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Causes of Delays in High Rise Building Construction Projects in Islamabad

by

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degree of Master of Science

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(Usama Akhter)

Abstract

Schedule delays are prevalent in high rise buildings building construction projects in Islamabad, which affects the efficiency of the structures, project cost and project management. This study aims to identify, assess and prioritize critical drivers of those delays in the rapidly vertically growing city. A structured questionnaire comprising of 30 risk factors derived from literature was administered to the local industry stakeholders using a quantitative research design. Data statistical analysis was performed using the SPSS software, which started with Cronbach's alpha reliability data analysis ($\alpha=0.84$) for ensuring the internal consistency of the data, and continued with descriptive data analysis and variance testing to confirm the consensus of the samples obtained. Next, a Relative Importance Index (RII) was used to rank in practice the most important risks that impact high-rise project timelines. According to the results, the most significant delays are client financial issues, $RII = 0.87$; slow local authority approval processes, $RII = 0.84$; and frequent changes to designs by consultants, $RII = 0.81$. In addition, a high and statistically significant level of agreement ($r_s=0.76$, $p<0.05$) was found among stakeholders on these risk rankings using SPSS and MS Excel. These are the major constraints that lead to further delays in the project, and which contribute to the increased project costs and the failure to meet the deadlines. The core significance of this study lies in the adaptation and application of project management frameworks for high-rise buildings at a global level to Islamabad's local context, offering relevant information that can help address the different challenges that exist in the region, including seismic risks and localized supply chain disruptions.

Key words: High-Rise Building Construction, Construction Delays, Relative Importance Index, Site Management & Quality Control

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Abbreviations

CDA	Capital Development Authority
HRCs	High Rise Construction Projects
K-S Test	Kolmogorov-Smirnov Test
NOC	No Objection Certificate
REITs	Real Estate Investment Trusts
RII	Relative Importance Index
S-W Test	Shapiro-Wilk Test
SPSS	Statistical Package for the Social Sciences
Sig.	Significance (p-value)
df	Degrees of Freedom

Chapter 1

Introduction

1.1 Background

Construction projects are critical towards the utilization of resources in the country and economic development. The most important aspect of the success of any project is the timely completion of the project [1]. In constructing high-rise buildings, delay could be defined as the time overrun either beyond completion date specified in a contract, or beyond the date that the parties agreed upon for delivery of a project [2]. It is a project that is going over its allotted schedule and is deemed as a typical issue in construction projects. The Council on Tall Buildings and Urban Habitat (CTBUH) classifies a high-rise building not by the height alone but if the structure's design, operation and vertical transportation components are greatly affected by height [3]. In the local context, a building is classified as "high rise" building for the purposes of the Building Code of Pakistan (BCP), and the Capital Development Authority (CDA) bylaws, Being more than 50 feet (about 15 meters) high, or if it has 5 or more residential or commercial stories is considered high rise [4]. Such structures have different structural engineering parameters, advanced wind and seismic load analysis and significant capital investment requirements, different construction workflows from low to mid-rise projects. This study selected **Islamabad** as a study area for the following reasons:

Islamabad is a perfect and novel geographical laboratory for this study because of its dramatic transformation from horizontal to vertical urban development imposed by the state. Islamabad was designed in 1960 as a low-density, grid-iron "DiNapoli's" with height restrictions; for nearly 60 years it has had a horizontally expansive appearance [5]. A big turnaround, however, occurred when the Prime Minister's instruction and the subsequent changes in the CDA policy removed any height restrictions from all commercial areas and the Blue Area axis [6]. The sudden shift in regulation has resulted in the highest number of high-rise buildings being constructed in an unprecedented time.

Given the context of unique challenges in the construction ecosystem in Islamabad, investigating construction delays becomes significant here. In contrast to vertical mega-cities, Islamabad's local supply chains, niche high-rise workforces and municipal authorisations are making concerted efforts to adjust to the pace of verticalization, with resulting serious project management tension [7]. Moreover, the city is very close to active seismic lines (e.g. Margalla Hills with Main Boundary Thrust) and requires very strict structural checks which often lead to conflict between developers and authorities [8]. Therefore, the study of delays in Islamabad is very important to get immediate idea about coping mechanism of this master planned horizontal city with the logistical, financial and structural pressures due to its fast vertical expansion.

Construction of high-rise projects have a high level of socio-economic benefits to the stakeholders, including governments, and industry and society stakeholders but are likely to experience delayed construction, which have adverse effects on the construction project completion and expected impact. A construction project is said to be delayed when there is a time overrun in the original schedule meaning that the project is not completed on the original agreed date in the contract [9]. In some cases, delay to the owner translates into a loss of revenue by not having production facilities and rent-able space or a reliance on existing facilities [10]. In other cases, delay to the contractor implies increased overhead costs due to longer work period, increased material costs and increased labor costs due to inflation. Timely completion of projects is one of the indicators of efficiency, but

the construction process is exposed to a lot of unpredictable variables and factors; these include performance of parties, availability of resources, environmental conditions, other parties' involvement and contractual relations. However, it rarely happens that a project is completed within the specified time [11]. Pakistan with a population of over 180 million is one of the rapidly urbanizing countries of the world.

Such a vast population in the country demands the development of sufficient infrastructure like multi-story buildings to match the increasing urban demands and the decreasing space in the urban centers in Pakistan [12]. While many studies have individually identified the risk factors that contribute to project delays in construction projects, most of the previous studies only consider the individual cause of delays and not the compounding or cumulative effect of various risk factors on the project timelines and project performance measures in complex HRCPs in Islamabad [13, 14]. Past research has filtered a range of factors causing delay due to inflationary material prices, scarcity of technical staff and slowdown in the bureaucratic approvals along with a lot more co-dependent factors in developing economy like Pakistan [15, 16]. As a low-income economy, Pakistan must find a way through which low cost and high-quality multistorey projects especially that of high-rise buildings could be constructed by correcting the delayed factors in construction processes [17]. The objective of this study is to identify and analyze the factors considered critical in causing delays in high-rise projects.

1.2 Research Motivation

With the rapid urbanization of Islamabad and consequent lack of available land, has come the need to strategically shift the development process of the city to high-rise development instead of horizontal extension to support the growing population. This transformation is driven by desperate need to make the construction of high-rise buildings safe in Islamabad. Nonetheless, this vertical growth puts the city under a lot of strain in terms of structural problems, project overruns, project delays, and safety concerns. This research becomes significance as it contributes

to the success of high-rise construction in Islamabad. Baseline studies are thus vital in assessing how vertical density can be taken care of on sustainable basis without overloading the current urban structure. This study focuses on high-rise building projects in Islamabad, Pakistan, aiming to identify, analyze, and rank factors causing delays.

1.3 Problem Statement

Construction delays remain a critical challenge in construction projects and frequently lead to significant cost overruns [18]. Design changes, financial constraints, poor planning, and weak coordination among project stakeholders are widely reported as major factors contributing to delays in construction projects [19]. Recent studies also highlight that internal and external factors continue to be dominant causes of delays in building projects [20]. Therefore, there is a strong need to further investigate these delay factors in a more detailed and context-specific manner, in building projects.

1.4 Research Questions

This research study encircles around the following questions:

- i. What are the major factors causing delays in construction building projects?
- ii. How do the delay factors affect the performance of construction projects?
- iii. How can these delay factors be mitigated?

1.5 Research Objectives

The purpose of this research is to examine the delaying environment around construction of high-rise buildings in Islamabad and identify, factors causing delays. To attain this purpose, the following research objectives are set below:

- i. To identify the major factor that cause delay in building project.

- ii. To rank the identified factors on the basis of Relative Importance Index.
- iii. To propose a set of guidelines for the mitigation of delay factor.

1.6 Scope of Research

This research will focus on high-rise building construction projects and aims to identify and analyze the major factors causing delays in the project developments. Data was gathered from construction professionals, including project managers, contractors, consultants, and engineers, using structured questionnaires. By examining the experiences and perspectives of the research respondents, the study will evaluate how different delay factors influence the overall performance, efficiency, and timely completion of high-rise construction projects. Based on the findings, practical recommendations and strategies were proposed to overcome delays, improve project planning, enhance resource allocation, and ensure smoother execution of high-rise building projects in Islamabad.

1.7 Brief Methodology

This research will adopt a structured and systematic methodology, combining literature review, and questionnaire surveys to investigate the causes and effects of delays in high-rise building construction projects in Islamabad. The study will focus on key delay factors, including labor shortages, material and equipment delays, coordination challenges, fragmented planning, contractor-related issues, and regulatory bottlenecks, as well as strategies to mitigate their impacts on project schedules and performance. The methodology follows a stepwise approach as outlined in the flowchart. Initially, a comprehensive literature review will be conducted to identify knowledge gaps, formulate research questions, and define research objectives. Based on this review, critical delay factors will be identified and a detailed questionnaire will be developed to collect primary data from project stakeholders,

including contractors, consultants, and project managers. Data collection will be carried out through structured surveys.

The collected data will be systematically analyzed using quantitative and qualitative methods to evaluate the frequency, severity, and interaction of delay factors, and their impact on project timelines and workflow efficiency. The study will also assess potential mitigation strategies by examining best practices and lessons learned from ongoing and completed high-rise projects. Insights from this analysis will be used to provide evidence-based recommendations for proactive schedule management, resource optimization, and improved project performance in Islamabad's high-rise construction sector.

1.8 Research Significance

Study focuses on high-rise building projects, which involve complex construction processes and management challenges. The study collects data from multiple construction stakeholders including contractors, consultants, and project managers to provide a comprehensive understanding of delay causes. The study will support construction professionals and decision-makers in reducing delays and improving project performance. The study explicitly deals with a significant research gap which has not been filled before as there is an absence of context specific, localized and empirically proven information on the process of building projects in high rise constructions in rapidly expanding urban cities such as Islamabad. There is an abundance of building literature that groups high-rise construction projects together under the general title of 'infrastructure', however this thesis identifies some unique vertical issues in building including vertical logistical problems, specialized special equipment, and safety compliance monitoring that must be tracked at height. Moreover, it introduces novelty by developing a hybrid conceptual modeling approach that combines conceptual modeling with quantitative delay control, which is tailored specifically for the development of the dynamics of the South Asian market, instead of taking the instability of institutions and the supply chain as external noise.

1.9 Thesis Structure

The subsequent thesis is composed of five chapters starting from problem identification to problem management.

Chapter 1: This chapter provides the Introduction with the research background, research problem, questions, objectives, and methodology of the study.

Chapter 2: This chapter provides a detailed review of High-Rise Construction risks in Islamabad, and highlights assessment methods and techniques applied in real-time construction environment.

Chapter 3: This chapter presents research design, techniques of data collection and analytical tools used.

Chapter 4: This chapter presents empirical results, data analysis, and assess results in the light of study objectives.

Chapter 5: This chapter concludes the thesis with an overview of the research findings and suggests a way forward for future research in overcoming delays in construction of high-rise buildings.

Chapter 2

Literature Review

2.1 Background

In the preceding chapter, it has been understood that most empirical studies focus on the construction issues individually and not as part of a coordinated system designed to manage delays in various high-rise construction activities. The existing literature also corroborates that structured planning, proactive monitoring and coordination of stakeholders are indeed effective in improving communication, tracking progress in real time, and effective in the identification, prediction and suppression of cascading delays from multiple interrelated sources, but there is limited empirical evidence available on how a unified and combined approach can systematically identify, predict and mitigate cascading delays from multiple inter-related sources. The existing lean construction research is largely theoretical or focused on a single case, so there is a need to know about how lean and adaptive scheduling methods work in high-rise construction projects where disruption in one activity can cause a domino effect on the critical-path activities. This chapter throws light on vertical urbanism culture prevailing in Pakistan particularly in Islamabad. It moves on to segregate and highlight key factors that cause delays in High Rise Building Construction Projects in Islamabad. It provides an insight into the vertical urbanism culture of Pakistan, especially of Islamabad. It then

discusses the critical factors contributing to the project delays in high-rise building construction in Islamabad.

2.2 Global Concerns and Statistics of Delays

Construction delays have been known to be system wide global phenomenon and studies have shown that very large projects are practically always behind their original deadlines.

In the world, it is estimated that almost 90 percent of infrastructure projects and high-rise projects are affected in one way or the other with the average delay in the project being between 10 percent and 30 percent of the planned project duration depending on the region and economic stability [21].

In the developing economies such statistics tend to be more dramatic; such as the 100 various causes of project delays that have been identified in the Pakistani construction industry [22].

These delays are not only a question of time, but in the majority of cases results in enormous losses of money and mistrust in the urban development sector. It has been statistically calculated that each month of delay in the project of a high-rise can add an increment to the total costs of the project to the range of 1% to 5 [23].

Additionally, the global construction industry has found the following to be the two most prevalent recurrent statistical causes of delay in the international borders: poor site management, and financial troubles of the client. These global problems become more troublesome in specific circumstances like Islamabad due to the localized problems like bottlenecks in regulations and energy crisis, creating an unstable environment within which to keep project timelines [24].

Then, schedule performance has become one of the main measures of the success of construction corporations all over the world, because of the statistical frequency of delays.

2.3 Role of Construction Industry as an Engine of Economic Growth

The construction industry is considered as one of the most important industries for economic development of any country, because it is one of the primary industries in contributing to Gross Domestic Product (GDP) and a significant part of multi-sectoral growth. The industry in developing countries like Pakistan is a lead sector as it has direct link with the performance of over 40 allied industries like cement, steel, timber and glass making industries, etc. [25]. In addition to contribution of GDP, the industry is a huge employer of skilled and unskilled manpower, which is about 2.5 to 10% of the total labor force in Pakistan, historically. Therefore, a strong construction industry is seen as being crucial in eradicating poverty and ensuring urban stability in metros such as Islamabad [26]. The high-rise segment of this industry is the most capital-intensive and is considered to be a specialized subdivision of civil engineering, where one has to throw out the traditional low-rise concepts. The vertical construction process can be managed most simply using a “cycle of production” consisting of repetitive tasks that consist of the formwork, reinforcement, and concreting work on a dozen or more levels. The resulting vertical motion gives rise to an operational environment that is very unique, with the Critical Path being highly vulnerable to any minor disturbance. Memon et al. [12] state that the failure of any materials or a mechanical problem with the tower crane can cause the entire team on the higher levels to stop working.

This vulnerability is especially pronounced at Islamabad where the vertical growth model is perceived as a must to rejuvenate the urban market and to make the most efficient use of available land. The large population in high-rise developments in the capital city creates a demand for high density economic services that promote agglomeration and the need for advanced MEP (Mechanical, Electrical, and Plumbing) services.

It can be established that the construction industry is one of the most stimulating industries with high backward and forward linkages from the study conducted

[27]. Each investment in a high-rise in Islamabad generates a lot of demand for steel from the north and elevator suppliers from across the country. The construction industry in Pakistan is the second largest contributor of employment opportunities with approximately 7.6 percent of the country's workforce engaged in this sector [28]. In the case of Islamabad city, a steady stream of work is created in the construction of high-rise projects for various professionals ranging from the architects, specialized crane operators, and others. The economic surveys indicate that the sector contributes up to PKR 380 billion to the GDP every year and a steadily increasing proportion of the private sector investments is being made in high-rise residential units [29].

In normal times, the sector's growth is cited as justification for fiscal policy action to boost the economy when it is in trouble. The facts and figures imply a two-way causal link between the value of output in construction sector and the overall growth of the economy. The city of Islamabad has implemented vertical innovations to address the issue of urban extension and utilize the infrastructure optimally, thus lowering the economic cost of urban spread [30].

The expansion of the capital can be possible without incurring an excessive increase in existing built-up areas by building up; the preservation of the surrounding green belts and agricultural land can be achieved. High-rise towers are also a source of technological prestige for the city, bring FDI and corporate headquarters [31].

As buildings have become taller and taller in prime locations, new housing options have emerged, along with new avenues for small investors in Real Estate Investment Trusts (REITs), to help ease the constant housing shortage. Despite this, the industry is still vulnerable to external shocks like the fluctuations of commodity prices in the world and the exchange rate of PKR. Fatima & Nawal, [31] note that a sudden surge in the price of high tensile steel could cause work to stop, affecting the whole economy. In addition, the logistics system of high-rise structures in urban environments such as Islamabad is very complex, which demands a higher level of digitalization to ensure an efficient economic operation of the city logistics system [32].

The use of digital tools can reduce the significant financial impact that can result from project delays and material waste. The construction of high-rise projects also provides an opportunity to modernize the local construction workforce, which will include training them in the use of industrialized formwork and safety standards. Ways of sustainable vertical practice, for example energy efficient facade and vertical garden, provide additional possibilities of the “green” economic growth [33].

Mixed-use towers help to mitigate the financial burden associated with car - dependent commuting by consolidating residential and commercial uses in a central location. Resilience of the sector, therefore, is a prerequisite for the overall resilience of the Pakistan economy in urban areas. The recent policy measures like the fixed tax regime for builders have been crucial in ensuring the momentum of the construction industry [34]. Islamabad’s vision to develop modern infrastructure and standardize urban living are impossible without a vibrant high-rise industry.

The industry not only constructs but also creates the base structure for other industries such as the secondary and tertiary sectors. Continuing vertical projects are a “stabilizer” in times of economic downturn as they ensure the demand for raw materials and labor. The cityscape of Islamabad has evolved and expanded, highlighting the sector’s contribution to urbanization and modernization in the country. As the vertical clusters of buildings are formed with amenities, infrastructure such as roads and utility pipelines can be reduced overall, with a public cost [35].

Furthermore, tall buildings are emblematic of the advances made in architecture in more recent times, bestowing dignity and worldwide recognition to the capital. The vertical construction is not only the key to the urban planning for urbanization, but also the key for national economic survival. The sector is able to mobilize local human and material resources and therefore is a key instrument for socioeconomic stability. In conclusion, the high-rise industry in Islamabad fills the gap between the old and new economy in the 21st century, and traditional craftsmanship. The projects’ successful completion is crucial to the economic success of the twin cities and the prosperity of the nation as a whole [36].

2.4 Issues and Challenges in the Construction Industry

The construction industry is one of the most volatile, fragmented and low productivity, high risk sectors in the world. These issues are compounded in the developing countries such as Pakistan where there is a lack of institutional structure and standard processes. The main issue in front of the local industry is that of the "briefcase contractors" that has no technical equipment or professional staff to support modern projects, says [37].

The splitting up of the work results in a lack of integrated project delivery by each party, often working at cross purposes with the project's success. According to Gardezi et al. [38], the industry is currently facing the problem of "payment culture" and if the top person withholds payment, the whole site work comes to a halt. Moreover, Fatima & Nawal, [31] note that construction prices are extremely volatile due to their global price fluctuations with oil and steel, making long-term budgeting almost impossible. The other major challenges are the lack of skilled migrants (the "skills gap") as a majority of migrant laborers are untrained and learn during their employment [39]. This deficiency in skills can not only lower the standard of work produced, but greatly increase the number of accidents and safety violations on site. According to Nasir et al. [40], construction industry is still the least digitized industry in Pakistan, where the use of manual record-keeping and verbal instructions are common. This digital lag leads to low transparency and hard to monitor the real progress against planned milestones for owners. The post-pandemic scenario has brought new challenges including complete disruption of the traditional supply chains and the skyrocketing logistics cost. Another emerging challenge is environmental sustainability due to high carbon emissions and smog in urban areas such as Islamabad [41].

However, the regulatory bodies, such as the CDA, often cannot keep up pace with the fast rate of urbanization, and as a result the building codes are lagging in being updated after big crisis has occurred. Sohu et al. [42] have said that

insuring construction projects is a complex process that does not have any dedicated insurance product, which means that the companies have to self-insure, and as a result, they may be facing financial ruin when a major delay occurs. Compromises and disagreements are commonplace and a common feature of the industry: Sohu et al. [43] point out that it is common for projects to be busier in courts than in construction. Traditional 'Design-Bid-Build' contracts create a competitive environment that fosters contractors to throw down bids and then reap any profits through too many claims and change orders. Rashid. [36] stated that the challenge to Building Information Modeling (BIM) goes beyond the financial; senior management may view a loss of control over the manual process as a risk. Engineering team and site labor communication often causes the use of high specification materials in an incorrect manner, causing waste of materials in the site [44]. The industry also has a "transparency challenge" as hidden costs incurred throughout the tendering process, together with unofficial commissions, increase project spend. According to Khan et al. [45], there are no scientific data to manage projects, but only a "rule of thumb" approach, since there is no professional consultancy organization managing the projects. Other restrictions such as working hours and noise regulations which must be adhered to in urban sites also limit the use of heavy machinery. While Faridi et al. [41] argued that the absence of indigenous R&D results in that the construction industry in Pakistan is a net importer of construction technology which drives the industry to be vulnerable to currency fluctuations. Lack of infrastructure at new project locations (e.g., unreliable electric or water supply) requires contractors to spend large amounts of money on temporary infrastructure. Nadeem et al. [46] stated that the construction industry is at a turning point, and it is necessary to either modernize the industry's management process or face the mounting delays and cost overruns. In conclusion, it is important to address the systemic issues of the industry and make the appropriate policy decisions to enable the successful delivery of high-rise projects, as well as the professionalization of the key workers and the industry.

This synthesis demonstrates that the challenges are not only technical, but also are part of the economic and administrative fabric of the country.

2.5 An Insight of High-rise Buildings in the Construction Industry

In the construction projects of high rises buildings, planning and management are necessary in order to achieve scheduling performance and making sure that it is completed in time. Yet, these projects are often experience delays because of a multiplicity of external and internal factors that discontinue planned work processes and construction sequences [2]. The reasons why high-rise buildings take a long time to be completed may be due to poor planning, improper management of sites, financial constraints, complicated design specifications, shortage of labor, problems with the supply of materials, and poor coordination of project stakeholders. Due to the vertical complexity and technicality of high-rise constructions, all these factors can be more crucial and critical to have a great influence on the implementation of projects. Such causes of delay are minimized when they are not effectively handled efficiency in the project, which leads to the long construction periods, loss of productivity and generally performance decline. Delays are one of the most frequent that were consistently identified in previous research. problems that can be posed by high-rise construction projects especially in the developing countries where the projects are undertaken. The environments that are likely to be faced are uncertain and natural resources are limited [12]. High rise buildings are a specialized area of civil engineering and are so challenging that the old methods of low-rise building just can't be used here. At its most basic, this is a repetitive "cycle of production" as the tasks of formwork, reinforcement, and concreting are repeated on dozens of levels. This vertical activity generates a unique operational environment in which the Critical Path is extremely vulnerable to any disruption. Memon et al. [12] stress that if there are any issues with the materials supply or if the crane has a mechanical failure, all teams extending from the higher floors can be suspended. This is further exacerbated in Islamabad where road closures and demonstrations often disrupt 'just in time'-deliveries which are critical for limited space urban locations, as mentioned by Ullah et al. [47].

The sensitivity of the schedule implies that, if the owner delays progress payments,

then the whole resource chain can be paralyzed in a few days, as stated by Gardezi et al. [38].

High-rises in Pakistan are technically complex, which is often not aligned with the skill sets of the local labor force, thereby causing delays in the cycle time, according to Soomro et al. [43]. In addition, Nadeem et al. [46] emphasized that the regulatory review by the CDA adds “waiting times” in administration, which are not typically taken into account in the initial critical path analysis. It is noted that economic volatility in Pakistan results in sharp fluctuations in the price of high tensile steel and on many occasions, these fluctuations force the procurement to be halted during the emergency. Masood et al. [39] noted that many companies do not have the means of a vertical safety training and therefore experience work stoppages after an incident on a higher level. Because of the lack of the BIM Coordination, MEP clashes are more difficult to resolve in a high-rise core than in a low-rise building, as suggested by Rashid [36]. The tallness of these buildings also poses wind-load and pumping challenges that necessitate certain machines that are not readily found in the local rental market [48]. As the building continues to grow, vertical movement of people and waste materials becomes a major bottleneck and a source of productivity loss. Aleem et al. [49] cited that consultants’ slow responses to RFIs can cause contractors to become ‘trapped’ on the critical path of the ongoing floor cycle. The traditional approach to building is based on labor intensive methods, which is what Faridi et al. [41] say is causing Pakistani high-rises to be built almost 40% longer than other high-rises in the region. During the finishing phases, Nasir et al. [40] were able to write about the year-long delays that were caused by global supply chain disruptions for elevators and specialized glass facades. According to Sohu et al. [42] disputes over land and air rights in Islamabad frequently end up in court and result in the suspension of construction work. The extreme summer temperatures in the capital also prolong the curing time of the concrete and reduces the work time of the workers. Rehman et al. [50], argued that noise and dust limitations for heavy vertical activities in residential areas of Islamabad restrict the number of working hours. Inadequate site management by contractors results in poor coordination

between different trades operating at the same time at different levels, as noted by Khan and Gul [37]. As mentioned by Rehman et al. [50], the lack of experience on the design codes for height is a common issue in the design process and requires some adjustments in the structure during the construction of the mid-levels.

For multi-year vertical projects, financing them over the long-term is precarious due to the fluctuating interest rate. According to Waheed et al. [51], the current labor shortage is particularly affecting the technical trades of high-rise MEP systems, especially in the post-pandemic era. All of these provide a strong indication that the high-rise sector in Islamabad is a high-risk sector where technical, economic and regulatory issues come together and cause huge delays. In the end, for these types of projects to be successful, a new approach to project management is necessary and the application of high precision vertical projects logistics is needed.

2.6 Classifying Delayed Factors in the Construction Industry Projects

Delay factors are generally broken down into the following classes, one for each of the stakeholders and one for each of the operations, in order to identify the causes of delay systematically. Client Related Factors are the first major category and involve financial factors like the slow response time to pay contractors, slow decision making in the project, slow approval time for design changes, and unrealistic scheduling expectations in the project [52].

In reverse of this, are Contractor-Related Factors, which are related to the inefficiency of the executing agency; these are often: poor site management and supervision, insufficient planning or scheduling, insufficient technical expertise in high-rise construction, financial difficulties or cash-flow mismanagement at key project phases [12]. Consultant-Related Factors directly affect these workflows, mainly through structural and architectural design related issues, slow detailed working drawing preparation and approval, insufficient site inspections, and lack

of coordination between the design desk and field engineers. In addition to human stakeholders, the classification also includes Material and Equipment-Related Factors, including unexpected market shortages of specialized high-rise materials (e.g., high-strength steel, specialized concrete mixers), late delivery, purchasing delays and frequent breakdowns of tower cranes or concrete pumps, etc.

Likewise, Labor-Related Factors consist of persistent lack of experienced high-rise technicians; low labor productivity and incidents, or strikes, in the workplace causing work site delays. Finally, projects are exposed to External and Environmental Factors that are largely outside the control of the project team, such as weather conditions, change in regulation by municipal bodies like the Capital Development Authority (CDA), delays in connecting utilities, force majeure and extreme macroeconomic issues like inflation or sudden price increases to materials [53].

2.7 Project Performance

Project performance is indicated by the success in containing cost overruns and delays. Time increases not only extend the life of projects, but also result in contractual conflicts and low productivity in the construction industry. Performance is currently impeded by the failure to undergo a paradigm shift; until a move from family-business to large-scale companies with deep pockets is made, performance will remain stagnant [45]. Metrics, such as cost and time, are common measures of construction project performance against its baseline [14]. Delays on projects are also accompanied with costs that are unbudgeted. Cost performance can be considered the leading metric in construction worldwide out of the four main constraints of quality, scope, time and cost. In a study into construction projects in Asian countries, Aleem et al. [45] found only about 13% of construction projects were completed within the specified budget, and the real cost of the project was 28 percent more than the expected cost.

These issues are also evident in developed as well as developing economies, and are more or less pronounced in projects of varying sizes and nature. This study,

with a sample of 40 projects, offers insights into the various factors affecting delays in high-rise construction projects, underscoring the importance of planning and control in handling these complex issues to ensure the success of construction projects around the world. While global studies focus on fuzzy models for estimating cost overruns, research from Pakistan shows that the national literacy rate and a particular "technical labor gap" are relevant to the current labor shortage in the modern vertical engineering, especially in places such as the Blue Area. In the vibrant city of Islamabad, numerous projects are rassing with time delays [54].

The research undertaken in Islamabad, Pakistan, addresses a significant gap in understanding and managing delays in high-rise construction projects, particularly those intended for commercial use and recognition and prioritization of factors that affect delays for construction projects. The research involves a holistic approach with its focus on societal significance, scale and variety of projects, and makes a valuable contribution to the knowledge of construction delays [55]. The input of expert construction project managers and engineers is critical as they provided expertise via two surveys, which were carefully analyzed. Significantly, this study pioneers, for the first time in high-rise construction project management, a hybrid approach from conceptual modeling to quantitative delay control. The study also pioneers the linkage between the case study and urban development characteristics, displayed using an innovative approach [56].

This research seeks to identify factors that cause delays in construction projects and their effect on project success in terms of time, cost and quality. This study seeks to address the existing gap in knowledge of the complex factors behind delays in high-rise construction projects, and, as a result, contribute to better strategies and practices for project management.

2.8 Technical Identification of Delayed Factors

The Table 2.1 provides a detail of notable 30 studies done by different researchers in their respective times and identified delayed factors encompassing finances,

planning, budgeting, allocation of resources, policy matters, cost overrun, delays in time, cost, and effects of delays.

TABLE 2.1: Delay Factors in High-Rise Construction

Sr. No.	Source	Paper Title	Delay Factors Identified
1	Gardezi et al. [38]	Time extension factors in Construction industry of Pakistan	• Inaccurate timelines
2	Khan and Gul [32]	Empirical study of critical risk factors causing delays in construction projects	• Ineffective project planning and scheduling
3	Soomro et al. [57]	Causes of time overrun in construction of building projects in Pakistan	• Slowness in decision making • Bureaucratic hurdles
4	Nadeem et al. [46]	Analysing delay factors in construction projects using Z-number approach: insights from Pakistan	• Poor communication and coordination
5	Iqbal et al. [48]	Analyzing The Causes of Project Failure and Cost Overruns in Building Construction Industry by Using a Mixed-Methods Approach	• Poor quality control
6	Khan et al. [45]	Identification and analysis of significant delay factors in construction projects	• Weak site management
7	Aziz et al. [58]	Delay mitigation strategies and the implication on the construction industry	• Gap in technical labor skills • Need to adopt delay mitigation strategies
8	Ullah et al. [17]	Identifying the most effective delaying factors using FCEM-AHP: A case study of Pakistan's construction industry	• Lack of modern construction equipment
9	Ali et al. [58]	Identification and assessment of factors causing delays in construction projects at public sector universities in Khyber Pakhtunkhwa, Pakistan.	• Height restriction changes • Late delivery of long-lead items • Delay in obtaining permits and licenses

Table 2.1 continued from previous page

Sr. No.	Source	Paper Title	Delay Factors Identified
10	Memon et al. [12]	Investigation of project delays: Towards a sustainable construction industry	• Tech integration delays / Poor IT usage • Shortage of workers for complex task
11	Haseeb et al. [59]	Causes and effects of delays in large construction projects of Pakistan	• Design changes during construction
12	Bhatti et al. [60]	Integrating Sustainability into Project Management Practices: Experiences of Managers in Infrastructure Projects	• Inadequate experience • Tech integration delays
13	Ali et al. [61]	Managing of Subcontractors Failure in Construction Projects	• Late reviewing and approving design documents
14	Ejaz et al. [62]	Assessment of delays and cost overruns during construction projects in Pakistan	• Changes in material types and specifications
15	Zidane & Andersen [63]	The top 10 universal delay factors in construction projects	• Poor planning • Insufficient data collection and site supervision
16	Masood et al. [39]	Investigating the delay factors of construction projects in metropolitan city of a developing country	• Slow review process • Consultant-Related Delay
17	Faridi et al. [41]	Factors Affecting Construction Delays	• Poor communication and coordination
18	Ali et al. [58]	Identification and assessment of factors causing delays in construction projects	• Delay in contractor payment
19	Aleem et al. [49]	Exploring the factors contributing to public sector building construction delays and mitigation solutions in Pakistan	• Shortage of specialized construction equipment
20	Assaf & Al-Heji [11]	Causes of delay in large construction projects	• Shortage or delay of material

Table 2.1 continued from previous page

Sr. No.	Source	Paper Title	Delay Factors Identified
21	Maqsoom et al. [53]	Factors causing the time delay in projects: Empirical evidence from Pakistani construction industry	• Gap in technical labor skills
22	Waheed et al. [51]	Assessing And Mitigation of Quality Issues of High-Rise Building Projects in Pakistan	• Changes in material types and specifications
23	Nadir et al. [64]	Causes and monitoring of delays and cost overrun in construction projects in Pakistan	• Project location causes delay.
24	Irfanullah et al. [1]	Determinants of project time extension in Pakistan	• Ineffective project planning and scheduling
25	Farooqui et al. [65]	Assessment of Pakistani construction industry—current performance and the way forward	• Conflict between consultant and contractor
26	Fatima & Nawal [31]	An empirical assessment of the factors causing delays in project completion in the construction sector of Lahore Pakistan	• Poor use of advanced Engineering design
27	Rashid [16]	Analysis of delay factors and their effects on construction projects	• Project location causes delay.
28	Nisar & Asif [29]	Factors leading to failures of infrastructure development projects in Pakistan	• Price fluctuations
29	Rashid et al. [27]	Causes of delay in construction projects of Punjab-Pakistan: An empirical study	• Poor quality control
30	Ud Din et al. [66]	Comparative Analysis of Factors Causing Delay in Residential Construction Projects in Pakistan	• Slow decision-making

2.9 Summary

The literature review confirms that schedule overruns in large-scale construction projects are a systemic global crisis and that in the world of large-scale construction projects, according to stats, China reflects a mean overrun cost of 5.41%.

Other countries reflect cost overruns ranging to 28% from 7.90% [67, 68].

Although the construction industry is a major driver of economic growth, enabling it to stimulate more than 40 allied sectors and contributing up to 10 per cent of national GDP [69], delayed projects turn economic assets into stagnant liabilities. The study developed a consolidated Table 1 of delayed factors in Chapter 2 on the basis of mapping criterion of 'one baseline study, one representative factor' to map historical construction delays in 30 key papers. These 30 operationalized factors were distributed among our four statistical constructs that define our empirical model: Design Related, Financial/Economic, Management/Administrative and Code/Regulatory Factors.

All the 30 studies added value in their respective context; this study added a strong predictive value by applying ranking method to identify and rank the design related factors, Code and Regulatory Factors and financial and economic factors. Emphasizing its specific geographical focus, this study isolates the critical drivers of project overruns in the rapidly verticalizing landscape of Islamabad.

Chapter 3

Research Methodology

3.1 Background

The previous chapter builds upon the extensive literature review that provided a theoretical framework for automated sensing metrics, worker behaviour and environmental hazards. The analysis of the literature identified key knowledge gaps around the implementation of proactive safety technologies in the construction sector, such as the interactions between these variables in complex site settings. The literature is able to build on these theories to create a conceptual model that illustrates a safety structure that brings together measures of safety, technology, unsafe acts and unsafe conditions into a direct connection that affects the frequency of near-miss events. This theoretical basis eventually gives conceptual support for moving from a historical synthesis to a more focused investigation into the real world.

This chapter sets to offer the methodology as explanation of the research, followed by data collection and analysis techniques using on the basis of quantitative research method, structured questionnaire, the purposive sampling approach leading to investigate the theoretical foundations of the method. This chapter gives a comprehensive description of the research process, starting by choosing

the appropriate study design and the key elements influencing phenomenon being considered. This chapter describes how the sample size was determined and describe the characteristics of the sample. Finally, to figure out the factors that cause delay in project finalization is aim of the study; afterwards, it explains the questionnaire design, to collect important data on the factors. This chapter takes on the data collection and analysis approaches, making sure that the approaches are suitable for solving the research challenge.

3.2 Philosophy and Design of the Research

Research philosophy is the researcher's thoughts through which reliable and new knowledge regarding the objective of the research is acquired [60]. Simply put, it forms the basis of the research, which involves the selection of research approach, development of the problem, collection of data, processing and analysis. The research design for this research follows a quantitative methodology in order to achieve the study objectives. The research design follows a deductive research strategy as an initial step where an analysis is conducted based on available theoretical frameworks identified in the literature.

A cross-sectional study design was used for this study because it enables data collection of different delay factors from a wide range of high-rise projects that are either under construction or completed at the same time. This design represents an efficient snapshot of the current realities in the industry of Islamabad where vertical construction is happening at a break-neck speed since 2019.

It gives the researcher the opportunity to observe the immediate perception of various stakeholders (clients, contractors, consultants etc) without the time lapse and drop-out effects that are often associated with longitudinal studies. This method is very suitable to examine the statistical relationship between active delay factors and project performance indicators in the current economic and regulatory environment [70]. Under the provisions of a deductive approach, empirical data is collected and analyzed, and finally, a theory is examined.

3.3 Inclusion and Exclusion Criteria

It has been decided to set strict eligibility boundaries to ensure data integrity in the context of high-rise building industry.

3.3.1 Inclusion Criteria

- i. A professional should be at least three years of experience in the construction industry in Pakistan.
- ii. The participants should be engaged in or have managed a building project in Islamabad within last three years and have five story or 50 feet tall (according to high rise classification criteria of CDA).
- iii. The project should be a high-rise building for commercial, residential or mixed uses.

3.3.2 Exclusion Criteria

- i. People involved in single storey residential villas, horizontal infrastructure (road, bridge) or industrial development are not included.
- ii. Individuals with limited project management expertise or oversight, such as unskilled site staff, administrative clerks, and suppliers are not included as they do not possess the strategic understanding needed to see systemic delays.
- iii. Projections outside of the specific CDA regulatory area within Rawalpindi and outer (not adjacent) areas are not included as this would contaminate the data with policy-based data.

3.4 Sampling Justification

Since there is no complete and centralized, public archive of all the professionals working in construction field in high rise of Islamabad, a purposive and snow ball

sampling method was appropriate. Purposive sampling helps to make sure that surveys are deliberately targeted towards information rich cases [71].

Those cases of experts that have the exact technical and managerial expertise needed to evaluate complex high-rise delays. This was combined with a snow-ball sampling chain mechanism, which effectively involves initial contacts of tier-1 contractors to get access to the historically protected developer networks and private consultants, across key vertical hubs in the city (Blue Area, Sector G-11, DHA etc.). The sample size was determined based on G Power software and/or Cochran's formula for unknown populations to obtain statistical power to conduct high level quantitative analyses [72] like the Relative Importance Index (RII) and Multiple Linear Regression of representative samples (e.g., $N = 150+$ respondents).

Systematic controls were used to ensure objectivity as non-probability sampling is a risk of selection bias. The respondents were carefully diversified into three independent groups of respondents: 33% were from client/development organisations, 33% were from contracting organisations and 33% were from independent consulting organisations.

3.5 Research Design

The research design for this research follows a quantitative methodology in order to achieve the study objectives. It follows a deductive research strategy as an initial step where an analysis is conducted based on available theoretical frameworks identified in the literature [73].

Under the provisions of a deductive approach, empirical data is collected and analyzed, and finally, a theory is examined. This is a Systematic process that involves three stages to accomplish a research process. The flow of the methodology (shown in Figure 1) proves the logical course of action in order to increase the reliability and validity of the research.

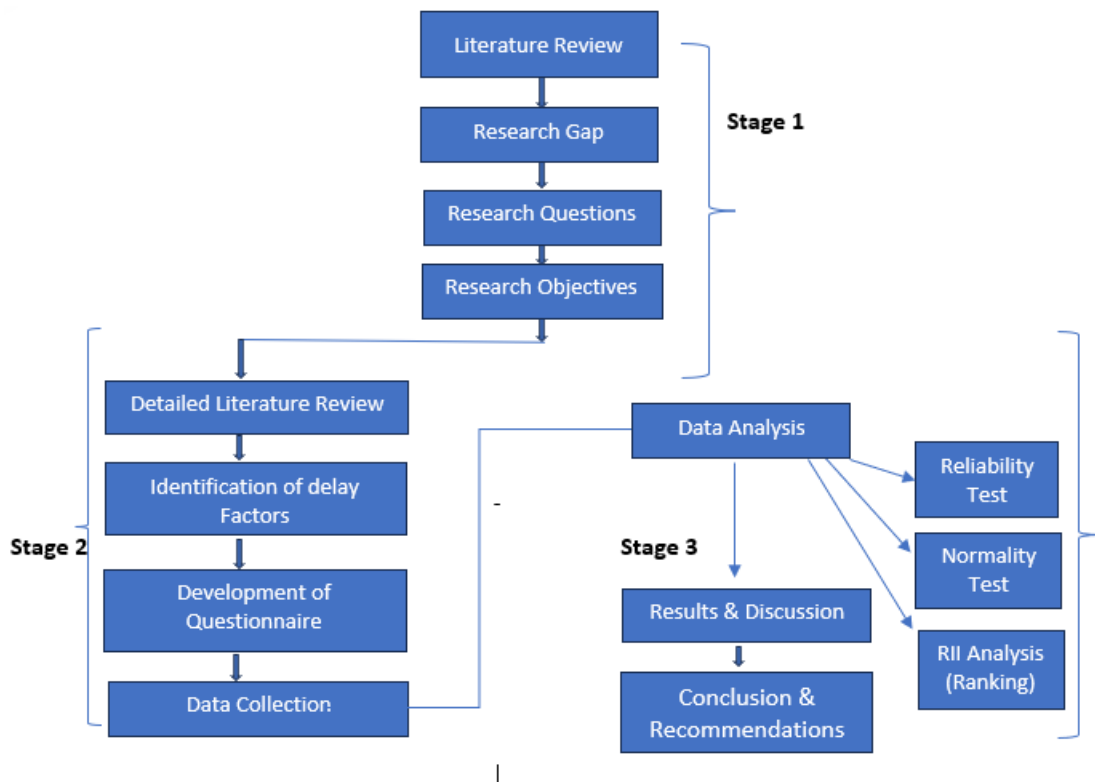


FIGURE 3.1: Systematic Process of Methodology

3.6 Stage 1

The Preliminary Investigation enlightens that the intricate nature of high-rise building work poses some difficulties for contractors to complete projects on time. There are numerous reasons behind the delays in high-rise building projects depending on each country [30]. The Preliminary Investigation and Literature Review establish that, although the level of mega projects is rising across the globe, the construction sector is always the last to follow other industries as it incurs significant losses in terms of productivity and has a history of chronic delays. The investigation points to the fact that in a particular situation, i.e. in the context of Islamabad, the changeover to vertical urbanism is negatively impacted by the prevailing high inflationary pressures during the period of the 2025-2026 economic landscape, as well as by hard regulatory resistance caused by the Capital Development Authority.

After noticing the absence of experiential baseline data with the theoretic deficiencies across the literature, the research gap in literature was apprehended, laying the necessity to look for evidences to tailor a framework enabling quantification of combination of delay connections to stabilize schedule reliability. Guided by research gap, it is the stage to demarcate research questions.

The research questions are elaborated and formalized in a sequential and systematic way that allows for clear and actionable research goals to emerge in the process. These questions create the analytical backbone of the study by systematically moving from descriptive inquiries on what causes delays, to critical investigations of the dynamics between stakeholders and mitigation approaches. This step-by-step approach methodologically guides the empirical investigation from the start of identifying and characterizing delay factors in the high-rise sector of Islamabad.

This formal connection therefore, ensures that each research goal is directly linked with a research question built on a theoretical background, resulting in a seamless and convincing research process, from the problem formulation to the practical implementation of the problem.

The research objectives for this study are developed in a systematic manner with the help of three fundamental theories; namely the Theory of Constraints (TOC), the Stakeholder Theory and Lean Construction Theory. The construction of high-rises in Islamabad is a multi-disciplinary system with few easy-to-define delays. TOC provides a method for moving from a simple list of causes of delays to a systematic investigation of systemic delays that limit the vertical flow of projects within the organization.

In addition, the construction industry in Pakistan is a highly fragmented one and the operational justification of RO3 is based on the Stakeholder Theory, which acknowledges that clients, contractors and consultants have diverging perceptions of the accountability for delays arising out of these differing contractual interests. Lastly, Lean Construction Theory is the synthesis mechanism employed in RO4, where HRCs is conceptualized in terms of continuous streams of interdependent

workflows, rendering the traditional planning processes that are static and rigid more integrated and dynamic, and justifying the shift away from traditional static planning to an integrated, adaptive, and context-specific mitigation process in the context of Islamabad's volatile economic and regulatory landscape.

3.7 Stage 2

The first part of Stage 2 sets to look for a strong theoretical base by systematically and comprehensively reviewing literature on the current research areas related to construction delays, and delay mitigating mechanisms. This process goes beyond mere collation of sources and is a critical synthesis of the evolution of historical and contemporary scholarship that should provide a mapping of the evolution of delay analysis methodology on a global and regional level.

This review is based on a series of peer reviewed journal articles, conference proceedings and institutional reports that will identify the structural, managerial and environmental factors that have historically hindered construction workflows. Special attention is paid to the shortcomings of conventional project management approaches to the non-linear, vertical development of high-rise projects, in order to rationalize the use of adaptive planning approaches in the context of such projects. The in-depth review sets the theoretical groundwork to convert generic delay variables into a specific and empirically valid instrument that can be used for the diagnosis of the high-rise sector of Islamabad.

The second part of the second stage is to carefully extract, classify and validate potential delay factors in the literature, based on the theoretical foundations laid down in the literature review. The first step in this process is to compile a comprehensive master list of schedule disruptors developed by collating literature from around the world and in the region, and organized into different categories of operational factors, including client, contractor, consultant, materials, labor, equipment and external environmental factors. This is done not as a set of independent set variables, but rather as variables that can be interdependent, as

disruptions to high-rise construction may cascade across the critical-path variables. The subsequent empirical instruments are designed to reflect the multi-dimensional and interconnected nature of risk in vertical expansion projects, by means of this structural categorization. The initial list of the factors identified as delays is then carefully contextualized and localized to make the instrument extremely sensitive to the unique socio-economic and regulatory environment of Islamabad.

This includes adapting the generic indicators to the local construction practices including the particular delays in the procurement of materials due to restrictions on imports, variable costs of fuel and aggregates in Potohar region, and the local nature of the labor practices, where workers are seasonal and are employed through informal arrangements. Further, local administrative set-up issues, such as utility connection delays and complex environmental permits, are also specifically incorporated. This contextual filtering makes sure that the variables that are created are relevant, understandable to local practitioners and can yield actionable data.

A structured questionnaire was created to systematically collect and analyze the key factors that cause a building project to go over schedule in the context of a high-rise building. The purpose of this research instrument is to convert the 30 risk factors identified in the research into a measurable format so that the local industry can give an empirical response based on their field experience.

A structured questionnaire is a quantitative data collection instrument comprising a predetermined, standardized sequence of close-ended questions, Likert scales, or dichotomous yes/no queries designed to collect uniform data across a sample to quantify underlying psychological constructs, behaviors, or attitudes.

The research instrument is divided into three logical parts to guarantee that data is complete and all participants are willingly ready to complete the form. Section 1 includes information about the respondent's background to validate and ensure reliability of data. The variables considered are the profession (Client, Contractor, Consultant, Project Manager), the number of years' experience in the construction of high-rise buildings and the number of high-rise projects experience carried out in

Islamabad. Section 2: Project & Job Performance encompasses the 21 individual, key delayed factors in the 4 major categories.

A standard 5-point Likert Scale is used as a measurement scale to evaluate the impact of each factor on project timelines ranging from "Very Low" (2) to "High" (5) where "Average" (3) is the midpoint. Section 3: Delayed Factors includes aforementioned four key categories such as design related factors, financial and Economic factors, Management and Administrative factors, Code and Regulatory factors.

In order to reach busy construction professionals in various construction sites of Islamabad, the questionnaire was digitized and was sent using Google online Forms. Special architectural controls were put in place on the platform to maximize the data collected.

To ensure the questionnaire was properly structured, relevant, and measured accurately, it went through a detailed three-step validation process: content validation, a pre-test, and a pilot study. First, content validity was checked by giving the initial version to five experts—two senior professors in construction management and three experienced structural engineers from the Capital Development Authority (CDA).

They reviewed each question to make sure it was clear, academically strong, and aligned with Islamabad's building laws. Next; a pre-test was done with three site managers to spot any unclear terms or tricky language related to construction and make improvements. Lastly, a pilot study was carried out by giving the revised questionnaire to 20 construction professionals who fit the criteria but weren't included in the final results. The data from this pilot showed a Cronbach's alpha score above 0.70 for all main topics, proving the tool is reliable and consistent before it was widely used (75).

To enable the study's research framework, the process of data collection is carried out in a structured and multi-level process specially designed for the active high-rise construction sector in the regulatory jurisdiction of the CDA in Islamabad.

The data is collected through an instrument designed to measure the frequency and severity of the pre-defined delay factors.

The comprehensive approach is designed to ensure that the data collection provides high-density empirical metrics to inform the Relative Importance Index (RII) ranking in the analysis phase of the research, as well as stakeholder consensus modelling. The data was gathered amongst construction professionals who had the privilege of working on high rises in the metropolis of Islamabad-Rawalpindi.

The researchers opted non-probability sampling methods mainly due to the fact that there was no official list of the construction companies that have dealt with delay claims. In the absence of a specific sampling frame [74] for construction organizations, this implies that rather than selecting participants randomly out of a full list, they selected experts (such as, project managers and engineers in Islamabad) based on their specific experience and availability [74].

The sampling frame comprised of professionals in contracting firms, consulting engineers, project managers, regulatory agencies, contractors, and clients that had construction-related expertise. The sampling technique utilized was based on purposive sampling techniques to give it some level of representation of the different stakeholder groups and organizational hierarchies. Since it is a correlational study, Harris & Quade [75] provided sample size formula for such studies. The formula is:

$$N > 50 + m$$

N denotes the minimum sample size required; $m = 4$ predictor variables. Therefore, our target sample for this study is 95 which is satisfactory with regard to statistical strength of the dataset.

In this study only the active construction professionals and key institutional stakeholders involved in the implementation of high-rise building projects within the geographical and administrative boundaries of Islamabad were considered as the target population. This population includes Site Engineers, Clients, contractors and consultants are the target population to be selected by this study that is

located within the city of Islamabad. Response rate which explains the response level of the research respondents remained 95% which is satisfactory [75].

3.8 Stage 3

Data analysis involves consulting a score of research articles relating to data analysis and for propagation of knowledge. The data worked out through Excel program and specialized program of SPSS as gathered through the survey questionnaire to undertake statistical analysis for descriptive and inferential run. This section targets to ascertain the prevailing trends in construction, and examine the linkage of independent and dependent variables.

The initial data analysis was to be done using the descriptive statistics using the IBM SPSS Statistics program. The frequency distributions was used in summarizing the demographic variables of the respondents in order to profile the sample composition and ensure that the coverage is representative [76]. Frequency distributions were made to identify response patterns, and learn response distribution patterns of each variable.

To guarantee the survey instrument's internal consistency and stability, a reliability test should be performed prior to undertaking advanced statistical analyses. In questionnaire-based construction studies using Likert scales, Cronbach's alpha remains the most commonly used measure to assess the extent to which a group of items effectively captures a single latent construct [77].

A Likert scale is commonly used in the industry to turn the subjective psychological feelings, into clear, numerical values that can be easily analyzed using statistics [77].

The Cronbach's alpha value varies from 0 to 1, with a score of 0.70 or above typically deemed an acceptable standard for research, signifying that the survey items reliably assess the intended delay factors [78]. Utilizing this test guarantees that the information obtained from construction stakeholders about project delays

is reliable, devoid of random error, and sufficiently strong to support valid future analyses and structural modeling.

Before selecting the appropriate statistical techniques for testing hypotheses or establishing correlations, a normality test is essential to determine whether the collected sample data is normally distributed. Determining the distribution shape guides the choice between parametric tests (which assume normality) and non-parametric tests (which do not assume normality). For construction management datasets, which often feature moderate-to-large sample sizes, the Shapiro-Wilk and Kolmogorov-Smirnov tests are standard diagnostic tools, supplemented by skewness and kurtosis evaluations [79].

If the significance value is greater than 0.05, the data is assumed to be normally distributed; conversely, a value of less than 0.05 indicates a non-normal distribution, which is common in construction delay surveys due to varying stakeholder perspectives and subjective ordinal Likert ratings [80]. Justification for using the S-W test results show that for each variable, the significance (Sig.) is very low ($p = 0.009$ with three categories at .000). This strongly supports the K-S test result, which indicates that our data significantly differs from a normal distribution. This indicates that data distribution is satisfactory.

The Kruskal-Wallis test, a non-parametric method, is chosen because the data didn't follow a normal distribution, as confirmed by the Shapiro-Wilk test, which showed that most of the key factors were significantly different from a normal curve. In that case, the Kruskal-Wallis test is applied for some results to be above the 0.5 threshold [81]. This statistical information is crucial for developing targeted risk management plans, validating the overall framework, and implementing counter measures to avert delay factors [81].

The Relative Importance Index (RII) is calculated in order to rank all the turbulent factors in terms of perceived importance. RII is used to convert the ratings of the 5-point scale to a normalized index between 0 and 1 to ensure that the ratings of the different delaying categories can be directly compared [82]. With data measured at ordinal scale, this research found it appropriate to use non-parametric statistics

involving frequencies, relative index analysis. Our main method is the Relative Importance Index (RII). Justification is using RII because it is a descriptive, non-parametric approach that does not rely on data following a normal distribution. Therefore, the fact that our data is not normally distributed does not affect the accuracy of our RII rankings at all.

These were adopted in view of the fact that ordinal scales produce ranking data for which parametric methods are unsuitable [74]. The Statistical Package for the Social Sciences (SPSS) was used to calculate the valid percentage ratings of the research variables. The following mathematical formula is applied to ascertain the ranking order:

$$R-II = \sum \frac{W}{A} \times N$$

W is the score given by each person, based on a scale from 1 to 5. A is the highest possible score (which is 5 in this study) that someone gave for a specific topic. N is the total number of people who rated that topic, which is 75 in this case. The R-II value comes out as a number between 0 and 1. A higher number means the issue was seen as more important or happened more often on construction sites.

The results and discussion section provides a detailed examination of the findings from the quantitative analysis. It moves the focus from the raw data to a more meaningful story, explaining how different factors interact. It looks closely at the main relationships between the independent causal factors specifically design-related, financial, administrative, and regulatory issues and how they together affect project and job performance. The conclusion and recommendations section summarizes the key points of the study. It shows that combining lean and adaptive production control methods is crucial for early identification and handling of delays in vertical expansion projects. It turns these research findings into clear, useful suggestions for the construction industry in the Islamabad Capital Territory.

3.9 Summary

Chapter 3 outlines a methodology to enlist a range of factors relating to Islamabad's high-rise construction. It resorts to adopt quantitative research design to

systematically investigate the variables causing high-rise construction delays in Islamabad. The methodology centers on a primary data collection process involving project managers, contractors, developers, engineers, and clients through a structured questionnaire using 5-point Likert scale to evaluate delay factors. Finally, the chapter details the use of rigorous statistical techniques including Descriptive and inferential statistics to rank the critical factors. The following chapter will derive the findings using this methodology.

Chapter 4

Results and Analysis

4.1 Background

The empirical results reported in the previous chapter flows directly from the various theoretical dimensions of the literature review, crossing the line from theory into actual data. While proactively managed safety has long been explained as being dependent upon a careful interplay between sensing technologies, human behavior, and physical site environments, it was often only validated qualitatively at a very general level for high-rise developments. This chapter aims to fill that gap by providing the statistical analysis of the data gathered from urban construction sites, and a systematic investigation of the interaction between safety technology metrics, unsafe acts and unsafe conditions as they relate to near-miss events. These findings, when linked to practitioner understanding, validate the conceptual model that had been developed in the previous phases of the study, making it empirical.

Chapter 4 discusses the results from the data collected and provides a thorough analysis to understand the reasons behind delays in high-rise construction projects in Islamabad. There has been a huge increase in high-rise building projects in the capital of Pakistan, but these complex projects often face schedule delays that affect economic and operational goals. The main goal of this chapter is to take

the information gathered from important industry players like clients, consultants, and contractors and turn it into useful knowledge. Using statistical methods to look at the causes of delays, this section focuses on the main obstacles, such as regulatory issues, financial problems, and supply chain challenges that are specific to Islamabad. The analysis presented here forms the basis for understanding why these delays happen, which leads into the strategic suggestions provided in later parts of this study.

4.2 Demographic Details of Respondents

This section throws light on the demographic profile of research participants;

4.2.1 Professional Role

This section presents results on professional role of Client, Consultant and Site Engineer as respondents of this research study.

TABLE 4.1: Professional Role

	Frequency	Percent
Client	19	20.0
Consultant	28	29.5
Site Engineer	23	24.2
Contractor	25	26.3
Total	95	100.0

Table 4.1 provides the results that a total of 95 respondents from different backgrounds of the construction industry in Islamabad participated in the survey. The consultants are the biggest professional role group at 29.5% and make up 28% of the organizations surveyed. while 24.2% roles filled by Site Engineers and 20.0% of roles are held by Clients.

4.2.2 Organization

This part of the dissertation presents type of organization represented by respondents such as Client, Consultant, and Site Engineer.

TABLE 4.2: Organization

	Frequency	Percent
Consultant	27	28.4
Contractor	28	29.5
Client	25	26.3
Other	15	15.8
Total	95	100.0

Results indicated in table 4.2 point out that Contractors constitute a frequency of 28n (29.5%); Consultants make up 28.4% (n27) of the organizations while 26.3% (n25) of roles participated by the others category.

4.2.3 Education

This section presents educational profile of research participants in tabular form.

TABLE 4.3: Education

	Frequency	Percent
Bachelors	28	29.5
Masters	37	38.9
PhD Scholars	30	31.6
Total	95	100.0

Results reveal that the sample has a high degree of education with 38.9% (n37) having a Master's degree, 31.6% (n30) and 29.5% (n28) were having a PhD and a Bachelor's degree. The formal educational profile of the respondents (N = 95) sets a high standard and foundation of technical skills for the primary data collected for this study. The structural engineering, the coordination of mechanical, electrical

and plumbing (MEP) and the application of project management methodologies that are required for high-rise developments are complex.

The data shows that there are a significant number of individuals who have specialized engineering and architectural degrees like Bachelor of Science (B.Sc.), Master of Science (M.Sc.), and Doctor of Philosophy (Ph.D.) in subjects related to construction and architecture. This academic depth means that the respondents in the survey have both the cognitive and technical abilities to properly assess the important factors of the schedule.

4.2.4 Years of Experience

This part presents years of experience of respondents of this research.

TABLE 4.4: Years of Experience

	Frequency	Percent
0-5	19	20.0
6-10	34	35.8
11-15	24	25.3
>15	18	18.9
Total	95	100.0

A plurality of the respondents n34 (35.8%) have 6–10 years of experience, followed by 11–15 years n24 (25.3%), whilst n19 were having 0–5 years (20.0%), and n18(18.9%) had more than 15 years. Combined with educational backgrounds, respondents' years of experience show a mid-to-senior level of experience in the field. The dataset has a high proportion of professionals with 10-15+ years of active experience in the construction industry, with many of them in decision making positions at senior levels including senior project managers, chief structural engineers and principal consultants. The extensive operational experience that has been gained is methodologically important when it comes to analyzing the delays that occur in high-rise projects, as such delays are rarely isolated events, but rather form cascades, impacting on various critical-path flows over the course

of several years. A high proportion of experts from the industry ensures that the data reflect long-term exposures to real-life project crises, contractual issues and macro-economic changes. The resulting Relative Importance Index (RII) and consensus modeling has a high degree of validity.

4.2.5 Primary Project Location

Results on territorial break up of location of primary projects around Islamabad are presented in this section.

TABLE 4.5: Primary Project Location

	Frequency	Percent
Blue Area	25	26.3
DHA	21	22.1
Gulberg Greens	28	29.5
Other	21	22.1
Total	95	100.0

The results shown in table 4.5 unveil that regional break up of primary project location shows that Gulberg Greens has the highest 29.5% participation (n28), Blue Area 26.3% (n25) and DHA 22.1% (n21) and the remaining 22.1% (n21) is in other areas constituting the aggregate sample size of 95N). Justified the sample size of 95 using standard statistical sample determination formulas (e.g., Harris & Quade, 1992; $N_{\geq 50+m}$ rule for regression modeling). The primary locations of the projects and respondents' relationship are predominantly in the residential and commercial areas that supports respondents' empirical data and places it into the context of the unique geographical, regulatory and socio-economic setting of Islamabad. The fact that the majority of the respondents were engaged in active vertical projects in the central areas of Islamabad like commercial corridor Blue Area, G-11 and major expansion areas of zone V, bring the industrial reality of the region into consideration. These local contexts involve particular fluctuations in prices of domestic materials, seasonal labour migration in northern Pakistan and the problem of utility connections through the bureaucracy. This strong

geographical linkage ensures that the Strategic Framework developed in the end is not merely a ‘Lean Construction Model’, but a ‘Toolkit based on Evidence’ that is specific to the operational context of Islamabad’s vertical growth.

4.3 Reliability Statistics

TABLE 4.6: Reliability Statistics

Constructs	No. of Items	Cronbach’s Alpha
Project & Job Performance	10	0.88
Design-Related Factors	6	0.74
Financial and Economic Factors	2	0.74
Management and Administrative Factors	8	0.86
Code and Regulatory Factors	5	0.77
Overall	31	0.90

The survey instruments were assessed for internal consistency and reliability using Cronbach’s Alpha. Cronbach’s Alpha for the overall scale: The internal consistency of the overall scale (31 items) presented an excellent Cronbach’s Alpha value at 0.90 [76]. The 10-item ”Project & Job Performance” scale (0.88) and the 8-item ”Management and Administrative Factors” scale (0.86) have very high reliability scores. The internal consistency of the remaining constructs (Design-Related (0.74), Financial and Economic (0.74), Code and Regulatory (0.77)) are all acceptable.

4.4 Normality Test

TABLE 4.7: Tests of Normality

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Project & Job Performance	0.092	95	0.047	0.963	95	0.009
Design-Related Factors	0.108	95	0.008	0.957	95	0.004

Table 4.7 continued from previous page

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Financial and Economic Factors	0.135	95	0	0.883	95	0
Management and Administrative Factors	0.145	95	0	0.951	95	0.001
Code and Regulatory Factors	0.127	95	0.001	0.952	95	0.002

a. Lilliefors Significance Correction

Formal tests for normality were carried out for the five key delay constructs, both the Kolmogorov-Smirnov (K-S) test (with Lilliefors significance correction) and Shapiro-Wilk (S-W) test, on the collected data ($N = 95$). When testing hypotheses in normality, the null hypothesis (H_0) is that the data is normally distributed. Thus, if the value for significance (Sig. or p-value) is less than the commonly used alpha level of .05 ($p < .05$), the data does not follow a normal distribution and H_0 is rejected.

All the five core constructs are significantly different from normal distribution (empirical results). For the primary target variable, Project & Job Performance, both the K-S test (Statistic = .092, $p = .047$) and the S-W test (Statistic = .963, $p = .009$) yield p-values below the .05 threshold. The pattern is even more non-normal within the categories of causal factors.

This normality test gives the absolute reason to use non parametric (statistical) methods for comparing stakeholders (Clients, Contractors, Consultants) perceptions and the Relative Importance Index (RII) for ranking the delay factors. K-S results unveil that all the three categories reflect Sig. value less than 0.05 (ranging from .000 to .047). Rest of the two exceed .05 which lays the need to apply K-W test.

4.5 Kruskal-Wallis Test

Hypothesis Test Summary				
	Null Hypothesis	Test	Sig.	Decision
1	The distribution of PJP is the same across categories of Education.	Independent-Samples Kruskal-Wallis Test	.264	Retain the null hypothesis.
2	The distribution of DRF is the same across categories of Education.	Independent-Samples Kruskal-Wallis Test	.631	Retain the null hypothesis.
3	The distribution of FEF is the same across categories of Education.	Independent-Samples Kruskal-Wallis Test	.998	Retain the null hypothesis.
4	The distribution of MAF is the same across categories of Education.	Independent-Samples Kruskal-Wallis Test	.056	Retain the null hypothesis.
5	The distribution of CRF is the same across categories of Education.	Independent-Samples Kruskal-Wallis Test	.699	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

FIGURE 4.1: Kruskal-Wallis Test

4.6 Relative Importance Index RII Analysis

TABLE 4.8: Relative Importance Index of Project & Job

S. No.	Questions Project & Job Performance	Relative Importance Index (RII)	Overall Priority Rank
1.	Project performance is frequently compromised because initial timelines are often unrealistic or inaccurate.	0.8631	4
2.	The effectiveness of project planning and scheduling directly correlates with the overall success of the construction phase.	0.8189	6
3.	Slowness in decision-making by stakeholders acts as a significant bottleneck for timely project completion.	0.8463	5

Table 4.8 continued from previous page

S. No.	Questions Project & Job Performance	Relative Importance Index (RII)	Overall Priority Rank
4.	High levels of performance require strong communication and coordination among all project teams.	0.9200	2
5.	Maintaining strict quality control standards is essential to prevent rework and performance lags.	0.800	7
6.	Weak site management often leads to poor day-to-day scheduling, which negatively impacts labor productivity.	0.9936	1
7.	A gap in technical labor skills specifically slows down the specialized requirements of high-rise construction.	0.7600	8
8.	The low efficiency or shortage of specialized equipment can stall vertical growth and overall site performance.	0.8189	6
9.	Performance is hindered by slow CDA compliance certification and bureaucratic hurdles in obtaining NOCs.	0.9063	3
10.	The effective use of advanced management strategies is necessary to mitigate delays and maintain high performance levels.	0.8189	6

Prioritization by respondents leads to the RII rankings of top specific drivers of disruption in each category. Project & Job Performance reflects Weak site management leading to poor day to day scheduling is the top concern (RII = 0.9936) closely followed by strong communication/coordination needs (RII = 0.9200).

TABLE 4.9: Relative Importance Index of Design Related

S. No.	Questions Design Related Factors	Relative Importance Index (RII)	Overall Priority Rank
1.	Frequent design modifications are made during the construction phase.	0.8694	2
2.	Lack of relevant experience within the consultant's design team	0.8126	3

Table 4.9 continued from previous page

S. No.	Questions Design Related Factors	Relative Importance Index (RII)	Importance Index (RII)	Overall Priority Rank
3.	Delays in the review and approval of design documents.	0.8168		3
4.	Mid-construction changes are made to material types and technical specifications.	0.802		4
5.	Inadequate site surveys and data collection are made prior to finalizing the design.	0.8042		4
6.	Limited utilization of advanced engineering and design software is made.	0.9063		1

Design-Related Factors reflect the most common problem is the limited use of advanced engineering and design software ($RII = 0.9063$), and the frequent changes in design during the construction phase ($RII = 0.8694$).

TABLE 4.10: Relative Importance Index of Financial and Economic Factors

S. No.	Questions Financial and Economic Factors	Relative Importance Index (RII)	Importance Index (RII)	Overall Priority Rank
1.	Contractor payments are frequently delayed.	0.8863		2
2.	Material price fluctuations heavily impact the project budget.	0.9031		1

Financial and Economic Factors reflect that Material price fluctuation is the top ranked factor that has a significant impact on the project cost ($RII = 0.9031$) compared to contractor payment delays ($RII = 0.8863$).

TABLE 4.11: Relative Importance Index of Management and Administrative

S. No.	Questions Management and Administrative Factors	Relative Importance Index (RII)	Importance Index (RII)	Overall Priority Rank
1.	Delays frequently occur due to the management's inability to optimize resource allocation.	0.7663		3

Table 4.11 continued from previous page

S. No.	Questions Management and Administrative Factors	Relative Importance Index (RII)	Importance Index (RII)	Overall Priority Rank
2.	The administrative process for late reviewing, negotiating, and approving varied orders is highly inefficient, causing prolonged project stagnation	0.7600		3
3.	Inadequate site supervision and weak administrative control over subcontractors lead to frequent construction defects, necessitating time-consuming rework.	0.7621		3
4.	The administrative workflow for approving architectural drawings, material submittals, and progress invoices is excessively delayed by the consultant or client.	0.7494		2
5.	Quality control measures on site are strictly inadequate.	0.8021		1
6.	Weak site management disrupts the efficiency of daily scheduling.	0.7957		2
7.	Structural conflicts regularly occur between the consultant and the design engineer.	0.7284		4
8.	Advanced project management strategies are rarely utilized to mitigate delays.	0.7600		3

Management and Administrative Factors got the major priority (RII = 0.8021) strictly inadequate site quality control measures.

TABLE 4.12: Relative Importance Index of Code and Regulatory

S. No.	Questions Code and Regulatory Factors	Relative Importance Index (RII)	Importance Index (RII)	Overall Priority Rank
1.	Unstable Political situation causes delay.	0.8147		3
2.	Delay in obtaining permits and licenses from authorities.	0.7768		3
3.	Whether project location is related to delay.	0.7642		3

Table 4.12 continued from previous page

S. No.	Questions Code and Regulatory Factors	Relative Importance Index (RII)	Importance Rank	Overall Priority Rank
4.	Bureaucratic hurdles were present in obtaining NOCs.	0.8442		2
5.	Slow CDA process causes delay in project handover.	0.8505		1

Code and Regulatory Factors reflect the slow official processes in CDA office causing project handover delay comes in at the top of the list of regulatory challenges (RII = 0.8505), and bureaucratic problems for acquiring NOCs follow at 0.8442.

TABLE 4.13: Integrated Delay Factors Based on RII

Operational Framework Dimension	Core Construct Category	Relative Importance Index Score	Priority Rank	Threshold Classification	Significance
Project & Job Performance	Weak site management often leads to poor day-to-day scheduling, which negatively impacts labor productivity.	0.9936	1	Critical	Significance
Project & Job Performance	High levels of performance require strong communication and coordination among all project teams.	0.92	2	High-to-Critical	Significance
Design-Related Factors	Limited utilization of advanced engineering and design software is made.	0.9063	3	High-to-Critical	Significance
Project & Job Performance	Performance is hindered by slow CDA compliance certification and bureaucratic hurdles in obtaining NOCs.	0.9063	3	High-to-Critical	Significance
Financial and Economic Factors	Material price fluctuations heavily impact the project budget.	0.9031	5	High-to-Critical	Significance
Financial and Economic Factors	Contractor payments are frequently delayed.	0.8863	6	High	Significance
Design-Related Factors	Frequent design modifications are made during the construction phase.	0.8694	7	High	Significance
Project & Job Performance	Project performance is frequently compromised because initial timelines are often unrealistic or inaccurate.	0.8631	8	High	Significance

Table 4.13 continued from previous page

Operational Framework Dimension	Core Construct Category	Relative Importance Index Score	Priority Rank	Threshold Classification	Significance
Code and Regulatory Factors	Slow CDA process causes delay in project handover.	0.8505	9	High	Significance
Project & Job Performance	Slowness in decision-making by stakeholders acts as a significant bottleneck for timely project completion.	0.8463	10	High	Significance
Code and Regulatory Factors	Bureaucratic hurdles were present in obtaining NOCs.	0.8442	11	High	Significance
Project & Job Performance	The effectiveness of project planning and scheduling directly correlates with the overall success of the construction phase.	0.8189	12	Moderate-to-High	Significance
Project & Job Performance	The low efficiency or shortage of specialized equipment can stall vertical growth and overall site performance.	0.8189	12	Moderate-to-High	Significance
Project & Job Performance	The effective use of advanced management strategies is necessary to mitigate delays and maintain high performance levels.	0.8189	12	Moderate-to-High	Significance
Design-Related Factors	Delays in the review and approval of design documents.	0.8168	15	Moderate-to-High	Significance
Code and Regulatory Factors	Unstable Political situation causes delay.	0.8147	16	Moderate-to-High	Significance
Design-Related Factors	Lack of relevant experience within the consultant's design team	0.8126	17	Moderate-to-High	Significance
Design-Related Factors	Inadequate site surveys and data collection are made prior to finalizing the design.	0.8042	18	Moderate-to-High	Significance
Design-Related Factors	Mid-construction changes are made to material types and technical specifications.	0.802	19	Moderate-to-High	Significance
Project & Job Performance	Maintaining strict quality control standards is essential to prevent rework.	0.8	20	Moderate-to-High	Significance
Code and Regulatory Factors	Delay in obtaining permits and licenses from authorities.	0.7768	21	Moderate	Significance
Code and Regulatory Factors	Whether project location is related to delay.	0.7642	22	Moderate	Significance
Project & Job Performance	A gap in technical labor skills specifically slows down the specialized requirements.	0.76	23	Low-to-Moderate	Significance

4.7 Discussion

The main objective of the research was to identify the key factors that cause delay in building project, and study their effects on construction project's performance. Finally, is to prepare a set of guidelines that could play decisive role in mitigating delay factors. Multi-construct Relative Importance Index Analysis (RII) was used to achieve the first objective aimed at identifying and ranking the major causes of delay in high-rise buildings of Islamabad. This was a statistical mapping of 30 'operationalized' variables in project environments identifying major deficiencies in management, regulatory issues and supply chain constraints. The objective two evaluates the systemic impact of the factors identified above by measuring the precise impact of such factors on project measures of success. Finally, statistical tests like statistics, normality test, RII test were performed as per Objective three to gain the statistical view and effectiveness of the proposed risk-priority guidelines.

The empirical analysis has been repeatedly showing that administrative and management weaknesses (in particular weak site management and poor planning) are the most significant factors in the disruption index. The systemic failure is that there is a fundamental sense of disintegration in the local construction culture with regard to accountability. The requirement for highly integrated and real-time logistics tracking in high-rise projects is matched by the often-old-fashioned hierarchical structures that exist within local project management, and communication between multiple levels of subcontractors, structural engineers and site supervisors still disjointed. In realism, this structural collapse adds to grave logistic bottlenecks. For example, the lack of coordination during material lifting and handling operations causes the tower crane and material lift to idle or face extreme difficulties, which slows down the construction speed, particularly in areas higher up, and can even temporarily stop downstream finishing work.

At the same time, delay in approvals by the Capital Development Authority (CDA) bureaucracy present unique institutional constraints of Islamabad territory, with their high RII scores. Unlike horizontal infrastructure projects, in vertical high-rise projects in the federal capital there is strict multi-agency monitoring, dense zoning

and changing floor-area ratio (FAR) and height-clearance regulations. There is no agile and common digital clearance portal between the institutions, and the clearance process for digital products rather long and bureaucratic. These regulatory bottlenecks result in significant time delays in the unplanned phase in the project lifecycle at the beginning. As the developers wait for the basic approvals and No Objection Certificates (NOC) for the height of the project, nothing happens at the physical location, creating economic quarters that are unpredictable, and directly impacting the project on macro-economic shocks. This exposure is extremely magnifying the effect of price fluctuations of materials, which became a high-impact, volatile financial delay factor. This is because macroeconomic instability, rapid currency devaluation and inflation in the supply chain in the domestic economy is a factor. The majority of building materials are energy intensive, and dependent on inputs from other countries, so that a change in world energy markets has immediate impact on local building material suppliers. In high-rise situations, this type of commercial friction comes in the form of an instant cash-flow stop. If raw material prices rise during a contract, there will be disputes between a client and a contractor if they have a fixed price contract.

Disputes between a client and a contractor will occur if the price of raw material rises mid-contract and the contract has a fixed price or if the escalation clause is not well designed. Site managers are forced to postpone structural concrete pours with the project being extended in general due to supplier' canceling deliveries to deal with credit risk.

This research points to some contacts and differences with the international, regional and historical building documents. Pervious financial constraints and site management failures in Islamabad were found to have a strong predictive value that is well correlated with other studies on construction failures in developing markets. For example, the results echo the published global research that shows poor site management and cash-flow problems faced by contractors are common causes for delays in projects across the developing economies. On the regional level, the findings align with past infrastructure studies in Pakistan, which showed that fluctuations in the prices of materials are a chronic and unknown source of stress

that regularly disrupts the predictable construction workflows of the national infrastructure sector. This study, however, differs greatly from general infrastructure studies in its specific exploration of vertical space. Generic labor productivity and equipment failures are dominant on the risk index for general construction studies, but the thesis shows that spatial constraints and institutional design checks are key risks on high-rise projects. The high-density high-rise sector in Islamabad faces high constraints as compared to other sectors of a horizontal residential development. In vertical projects, the compounding loss of rental or commercial capitalization rises much faster than in horizontal development projects, daily.

In addition, the specific regulatory challenges of the local CDA heights constraints is a specific administrative constraint, not found in other national or rural construction studies.

To justify the novelty of the study of high-rise buildings in Islamabad, which is transforming from a strictly regulated, low density horizontal landscape to rapid vertical urbanization Islamabad, considered to be the administrative capital of Pakistan, is going through massive structural change because of the implementation of new building height regulations in 2019. This makes this study unique in the context of a planned horizontal city being adapted to a vertical density at a real-time. This provides a sufficient test to evaluate the effect of rapid high-rise development on microclimates, seismic risk management (as Islamabad is near active fault zones such as Main Boundary Thrust) and infrastructure stress caused by high rise development originally designed for low rise areas. Moreover, the current literature in the realm of high-rises is largely concerned with hyper-dense mega-cities that made their ascent in several centuries, such as Dubai, New York or Hong Kong. Yet another model is that of Islamabad - a medium-sized, socio-economically distinct South Asian capital, in a delicate balance between enforcing environmental protection (for example, Margalla Hills National Park) and financing the real estate. The study's analysis of this particular landscape is of particular geographical interest because it adds to urban planning literature opening new, empirical perspectives on sustainable vertical growth, structural resilience and community adaptation of newly verticalizing cities in the developing world.

Results driven by this study were conveyed through e-mail to the sampled Engineers, contractors, and other professionals for their feedback and subsequent suggestions on ranking index of delayed factors; their suggestions enabled this research to develop doable recommendations.

Chapter 5

Conclusion and Recommendations

5.1 Background

The empirical findings and statistical relationships are now brought forward to the academic arena to provide a context for the results of the present study in relation to historical investigations. A comprehensive literature review identified a need for effective indicators of safety that are actionable and proactive, followed by a data analysis that offered the empirical data for understanding what sensing metrics, worker behaviors, and site conditions relate to near-miss occurrences. This chapter combines the two, examining the extent to which the particular experiences of high-rise construction fit into or conflict with current international safety frameworks. In combining theory with empirical realities, this discussion outlines the overall contribution this study makes to the broader body of construction safety literature and what implications this has for hazard mitigation in real time on active jobsites.

This chapters presents conclusion, Recommendations, Theoretical Implications, Managerial Implications and Limitation faced by this study and recommending future directions for further research.

5.2 Conclusion

This study aimed to explore the key factors causing the time delays in high-rise construction projects in Islamabad, Pakistan. This study involved 95 key industry players, mostly highly educated consultants, contractors, and site engineers, who were based in a number of key locations including Gulberg Greens, Blue Area, and DHA. The study was designed to measure the effect of different risk factors affecting project performance and job performance. The empirical results indicate that Design-Related Factors (DRF) have the biggest influence on project delays and account for 37.9% of the variance of the project performance ($R^2 = .379$, $p < 0.001$). Of these, the lack of use of advanced engineering and design software ($RII = 0.9063$) and the number of design changes during construction (0.8694) are serious constraints.

Second, the Code and Regulatory Factors (CRF) (20.5% $R^2 = .205$, $p < 0.001$) were the second most significant predictor. The slow Capital Development Authority (CDA) approval process ($RII = 0.8505$) and the thick bureaucratic layers in obtaining No-Objection Certificates (NOCs) ($RII = 0.8442$) are the key reasons. Financial and Economic Factors (FEF) ($R^2 = .064$) and Management and Administrative Factors (MAF) ($R^2 = .053$) had lower total predictive weight in the regression models, but specific items in those models are still considered to be very critical. Of particular concern, macroeconomic instability in the form of raw material price fluctuations ($RII = 0.9031$) and operational shortcomings such as weak site management with poor day-to-day scheduling ($RII = 0.9936$) severely limit the vertical development of high-rises. To conclude, high-rise delays in Islamabad is a multi-faceted problem that is largely technical design related and externally regulatory inefficient.

5.3 Recommendations

Based on the above deliberations, the following measures are recommended to adopt for each stakeholder;

5.3.1 Recommendations for Clients or Developers

- i. **Set Up Secure Financial Backing:** Since cash flow problems often cause delays, clients should create secure escrow accounts or bank guarantees that are only used for project milestones. This helps ensure that payments to contractors are made within the 14 to 30-day timeframe, stopping supply chain issues from happening.
- ii. **Avoid Changes Late in the Project:** Before starting construction, clients should focus on detailed planning and finalize the building design.
- iii. **Choose Contractors Based on Value:** Instead of just picking the cheapest option, clients should use a scoring system that looks at both technical skills and financial stability. This ensures the contractor is strong enough to handle the challenges of high-rise building.

5.3.2 Recommendations for Contractors

- i. **Improve Supply Chain Management for High-Rises:** Contractors should plan ahead for materials instead of waiting until the last minute. Important equipment like cranes and pumps should be ordered or rented with maintenance plans to avoid breakdowns at high levels.
- ii. **Use Up-to-Date Scheduling Tools:** Replace old Gantt charts with more flexible project tools like Critical Path Method (CPM) combined with real-time tracking. This helps site managers plan better and spot problems before they cause delays.
- iii. **Train Workers in Specialized Techniques:** Working with technical schools to teach workers skills such as advanced formwork techniques, concrete pouring, and high-altitude safety can boost daily output and improve safety on the job.

5.3.3 Recommendations for Consultants

- i. **Make Sure Designs Are Buildable:** Consultants should check that all structural plans match the architectural, mechanical, electrical, and HVAC designs before starting the project. This reduces delays caused by conflicting plans.
- ii. **Speed Up Document Reviews:** Create a strict agreement for approving contractor questions and material submissions, making sure they are approved within 7 business days.
- iii. **Be Proactive on the Site:** Instead of waiting for problems to appear, consultants should actively check the site and help fix issues like structural misalignment before concrete is poured.

5.3.4 Recommendations for the Capital Development Authority

- i. **Create a Fast-Track Approval Portal:** The CDA should set up a single online system for high-rise building permits. Using an automated system can process approvals for structure, environment, and safety much faster, going from months to weeks.
- ii. **Update Zoning Rules:** Since more buildings are going vertical, the CDA must update rules about land use, space ratios, access for big machinery, and required setbacks to prevent legal problems between properties.
- iii. **Do Regular Structural Checks:** Because Islamabad is near fault lines, the CDA should require third-party checks during design and surprise tests on materials to make sure everything meets the Pakistan Building Code.

5.4 Theoretical Implications

This research makes a valuable addition to the existing project management literature, and specifically to the development of economies in South Asia.

Although much delay literature lumped together the word ‘infrastructure’, this study distinguishes variables related to high-rise dynamics (such as specific equipment shortage, vertical logistics), this research study contributed to enlarge the field of Delay Frameworks for Vertical Infrastructure.

This study contradicts the tenet in construction literature that financial liquidity is always the most important cause of delay, by shifting the focus of empirical analysis from the financial to the design determinants. It empirically shows that in institutional settings such as Islamabad, the design optimization and technological adoption (DRF) have a much better predictive power on performance ($R^2 = .379$).

Overall Cronbach’s Alpha (0.90) indicates the structural validity of the combination of institutional, financial and technical construct in one explanatory model for developing markets, due to the high internal consistency of the model.

5.5 Managerial Implications

Project managers, developers and industry practitioners can benefit from this study by learning:

Focus more on Front-End Engineering Design (FEED): Managers will have to spend more time and resources on the advanced software utility and rigorous preconstruction site survey. The single most important way to reduce design errors is to do so early on in the project ($r = .616$).

Stop using idealistic timelines: Project schedulers should be discontinuing using idealistic timelines. Schedulers need to review and establish realistic time-buffer (float) in project baselines, in particular from the CDA and NOC, via proactive efforts.

Increase Quality Control Governance: Poor quality control of the site was the biggest administrative failure ($RII = 0.8021$), and managers need to establish strong independent quality control and quality assurance procedures to avoid re-work which is time consuming and expensive.

5.6 Limitation & Future Research

To move forward in the domain of construction project management, future research should shift from the current approach that looks at things in one moment (cross sectional) to using methods that look over time (Longitudinal) and include new technologies. This will help better understand how Islamabad's buildings are growing quickly and changing. Instead of using simple rankings, researchers should use Structural Equation Modeling (SEM) to uncover the complex and hidden connections between different delays caused by various stakeholders. This approach should also be used in different parts of the country by comparing Islamabad's planned city layout with more crowded, naturally developed areas like Karachi and Lahore. This will help identify differences in rules and regulations across regions. Additionally, future studies should look at how digital tools can improve projects by using 4D/5D Building Information Modeling (BIM) to fix design issues and also train Artificial Intelligence (AI) and Machine Learning (ML) systems with past project data. This will help the local industry change from fixing problems after they happen to predicting and managing schedules automatically.

The limitations and future research for the study are presented in this section. While the research is empirical and provides deep insights into the subject, some weaknesses suggest avenues for further research:

First of all, the limitations came from Geographic Constraint that this study was confined to high-rise buildings in Islamabad (Blue Area, DHA and Gulberg Greens). Future studies should be conducted on other major metropolitan cities in Pakistan, and conduct a comparative study of the regulatory framework and market dynamics of these cities.

Sample Size and Methodological Scope wise, the results are based on 95 respondents and quantitative survey techniques. Further research may use a mixed methodology or semi-structured interviews with the CDA officials to explore the underlying detail and context of the issues of delays in the bureaucracy.

Regarding macroeconomic variables, this study recorded the changes in the price of materials at a given time in space. Longitudinal studies following the immediate ongoing relationship between the national inflation measure and high-rise schedule compliance would create more powerful forecasting tools.

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Appendix

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

Causes of Delays in High-Rise Building Construction Projects in Islamabad

Researcher: Usama Akhter

Objective: This survey aims to identify the factors contributing to construction delays and evaluate their impact on project performance within the Islamabad capital territory.

Dear respondent,

This survey is conducted purely for academic purpose. All data collected will be kept strictly confidential and utilized to extract "Causes of Delays in High-Rise Building Construction Projects in Islamabad" and later use for recommendation purposes only.

Thank you for your valuable time and participation.

** Indicates required question*

Section 1: Participant Information

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

1. Professional Role: **Mark only one oval.*

- ☐ Client
- ☐ Consultant
- ☐ Site Engineer
- ☐ Contractor
- ☐ Other:

2. Organization **Mark only one oval.*

- ☐ Contractor
- ☐ Consultant
- ☐ Client
- ☐ Other

3. Education: **Mark only one oval.*

- ☐ Bachelors
- ☐ Masters
- ☐ PhD
- ☐ Other:

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

4. **Years of Experience:** **Mark only one oval.*

- ☐ 0–5
- ☐ 6–10
- ☐ 11–15
- ☐ > 15

5. **Primary Project Location:** **Mark only one oval.*

- ☐ Blue Area
- ☐ Gulberg Greens
- ☐ DHA
- ☐ Other

Section 2: Project & Job Performance

Please tick the box that is compatible with your level of agreement: ranging from 1 to 5, 1 indicating "Very Low" 2 representing "Low" 3 denoting "Average" 4 signifying "High" and 5 denoting "Very High".

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

6. Project performance is frequently compromised because initial timelines are often unrealistic or inaccurate. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

7. The effectiveness of project planning and scheduling directly correlates with the overall success of the construction phase. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

8. Slowness in decision-making by stakeholders acts as a significant bottleneck for timely project completion. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

9. High levels of performance require strong communication and coordination among all project teams. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

10. Maintaining strict quality control standards is essential to prevent rework and performance lags. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

11. Weak site management often leads to poor day-to-day scheduling, which negatively impacts labor productivity. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

12. A gap in technical labor skills specifically slows down the specialized requirements of high-rise construction. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

13. The low efficiency or shortage of specialized equipment can stall vertical growth and overall site performance. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

14. Performance is hindered by slow CDA compliance certification and bureaucratic hurdles in obtaining NOCs. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

15. The effective use of advanced management strategies is necessary to mitigate delays and maintain high performance levels. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

Section 3: Delayed Factors

1. Design-Related Factors

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

16. Frequent design modifications are made during the construction phase. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

17. Lack of relevant experience within the consultant's design team *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

18. Delays in the review and approval of design documents. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

19. Mid-construction changes are made to material types and technical specifications. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

20. Inadequate site surveys and data collection are made prior to finalizing the design. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

21. Limited utilization of advanced engineering and design software is made. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

2. Financial and Economic Factors

22. Contractor payments are frequently delayed. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

23. Material price fluctuations heavily impact the project budget. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

3. Management and Administrative Factors

24. Delays frequently occur due to the management's inability to optimize resource allocation. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

25. The administrative process for late reviewing, negotiating, and approving varied orders is highly inefficient, causing prolonged project stagnation *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

26. *

Inadequate site supervision and weak administrative control over subcontractors lead to frequent construction defects, necessitating time-consuming rework.

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

27. The administrative workflow for approving architectural drawings, material submittals, and progress invoices is excessively delayed by the consultant or client. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

28. Quality control measures on site are strictly inadequate. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

29. Weak site management disrupts the efficiency of daily scheduling. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

30. Structural conflicts regularly occur between the consultant and the design engineer. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

31. Advanced project management strategies are rarely utilized to mitigate delays. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

4. Code and Regulatory Factors

32. Unstable Political situation causes delay. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

33. Delay in obtaining permits and licenses from authorities. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

34. Whether project location is related to delay. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

35. Bureaucratic hurdles were present in obtaining NOCs. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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Causes of Delays in High-Rise Building Construction Projects in Islamabad

36. Slow CDA process causes delay in project handover. *

Mark only one oval.

- ☐ Very Low
- ☐ Low
- ☐ Average
- ☐ High
- ☐ Very High

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