to identify the critical factors leading to cost overruns in building projects. Reliability analysis, Factor Reduction Analysis, correlation analysis, Normality Analysis, and the choice of parametric or non-parametric tests are selected to ensure that the data gathered is accurate, reliable, and meaningful. The next step is to use the AMOS software to create a structural equation model (SEM) after the data analysis. The SEM is made using AMOS software, enabling the estimation of direct and indirect relationships between variables.

3.2 Research Design

A thorough analysis is rooted in a comprehensive examination of existing literature concerning cost overruns within building construction projects. A meticulous review of the available body of work was undertaken to delve into contemporary research domains to precisely identify the fundamental factors contributing to cost overruns in building projects. In this study, questionnaire surveys are employed. Information from stakeholders has been gathered using a questionnaire using the survey approach. This study used descriptive research to help evaluate the key elements contributing to cost overruns in building projects. The cost overrun causes were shortened using the Delphi approach, and a questionnaire was created. Two rounds of Delphi technique is used to refine the questionnaire. A statistical method has been used to analyze the data. SPSS allows users to enter, import, and manage data efficiently. You can input data directly into the software or import it from various file formats, such as Excel, CSV, and others. Amos software has used to identify the critical factors leading to cost overrun in building projects. After the data analysis, conclusions and suggestions were made. Figure 3.1 shows the details of the methodology adopted in the research work.

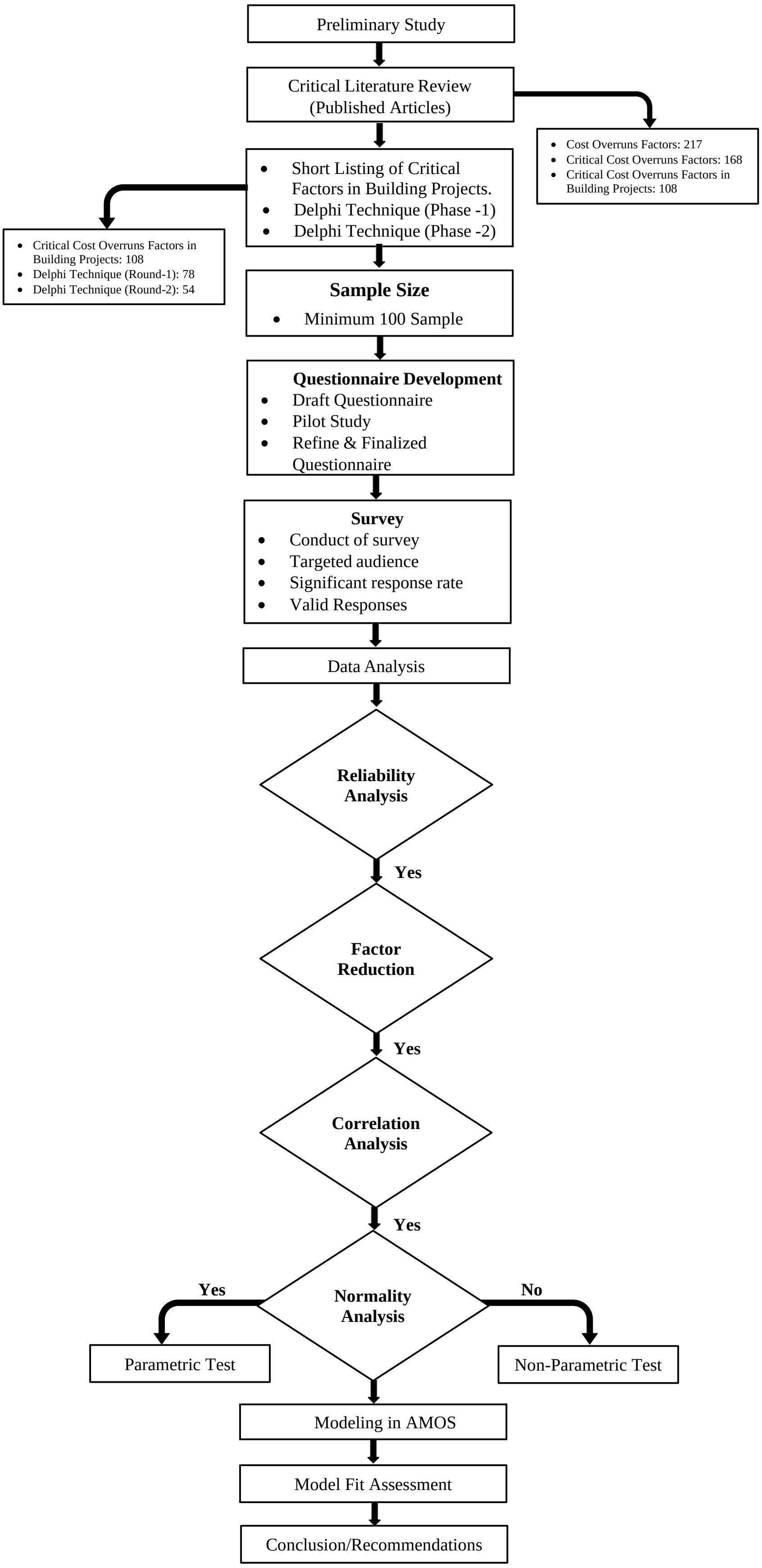

Figure 3.1: Brief Methodology.

3.2.1 Study Area

This study is limited to a specific geographic region, namely zone V of Islamabad and tehsil Rawalpindi in Pakistan. The study is also limited to residential buildings within a particular height range of 4 to 7 storeys, specifically B+G+2 or G+3 to B+G+5 or G+6. These limitations are essential to consider when interpreting the results of the study. This region's construction practices, building codes, and regulations may differ from the other areas, affecting the critical factors leading to cost overrun. These constraints are crucial when extrapolating the findings to different geographical regions or nations. The study is also limited to residential buildings within a specific height range. The factors contributing to cost overrun may differ for buildings of different heights, such as high-rise or low-rise buildings. Thus, The study's findings might not apply to building projects over this range in height.

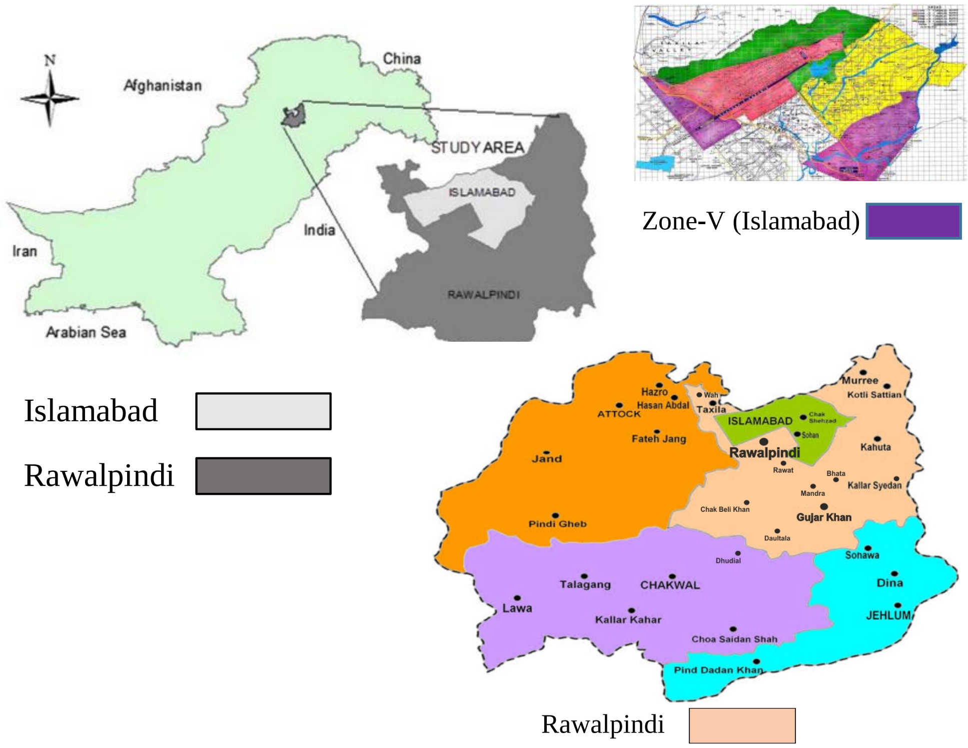

Figure 3.2: Overview of the Study Area.

3.2.2 Data Acquisition from Literature for Factors

A critical literature review was conducted to pinpoint the key elements responsible for cost overruns in building projects. The essential factors are shortlisted based on their frequency of occurrence and significance in the selected research work. The shortlisting process critically evaluates each factor to ensure that it contributes significantly to cost overrun in building projects. Factors that are less significant or do not consistently appear across the selected research papers are being excluded. The Delphi technique helps to validate the shortlisted critical factors and ensure that the identified factors are relevant and appropriate. In this research, two rounds of the Delphi technique is used.

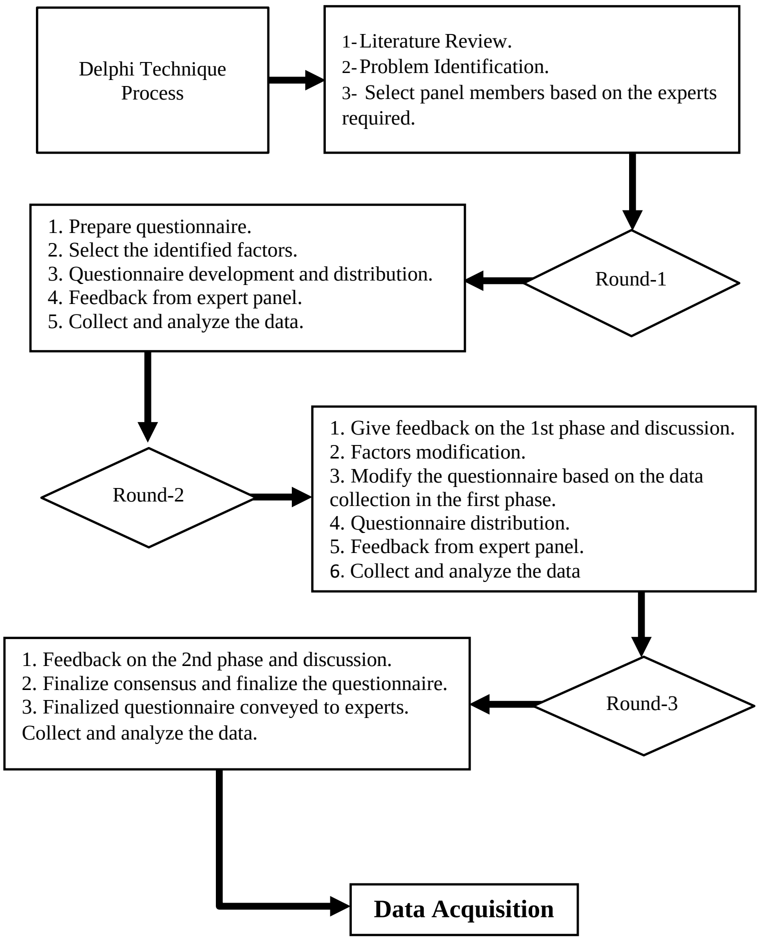

FIGURE 3.3: Delphi technique process.

In the first round, a survey questionnaire is developed and sent to a panel of experts who are selected based on their experience and knowledge in building projects. After analyzing the responses from the first round, a summary report is prepared, highlighting areas of agreement and disagreement among the experts. The summary report is shared with the panel of experts, who then revise their ratings based on the feedback provided. In the second round, the revised survey questionnaire is sent to the panel of experts, who are asked to rate the critical factors again. This research is developing a list of questions based on the shortlisted critical factors identified through the Delphi technique.

3.2.3 Likert Scale

In this study, the Likert Scale gathers participant data regarding their opinions and perceptions of the crucial causes of cost overruns in building projects. Participants are asked to rate their level of agreement or disagreement with statements related to each critical factor on a 5-point Likert Scale. The responses are then analyzed to determine the most critical factors contributing to cost overrun in building projects.

Table 3.1: Likert Scale.

Sr. No	Description	Score Range
1	Strongly Disagree	1
2	Disagree	2
3	Neutral	3
4	Agree	4
5	Strongly Agree	5

3.2.4 Questionnaire Development and Sample Size

Once the questions are organized, a draft questionnaire is being developed and reviewed. The first phase of the survey involves the development of the questionnaire. Initially, a draft questionnaire is created, comprising carefully crafted questions related to the research objectives and the factors contributing to cost overruns in building projects. The pilot study used for evaluating the questionnaire's relevance, clarity, and usability. The questionnaire's quality is being improved by gathering participant feedback and making the necessary adjustments. The questionnaire is being created with the respondents in mind, making it clear and simple to understand. The questions are being designed to collect both quantitative and qualitative data, and the response options are being carefully chosen to maximize the data gathered. A small sample of respondents is being used in a pilot study to test the questionnaire. The pilot study is assisting in identification of any issues with the questionnaire, such as ambiguous questions or challenging-to-interpret response choices. The questionnaire is being improved and finalized based on the knowledge gained from the pilot study, ensuring it successfully captures the necessary information on cost overrun factors in construction projects. The questionnaire is being improved based on feedback from the pilot study to ensure its simplicity and clarity. This meticulous questionnaire-development process is adopted to increase the validity and reliability of the survey's data.

The most crucial step in survey-based research is data collection because the outcome depends entirely on it. The data acquisition techniques thus determine the success of the procedures. After the questionnaire is refined, it is finalized for use in the main study. The completed questionnaire is reviewed and ensured that it effectively captures the critical factors leading to cost overruns in building projects. After the creation of the data-gathering tool, a survey is run. Industrial professionals in both public and private organizations are the target audience for the questionnaire dissemination. Regarding the goals and purposes of the performed questionnaire survey, respondents are approached. The final questionnaire is distributed to a larger sample of respondents, and the data collected is analyzed to identify the factors that have the most significant impact on cost overruns in building projects.

The data sample under analysis is derived from individuals who are currently participating in an online survey. By utilizing online surveys, a wide array of individuals can be engaged, thereby encompassing diverse demographics and various backgrounds. The inherent convenience and accessibility of online surveys enable a broader spectrum of participants to contribute, thereby expanding the overall range of collected data. Consequently, this data sample offers us an immediate glimpse into the attitudes, opinions, or behaviors of actively participating respondents. This dynamic perspective is well poised to support a comprehensive and contemporaneous analysis of the research objectives. In 2014, Singh and Masuku [78] put forward a guideline that recommends having at least 100 data points for each major group or subgroup within a sample. Additionally, for smaller subgroups, it was advised to have a sample size of around 20 to 50 data points. This suggestion is rooted in the concept of striking a balance between achieving statistically meaningful results and being practical about data collection. Having a sufficient number of data points within each group ensures that the results drawn from the sample accurately reflect the characteristics of the larger population. This guideline acknowledges that the variability within smaller subgroups may require a relatively smaller sample size to draw valid conclusions. By following this approach, researchers can enhance the reliability of their findings while making optimal use of available resources.

$n = \frac{Z^2 \times p \times (1-p)}{E^2}$

Where:

- n represents the required sample size.
- Z is the Z-score associated with the desired confidence level.
- p is the estimated proportion of the population with a certain characteristic.
- E is the desired margin of error.

3.3 Data Collection Procedure

A pilot study was conducted to ensure the qualifications of the respondents, confirming their experience in working on buildings ranging from B+G+2 Storey to

B+G+7 Storey. The respondents were working on desired 7 storey building at 50 different sites in 6 different societies in Zone V Islamabad and city Rawalpindi. All sites were physically inspected. Their email addresses were collected for the purpose of sending out the questionnaire, facilitating direct communication and enabling a streamlined data collection process. Then, data collection methods and instruments are developed, followed by a pilot study. Participants are being recruited, and data is being collected through online surveys. Finally, the data is analyzed and reported for conclusions and future recommendations.

3.3.1 Conduct of Survey

A questionnaire was developed and distributed to stakeholders in the Rawalpindi and Islamabad regions through an online platform. The target was to obtain a minimum of 100 responses from industry professionals. However, 113 valid responses were received from stakeholders. The 5-point ordinal Likert scale, from "Strongly Disagree" to "Strongly Agree," was used to collect responses from construction industry professionals. With significant differences between construction methods, a rating of 1 indicated the item was of the most negligible significance, and a rating of 5 indicated the object was of the utmost importance.

TABLE 3.2: Industry Key Personnel background.

Sr. No	Category	Experience	Sector
1	Client, Contractor, Consultant	10 to 15 Years Experience	Government, Semi-Government, Private
2	Client, Contractor, Consultant	05 to 10 Years Experience	Government, Semi-Government, Private
3	Client, Contractor, Consultant	01 to 05 Years Experience	Government, Semi-Government, Private

A survey was undertaken after the development of the questionnaire. Participants must respond to a questionnaire about the crucial factors that cause cost overruns in building projects. The questionnaire is designed using the Likert Scale, allowing participants to rate their level of agreement or disagreement with statements related to each critical factor. The collected responses are analyzed using statistical methods to identify the key factors that play a significant role in causing cost overruns. A combination of direct and indirect methods is utilized to engage potential participants and ensure a broad and varied group for the study. A list of construction practitioners and affiliated experts involved in construction processes was compiled, and the survey was sent to them. The questionnaire was disseminated electronically through email. Two follow-up reminders were sent after the initial distribution to encourage participation.

3.3.2 Response Rate and Valid Responses

In the realm of questionnaire-based surveys, two pivotal metrics that significantly influence the quality and reliability of gathered data are the response rate and valid responses. The response rate denotes the proportion of individuals. Valid responses are those that meet predetermined criteria, including the requirement of completeness, logical consistency, and the absence of duplicate submissions. The survey's response rate was assessed to determine its significance, with a target of 100 responses. Additionally, efforts were made to ensure the validity and reliability of the answers by implementing quality control measures and removing incomplete or duplicate submissions.

3.4 Data Analysis Procedures

The information gathered from construction industry experts was examined using the statistical program for social sciences (SPSS) i.e reliability analysis, factor reduction, correlation analysis, normality anlysis and parametric and non parametric test. Reliability analysis determines the consistency and stability of a set of measurements. The collected data was reviewed as described below.

3.4.1 Reliability Analysis Procedure

Reliability analysis determines the consistency and stability of a set of measurements or data over time. In this study, reliability analysis testing is based on the information gathered from the surveys and questionnaires to ensure the information is reliable and consistent. Cronbach's alpha is calculated by analyzing the correlations between each item in questions or statements. In this study, Cronbach's alpha is calculated for each set of questions related to the critical causes of cost overruns [79]. A value of 0.7 or higher is considered acceptable for reliability analysis, indicating that the set of questions is reliable and consistent for further analysis [79]. Reliability testing is essential in ensuring the validity of the data and the accuracy of the conclusions drawn from the analysis.

TABLE 3.3: Ranging Scale of Cronbach's Alpha [80].

Internal Consistency	**Cronbach's Alpha**
Excellent	$\alpha \geq 0.9$
Good	$0.9 \geq \alpha \geq 0.8$
Acceptable	$0.8 \geq \alpha \geq 0.7$
Questionable	$0.7 \geq \alpha \geq 0.6$
Poor	$0.6 \geq \alpha \geq 0.5$
Unacceptable	$0.5 \geq \alpha$

3.4.2 Factors Reduction Analysis Procedure

Statistically, factor reduction analysis is a method that helps identify latent variables, referred to as factors, from a set of observed variables. Its primary purpose is to explore and explain the relationships among numerous variables by condensing them into a more condensed collection of variables. These elements stand in for the variance that the observed variables share. Firstly, it aids in dimensional reduction by identifying the common underlying factors, thus simplifying data analysis and making it more manageable. Secondly, it facilitates the data exploration by uncovering the underlying structure of a data set and revealing relationships among variables. This enables researchers to identify significant variables contributing to the factors and discover patterns within the data. Lastly, factor analysis assists in variable grouping, allowing related variables to be grouped based on their shared variance. This aids in understanding the relationships between variables and organizing them for further analysis.

Factor analysis also has limitations that must be considered. Violations of these assumptions can impact the accuracy of the results. Additionally, interpreting factor analysis results involves subjective judgment. Researchers need to decide the number of elements to keep, the rotational technique, and the interpretation of factor loadings. Selecting an inappropriate number of factors to drag can result in over-extraction or under-extraction. Over-extraction leads to factors that are difficult to interpret, while under-extraction may overlook critical underlying factors. The quality and characteristics of the data, such as missing data, outliers, or skewed distributions, can impact the results of factor analysis. Finally, factor analysis aims to explain the variance in observed variables using fewer factors, but it may only capture some of the conflicts, leaving unexplained residual variance. Therefore, being aware of these limitations and exercising caution when conducting factor analysis is crucial. Researchers ensure that the assumptions are met, interpret the results carefully considering subjective judgment, and are mindful of the impact of data quality on the outcomes.

3.4.3 Correlation Analysis Procedure

Correlation analysis is a statistical method for examining the relationship between two or more variables. It measures the degree of association or correlation between two variables and helps identify data patterns and trends. This study uses correlation analysis to ascertain the association between critical factors and cost overruns in building projects. The correlation coefficients are calculated to determine the direction and strength of the relationship between the variables. The Pearson correlation coefficient is commonly used for this purpose, having a value of 0 indicates is no correlation, a value of 1 shows a positive correlation, and a value of -1 shows negative correlation. The correlation analysis results help in identification of the critical factors that have the strongest correlation with cost overruns in building projects. This information can be used to develop effective cost-control strategies and prevent cost overruns in future projects.

3.4.4 Normality Test Procedure

Using statistical analysis, a normality test determines whether a data set has a normal distribution or a Gaussian distribution. The primary purpose of conducting a normality test is to evaluate the appropriateness of applying statistical methods that assume normality. These methods include parametric tests such as regression analysis, analysis of variance (ANOVA), and t-tests. By checking the normality assumption, researchers can ensure the validity and reliability of their statistical calculations. These tests provide a numerical measure or p-value indicating the degree to which the data deviates from a normal distribution [81]. However, it's important to note that normality tests have certain limitations. Firstly, it is essential to remember that normality is an assumption and a simplification of real-world data. While many statistical methods assume normality for their validity, they can still produce reliable results even if the hypothesis is slightly violated, especially with large sample sizes.

Additionally, the power of normality tests can be influenced by minor deviations from normality and may produce statistically significant results in large samples due to sample size. This can lead to rejecting the normality assumption when it is not practically significant. Furthermore, normality tests can be sensitive to deviations from normality in the distribution's tails while being less sensitive to variations in the center of the distribution. Therefore, it is vital to interpret the results of normality tests cautiously, considering the overall shape and characteristics of the data. Normality tests are sample-dependent, meaning the results can vary depending on the specific sample used. Therefore, even if the data passes a normality test in one sample, it does not guarantee that it will hold for other populations or samples. Calculating normality ensures that statistical tests are accurate and reliable, and that the results are meaningful and helpful in identifying the important causes of cost overruns in building projects

3.4.5 Parametric and Non-parametric Test Procedure

Parametric tests are based on specific assumptions about the population distribution, such as normality or homoscedasticity. These tests are typically more effective and powerful when the assumptions are valid than non-parametric tests. ANOVA, linear regression, and t-tests are examples of parametric tests. On the contrary, non-parametric tests do not require population distribution assumptions. They are generally less powerful and efficient than parametric tests. However, they can be used in situations where the assumptions of parametric tests fail or the data is non-normal. Examples of non-parametric tests include the Mann-Whitney U test, the Wilcoxon rank-sum test, and the Kruskal-Wallis test.

In this study, both parametric and non-parametric tests are used to analyze the data. Assuming the data satisfies the necessary assumptions, parametric tests like t-tests and regression analysis test hypotheses about the means and relationships between variables. When the assumptions of parametric tests are not met, non-parametric tests such as the Wilcoxon rank-sum test and Spearman correlation are used as alternatives. By employing both parametric and non-parametric tests, the results of the statistical analysis are ensured to be robust and reliable, irrespective of the underlying distribution of the data. This approach aids in identifying the critical factors leading to cost overruns in building projects and in developing effective cost control strategies. The outcomes of parametric tests indicate that the data distribution is normal, while the results of non-parametric tests indicate that the data distribution is not normal. A non-parametric test is employed when the data does not appear to follow a normal distribution. The test fails to support the normality hypothesis if the p-value is less than or equal to 0.05. The following presents the formula for assessing normality:

• If p-value is greater than or equal to alpha level, the data have a normal distribution. P-value $\geq$ alpha level.
• If the p-value is greater than or equal to the alpha level, the data do not have a normal distribution. P-value $\leq$ alpha level.

3.4.6 Structure Equation Modeling Procedure

A statistical method known as structural equation modeling (SEM) enables the testing of complex relationships among multiple variables. It examines the causal connections between variables and assesses the fit of a theoretical model. In this study, the AMOS software is utilized for SEM analysis. AMOS is a user-friendly software that allows the creation and testing of models using path analysis, confirmatory factor analysis, and other statistical techniques. The SEM analysis entails various steps, including model identification, estimation, and evaluation during the modeling process. The SEM analysis aims to identify the critical elements causing cost overruns in building projects and the relationships among these elements. Through SEM analysis, the relative weight of each factor contributing to cost overrun can be evaluated, and potential interventions or strategies for cost control and project enhancement can be identified. The results of the SEM analysis offer insights into the underlying causal mechanisms of cost overruns in building projects, contributing to future research and practice in this research area.

This step involves defining the variables, of their relationships, and the underlying theory that guides the model. It is essential to clearly define the variables and their measurement scales and hypothesize the relationships between them based on prior research or theory. This step involves determining whether the model is identifiable, meaning it can be estimated from the data. A model is identifiable if there is sufficient variation in the data to estimate the parameters accurately. It is also essential to check for potential problems, such as multicollinearity, that may affect the estimation of the model. This step involves estimating the model parameters using maximum likelihood estimation or another appropriate method. The assessment consists of finding the best-fitting model that explains the observed data. The estimated model parameters are used to test the significance of the relationships between the variables and assess the model's overall fit. This step involves the evaluating the model's goodness of fit, which assesses how well it fits the data as observed. Several indices, including the chi-square test, root mean square error of approximation (RMSEA), and comparative fit index (CFI), are used to evaluate the goodness of fit. A good model suitable means that the model adequately explains the observed data.

3.5 Summary

This study used a methodology to identify the critical factors leading to cost overrun in building projects. A literature review is conducted to identify the factors contributing to cost overruns in construction projects. Then, frequency analysis is employed to determine the critical factors leading to cost overruns. After the shortlisting of critical factors in building projects, two rounds of the Delphi technique are utilized. Following this, factor reduction analysis is employed to further refine the list of factors relevant to building projects only. Subsequently, correlation analysis is conducted to identify relationships between the factors. Normality analysis is then used to assess whether the data follows a normal distribution. Based on the normality test results, non-parametric tests are performed. Finally, structural equation modeling is used to identify the critical factors contributing to cost overruns in building projects. The top ten influencing factors in SEM Matrix are shortlisted based on their impact on cost overruns. The modeling involved specifying the variables, their relationships, and the underlying theory that guides the model. The modeling involved specifying the variables, their relationships, and the underlying theory that guides the model. The model was then identified to determine if it was estimable from the data, and the maximum likelihood estimation method was used to determine the model parameters. The model's goodness of fit was assessed using many indices. The study was limited to a specific geographic region, namely zone V of Islamabad and tehsil Rawalpindi, and to residential buildings that are between 4 to 7 story in height, specifically B+G+2 or G+3 to B+G+5 or G+6. The data was gathered using a Likert scale, and the analysis revealed important factors that frequently cause building projects to go over budget.

Chapter 4

Results and Discussion

4.1 Background

This chapter delves into the outcomes derived from a questionnaire distributed among stakeholders in Rawalpindi and Islamabad, with the primary aim of discerning the principal factors contributing to cost overruns within building projects. The gathered data underwent thorough analysis employing SPSS, and the resulting insights were effectively presented through a combination of informative graphs and tables. The central focus of this research was to identify or establish the relative significance of the critical factors leading to cost overruns. The evaluation process involved soliciting responses from various participants, including contractors, consultants, and clients residing in both cities. AMOS provides several analysis options, including structural equation modeling (SEM), confirmatory factor analysis (CFA), multi group confirmatory factor analysis (MGCFA), means and covariance structure analysis (MACS), and path analysis, which allow researchers to test the measurement properties of latent constructs and examine the direct and indirect effects of variables, respectively. It also enables researchers to assess mediation and moderation effects, perform multi-group analyses, and conduct model comparisons. In this research work a statistical method called structural equation modeling (SEM) examines intricate connections between observed variables and latent variables. As a result, a comprehensive framework was developed, highlighting the critical factors that bear responsibility for cost overruns. Additionally, a set of guidelines has been formulated to reduce the detrimental impact caused by these overruns. By providing these guidelines, the study offers practical strategies for mitigating the adverse consequences of cost overruns in building projects.

4.2 Rate of Respondents

In this research, 150 questionnaires were distributed to the participants, and 113 completed questionnaires were received back, representing an impressive response rate of 75 percent. Notably, according to Ashley and Boyd [82], a satisfactory response rate is 50 percent; while anything above 70% is regarded as genuinely commendable, a response rate of 60% is considered good. Hence, the obtained response rate of 75 percent is excellent, reflecting a high level of engagement and active participation from the respondents. This high response rate holds significant value, providing a solid foundation for deriving conclusive findings from the collected data. It is generally accepted that when the population size is unspecified, a sample size exceeding 50 percent is considered acceptable and appropriate [58]. The substantial number of returned questionnaires further contributes to the reliability and representatives of the gathered data. With such a significant response rate, the findings of this study can be deemed more reliable and generalization to the target audience. The increased sample size enhances the statistical power of the analysis and strengthens the validity of the study's conclusions. The high level of participation also suggests that the respondents were genuinely interested in the research topic, indicating their willingness to contribute their perspectives and experiences. This high level of engagement bolsters the study's credibility, as it suggests that the participants perceived the research as relevant and important. This level of participation affirms the quality of the data collected and adds weight to the conclusions drawn from the study. The researchers can confidently rely on the substantial number of returned questionnaires to make meaningful inferences and recommendations based on the findings.

4.3 Characteristics of Respondents

The demographic response data provides insights into the educational qualifications of the respondents. Figure 4.1 illustrates the distribution of educational backgrounds among the participants. It reveals that 2.7 percent of the respondents held a Ph.D. in Civil Engineering, while the majority, comprising 38.9 percent, had obtained an MS degree in Civil Engineering. Additionally, 47.8 percent of the participants possessed a bachelor's degree, and a smaller proportion of 10.6 percent held a master degree in Project Management. These findings highlight the diverse educational backgrounds of the respondents, with a significant proportion having advanced qualifications in Civil Engineering at both the master's and doctoral levels. The representation of individuals with expertise in Project Management is comparatively lower, suggesting the need to consider their perspectives when analyzing the factors leading to cost overruns in building residential projects.

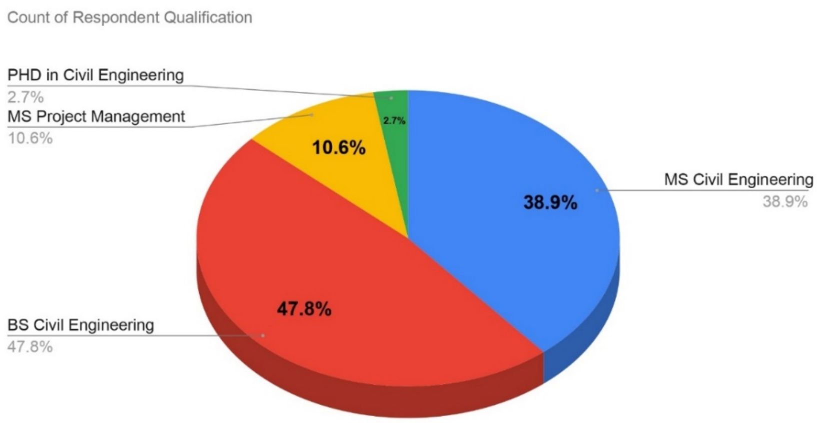

FIGURE 4.1: Count of Respondent Qualification.

The presented Figure 4.2 underscores the significant contribution made by construction professionals in this study. According to the demographic response data, most participants were professional civil engineers, indicating a solid representation of this group. Notably, the response rate from contractor representatives was 45.1 percent, demonstrating a substantial involvement from this sector. Consultant representatives accounted for 31.9 percent of the respondents, showcasing their active participation in the study. Client representatives constituted 18.6 percent of the responses, indicating their valuable input. On the other hand, individuals from the education department constituted only 4.4 percent of the overall respondents, suggesting a relatively lower involvement from this group. These findings highlight the predominant presence of construction professionals, particularly civil engineers, in shaping the study's outcomes. Their substantial engagement and response rate reinforce the relevance and credibility of the research findings within the context of building projects and cost overrun.

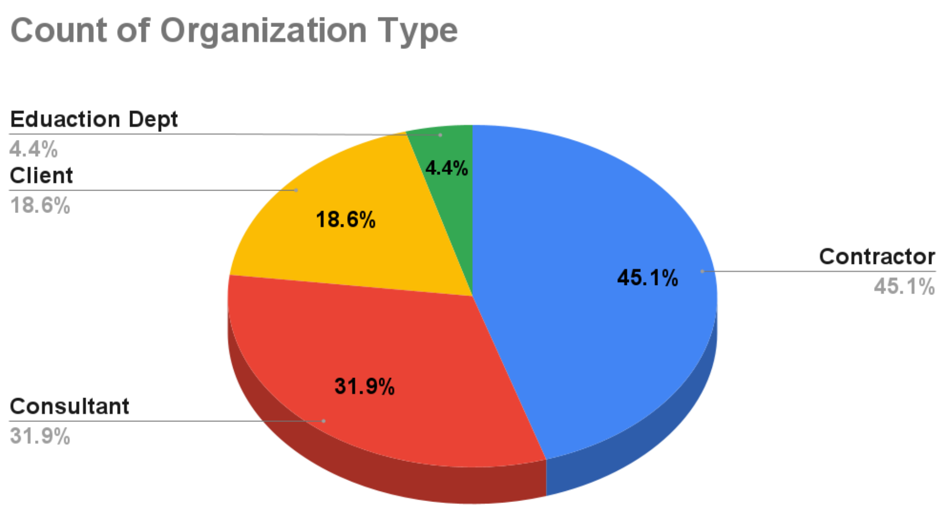

FIGURE 4.2: Count of Organization Type.

The experience level of professionals proved to be a significant factor in their effectiveness. A considerable number of participants in the survey had experience in building construction projects. The data reveals that 63.7 percent of respondents possessed knowledge equal to or greater than five years. Furthermore, 19.5 percent of participants reported having 6 to 10 years of experience, while 10.6 percent indicated 10 to 15 years of experience. Interestingly, 6.2 percent of respondents boasted an experience exceeding 15 years. These findings highlight the prevalence of experienced individuals within the surveyed group, suggesting that a substantial portion of the professionals involved had a wealth of practical knowledge in the construction field. The substantial number of completed questionnaires indicates a thorough exploration of the subject matter and a rich data set for analysis. Overall, the achieved response rate surpasses the thresholds of both satisfactory and good response rates, making it highly commendable.

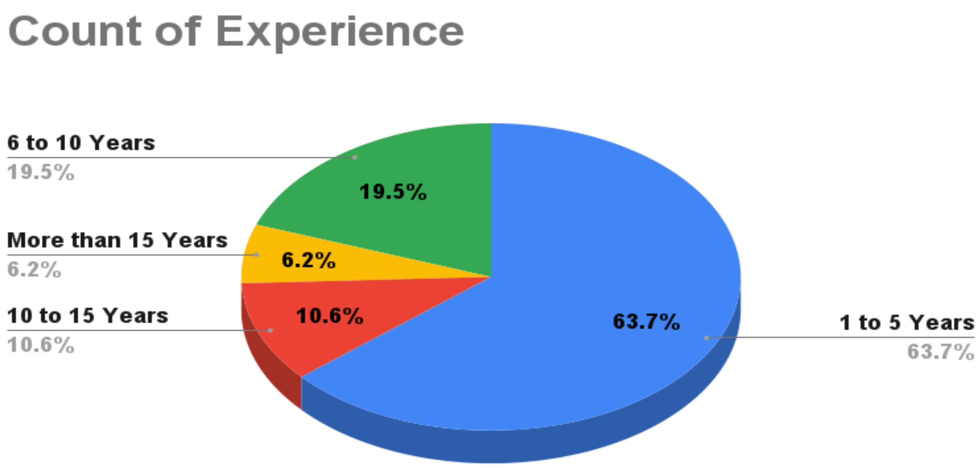

FIGURE 4.3: Count of Experience.

4.4 Data Analysis Results

The following sections present and discuss the analysis findings from the questionnaire survey.

4.4.1 Reliability of the Research

The reliability of the research refers to the consistency and stability of the measurement or data collection process. It assesses the extent to which the research instrument or methodology produces consistent and dependable results over time. Reliability is essential because it ensures that the research findings can be replicated or repeated under similar conditions, enhancing the overall credibility and trustworthiness of the study. Various statistical techniques, such as Cronbach's alpha for internal consistency or test-retest reliability, are often employed to evaluate and establish the reliability of research measures. This statistical test is beneficial when a survey or questionnaire consists of multiple Likert-type questions to form a scale. The purpose of applying Cronbach's alpha was to assess whether the hierarchy created by these questions was reliable and consistent in measuring the intended construct. The reliability analysis allows researchers to assess the stability of their measures over time, ensuring that similar results are obtained when the same measurements are administered on two separate occasions.

(a) Reliability of the Questionnaire

To ensure the questionnaire's validity used in this study, the researchers employed Cronbach's alpha test, widely recognized as a measure of internal consistency. By calculating Cronbach's alpha coefficient, the researchers could determine the extent to which the questions in the scale were correlated and collectively measured the construct of interest. A higher Cronbach's alpha value indicates greater internal consistency among the questions, suggesting that the scale is reliable for measuring the construct. Conversely, a lower Cronbach's alpha value may indicate inconsistencies or weaknesses in the scale. The use of Cronbach's alpha in this study helps to establish the reliability of the questionnaire and enhances confidence in the validity of the research findings. Ensuring that the questions within the scale demonstrate internal consistency increases the likelihood that the data collected accurately reflects the targeted construct and can be replicated in future studies.

(b) Reliability Analysis

The reliability test, also known as Cronbach's alpha test, is a fundamental analysis conducted to verify the reliability of the data. This study summarizes the reliability data obtained from SPSS in Table 4.1. Cronbach's alpha test is a valuable statistical analysis used to evaluate the internal consistency and reliability of the data sets. It assesses the extent to which the questions or items in the dataset are correlated and collectively measures the construct of interest [83]. Statistics are employed to evaluate the reliability test, specifically inter-item consistency. A higher value indicates a more substantial relationship among the test items, while a lower value suggests a weaker connection. Typically, a reliability value between .70 and .99 is considered acceptable. In case study, data obtained a Cronbach's alpha of .987, confirming the consistency of the data. This indicates that the reliability analysis results are reliable, allowing for further research to be conducted with confidence.

Table 4.1: Reliability Statistics of Questionnaire.

Description	**Number**	**Percent**	**Cronbach's Alpha**
Valid	54	100.0	0.987
Excluded	0	0	
Total	54	100.0	

4.4.2 Factor Reduction Analysis

A statistical method known as factor analysis isolates underlying latent variables, also known as factors, from a collection of observed variables. It aims to explain the relationships among a large number of variables by reducing them to lesser numbers of variables. These factors represent these variables' common variance. The purpose of conducting factor analysis in SPSS (Statistical Package for the Social Sciences) is multi-fold. Firstly, it assists in dimensional reduction by identifying the common underlying factors, which simplifies data analysis and makes it more manageable. Factor analysis enables data exploration by uncovering the underlying structure of a data set and revealing the relationships among variables. A statistical method known as factor analysis isolates underlying latent variables, also known as factors, from a collection of observed variables. It aims to explain the relationships among a large number of variables by reducing them to lesser numbers of variables. These factors represent these variables' common variance.

The purpose of conducting factor analysis in SPSS (Statistical Package for the Social Sciences) is multi-fold. Firstly, it assists in dimensional reduction by identifying the common underlying factors, which simplifies data analysis and makes it more manageable. Factor analysis enables data exploration by uncovering the underlying structure of a data set and revealing the relationships among variables.

TABLE 4.2: KMO and Bartlett's Test.

Description	**Value**
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.	.941
Bartlett's Test of Sphericity (Approx. Chi-Square)	7271.402
Bartlett's Test of Sphericity (Df)	1431
Bartlett's Test of Sphericity (Sig.)	.000

The initial eigenvalues for each component, which show how much variance is explained by that component alone, are shown in the "Initial Eigenvalues" column. The column "Extraction Sums of Squared Loadings" displays the variance attributable to each element following extraction. The values in the table, known as factor loadings, indicate the strength and direction of the relationship between each variable and each component. Principal Component Analysis (PCA) is the extraction technique used in this analysis, and Varimax with Kaiser Normalisation is the rotation technique. By maximizing the variance accounted for by each component, the rotation aims to streamline the factor structure and make it simpler and easier to interpret.

TABLE 4.3: Total Variance of Factor Analysis.

Sr No.	**Total**	**Variance %**	**Cumulative %**	**Total**	**Variance %**	**Cumulative %**	**Total**	**Variance %**	**Cumulative %**
1	32.584	60.341	60.341	32.584	60.341	60.341	12.270	22.723	22.723
2	2.462	4.560	64.901	2.462	4.560	64.901	9.537	17.661	40.384
3	2.105	3.899	68.800	2.105	3.899	68.800	9.438	17.477	57.861
4	1.551	2.872	71.672	1.551	2.872	71.672	6.988	12.941	70.802
5	1.255	2.323	73.995	1.255	2.323	73.995	1.724	3.193	73.995

In this case, the process converged after nine iterations. The factor loading in the rotated component matrix can be interpreted as the correlations between the observed variables and the underlying factors. Higher absolute values indicate more robust relationships. The factor reduction analysis process has distilled the original pool of 54 factors into a more streamlined and focused selection of 28 key factors.

TABLE 4.4: Rotated Component Matrix of Factor Analysis.

Factors	**Component**				
	1	**2**	**3**	**4**	**5**
Factor_43	0.736				
Factor_38	0.720				
Factor_40	0.713				
Factor_51	0.677				
Factor_41	0.674				
Factor_54	0.668				
Factor_44	0.667				
Factor_21		0.754			
Factor_26		0.689			
Factor_14		0.683			
Factor_13		0.673			
Factor_18		0.658			
Factor_23		0.653			
Factor_20		0.647			
Factor_10			0.751		
Factor_11			0.744		
Factor_2			0.735		
Factor_5			0.731		
Factor_9			0.731		
Factor_4			0.688		
Factor_3			0.679		
Factor_34				0.649	
Factor_30				0.637	
Factor_31				0.632	
Factor_27				0.608	
Factor_29				0.596	
Factor_28				0.594	
Factor_33				0.574	

These factors have been carefully identified as the most pertinent within the context of the study, allowing for a more in-depth exploration of the underlying dynamics. The resulting 28 factors encompass a wide spectrum of potential influences, each playing a significant role in shaping the outcomes under investigation. After shortlisting the 28 factors, the data was subjected to a reassessment of the Cronbach's alpha value, which was determined to 0.976. This high value indicates a remarkable level of internal consistency within the data set. The selected factors demonstrate strong inter-relatedness and reliability, thereby enhancing the overall robustness of the data. The shortlisted set of 28 factors is further categorized into four main aspects, namely Project Construction Disruption Factors, Execution Obstacles and Underlying Factors, Project Risk Factors, and Cost Overrun Factors.

4.4.3 Factors Correlation Analysis

This study aims to establish relationships between variables using SPSS software. The cross tabs method of descriptive statistics analysis with Chi-square and corrected standard residuals display was employed. Correlation analysis is a statistical technique used to measure and describe the relationship between two or more variables. Correlation analysis primarily uses correlation coefficients, such as the Pearson correlation coefficient, to quantify the relationship between variables [82].

TABLE 4.5: Correlation of Construction Disruption Factors.

		Factor_43	Factor_38	Factor_40	Factor_51	Factor_41	Factor_54	Factor_44
Factor_43	Pearson Correlation	1						
Factor_38	Pearson Correlation	.746**	1					
Factor_40	Pearson Correlation	.796**	.770**	1				
Factor_51	Pearson Correlation	.785**	.757**	.835**	1			
Factor_41	Pearson Correlation	.703**	.717**	.802**	.767**	1		
Factor_54	Pearson Correlation	.734**	.735**	.747**	.704**	.825**	1	
Factor_44	Pearson Correlation	.662**	.641**	.652**	.614**	.691**	.782**	1

The Pearson correlation coefficient, which ranges from -1 to +1, calculates the degree of linear association between two variables. If the correlation coefficient is high, there is a positive linear relationship between the two variables, which means that as one variable rises, the other generally tends to rise. A negative correlation coefficient, on the other hand, denotes a negative linear relationship, where a rise in one variable causes a fall in the other. The variables have no linear relationship, as indicated by a correlation coefficient of 0. Additionally, factor analysis was carried out to isolate a select few factors responsible for the observed variable relationships. The 2-sided Asymptotic Significance, which was derived from Pearson Chi-Square, was used to determine whether there were any relationships between the variables. For Asymptotic Significance values (p-values) less than 0.05, a strong connection was assumed, and a tendency was assumed for values between 0.05 and 0.06. Only tables showing correlations or trends meeting these criteria are presented in this research.

Table 4.6: Correlation of Execution Obstacles and Underlying Factors.

		Factor_21	Factor_26	Factor_14	Factor_13	Factor_18	Factor_23	Factor_20
Factor_21	Pearson Correlation	1						
Factor_26	Pearson Correlation	.634**	1					
Factor_14	Pearson Correlation	.712**	.638**	1				
Factor_13	Pearson Correlation	.663**	.713**	.719**	1			
Factor_18	Pearson Correlation	.722**	.712**	.665**	.656**	1		
Factor_23	Pearson Correlation	.679**	.756**	.654**	.693**	.682**	1	
Factor_20	Pearson Correlation	.642**	.733**	.625**	.618**	.679**	.685**	1

A negative correlation coefficient, on the other hand, denotes a negative linear relationship, where a rise in one variable causes a fall in the other. The variables have no linear relationship, as indicated by a correlation coefficient of 0. Owner's delay in making progress payments exhibits a moderate positive correlation with omissions and errors occurred in quantities bill ($r = 0.722$). Changes in material specifications demonstrates a moderate positive correlation with client's financial difficulties (limited budget) ($r = 0.733$). Skilled labor shortage shows a moderate positive correlation with project budget & inaccurate cost estimation ($r = 0.719$). project budget & inaccurate cost estimation exhibits a moderate positive correlation with delay in land acquisition/handover to the contractor ($r = 0.693$). Omissions and errors occurred in quantities bill demonstrates a moderate positive correlation with client's financial difficulties (limited budget) (r = 0.679). Delay in land acquisition/handover to the contractor shows a moderate positive correlation with client's financial difficulties (limited budget) (r = 0.685). The reported correlations are significant at the 2-tailed 0.01 level, indicating close ties between these variables. These findings imply that the variables are interconnected and that common patterns or influences influence these associations.

Table 4.7: Correlation of Project Risk Factors.

		Factor_10	Factor_11	Factor_2	Factor_5	Factor_9	Factor_4	Factor_3
Factor_10	Pearson Correlation	1						
Factor_11	Pearson Correlation	.791**	1					
Factor_2	Pearson Correlation	.752**	.793**	1				
Factor_5	Pearson Correlation	.703**	.755**	.713**	1			
Factor_9	Pearson Correlation	.783**	.745**	.681**	.688**	1		
Factor_4	Pearson Correlation	.745**	.709**	.670**	.728**	.668**	1	
Factor_3	Pearson Correlation	.756**	.735**	.747**	.734**	.707**	.776**	1

The correlation analysis shows strong and significant relationships among the factors. The Pearson correlation coefficients indicate robust positive associations between the pairs of factors. Severe weather conditions exhibits a strong positive correlation with laws and regulations (r = 0.791), National policy changes (r = 0.752), insufficient design (r = 0.703), unpredictable Ground Conditions (r = 0.783), inadequate Contract management (r = 0.745), and inflation (r = 0.756). Laws and regulations shows a strong positive correlation with national policy changes (r = 0.793), Insufficient design (r = 0.755), unpredictable ground conditions (r = 0.745), Inadequate contract management (r = 0.709), and inflation (r = 0.735). National policy changes demonstrates a strong positive correlation with insufficient design (r = 0.713), unpredictable ground conditions (r = 0.681), inadequate contract management (r = 0.670), and inflation (r = 0.747). Insufficient design exhibits a strong positive correlation with unpredictable ground conditions (r = 0.688), Inadequate contract management (r = 0.728), and inflation (r = 0.734).

Unpredictable ground conditions shows a strong positive correlation with inadequate contract management (r = 0.668) and inflation (r = 0.707). Inadequate contract management demonstrates a strong positive correlation with inflation (r = 0.776). The strength of this relationship indicates a close association between the two variables, where they tend to vary. These correlations are highly significant at the 0.01 level (2-tailed), underscoring these relationships' robust and interconnected nature.

Table 4.8: Correlation of Cost Overrun framework.

		Factor_34	Factor_30	Factor_31	Factor_27	Factor_29	Factor_28	Factor_33
Factor_34	Pearson Correlation	1						
Factor_30	Pearson Correlation	.668**	1					
Factor_31	Pearson Correlation	.771**	.626**	1				
Factor_27	Pearson Correlation	.783**	.584**	.766**	1			
Factor_29	Pearson Correlation	.685**	.539**	.702**	.645**	1		
Factor_28	Pearson Correlation	.745**	.565**	.784**	.745**	.626**	1	
Factor_33	Pearson Correlation	.754**	.666**	.775**	.715**	.735**	.739**	1

Delay in performing inspection and testing exhibits a strong positive correlation with obstacles from government (r = 0.783). Discrepancies between project documents in planning stage shows a strong positive correlation with consultant's rejection of submittals (r = 0.666). Lack of coordination between project's parties exhibits a strong positive correlation with consultant's rejection of submittals (r = 0.775). Discrepancies between project documents in planning stage exhibits a strong positive correlation with consultant's rejection of submittals (r = 0.739).

4.4.4 Normality Analysis

A normality test is a statistical technique to determine whether a given data set follows a normal distribution. A normality test aims to assess whether the data can be assumed to be normally distributed. Normality tests, such as the Shapiro-Wilk test and Kolmogorov-Smirnov test [84]. The purpose was to determine whether the gathered data follows a normal distribution. Kim and Parket [85] have previously established that non-parametric tests are suitable when data does not exhibit a normal distribution.

TABLE 4.9: Normality Test Analysis.

Factors	**Kolmogorov-Smirnova**			**Shapiro-Wilk**		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Factors_43	0.265	113	0.000	0.830	113	0.000
Factors_38	0.294	113	0.000	0.827	113	0.000
Factors_40	0.300	113	0.000	0.807	113	0.000
Factors_51	0.316	113	0.000	0.801	113	0.000
Factors_41	0.286	113	0.000	0.807	113	0.000
Factors_54	0.281	113	0.000	0.813	113	0.000
Factors_44	0.311	113	0.000	0.807	113	0.000
Factors_21	0.274	113	0.000	0.844	113	0.000
Factors_26	0.319	113	0.000	0.821	113	0.000
Factors_14	0.320	113	0.000	0.797	113	0.000
Factors_13	0.262	113	0.000	0.846	113	0.000
Factors_18	0.275	113	0.000	0.850	113	0.000
Factors_23	0.308	113	0.000	0.799	113	0.000
Factors_20	0.316	113	0.000	0.800	113	0.000
Factors_10	0.305	113	0.000	0.815	113	0.000
Factors_11	0.296	113	0.000	0.802	113	0.000
Factors_02	0.325	113	0.000	0.752	113	0.000
Factors_05	0.318	113	0.000	0.801	113	0.000
Factors_09	0.302	113	0.000	0.818	113	0.000
Factors_04	0.314	113	0.000	0.808	113	0.000
Factors_03	0.275	113	0.000	0.729	113	0.000
Factors_34	0.302	113	0.000	0.820	113	0.000
Factors_30	0.302	113	0.000	0.823	113	0.000
Factors_31	0.288	113	0.000	0.799	113	0.000
Factors_27	0.314	113	0.000	0.826	113	0.000
Factors_29	0.251	113	0.000	0.875	113	0.000
Factors_28	0.258	113	0.000	0.861	113	0.000
Factors_33	0.286	113	0.000	0.851	113	0.000

In this reseach, the Kolmogorov-Smirnov test was used, and the normality hypothesis would be rejected if the obtained p-value was equal to or smaller than 0.05. The results presented in Table 4.9 showed that all variables had a significance value of 0.000, indicating a rejection of the normality hypothesis. A small p-value (less than the chosen significance level, typically 0.05) indicates evidence against the null hypothesis of normality. Kolmogorov-Smirnov and Shapiro-Wilk tests, conducted on multiple variables. These tests assess whether the data for each variable follows a normal distribution. For the Kolmogorov-Smirnov test, the statistic and p-value are provided. A small p-value (less than the chosen significance level, typically 0.05) indicates evidence against the null hypothesis of normality. In this case, all the factors have p-values of 0.000, indicating that the data deviates from a normal distribution according to this test. The Kolmogorov-Smirnov normality test results show that all significant values are below the alpha threshold of 0.05, leading to the rejection of the null hypothesis. The skewness of the data indicates the direction of the deviation from normality. In this study, a positively skewed dataset shows that the right tail is longer than the left tail, implying that the distribution's mass is concentrated on the left while the right tail is extended. Consequently, the mean tends to be greater than the median in positively skewed distributions. Understanding the implications of positive skewness is essential for accurate data analysis. In the normality test (Kolmogorov-Smirnov test), the Y-axis represents the frequency, while the X-axis represents the number of participants.

4.4.5 Kruskal Wallis (Non Parametric) Analysis

The normality test indicated that the data did not follow a parametric distribution, so it became crucial to examine the respondents' level of perception. The non-parametric method, called Min-Max scaling, is used for normalizing data. This method is valuable for transforming data into a common scale, allowing for meaningful comparisons and analyses without relying on specific distributional assumptions. The data is transformed to a predefined range, typically between 0 and 1, by using the minimum and maximum values in the dataset. This scaling process ensures that all the values are proportionally adjusted to fit within the specified range, making them directly comparable despite the original distribution shape. A non-parametric statistical test called the Kruskal-Wallis test enables the comparison of numerous related samples. The Kruskal-Wallis test was utilized to determine if the respondents held similar or different perceptions across the identified factors. By analyzing the data using the Kruskal-Wallis test, researchers could examine any potential variations in perception among the respondents and gain insights into the overall level of agreement or disagreement. As indicated by the non-parametric nature of the data according to the normality hypothesis, the Kruskal-Wallis test was employed to examine the level of perception among the respondents. This test, as proposed by Kruskal and Wallis [86], determined whether respondents' views on each indicated component were similar or distinct. The null hypothesis would be rejected if the p-value was less than 0.05.

The Kruskal-Wallis test results show that the respondents' medians are equal, which is the null hypothesis (H0: p *geq* alpha level). When the significance value is higher than 0.05, everyone's opinions on the cost overrun factors are assumed to be similar. The factors listed in the table are likely related to a construction or project management context, and the decision to retain the null hypothesis means there is not enough evidence to reject the idea that these factors have no significant impact on the outcome being studied. It is significant to remember that the null hypothesis typically represents the idea of no effect or difference between groups in statistical analysis. In this instance, the null hypothesis suggests that the factors listed do not significantly affect the outcome being studied. The magnitude of impact (also known as effect size) for each factor is provided, and it ranges from 0.050 to 0.311. Effect size values close to 0 indicate a weak impact, while values closer to 1 suggest a more substantial impact. Since the significance level is set at 0.050, it means that the decision to retain the null hypothesis is made for factors with an asymptotic significance greater than 0.050, stating that the statistical evidence is insufficient to rule out the null hypothesis for these factors [86]. This method is valuable for transforming data into a common scale, allowing for meaningful comparisons and analyses without relying on specific distributional assumptions. Several factors, Laws and Regulations takes precedence with a probability of 0.311, skilled labor shortage possesses a probability of 0.233, project budget & inaccurate cost estimation and inflation follow closely, with probabilities of 0.171 and 0.165 respectively, highlighting their potential substantial influence.

TABLE 4.10: Kruskal Wallis Test Results.

Sr. No	Factors ID	Description	Magnitude of Impact	Decision
1	Factor_43	Accidents on site	0.065	Retain the null hypothesis.
2	Factor_38	Ineffective planning & scheduling	0.061	Retain the null hypothesis.
3	Factor_40	Delay in site mobilization	0.054	Retain the null hypothesis.
4	Factor_51	Delay in delivery of materials	0.094	Retain the null hypothesis.
5	Factor_41	Rework and wastage on site	0.091	Retain the null hypothesis.
6	Factor_54	Ineffective quality control process	0.062	Retain the null hypothesis.
7	Factor_44	Changes in government regulations and laws	0.057	Retain the null hypothesis.
8	Factor_21	Owner's delay in making progress payments for completed works	0.072	Retain the null hypothesis.
9	Factor_26	Changes in material specifications	0.050	Retain the null hypothesis.
10	Factor_14	Skilled Labor Shortage	0.233	Retain the null hypothesis.
11	Factor_13	Project Budget & Inaccurate Cost Estimation	0.171	Retain the null hypothesis.
12	Factor_18	Omissions and Errors in BOQ	0.090	Retain the null hypothesis.
13	Factor_23	Delay in land acquisition	0.136	Retain the null hypothesis.
14	Factor_20	Client's financial difficulties	0.122	Retain the null hypothesis.
15	Factor_10	Severe weather conditions	0.054	Retain the null hypothesis.
16	Factor_11	Laws and Regulations	0.311	Retain the null hypothesis.
17	Factor_2	National Policy Changes	0.089	Retain the null hypothesis.
18	Factor_5	Insufficient design	0.063	Retain the null hypothesis.
19	Factor_9	Unpredictable Ground Conditions	0.097	Retain the null hypothesis.
20	Factor_4.	Inadequate Contract Management	0.077	Retain the null hypothesis.
21	Factor_3	Inflation	0.165	Retain the null hypothesis.
22	Factor_34	Consultant's delay in performing inspection and testing	0.079	Retain the null hypothesis.
23	Factor_30	Designer lack of experience	0.098	Retain the null hypothesis.
24	Factor_31	Lack of coordination between project's parties	0.159	Retain the null hypothesis.
25	Factor_27	Obstacles from government	0.074	Retain the null hypothesis.
26	Factor_29	Inadequate geotechnical investigations report	0.164	Retain the null hypothesis.
27	Factor_28	Discrepancies between project documents in planning stage	0.066	Retain the null hypothesis.
28	Factor_33	Consultant's rejection of submittals	0.096	Retain the null hypothesis.

Several factors, Laws and Regulations takes precedence with a probability of 0.311, skilled labor shortage possesses a probability of 0.233, project budget & inaccurate cost estimation and inflation follow closely, with probabilities of 0.171 and 0.165

respectively, highlighting their potential substantial influence. Lastly, lack of coordination between project's parties is also prominent with a probability of 0.159. Delay in land acquisition stands out with a probability of 0.136. Client's financial difficulties follows closely with a probability of 0.122. Furthermore, national policy changes and unpredictable ground conditions each hold probabilities of 0.089 and 0.097, respectively, signifying their moderate potential impact. Similarly, discrepancies between project documents in planning stage possesses a probability of 0.096, emphasizing the need for comprehensive planning. Lastly, rework and wastage on site, due to errors or quality of work possesses a probability of 0.091, indicating a minor influence. inadequate contract management, owner's delay in making progress payments for completed works, Insufficient design, and Consultant's delay in performing inspection and testing, and giving instructions all exhibit probabilities ranging from 0.063 to 0.079, suggesting that these factors have limited impact.

4.4.6 Structure Equation Modeling (SEM)

AMOS provides several analysis options, including structural equation modeling (SEM), confirmatory factor analysis (CFA), multi group confirmatory factor analysis (MGCFA), means and covariance structure analysis (MACS), and path analysis, which allow researchers to test the measurement properties of latent constructs and examine the direct and indirect effects of variables, respectively. It also enables researchers to assess mediation and moderation effects, perform multi-group analyses, and conduct model comparisons. In this research work a statistical method called structural equation modeling (SEM) examines intricate connections between observed variables and latent constructs. By estimating and analyzing the direct and indirect relationships between variables, SEM enables the testing and improvement of theoretical models. An easy-to-use interface is provided by IBM's AMOS (Analysis of Moment Structures) software package for performing SEM. In SEM, variables are classified as either observed or latent. Observed variables can be measured directly, whereas latent variables must be inferred from observed variables based on their interactions. The relationships between observed and latent variables are represented by paths or arrows in the model. These equations represent the hypothesized relationships between variables. Several fit indices, including chi-square, comparative fit index (CFI), and root mean square error of approximation (RMSEA), are used to assess the model's goodness of fit. Structural Equation Modeling (SEM) involves four main key factors: Construction disruption, Execution obstacles and underlying, Project risk and Cost overrun factors.

(a) Construction Disruption Factors

The Construction Disruption encompasses several critical factors that can significantly impede the progress and efficiency of building projects. These components encompass a range of challenges that, if not properly addressed, can lead to delays, increased costs, and compromised project outcomes. Accidents on site pose a substantial threat to both the safety of workers and the timely completion of building projects. They can result in injuries, fatalities, and damage to equipment, causing disruptions and necessitating additional resources to rectify the situation.

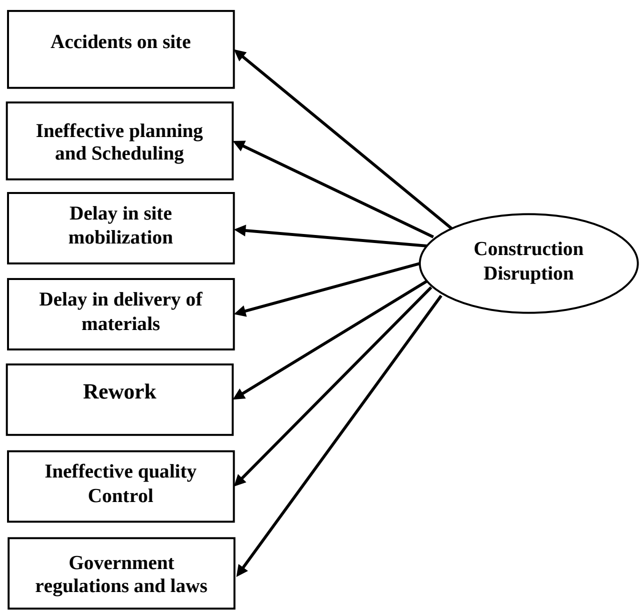

Figure 4.4: Framework of Construction Disruption Factors.

Delays in site mobilization and the delivery of essential materials can hinder the initiation and progression of work. These delays can cascade through the project timeline, causing a ripple effect of inefficiencies and setbacks. Rework, arising from inadequate workmanship or design flaws, demands additional time and resources to rectify errors. This not only disrupts the project's flow but can also lead to increased costs and diminished quality. Ineffective quality control processes can result in rework, requiring corrective actions and re-evaluation. This can lead to project interruptions and a diminished reputation for delivering reliable and high-quality construction outcomes. Government regulations and laws introduce an additional layer of complexity. Non-compliance or unexpected regulatory requirements can lead to project stoppages, modifications, or legal disputes, causing disruptions that can impact both timelines and budgets.

(b) Execution Obstacles and Underlying Factors

A spectrum of critical elements comes to the fore, each of which can pose significant hurdles to the successful implementation of building projects. These factors encompass a range of complexities that, if not managed adeptly, can lead to cost overrun. Payment delays, a prominent challenge, can impede the smooth progression of construction endeavors. When payments are not disbursed in a timely manner, the availability of funds for necessary resources, labor, and materials becomes compromised, potentially causing work slowdowns or stoppages. Change specifications, while sometimes necessary for project adaptation, can introduce uncertainties and modifications that alter the course of construction. The scarcity of skilled labor is a persistent challenge in the construction industry. Shortages in qualified workers can hinder progress, as the available workforce might lack the expertise required for specialized tasks, leading to project delays and potential compromises in quality. Inaccurate cost estimation can lead to significant financial discrepancies during project execution. When initial estimates do not align with actual costs, construction projects may face budget overruns. Errors and omissions in the Bill of Quantities (BOQ) can lead to confusion and discrepancies in project materials and costs. These inaccuracies can lead to delays and disputes as adjustments and clarifications are sought to rectify the discrepancies. Delays in land acquisition can stall construction progress, particularly in cases where land rights, permits, or legal requirements are not secured in a timely manner. Operating within a limited budget can constrain decision-making and resource allocation. The challenge of managing project components while adhering to a tight budget necessitates careful planning and strategic prioritization to achieve project goals without compromising quality or timelines.

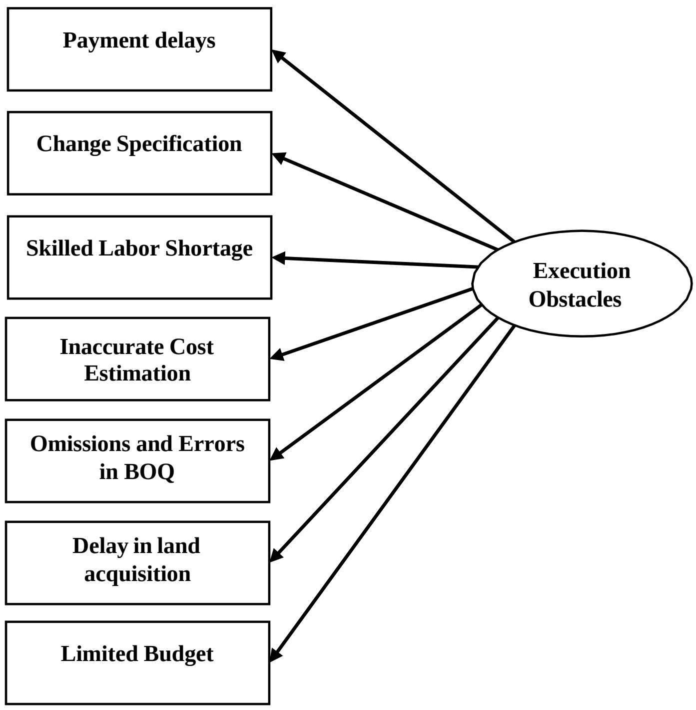

FIGURE 4.5: Framework of Execution Obstacles and Underlying Factors.

(c) Project Risk Factors

Extreme weather events, such as hurricanes, floods, or heavy snowfall, have the capacity to impede progress and necessitate resource-intensive recovery efforts. Navigating laws and regulations is a complex challenge that demands meticulous attention. The dynamics of national policies hold the potential to alter project landscapes. Insufficient design, though avoidable through meticulous planning, presents a risk that can lead to rework, delays, and additional costs. Designs that lack thoroughness or clarity may result in construction challenges that only become apparent during execution, leading to the need for adjustments that can impact project timelines and budgets. Unpredictable ground conditions pose a formidable risk, particularly in building projects where subsurface conditions are a critical factor. Discovering unexpected challenges beneath the surface, such as unstable soil or hidden obstacles, can lead to unanticipated delays and resource-intensive mitigation efforts. Inadequate contract management can undermine project success. Poorly defined contracts, lack of clarity on responsibilities, or inadequate communication among stakeholders can lead to disputes, delays, and even project termination. The specter of inflation adds yet another layer of risk. Fluctuations in economic conditions can impact material costs, labor rates, and overall project expenses. Failure to account for inflation can strain budgets and compromise project feasibility.

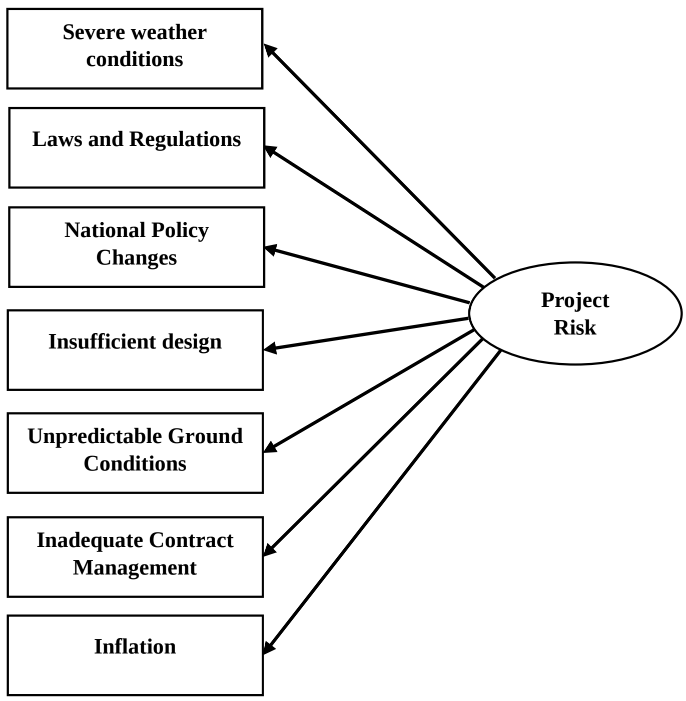

FIGURE 4.6: Framework of Project Risk Factors.

(d) Framework of Cost Overrun Factors

A comprehensive framework emerges, encompassing critical components that have the potential to drive construction projects beyond their initially estimated budgets. These factors collectively underscore the multifaceted nature of cost overruns and the need for proactive management to mitigate their impact. Consultant's delay in inspection introduces a layer of uncertainty that can lead to project delays and subsequent cost increases. Designer's lack of experience can contribute to design inefficiencies and oversights that may manifest during construction. Lack of coordination among project stakeholders can amplify the risk of cost overruns. Obstacles from government authorities or regulatory bodies can introduce unexpected challenges that impact project costs. Geotechnical investigations hold significant importance, as they influence foundation design and construction methodologies. Discrepancies between project documents, including architectural and engineering plans, can result in conflicts and misunderstandings during construction. Consultant's rejection of submittals can hinder project progress and inflate costs.

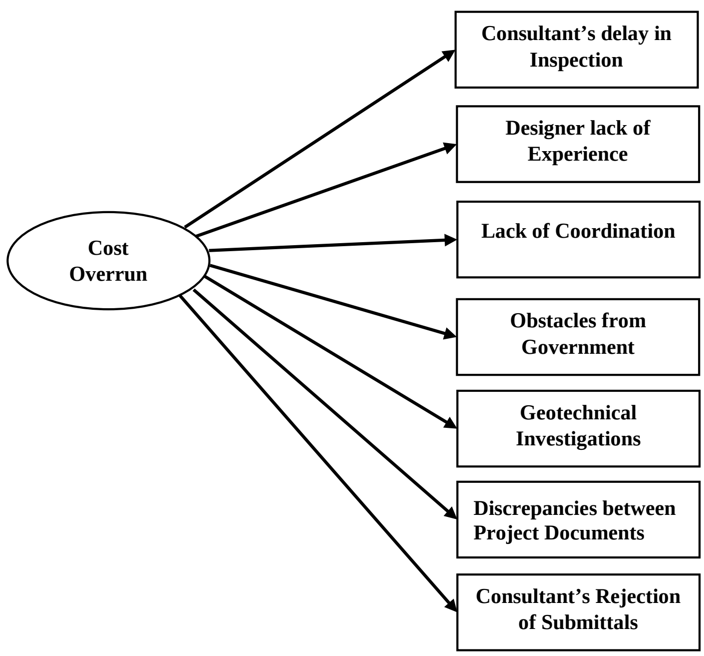

FIGURE 4.7: Framework of Cost Overruns Factors.

A cost overrun framework has been developed based on four key aspects: Construction disruption, Execution obstacles and underlying, Project risk and Cost overrun. Through SPSS factorial analysis, various factors within each aspect were identified and further categorized. These factors demonstrate interdependencies and can positively and negatively impact overall cost overruns in building projects. The framework aims to evaluate the relationship between these factors and their impact on the building construction sector in Pakistan. By considering the specific components within each aspect, this framework provides a comprehensive understanding of the factors influencing cost overruns in building projects. The analysis helps identify potential improvement areas, mitigate risks, and enhance project performance by addressing the underlying factors contributing to cost overruns. Ultimately, the framework offers valuable insights for stakeholders in the building construction sector to manage costs better and improve project outcomes.

Cost overruns in construction projects can arise due to various interrelated factors. The 54 shortlisted factors were subsequently reduced to 28 factors using factor reduction analysis. These 28 factors were further categorized into four main aspects. Correlation analysis was employed to determine the relationships between the variables. Normality analysis revealed that the data did not follow a normal distribution, leading to the use of non-parametric tests based on the normality test results. The top factors include inflation, contractual claims, changes orders during construction, unforeseen site conditions, improper planning, design mistakes, lack of contractor experience, errors and omissions in BOQ, inaccurate cost estimation, and lack of resources. Each of these factors, either independently or in combination, has the potential to significantly impact the financial viability of projects. The top 10 factors, listed in sequence, are as follows: inflation (0.98), contractual claims (0.96), changes orders during construction (0.95), unforeseen site conditions (0.95), improper planning (0.94), design mistakes (0.94), lack of contractor experience (0.94), Non BOQ items (0.93), inaccurate cost estimation (0.92), and lack of resources (0.92). These factors have been prioritized based on their ranking in a comprehensive ranking system, enabling decision-makers to address critical factors before the construction stage to avoid the impact of cost overruns. This comprehensive ranking system enables a focused approach to address the critical factors, ensuring proactive measures are in place to mitigate the risk of cost overruns and foster successful project execution.

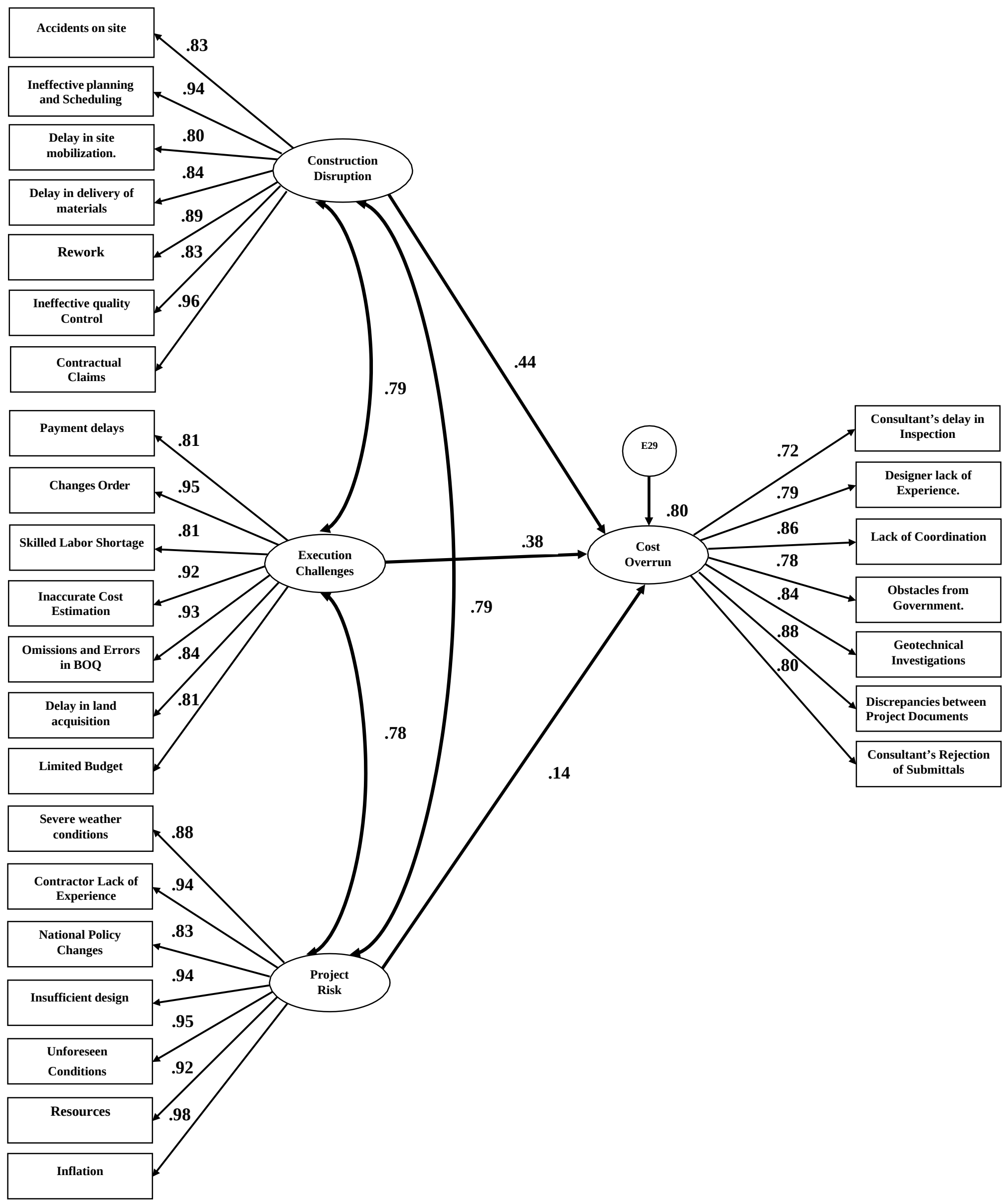

FIGURE 4.8: Combined Framework of Critical Factors.

The Cost Overrun Indicators Framework is built on analyzing three key aspects: Construction Disruptions, Execution Challenges, and Project Risks. A comprehensive cost overrun indicators framework has been developed to gain a deeper understanding and effectively address cost overrun. Effective implementation of swift modifications led to improved project adaptability, stakeholder satisfaction, and timely delivery despite evolving project dynamics. The framework considers various aspects, including the interplay between construction disruptions, execution challenges, and project risks. The framework aims to identify and track indicators that can signal potential cost overruns in building projects. Before finalizing the cost overrun indicators framework, thorough content and construct validity checks were conducted to ensure its accuracy and effectiveness. The refined version of the framework, shown in Figure 4.5, represents the culmination of these efforts and provides a comprehensive tool to assess and manage cost overrun risks in building projects. Structural equation modeling was used to finalize the most critical factors leading to cost overruns in building projects.

(e) Null Hypothesis

The null hypothesis, often denoted as "H0," is a fundamental concept in statistical hypothesis testing. It is a statement that suggests that there is no significant effect or relationship between variables or no difference between groups. It proposes that any observed differences or effects are purely due to chance or random variation. The value of "0.9" is determined based on the understanding that factors approaching a value of 1 signify the most significant factors. This standard is set to emphasize the prioritization of factors that hold considerable weight and influence in the context of the cost overrun. The selection of criteria such as 0.9, 0.8, and 0.7 often serves to categorize and distinguish the performance levels of individuals in a structured manner. This framework facilitates a clearer understanding of the variations in performance and aids in the differentiation of high, medium, and average levels of cost overrun. The results of the hypothesis testing reveal intriguing insights into the relationships among various critical factors leading to cost overrun. Each hypothesis provides valuable understanding regarding how these factors interact and potentially influence one another. This finding indicates that while there is a positive relationship between project risk and cost overruns, the influence of project risk on cost overruns might be less pronounced compared to other factors.

Table 4.11: Null Hypothesis Results.

Sr. No	Hypothesis	Relationship	Significance	Decision
1	H1	Construction Disruption ↔ Execution Challenges	0.79 (+)	Accepted
2	H2	Construction Disruption ↔ Project Risk	0.79 (+)	Accepted
3	H3	Execution Challenges ↔ Project Risk	0.78 (+)	Accepted
4	H4	Construction Disruption → Cost Overrun	0.44 (+)	Accepted
5	H5	Execution Challenges → Cost Overrun	0.38 (+)	Accepted
6	H6	Project Risk → Cost Overrun	0.14 (+)	Accepted

In the first hypothesis (H1), a significant positive relationship is identified between Construction Disruption and Execution Challenges, with a coefficient of 0.79. This suggests that when disruptions occur during construction, there is a corresponding increase in the challenges faced during project execution. Hypothesis (H2) delves into the relationship between Construction Disruption and Project Risk, revealing a substantial positive correlation of 0.79. The third hypothesis (H3) explores the connection between Execution Challenges and Project Risk, yielding a noteworthy coefficient of 0.78. Fourth hypothesis (H4), which examines the impact of Construction Disruption on Cost Overrun, a moderate positive relationship is observed with a coefficient of 0.44. This indicates that disruptions during construction have a discernible but somewhat less influential role in contributing to cost overruns in projects. While disruptions can lead to increased costs, their direct impact on cost overruns might be influenced by other factors. The fifth hypothesis (H5), focusing on the relationship between Execution Challenges and Cost Overrun, a coefficient of 0.38 signifies a positive connection. This implies that challenges encountered during project execution have a moderate influence on the occurrence of cost overruns. Execution challenges, such as delays or coordination issues, can contribute to higher project costs. Lastly, Hypothesis (H6) investigates the connection between Project Risk and Cost Overrun, revealing a relatively low positive correlation with a coefficient of 0.14.

(f) Model Fit

The model fit indices provide essential insights into the adequacy of the statistical model used in the analysis. The Chi-sq value of 539.751 suggests a reasonably good fit between the model and the observed data. The value of the RMR (Root Mean Square Residual) is 0.071, representing the average discrepancy between the observed data and the model's predicted values.

Table 4.12: Structural Equation Modeling Results.

Sr. No	Description	Value
1	CMIN (Chi-Sqaure Value)	539.751
2	DF (Degree of Freedom)	344
3	RMR (Root Mean Square Residual)	0.061
4	GFI (Goodness of Fit Index)	0.764
5	CFI (Comparative Fit Index)	0.937
6	RMSEA (Root Mean Square Error Adjusted)	0.071

A smaller RMR indicates a better fit. The GFI (Goodness of Fit Index) is 0.764. The CFI (Comparative Fit Index) is 0.937, which compares the model's fit with an independent model, representing a good model fit. A CFI value close to 1 indicates a good fit, and the obtained value of 0.937 is quite close to 1, showing a favorable fit of the model, and the RMSEA (Root Mean Square Error Adjusted) is 0.071. A lower RMSEA value suggests a better fit, and the obtained value of 0.071 indicates a good fit for the model. The model fit indices collectively offer that the statistical model fits the data well. The Chi-sq, DF, RMR, GFI, CFI, and RMSEA values all point towards a favorable fit, suggesting that the model reasonably represents the observed data.

4.5 Summary

The background section provided an overview of the research context, highlighting the motivation and objectives of the study. A significant factor in assessing the study's validity was the response rate achieved. The response rate refers to the percentage of participants who provided valid responses, indicating their engagement and cooperation with the research. The characteristics of the respondents from the construction industry were examined, including demographic information and professional profiles. These details provided a comprehensive understanding of the sample group. The analysis results section presented the findings obtained from the collected data. Various sub-sections were explored within the broader study of the research's reliability. The questionnaire's reliability was assessed in the study to ensure consistency and accuracy in measuring the intended constructs. The internal surface of the research tool was evaluated using reliability analysis techniques, further demonstrating the validity of the data. Factor analysis was utilized to identify underlying dimensions or factors within the observed variables, helping uncover latent influences in the building projects. The research's relationships between various variables were examined using correlation analysis, which shed light on the nature and strength of those relationships. Additionally, normality tests were performed to determine whether the data were distributed normally, ensuring the suitability of statistical analysis methods. Non-parametric tests were employed to analyze data that did not meet the assumptions of normality or had ordinal variables. Structural equation modeling (SEM) was used as a comprehensive analytical framework to assess complex relationships and test theoretical models in building projects. SEM allowed for examining direct and indirect effects between variables, providing a deeper understanding of the structural relationships within the research model. The reliability of the research process and the questionnaire were established through rigorous evaluation. Various statistical techniques, such as factor reduction analysis, correlation analysis, normality tests, non-parametric tests, and SEM, were applied to uncover meaningful insights and relationships within the data. These analysis results contribute to a more comprehensive understanding of the research topic and provide a foundation for future studies in the building projects. Inaccurate cost estimation, improper planning, inflation, inflation in fuel costs, design changes, unforeseen site conditions, errors and omissions in BOQ, design mistakes, contractual claims, lack of contractor experience, change orders, project rework, material procurement delays, on-site wastage, contractor inexperience, and inadequate project coordination and payment delays, force majeure, and lack of resources are the leading factors of cost overruns in building projects.

Chapter 5

Guidelines for Practical Implementations

5.1 Background

The analysis of the results provides an overall examination of critical cost overrun factors in building projects. These results are based on identified factors, which may differ based on circumstances such as the nature and location of the project. The factors were selected through a process that involved frequency analysis and shortlisting based on a literature study. The selection process was further refined using the Delphi technique. Once the responses were collected from the target audience, the validity of the responses was checked, along with the qualifications of the respondents, their organizations, and their experience. The influence of independent variables on the dependent variables was examined using factor reduction analysis. Frequency analysis was used to determine the number of occurrences for each selected factor chosen by the respondents. This research used correlation analysis to establish the type of correlation between variables. A normality test was also performed to see if the data had a normal distribution. Based on the data distribution, either parametric or non-parametric tests were applied. Subsequently, a structural equation modeling (SEM) model was constructed using Amos Software. Practical guidelines for implementation were developed in this chapter. The study provides guidelines at both stakeholder levels to minimize the effects of cost overruns in building projects.

5.2 Project Management Guidelines

Project management guidelines provide a structured approach for planning, executing, and monitoring projects. Practical implementations of these guidelines help to ensure project success within estimated budget. These guidelines are subdivided into three critical aspects: Contractor Level, Consultant Level, and Client Level, tailored to the specific responsibilities of each stakeholder. Adherence to these guidelines ensures a streamlined project workflow and contributes to successful project outcomes..

5.2.1 Guidelines at Client Level

• The client should ensure that thorough and detailed project requirements are

communicated to the consultant at the start of design stage and avoid any unnecessary changes particularly during construction stage.

• It is responsibility of the client to check the working capacity of the contractor

at bid evaluation stages. If the contractor is not resourceful then work should not be awarded to such contractor but if the contractor does not mobilize sufficient or agreed resources then contractor would be responsible for any cost overrun encountered in the completion and the client may reimburse liquidated damages from the contractor.

• Inflation is generally borne by the client in the form of price adjustment. The price adjustment formula of either FIDIC or Pakistan Engineering Council is adopted in Pakistan to optimize the impact of cost overrun.

• The client should pay the contractual claims only after Engineer's determination.

5.2.2 Guidelines at Consultant Level

• The consultant should verify the working capacity of the contractor at prequalification and bid evaluation stages. Selecting an inexperienced contractor can result in cost overrun, delayed completion and poor quality of the works.

The evaluation of price adjustment is done by the consultant based on the work done for four items i.e., Cement, steel fuel and labor. Further elaboration is done in the particular conditions of the contract.

• Cost estimation is generally done by the design consultant at the design stage. The design consultant is supposed to calculate the estimates within 15% bracket otherwise the contractor may submit claim for additional overheads or loss in overheads if the total cost varies more than 15%.

• Generally, the design and supervision consultants are same on majority of the projects however the design consultant has to indemnify the Employer/client for the assigned design. The client should get third party's review of the design to eliminate any apprehension or likelihood chance of design failure.

• The contractual claims are determined by the Engineer/ Consultant provided that all the prerequisites are fulfilled by the contractor like timely notification. There are generally two types of claims i.e., time extension and/or additional cost for any additional work etc.

5.2.3 Guidelines at Contractor Level

• Contractor is entitled to be paid the effect of inflation only for the stipulated duration of the contract. However, if the delay in project is determined on part of the contactor, then no inflation is paid to the contractor.

• It is contractor's obligation to conduct a preliminary site visit before tendering and the client provides soil investigation report to the contractor also. If the actual site conditions vary from the provided data, then contractor either may refuse to execute the work or may claim additional cost whichever agreed between both the parties.

• The contractor is supposed to execute all the on BOQ items which are shown in the construction drawings i.e., the constituent items of a BOQ items are not payable separately. However, if the client assigns any additional work after award stage would be deemed as Variation Order.

• Improper planning can cause delayed completion of the projects and under such conditions the client may claim liquidated damages from the contractor.

• Timely notification and submission of contemporary records is responsibility of the contractor to win any claim.

5.3 Summary

The study provides practical guidelines to minimize the impact of cost overruns at different stakeholder levels. At the client level, owners are advised to review and revise bid documents, assess contractor capabilities, and facilitate timely payments to contractors. These measures enhance project understanding, contractor selection, and smooth project execution. The contractor level emphasizes purchasing materials early, monitoring quality, employing qualified technical staff, implementing effective documentation systems, ensuring adequate financial resources, and minimizing waste. The involvement of a dedicated cost engineer is recommended to control costs throughout the project. Consultants are encouraged to thoroughly review and approve design documents, hire qualified staff, demonstrate flexibility in evaluating contractor works, prioritize design costs through multi-criteria analysis, implement cost reduction measures, and ensure the project scope encompasses all necessary work. The guidelines aim to address critical cost overrun factors and improve project outcomes by enhancing project understanding, effective contractor selection, efficient resource management, and proactive cost control techniques.

Chapter 6

Conclusion and Future Work

6.1 Conclusion

The research aimed to improve cost management practices in building projects by identifying the critical factors contributing to cost overruns and developing efficient management strategies for these factors. In this study, Structural Equation Modeling (SEM) was used to identify the critical factors leading to cost overruns in building projects. This study has helped in developing strategies to minimize the impact of cost overruns in building projects, ultimately improving the successful completion of projects within limited time frame and budget. This study identifies various factors causing cost overruns and uses frequency analysis to pinpoint the most significant ones in construction projects. A literature review is conducted to ascertain the critical factors contributing to cost overruns in building projects. The Likert scale captures respondent's agreement or disagreement intensity with statements. Data analysis involves reliability analysis, factor reduction analysis, correlation analysis, normality analysis, as well as parametric and non-parametric tests. Amos is utilized for modeling. By using structural equation modeling to identify the critical factors influencing cost overruns in building projects, gain a comprehensive understanding of various factors within the construction process are interconnected and impacted. This analytical approach acts as a powerful tool, multifaceted aspects inherent in construction endeavors. Stakeholders can make more well-informed decisions, backed by a nuanced comprehension of the factors. Moreover, the insights derived from this method offer practical guidance for implementing effective strategies in the management of construction projects, fostering better control over costs and overall project outcomes. According to demographic research, most respondents were affiliated with contractor firms (45.1%). Most respondents (47.8%) held a bachelor's degree, and the majority (63.7%) had 1-5 years of experience. Based on the findings, the following are the conclusions:

- Respondents identified the following top ten factors that contributing to cost overruns in building projects i.e inaccurate cost estimation, improper planning, inflation, unforeseen site conditions, errors and omissions in BOQ, design mistakes, contractual claims, lack of contractor experience, change orders and lack of resources.

- In Rawalpindi and Islamabad, major causes of cost overruns are market price fluctuations and inflation in fuel costs, design changes, poor planning, uncertain site conditions, inaccurate cost estimates, project rework, payment delays, material procurement delays, on-site wastage, contractor inexperience, and inadequate project coordination. These factors are consistently cited as key contributors to construction cost overruns in the region.

- Reducing the impact of cost overruns, focus on an accurate cost estimation, thorough project planning, risk management, streamlined design processes, clear contract management, collaborative stakeholder communication, and careful contractor selection. Implement robust project monitoring, resource allocation, and procurement management. Learn from past projects and leverage evolving technologies. Proactive actions during early stages can minimize future construction cost overruns. Establishing a dependable project budget involves detailed cost estimation based on input from professionals, historical data, and feasibility studies. Clear project scope definition and a comprehensive cost breakdown structure ensure accurate allocation. Including a well-calculated contingency, validated by experts, addresses unforeseen risks. Bench-marking against industry standards enhances reliability. Value engineering and consistent expense monitoring optimize costs. These processes instill owner confidence in budget reliability for on-budget project delivery.

6.2 Future Work

There are several avenues for further research and improvement in cost management practices within construction sector. The study proposes several recommendations for future work.

• This study focuses on building projects, specifically within Islamabad and Rawalpindi. However, a similar analysis can be conducted in a broader context, encompassing multiple regions, to obtain a more comprehensive range of insights and findings.

• One potential area of exploration is the integration of advanced technologies, such as Building Information Modeling (BIM) and artificial intelligence, into cost estimation and project planning processes. These technologies have the potential to enhance accuracy and predictability in cost projections. Additionally, conducting comparative studies across different regions or countries could provide valuable insights into how local factors influence cost overruns and which strategies are most effective in various contexts.

• Future research opportunities exist to investigate the effects of cost overruns on construction sector involving highways, bridges, high rise buildings, power plants, airports, hydro-power projects, Infrastructure Projects, and tunnels. This can be done by modifying the identified factors.

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Annexure A (Shortlisted Factors)

Shortlisted Factors of Cost Overrun

Sr. No	Factors No.	Description	Sr. No	Factors No.	Description
1	Factor_1	Market Price Changes, Inflation of prices in petrol and diesel	28	Factor_28	Discrepancies between project documents in planning stage
2	Factor_2	National Policy Changes	29	Factor_29	Inadequate geotechnical investigations report
3	Factor_3	Inflation	30	Factor_30	Designer lack of experience
4	Factor_4	Inadequate Contract Management	31	Factor_31	Lack of coordination between project's parties
5	Factor_5	Insufficient design	32	Factor_32	Deficient tender documentation
6	Factor_6	Inadequate Project Schedule Management	33	Factor_33	Consultant's rejection of submittals
7	Factor_7	Inadequate Planning	34	Factor_34	Delay in performing inspection and testing
8	Factor_8	Project Location Limitation	35	Factor_35	Existing underground utilities
9	Factor_9	Unpredictable Ground Conditions	36	Factor_36	Inadequate contractor experience
10	Factor_10	Severe weather conditions	37	Factor_37	Contractor's financial difficulties
11	Factor_11	Laws and Regulations	38	Factor_38	Ineffective planning and scheduling
12	Factor_12	Payment Delay	39	Factor_39	Delays in sub-contractors' work or caused by suppliers
13	Factor_13	Project Budget & Inaccurate Cost Estimation	40	Factor_40	Delay in site mobilization
14	Factor_14	Skilled Labor Shortage	41	Factor_41	Rework and wastage on site, due to errors or quality of work
15	Factor_15	Delay In Drawing Approval	42	Factor_42	The contractor does not carry out a field visit to the site during the bidding process
16	Factor_16	Project Rework	43	Factor_43	Accidents on site
17	Factor_17	The Owner Asked for Additional Works	44	Factor_44	Changes in government regulations and laws
18	Factor_18	Omissions And Errors Occurred in Quantities Bill	45	Factor_45	Involvement of external parties/stakeholders
19	Factor_19	Lack of communication with stakeholders	46	Factor_46	Lack of communication with stakeholders
20	Factor_20	Client's financial difficulties (Limited Budget)	47	Factor_47	Shortage of available skilled and non-skilled labor.
21	Factor_21	Owner's delay in making progress payments	48	Factor_48	Lack of attracting skillful technicians for work
22	Factor_22	Delays due to dispute resolution	49	Factor_49	Labor strikes
23	Factor_23	Delay in land acquisition/Handover to the contractor	50	Factor_50	Inadequate material procurement due to the unavailability of materials
24	Factor_24	Change orders during construction	51	Factor_51	Delay in delivery of materials
25	Factor_25	Premature tender documents	52	Factor_52	Complexity of procurement processes
26	Factor_26	Changes in material specifications	53	Factor_53	Damage to material in storage/at site
27	Factor_27	Obstacles from government.	54	Factor_54	Ineffective quality control process (Rejecting materials)

Annexure B (Questionnaire)

Questionnaire

Dear Respondent

I am Muhammad Hamza Zahoor, a postgraduate student from Capital University of Science and Technology (CUST) in Islamabad. I'm conducting a research project focused on **Identifying Critical Factors Leading to cost overrun in building projects using structural equation modeling.**

This research aims to reduce the impact of cost overruns in construction projects by identifying the factors that cause cost overruns, namely poor planning, inaccurate cost estimation, high resource cost etc. For further ranking the critical factors this questionnaire survey has been done. I am a post-graduate student in the field of Construction Engineering & Management. If you require any additional information or have any questions, don't hesitate to contact me through my email. I would be happy to provide any further details you may need

Yours Sincerely,

Muhammad Hamza Zahoor

Email: hamza.malik40755@gmail.com

MS Research Scholar,

Department of Civil Engineering,

Capital University Science and Technology, Islamabad.

Section 1: Demographic Data

Type	Description
Qualification	1 (Bachelor in Civil Engineering) 2 (MS in Civil Engineering), 3 (PhD in Civil Engineering), 4 (MS in Project Management)
Organization Type	1 (Client), 2 (Consultant), 3 (Contractor), 4 (Others)
Designation	1 (Project Manager), 2 (Resident Engineer), 3 (Assistant of Resident Engineer), 4 (Construction Manager), 5 (Planning Engineer), 6 (Project Engineer), 7 (Site Engineer), 8 (Others)
Experience	1 (1 to 5 Years), 2 (6 to 10 Years), 3 (10 to 15 Years), 4 (More than 15 Years)

Section 2: Project Management

According to your knowledge, respond the following project management factors in terms of their importance for cost overrun in building projects. Please indicate your level of agreement with the following statements using a scale of 1 to 5, where: **1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree**. Please tick (√) the appropriate box for each statement.

Sr. No	Description	Impact				
1	Changes in petrol and diesel prices affect transportation costs	1	2	3	4	5
2	Recent national policy changes impact the construction industry	1	2	3	4	5
3	Inflation has contributed to financial changes alot	1	2	3	4	5
4	Role of parties involved in a contract and awareness of their responsibilities and obligations impacts cost	1	2	3	4	5
5	The involvement of stakeholders in the systematic design change process impacting the project objective	1	2	3	4	5
6	An accurate and realistic project schedule leads to cost overrun	1	2	3	4	5
7	The consequences of inadequate planning on cost overrun	1	2	3	4	5
8	The project location impacting the cost overrun	1	2	3	4	5
9	Unpredictable ground conditions affecting the planned activities	1	2	3	4	5
10	Severe weather conditions and their potential impacts on projects	1	2	3	4	5
11	Impact of govt policies/regulations on the project implementation	1	2	3	4	5

Section 3: Client

According to your knowledge, respond the following client-related factors in terms of their importance for cost overrun in building projects.

Sr. No	Description	Impact				
1	Payment delays from clients causing cost overruns	1	2	3	4	5
2	The impact of project budget and cost estimate	1	2	3	4	5
3	The shortage of skilled labour cause cost overrun	1	2	3	4	5
4	Delays in approval for project drawings contributing to cost overrun	1	2	3	4	5
5	Project rework strategies and identification of potential improvements for project success	1	2	3	4	5
6	Additional works impacting project timelines and costs	1	2	3	4	5
7	Verification and validation process of accuracy BOQs on the project	1	2	3	4	5
8	Communication issues relevant to project requirements with clients	1	2	3	4	5
9	Financial difficulties of client causing termination of the project	1	2	3	4	5
10	Owner's delay in making progress payment for completed works	1	2	3	4	5
11	The project delays requiring dispute resolution	1	2	3	4	5
12	Delays in land acquisition or handover to the contractor affecting the project timelines	1	2	3	4	5
13	Change orders impacting project timelines and budgets	1	2	3	4	5
14	Bid process on premature tender documents	1	2	3	4	5
15	Modification in quality standards, specifications	1	2	3	4	5

Section 4: Designer and Consultant

According to your knowledge, respond the following designer and consultant related factors in terms of their importance for cost overrun in a building project.

Sr. No	Description	Impact				
1	Impact of government policies and regulations on managing inflationary pressures in construction project outcomes	1	2	3	4	5
2	Practical strategies to prevent or minimize discrepancies between project documents during the planning and design phase	1	2	3	4	5
3	Impact of geotechnical investigation to assess ground conditions	1	2	3	4	5
4	The designer's lack of experience has affecting the project's quality	1	2	3	4	5
5	Effective coordination between project parties	1	2	3	4	5
6	The importance of complete and accurate tender documentation	1	2	3	4	5
7	Effective management submittal review, approval process, and communication with consultants	1	2	3	4	5
8	Project delays caused by consultant's attitude in inspections, tests, and instructions	1	2	3	4	5

Section 5: Contractor

According to your knowledge, respond the following Contractor related factors in terms of their importance for cost overrun in building projects.

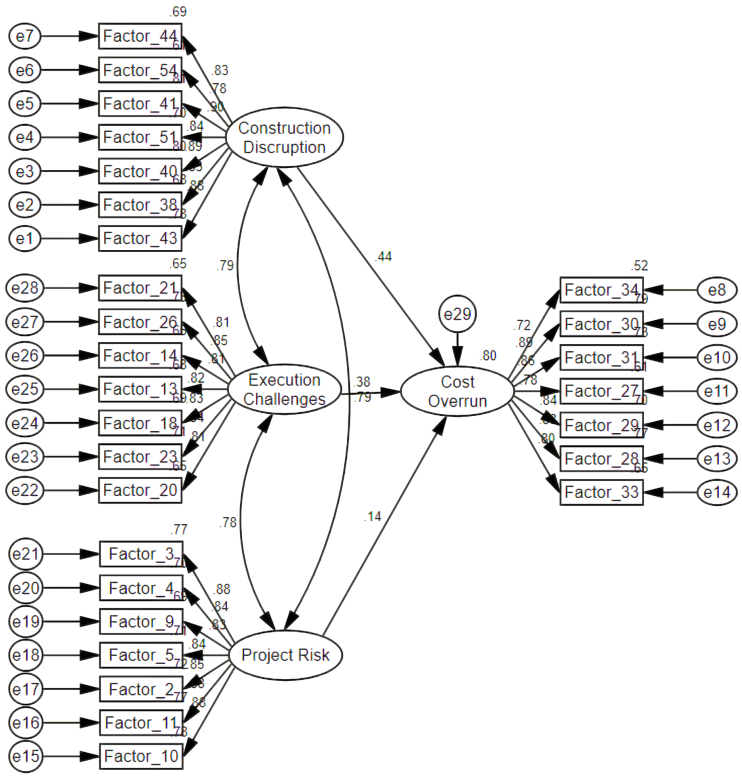
Sr. No	Description	Impact				
1	Unexpected underground utilities not encountered in design docs (e.g. live cables, pipelines) contributing to delays	1	2	3	4	5
2	The positive impact of the contractor's experience and managerial skills on the project	1	2	3	4	5
3	Enough financial resources causing project delays	1	2	3	4	5
4	Effective planning and scheduling on a project	1	2	3	4	5
5	The sub-contractors or suppliers also contributing to delays and cost overrun	1	2	3	4	5
6	Delays in obtaining the necessary permits and approvals for site mobilization causing cost overrun	1	2	3	4	5
7	Rework or material wastage on the construction site	1	2	3	4	5
8	The contractor is responsible for issues resulting from not visiting the site before bidding	1	2	3	4	5
9	Safety protocols reduce to construction site accidents	1	2	3	4	5
10	The impact of government regulations and laws (e.g., economy, tax, safety, environment, industrial, recruitment)	1	2	3	4	5
11	Involvement of external parties/stakeholders	1	2	3	4	5

Section 6: Material and Labour

According to your knowledge, respond the following Material and Labour related factors in terms of their importance for cost overrun in the building project.

Sr. No	Description	Impact				
1	Project managers can effectively improve labour productivity on construction sites	1	2	3	4	5
2	Shortage of non-skilled labour impacting construction projects	1	2	3	4	5
3	Lack of skilled technicians on construction projects causing cost overrun	1	2	3	4	5
4	The labour strike impacts the construction project	1	2	3	4	5
5	Delays in the procurement process due to the unavailability of materials leading to cost overrun	1	2	3	4	5
6	Delay in the delivery of materials during a construction project leading to cost overrun	1	2	3	4	5
7	The complexity of procurement processes contributing to delays	1	2	3	4	5
8	Damaging of materials during storage causing cost overrun	1	2	3	4	5
9	Uneffective quality control processes leading to cost overrun	1	2	3	4	5

Annexure C (Structural Equation Modeling)



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