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Identification of Factors Causing Construction Delays Using Linear Regression Model

by

Usman Hassan

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This humble effort is dedicated to

My Parents

who have taught me to believe in hard work and honest living

My Sister and Shahzaib

For their continuous support

My Supervisor

For his consistent guidance and support

CERTIFICATE OF APPROVAL

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Usman Hassan

(MCE221003)

THESIS EXAMINING COMMITTEE

S. No.	Examiner	Name	Organization
(a)	External Examiner	Dr. Khurram Iqbal Ahmed Khan	NUST, Islamabad
(b)	Internal Examiner	Dr. Syed Shujaa Safdar Gardezi	CUST, Islambad
(c)	Supervisor	Dr. Muazzam Ghous Sohail	CUST, Islambad

Dr. Muazzam Ghous Sohail
Thesis Supervisor
December, 2023

Dr. Ishtiaq Hassan
Head
Dept. of Civil Engineering
13th December, 2023

Dr. Imtiaz Ahmad Taj
Dean
Faculty of Engineering
December, 2023

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(Usman Hassan)

Abstract

Project delays in the construction sector are a persistent challenge that are significantly impacting the timelines, budgets, and overall project success. Understanding and mitigating these delays are crucial for sustainability in the construction industry. The objective of this research was to investigate the potential delay causing factors and impact of delays on time, cost, quality, and scope of a construction in developing country like Pakistan. A Questionnaire was circulated among the experts of construction industry who belong to different backgrounds, such as from contractors, consultants, site engineers, and managers etc. Their post and years of experiences were also considered.

Subsequently, the collected data from 111 individuals was analyzed using correlation and regression analysis in Statistical Package for Social Science (SPSS) version 16. The study included 7 major delay risk categories having 26 delay risk factors, for example, the material and equipment, contractual relations, financial factors, social factors, environmental factors, changes in design and scope, and scheduling and control. In this study, delay causing factors were considered as independent variables, while the delay was considered as dependent variable.

A strong impact of delays has been observed on the time and cost of the projects, findings showed that delays affect the project timelines and cost. Secondly, a positive correlation (r=.455) between changes in design and scope category and the delays has been found. It can be observed from analysis that inadequate design (architectural and structural) factor and changes in design and material during construction factor have positive correlation (r=0.628). This means that both factors influence each other in contributing delays. Through regression analysis of the collected data of this survey, it was interesting to note that most of the expert think that the inadequate design factor (t-test=2.618) is the major contributing factor to delays. In regression analysis of all major categories beta-value (0.284) test, t-test (3.147) and p-value (0.002) test showed that changes in design and scope category have major influence on timelines of projects. The findings emphasize that for the sustainable development, the delays in construction project should be minimized. Since design and scope of a project is in the hands of client,

consultant, and planner, the delays could be minimize by reducing the faulty design and improper planning at early stages. Once the project is in execution stage, any changes will results in delay and subsequently the time and cost of the project.

Keywords: Project delays, SPSS, Delay causing factors, Delphi method, Linear regression, Construction management

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Abbreviations

ANOVA	Analysis of variance
DV	Dependent variable
IV	Independent variable
SPSS	Statistical package for social sciences

Chapter 1

Introduction

1.1 Background

The construction sector holds significant importance in the economic growth of developing countries [1]. The civil Infrastructures like buildings, road networks, and dams have remarkable impact on human development. Completing a construction project within time frame, cost and quality was never been as important and necessary as it is in our times. The time, quality performance, and cost affect the efficiency of any construction endeavor [2]. It has become a challenge to predict the definite time period of a construction project. This process is dependent on several unpredictable factors which contribute to its performance and increase the delays risk [3]. A research on infrastructure projects revealed that project face 50% overrun from the estimated cost. The major reasons behind cost overrun are poor cost estimation, changes of scope and delayed construction activities [4].

Delay hazard is considered among the most challenging issues faced by construction industry around the globe. It is actually the extension in a specified period of project completion. Delays are classified into four major terms; non-excusable delays, concurrent delays, excusable delays without compensation, and excusable delays with compensation [5]. If both contractor and owner are responsible for delays than it is known as concurrent delays. Any unpredictable situation may result in excusable without excusable delays. Tolerance has been given without any permissible delay if it is not a fault of contractor and he may also be not

liable for it. If the owner is responsible for delay and it may interrupt the whole work or some part of it than this kind of delay is referred to as an excusable delay with compensations. If only contractor is responsible for delays than it will be non-excusable delay. Extension of deadline or delay: if the agreed completion time is earlier than actual completion time, the deadline may be extended by the contractor unless the target have been achieved. It has an adverse impact on project performance and has a cost overrun [6].

Delay hazard is a significant and formidable challenge encountered by construction firms. It have negative impacts which include poor productivity, time and cost overrun [7]. This issue often disrupts project timelines, leading to increased costs and potential contractual disputes. Construction companies must face with multiple factors that can contribute to delays, such as adverse weather conditions, material shortages, labor disputes, and unforeseen site conditions. Effectively managing and mitigating delay hazards is important for the successful completion of construction projects. Construction industry require large capital investment due to its complex and very large structure. It has become one of the biggest challenge of construction industry to meet planned deadlines of projects. It has significant impact on individuals involved in projects, cost disputes and may lead to destructive relationships. Its consequences contain the contractor, owner, and consultant in relations of arbitration, disagreement, and litigation. Designer consultant, owner, contractor, labor, material, project, and external factors are the leading factors in delays [8].

Environmental, social and financial factors are considered mainly in the present study to achieve sustainability in construction environment. Sustainable construction practices are important for minimizing environmental impacts and promoting resource efficiency in the building industry. One significant aspect of sustainability is the avoidance of construction delays. It can only be done when delay causing factors will be identified. Delays not only increase costs but also consume additional resources and energy, undermining the overall sustainability of a project [9]. By adopting effective project management strategies, utilizing advanced technology, and promoting collaboration among stakeholders, construction delays can be reduced, leading to more environmentally friendly and economically viable construction projects. Timely completion of projects is not only essential for meeting

project goals but also for ensuring that the principles of sustainability are upheld throughout the construction process.

Identification of delay causes is the first step to minimize the construction delays. It is still questionable to prepare models and tools to encounter the influence of factors contributing to delays. The first step is to investigate the accurate root causes of delays which may differ for each project and region. Most of the studies are related to time overrun as it is major aspect of construction projects [10]. It is also necessary to find the correlation between different factors to check their influence on each other along with delays. So there is need to develop such studies in construction management. In the present study delay causing factors will be identified by questionnaire and statistical methods are used to check precision of data. This research provide valuable insights that can inform more effective project management practices in the construction industry, ultimately leading to more successful and timely construction projects.

1.2 Research Motivation

Construction delays can significantly disrupt the allocated financial resources and result in cost overruns. To tackle this issue, it is needed to evaluate the factors that contribute to these delays. By identifying and addressing these underlying causes, such as unforeseen weather conditions, material shortages, or inadequate project management, construction projects can better adhere to their timelines and budgets, ultimately fostering a more sustainable and efficient construction industry.

Construction industry is facing major financial issues due to delays in construction. It can be overcome by proper assessing the delays causing factors and their sources which affects the time, scope, quality and cost of construction projects. It has been observed that involvement of linear regression model in the construction industry gives more precise and accurate results. So, that there is need to assess delay causing factors by obtaining survey and interpreting these values through statistical methods. This study will not be a one-time analysis. Instead, it will establish a framework for continuous improvement in risk prediction. As new data

becomes available, the models and techniques will be updated to maintain their accuracy and relevance.

1.3 Research Questions

- What measures can minimize the delays in the construction sector, especially in the local construction industry?
- How data can be assessed to figure out the impact of delay factors on time, cost, quality, and scope of project?
- Is it possible to use linear regression models with SPSS (Statistical package for social sciences) to interpret the values and generate precise outcomes?

1.4 Research Objective

1. The primary objective of this research is to identify the potential delay causing factors in the local construction sector.
2. It also involves a questionnaire survey to access the effect of different variables on time, cost, quality and scope of construction project.
3. To overcome uncertainties in prediction, the linear regression model through SPSS will be used to generate precise output.
4. This study aims to equip project management authorities with a proactive tool that enables them to anticipate and manage the likelihood of delays effectively, thereby enhancing overall project management and success.

1.5 Methodology

The method used, involves the identified factors, sources of delays and linear regression model as shown in figure 1.1. The questionnaire is designed to identify factors causing delay and their influence on time, quality, cost and scope of construction endeavors. Previous literature is used to identify the most potential

factors contributing to delays and Delphi method is used to validate the quality of questionnaire.

FIGURE 1.1: Methodology of Research

Questionnaire is divided into three parts: general information about the respondent in the initial section and the second section contain the question related to impact of construction delays on time, cost, quality and scope. The third section include the impact of delay causing factors on delays. The questionnaire is circulated in well reputed firms to get reliable feedback from local construction industry.

After completion of the questionnaire, data analysis was conducted utilizing a linear regression model and the SPSS tool. The outcome shows the most influential categories and factors that contribute significantly to the extension of planned timelines.

1.6 Research Novelty and Practical Implementation

According to the literature study and research analysis, use of regression models have significant role in the construction sector so it needs to be involved in local construction industry. It is also necessary to find out the factors which contribute to delays, so they can be considered at the initial stages of any project.

It can provide precise outputs which can be further used in construction projects to address the gaps between the sustainable construction. It also need to mention

that with time different factors change their trend on delays. So, recent research include updated responses of local construction industry. The analysis include not only identification of factors only but it also include major categories analysis and correlation analysis to check their relationship.

1.7 Thesis Structure

Thesis consist of five major chapters. These are:

Chapter 1 covers the introduction to problem in hand. It describes the delay factors and their impact, motivation of research, research objective, research methodology, and thesis layout.

Chapter 2 contains literature review. It consists of theoretical review, delays types,sustainability in construction projects, causes of delays, delays effects on construction projects, strategies to reduce delays, delay causing factors, empirical review and conceptual study of delay in construction project.

Chapter 3 explains the material and methods involved in assessment of delays which includes research approach and design, variables, data sources, and data collection methods, along with techniques for analysis. It also includes ethical considerations of study and validity of study.

Chapter 4 gives results and discussion of data analyzed in study which include general information of respondents, impact of construction delays on iron triangle and delay causing factors, impact of individual delay factors and impact of all major delay categories.

Chapter 5 outlines the conclusions and future recommendation.

At the end, the Annexure and References are provided.

Chapter 2

Literature Review

2.1 Theoretical Overview

The portion contain the detailed delays background, its causes and implications. Moreover, different studies related to construction delay assessment has been discussed. It covers experiences, findings, and trends, the study extends its scope to include diverse perspectives from both developed and underdeveloped countries, offering a comprehensive understanding in the construction industry.

2.1.1 Construction Projects

Different scholars defined the terminology 'project' in different ways. Definition of project is, ''A project is a temporary endeavor started to generate a unique output, result, or service" [11]. Any multitask, unique and one-time job having defined budget, work scope, team, starting and ending point is defined as project. It usually involves conflicts, need resources and require a specific capital for its completion. Completion of project depends on the achievement of goals and objectives set by the stakeholders [12]. Construction comprises of time consuming, heterogeneous, and complex activities and processes. Several unpredictable situations usually happen during construction projects. The characteristics of any two construction projects can never be similar to each other. There must be uniqueness between both [13].

2.1.2 Delay Definition

Delay is the situation when defined objectives do not complete in defined time period. In construction projects delays occur when project go beyond contractual deadlines. This situation usually happens to nearly all projects undertaken in construction industry [14].

Delays represent that the progress of the project is slower than the intended speed. To be precise it is the extension of time in completing the work from the time-frame defined in contractual documents [15]. Delay could also be defined as construction projects suffering from time overruns or set of people not able to attain their objectives during the completion time defined in the contract in the construction projects. These are actually are time extensions without ending construction task completely [16].

2.1.3 Delay's Classification

Delays are majorly classified into four major categories,

i. Concurrent or non-concurrent delays

ii. Excusable or non-excusable delays

iii. Non-critical or critical delays

iv. Compensable or non-compensable delay [17]

2.1.3.1 Concurrent or Non-concurrent Delays

Delays are Concurrent or non-concurrent when two independent delays or more happen in the similar time frame [18]. It has more significance if risk is expected to both parties; employer and contractor at the same time. In addition, if risk is expected at different times but its effect is equivalent than it is also referred as concurrent delays.

Concurrent delays, characterized by the simultaneous occurrence of different delays, can impact the critical path by introducing a complex interplay of multiple

time constraints. These are alternatively referred to as commingled delays, overlapping delays, and simultaneous delays and entangled delays [19].

2.1.3.2 Compensable or Non-Compensable

Delays with compensations are unavoidable extensions which occur if contractor is facing financial recovery from employer's side [20]. Employer's risk event is in result of direct and indirect cost in relation to time. These delays are mostly happening due to unavailability of proper shop drawings and design procedure, but some other responsible factors from owner side are like excessive owner involvement, changes in design during construction, and owner's incompetence to provide detail drawings. On the other side, in non-compensable delay contractor cannot get any compensation in result of any excusable delay. For that reason, a delay issue which may get covered should be resolved earlier. Contract term should clearly define about the delay type whether it is compensable or not. Usually, non-compensable delays are outlined in contractual documents which defines that no compensation will be given to contractor in terms of cost but time extension may be allowed [21].

2.1.3.3 Excusable or Non-Excusable Delays

Non-excusable delays are predictable time extensions and these can be controlled by contractor. The major factors of non-excusable delays are delays in subcontractor's work, late delivery of material from suppliers, inexperienced contractor or subcontractor, and labor disputes on project site caused by either unfair labor practices [22]. Non-excusable delays occur by the contractor or its suppliers. To compensate to owner, they are allowed to speed-up their processes in the defined time period. These compensations may be based on either actual damages or liquidated damages.

The major reason behind project based labor strike is unfair labor role or contractor's role in which he refuses to pay labor representatives. Contractor and owner have no control over excusable delays, like natural disasters, severe weather conditions and unforeseen future actions [23].

2.1.3.4 Critical or Non-Critical Delays

Critical delays act as a prevention to contractor for completing the respective project or activities as defined in the contractual documents while their is no significant impact on project deadlines by non-critical delays [24]. It has been shown that planned deadline of project is not affected by non critical delays but it significantly affects the activities in progress. Thus, categorizing delays as critical helps distinguish between those excusable and those considered inexcusable.

Delays which disturb the project timelines or its activities are termed as critical delays whereas non-critical delays do not disturb the defined timelines or project or individual activities. Delays in such activities will delay the closure date of project. Project ending date is controlled by some activities which depends on, the project itself, project's physical constraint, the contract requirement for phasing and sequencing, and schedule and plan of contractor [25].

2.1.4 Sustainability in Construction

Sustainability in the construction industry can be significantly enhanced through the proactive assessment and anticipation of project delays. Various research papers have explored this vital aspect of construction management. One study emphasized the importance of integrating sustainability considerations into construction delay assessment, highlighting that by doing so, construction projects can not only meet their completion timelines but also reduce environmental impacts and resource wastage [9]. Zhang et al. concluded in his study that the use of advanced data analytic techniques to predict delay risks accurately. Emphasizing how these predictive tools can assist in making informed decisions that helps to achieve sustainability goals [26].

Furthermore, another study emphasized the need for proactive risk mitigation strategies, such as effective stakeholder communication and adaptive project planning, as essential components in ensuring sustainable construction practices by mitigating delay [27]. It has also been observed that increased project duration not only disturbs the planned cost of project but also increase the carbon emission in the environment due to increased construction time. These research findings

collectively underscore the pivotal role of forecasting delay in achieving sustainability objectives within the construction industry. They highlight the crucial need for proactive measures and strategic planning to mitigate delays, emphasizing the integral link between timely project completion and broader sustainability goals in construction sector.

2.1.5 Causes of Delays

In the local construction sector, a prevailing trend is the widespread adoption of traditional contract approaches, reflecting a steadfast reliance on established methodologies for project execution and management. In construction sector, planning and supervision of projects is responsibility of engineers, architects and surveyors. Other stakeholders are client, procurement managers, contractor and subcontractors. Due to this complex structure of stakeholders, there is complex situation and pressure on individuals. The below is the detailed literature of delay causes.

Delays can happen in any construction projects; their intensity vary from project to project. In research industry, there are numerous studies on delay causes in construction projects. This study is validated by findings of such studies. Delay causes has been categorized into eight major groups: 1. Contractor-contributed factors include inadequate experience, errors and poor design procedures details, poor planning and management, and subcontractor's delays. Contractor is responsible for selecting subcontractor so delays by subcontractors also falls in delays caused by contractor, 2. Client-contributed factors include excessive owner involvement, delayed decisions, unrealistic timelines, and issuance of timely payments, 3. Consultant-contributed factors include delayed contract management, quality controls, inspection and testing and drawings approvals, 4. Equipment and labor factor includes, availability of equipment, workman productivity and availability, 5. External factors include, personal strikes, severe weather conditions and unfavorable site conditions, 6. Key factors include defects and quality, 7. Contractual management linked factors include miscommunication and disputes among various parties, 8. Contractual factors include, inconsistencies and errors in contractual documents [28].

Delays can be forecast by different methods, but traditional practice is to analyze the delays at design and execution stage. Most of the time lags and inefficiencies happen in the start of project which is mostly planning phase. Before staring of onsite delay events, it is significant to figure out delay causes in design phase [29]. It is challenging task, but the most common delay events are: inappropriate contract form and packaging strategy, inadequate specifications, poor definition of project, bills, contract drawings. In addition, requirements of employers include: allocation of insufficient budget, poor contingency plans for risk, poor development of design, inadequate project manager and team, poor selection of plant, lack of communication in planning, and incomplete information about site condition [30].

Research conducted by Kumar on delay causing factors categorized into seven different groups: consultant related causes, causes related to equipment,external causes, material related causes, contractor related causes and causes relating owner/client [16]. The factors related to contractors have more significant impact in occurrence of delays than consultant and owner related factors. The overall impact of external factors on delay events is less than other factors. Lack of communication between various project related groups is found to be a major cause of delays while external factors like unavailability of construction material and equipment, and inexpert manpower comes next to it.

Susanti, Fauziyah [31] conducted a study on delays assessment in Indonesia using SPSS tool, in which they circulated questionnaire and concluded their findings after taking 40 responses from experts. Land acquisition delay remains the most influencing delay causing factor in Indonesian construction industry. Srinivasan and Rangaraj [32] used a similar methodology and considered 17 factors and took 152 responses from field. They considered major delay risk factors which includes: social risk factors, management risk factors, environmental risk factors, technical risk factors, market risk factors and legal risk factors. Management and market risk factors has major impact on risk management in construction sector.

In Indian construction industry, research was conducted on delays assessment and cost overrun using SPSS tool have considered 35 different delay causing factors [33]. They circulated questionnaire with 33 construction management experts and their findings include five most influencing factors including, poor planning and

time estimates, poor cost estimates, poor workman-ship, changes in design and specifications after execution, and poor communication between various parties. Ismail and Khoiry [34] conducted a study on delays forecasting in Libya on road construction projects. They get data from field through circulating 256 responses on 39 delay related selected factors. Findings of study show that five major factors are more influencing in road construction, which are: unrealistic timelines, sub-surface effects, unavailability of proper budget for project, delayed utility services transfer and conversions by concerned individuals and client delayed payments in construction projects. The research conducted by Motaleb and Kishk [35] is related to delays effects and causes on construction endeavor in United Arab Emirates (UAE). Questionnaire is circulated to fifty construction experts and the data is validated through SPSS tool. Total 42 delay factors were considered in the study. Financial factors, owner-related factors and changes in design during construction are considered among the most influencing factors from all factors selected for this study.

Delays causes are also important to be investigated in national highway projects rather than only on building projects. Data collected from 79 different experts and after collection, data is validated through SPSS tool [36]. Out of total twenty-nine selected factors, researchers have concluded with top 10 most influencing factors. Delayed payments by owner, poor procurement safety measurements, inadequate team, low bid projects, unavailability of equipment, land acquisition, inexperienced contractor, unfair procurement process, contractor's financial issues, errors in design and estimates.

Another research on project timelines found that project monitoring and evaluation factor is considered among the most significant factor in forecasting delay level [28]. They considered 20 different factors and after circulating 65 questionnaires, SPSS is used to validate findings. Financial or economic related delays are found to be most influencing reason for delayed projects in Iranian construction industry [37]. In Egyptian mega industrial construction projects, out of 70 selected delay causing factors, unclear responsibility matrix, delayed consent and permits, delayed procurement process, delayed subcontractor's work, compliance risk and inadequate management factor are found to be more contributing factors to delays [38].

Sanni-Anibire et al. a research on delays assessment in tall buildings showed that 48 respondents have dominant point of view about 36 selected delay factors is that the major delay causes are delays in approval of materials and drawings, delayed sub-contractors work, delayed decision making, and late issuance of instructions [7]. Similar study in Malaysia on delays factor assessment is in building construction projects. Four categories are considered in that study: owner's responsibility, external factors, issues related to contractor, and client's responsibility. Client related issues are, shortage of manpower, poor productivity of manpower, construction errors, unavailability of material, financial issues, poor communication, inexperienced subcontractors, delayed material delivery, equipment shortage, poor management.

The most influencing delay causes in Malaysian construction industry are found to be, poor site management, delayed decision making, late material delivery, delays in diving instructions, improper supervision, financial issues, work errors, inexperienced consultant, material shortage in market, and incomplete documents. External factors poor economic condition, extreme weather conditions, changes in regulations and laws, material shortage, unavailability of equipment, and poor site conditions [28]. Within the country, the causes of project delays differ from one project to another. This divergence is rooted in factors such as the specific construction type employed, the nature of the procurement process undertaken, and the unique geographic location of each project within the country. This initiates a spectrum of challenges, necessitating diverse approaches to address and mitigate delays, as each project presents unique obstacles that require tailored solutions and strategic management. Recognizing and adapting to the distinct challenges posed by each project becomes essential for successful and timely completion.

2.1.6 Effect of Delays

Construction delays are considered among the perennial issues in construction sector. Delayed projects either got accelerated or most of the time their timeline goes beyond estimated duration of project. The most significant impact on delayed projects is cost overrun. The delay issue has been extensively emphasized by various scholars, leading to a unanimous conclusion that delays invariably exert a

detrimental impact on construction projects. Their insights underscore the imperative for effective project management strategies to minimize delays, reinforcing the critical significance of timely execution in ensuring project success and overall industry advancement.[39]. Completion of project in planned time and budget is major goal of all stakeholders and to deliver it with highest possible quality. Usually time delays have negative impact in construction sector due to different reasons and site conditions. Time delays, litigation,disputes, cost overrun, abandonment and arbitration are considered among the most common delays effect in construction sector [40].

Effects of delays are compromised product quality, disputes, low-profit margin, arbitration, time overrun and cost overrun, abandonment and litigation of project, and project cancellation in construction projects [41]. In Pakistan, cost and time overrun, negotiations, disputes, abandonment and court cases are considered among the most significant effects of delays [42]. The Nigerian construction industry found that seven delay effects significantly effects their projects. These are: total abandonment of project, poor public relations, time and cost overrun, litigation, claims, compromised project quality and disputes in construction endeavors[43].

Different parties have different consequences of delay. Loss of time, cost and capacity are most common consequences of delays. For contractor, the major consequences of delay are time loss and money loss with respect to additional expenses of labor cost, material and equipment used to incorporate with delays. For owner, unavailability of facilities and low profit margin are major delays effect [44]. Different studies on the effects and causes of construction delays have consistently established that budget overrun and time delays are the most basic and prominent delay effects. These findings emphasize the critical importance of effective project management and risk mitigation strategies to address these challenges, ensuring smoother construction processes and successful project outcomes[45]. Late project completion, third-party claims, work disruption, increased time-related costs, and contract termination emerge as significant effects of delays in construction projects. These consequences underscore the need for comprehensive risk assessment and proactive management to enhance project resilience and overall success in construction sector.

After assembling the project team, the project commences, marking the initiation of the collaborative efforts towards successful execution. Their main goal is to reach milestones within the expected time frame. This process utilizes the major part of allocated budget. The process is performed throughout the life cycle of project and is termed as project monitoring and controlling [46]. This process includes providing corrective measures if plan get deviated, prevent project against scope creep, and observation of projects performance and progress. It includes progress tracking process, comparison between predicted and actual outcomes, analysis of impacts and variances, and also doing corrections in it [47]. Monitoring and controlling is necessary where there is need to take back the team on track, comparison between plans, variance measurement and corrective measures to incorporate it in the construction industry. Project closing process group is responsible for reviewing a project, to check its achievement level with objectives and closure of contract, to do administrative closure and financial closure in construction sector[48].

2.1.7 Project Monitoring

Project monitoring is the process of collecting necessary data to make best decisive actions at best time with putting minimum efforts. The gathered data covers necessary and significant information for evaluation, analysis, reporting and discussion. This process is systematic and regular incorporated with all project cycles [49]. This process indicates the progress or errors of current project to project managers and stakeholder to achieve objectives of project. Monitoring is a broader term which intended to check the accuracy of direction to enhance the quality of project. Good monitoring is result focused, record keeping, recommend necessary measures and taking decisive actions. The scope of monitoring is to assess project progress and to provide necessary information to managers which may help in deciding about upcoming actions [50]. Time, quality and cost are considered among the primary elements in construction project management. The above mentioned factors should be assessed throughout the duration of project. Project monitoring data should be related to change notice, procurement invoices, project outputs, plans, test results, schedules, standards and work time cards. Tools and

mechanism of project monitoring include; yearly project reports, field visits, outcome groups, and reviews monitoring annually which include continual situation assessment with time [51]. It became easy to compare between the present and initial position of project through proper monitoring. So it is important to collect all necessary information about the project in initiation phase. The collected information is termed as baseline of project. Comparisons are usually made against the baseline established for project in future.

2.1.7.1 Types of Monitoring

Monitoring is classified into five major types including, impact monitoring, technical monitoring, financial monitoring, process monitoring and assumption monitoring [52]. In physical process monitoring/ process monitoring regular data is gathered and analyzed to check whether the direction of project is right to meet objectives of project. Measurement of project activities, inputs and outputs are involved in this type of monitoring. It provides indicator about the schedule of activities to client and managers planned for the specific project. Time management is directly related to management of physical progress and delays or late time completions in the construction sector. Considerable items during process monitoring are work style, project progress, management strategies, inputs and outputs of project. Physical progress can be easily monitored by assessing the milestones of project [53].

2.1.8 Delay Contributing Factors

In construction projects, delay contributing factors can be associated with various elements within the project environment. Identifying and understanding these multifaceted aspects is crucial for effective project management and timely completion. Material and equipment-related delays often arise due to the unavailability of necessary materials or equipment and their poor quality, which can hinder progress [54]. Issues in contractual relations can lead to project delays, such as mismanagement of contracts, delays in decision-making processes, excessive involvement of the client/owner, and late approvals caused by changes in government laws or

regulations [55]. Financial factors also contribute to delays, with poor cost estimation, price fluctuations, financial issues faced by contractors or clients, and delayed payments to subcontractors causing disruptions in the project timeline [56].

Environmental factors, such as severe weather conditions and natural disasters, can exert a significant impact on the construction site, resulting in unexpected delays. Mitigating these external challenges requires proactive risk assessment and contingency planning to ensure resilience in the face of unforeseen events, ultimately contributing to the project's overall success[57]. Social factors, including site accidents, property damages, disputes involving personnel, and even political instability, can introduce delays by creating disruptions and uncertainties on the project site [58]. Changes in project parameters often cause delays, particularly when there's inadequate initial design, frequent design or material changes during construction, errors due to inexperience, or constant changes in subcontractors and project teams during the execution of construction projects [59].

Scheduling and control aspects also play a crucial role in causing delays in projects. Poor communication among different parties on the construction site, ineffective resource planning and scheduling, low workforce productivity, inadequate supervision and inspection, as well as insufficient documentation and procedures detailing, all contribute significantly to project delays. Addressing these multifaceted issues requires a comprehensive and integrated approach to project management, emphasizing communication improvement, efficient resource allocation, and enhanced oversight and documentation protocols[60].

2.1.9 Methods for Minimizing Construction Project Delay

Different research scholars have suggested various practices to minimize the project delays in construction projects. Project time delays can be minimized by identifying site conditions in design of groundwork and foundations through strong management team [28]. In Nigeria a research was conducted which concludes that time delays can be minimized by two approaches: delay impact on delivery of project. Acceleration in site activities and establishment of contingency budgets [24] . To make sure people follow the rules about paying for damage, we can use

penalties called liquidated damages. We can also give rewards for finishing work early. By training and organizing workers properly, we can improve their skills. Instead of focusing only on prices, we should consider the abilities and past work of contractors more when deciding who to hire. We can also try different ways of making contracts, like design-build projects [61].

The researchers studying delays in Florida suggested that the process of approving building permits should be made simpler and faster. They found that managing changes in drawings, fixing incomplete or wrong specifications, and dealing with change requests all require efficient design process management and quick decision-making [62]. When it comes to dealing with delays, the contractors found that productivity can be increased by working extra time or in different shifts. Another useful approach was to ask for more time to complete the project [63]. If there were resource shortages, they recommended activities rescheduling, acquiring skilled workforce, and hiring subcontractors. The meetings at the construction site are crucial for resolving issues, yet it's essential to strike a balance, avoiding excessive convening to maintain efficiency and project momentum.

2.2 Empirical Analysis

Researchers have been studying construction project delays for a considerable duration, exploring various facets to enhance understanding and develop effective strategies for mitigating delays and optimizing project timelines. Their findings contribute invaluable insights to the ongoing efforts aimed at refining project management practices in the construction industry. They have made improvements and changes to how they categorize the reasons for delays. It's common for construction projects to encounter problems, and one of the most frequent challenges is a delays in construction sector. Delays can have more influence on the project's time, cost, and quality, and they can strain relationships between participants of project [64].

In Saudi Arabia, a research was conducted on different types of construction endeavors in the country. The study found that 70% of projects experienced delays. They surveyed 23 contractors, 19 consultants, and 15 owners, and they identified

73 different causes of delays, which were grouped into nine categories [65]. One cause that all three parties agreed on was change orders. The study showed that variables relating labor, contractors, projects, consultants, and owners were the most significant. In Malaysia, a study involving 150 respondents looked at the causes and effects of delays. They pointed out the top 10 most significant reasons from 28 delay causes, including issues like contractors improper planning, site mismanagement, and problems with subcontractors. They also found six different effects of delays [66].

Delays in construction projects are a prevalent global issue, regardless of their size or location. Delays often lead to increased costs and it may negatively effect the project progress, relationships between parties, and financial aspects [67]. Sometimes, delays even result in disputes or legal battles. In traditional contracts, both contractors and consultants identified similar delay causes, such as problems with the owner, inexperienced contractor, financial issues, and slow decision-making [68].

A study conducted in Florida concentrated on identification of the primary reasons for delays in the construction sector. The study aimed to understand different parties' perspectives on the delay causes, the task assignment, and delay types [69]. Consultants were identified as key contributors to design-related delays, as they share responsibility for the design process with the project owner. This underscores the importance of effective collaboration and communication between consultants and project stakeholders to streamline the design phase and mitigate potential setbacks, ensuring a smoother project progression.

2.3 Conceptual Framework of Study

Variables are characteristics that can be measured and have different values for different subjects. Researchers manipulate independent variables to see how they affect other variable. Predictor variables are synonymous with independent variables. In current research, the independent variables are material and equipment factors, contractual relations related factor, financial factors, social factors, environmental factors, changes in design and scope related factors and factors related

to scheduling and control. These variables forecast the alteration in the reliant variable, which is the time extension in construction endeavors. The project's strength is reflected in the extent of its delay.

This section aims to summarize the concepts from past research and show how they contribute to this study. Many studies have looked at late project completions and their impacts. In present study, delay causing factors are categorized into 7 categories, as shown in Figure 2.1, that can have either a negative or positive impact on project performance. If projects are negatively affected, they will experience delays. The causes of project delays are grouped into seven categories: Material and equipment factors, contractual relations related factor, financial factors, social factors, environmental factors, changes in design and scope related factors and factors related to scheduling and control.

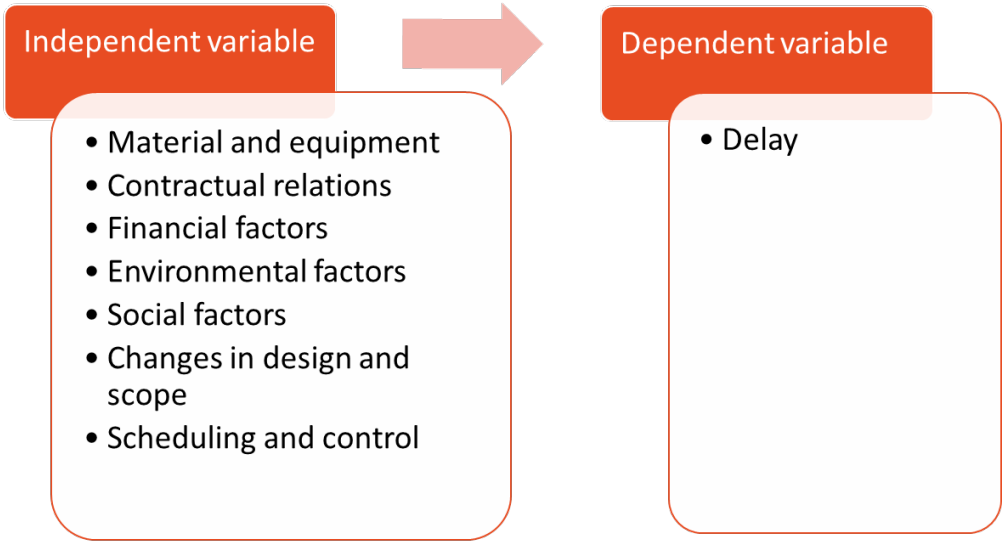

FIGURE 2.1: Conceptual Research Framework

Chapter 3

Methodology

3.1 Introduction

This section focuses on how information and data were gathered for the study. It explains the methods used to collect the data in the field. The chapter discusses how the research was designed, the size of the group studied, how the sample was chosen, how data was collected, and how the research followed proper plans. It also talks about how the data was analyzed to draw conclusions.

3.2 Approach and Design for Study

The quantitative approach was employed to analyze the data from the questionnaire. Meetings were also conducted with the experts of different construction fields to check the accuracy of questionnaire. Quantitative analysis helps explore and understand the relationships and patterns in the data [70].

The study designs followed a descriptive approach, concentrating on analyzing a scenario or issue in order to explain the connections among different factors. The goal was to gather the opinions of local construction regarding the causes and effects of delays. These causes and their impacts were identified through a thorough review of existing literature, guiding the formulation of questions that

encompass the perspectives of the public working within the construction industry. This approach ensures a comprehensive understanding of the challenges and enables targeted solutions for effective industry improvement as shown in figure 3.1.

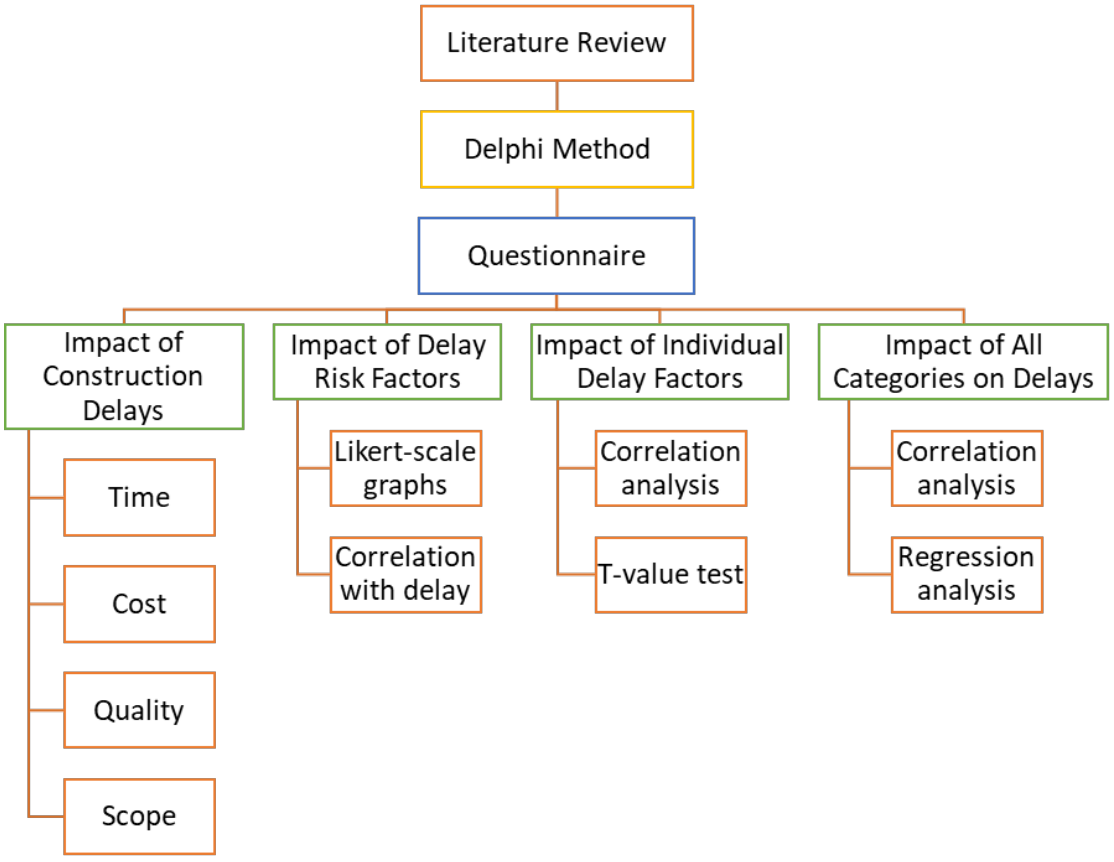

FIGURE 3.1: Research Approach

Delphi method is applied to authenticate the selection of questions and factors in questionnaire. After finalizing the data and circulating questionnaire in construction experts data is analyzed. In analysis first impact of construction delays on time, cost, quality and scope is assessed. Next, impact of delay causing factors in each category is analyzed through like rt-scale graphs and correlation analysis with delays. In next step, impact of individual 26 delay factors is analyzed through correlation analysis and t-test is performed to check the significance of factors. In last step, overall impact of all 7 categories is analyzed through correlation analysis

and regression analysis. Regression analysis will give the test results for precision of data and model fitness.

3.3 Methods for Collecting Data, Data Sources, and Variables

The present research focuses on seven main factors that cause delays in projects, such as i) Material and equipment factors, ii)contractual relations relating factor, iii) financial factors, iv) social factors, v) environmental factors, vi) changes in design and scope related and vii) factors related to scheduling and control. These factors were used to predict the occurrence of delays in construction projects in Pakistan. These main categories are further sub-divided into 26 delay causing factors.

The study gathered data from two different sources, i.e., primary and secondary. Questionnaires were used to collect primary data. It was given to employees of local construction companies to obtain their opinions about delays. Survey includes variety of respondents having different age groups, different experiences in construction field, and different designation in their respective firms. The ultimate target was to gather data from planning engineers, project managers, and owners as they are more concerned about the meeting projects planned deadlines.

The survey was employed as a research technique to collect data because it is a suitable approach to assess their point of view. The questionnaire was generated as shown in Appendix 8. The questionnaires were filled out by respondents and collected afterwards. The Likert scale was used in the questionnaires, where respondents could indicate their agreement or disagreement level on a five point rating system. Likert scale data is categorized into five scales which includes very low, low, medium, high and very high impact. The questionnaire is developed in two forms, the paper based and the online survey forms. Paper based survey is designed and circulated in hard form. It is the best way to collect data as quality of responses get verified during interviews. On the other way, as it is digital age and people usually are comfortable filling on online platforms. It is quite helpful

as it may save time of respondents and they can easily fill online forms in their spare time.

The secondary data employed in the research came from a review of past literature on project delays in the construction sector. This involved gathering information from literature, online resources, scholarly publications, and various academic documents. The literature review aimed to enhance comprehension of the theoretical facets related to the problem of research. This is actually qualitative analysis of questionnaire which includes that selected factors are also considered in previous researches. Although efforts are made to make most relevant categories (factors) which may effect the timelines of projects. The main purpose was to achieve sustainability in construction environment so factors are categorized into three main categories including social, financial and environmental factors.

The primary and secondary data were combined to ensure comprehensive coverage of all aspects of the investigation. The secondary data served as a reference to support the findings from the primary data collection. Here researcher focus on two type of data, qualitative data from the literature which is termed as secondary data and quantitative data as primary data. So on combination they provide a concrete and reliable output.

3.3.1 Delphi Method Application

Delphi method is to get the opinion from experts in the field which is under study, and then reach to a common decision based on the responses after a few rounds. It involves a panel of experts or stakeholders who provide their opinions and insights on a problem in hand. The process typically begins with a facilitator who poses a series of open-ended questions or scenarios to the panel members anonymously. Each expert independently responds to these questions, and their responses are collected and summarized by the facilitator. Hence, the Delphi method is a group decision to validate the data by considering the opinions of selected experts. It may take two or three rounds of consensus to get best response. The model does not expect the complete willingness of whole panel but the median is represented by the majority [71].

In subsequent rounds, the experts review the aggregated responses and engage in a discussion facilitated by the facilitator. They can revise their initial responses based on the group's feedback and insights. This process is repeated for several rounds until a consensus or convergence of opinions is reached among the experts. The Delphi method is particularly valuable when dealing with complex or uncertain issues, as it allows for the systematic gathering of diverse perspectives and can help to reduce bias or group think. Efficiency of any organization or project can be assessed by its projects timely completion. To cope with delay issues it is necessary to assess the causes of delays and their impact on time, cost, quality and scope through experienced panelist.

In this research, two rounds from 3 construction experts have been made who thoroughly go through the questionnaire and make their comments. Initially 36 factors were identified from the literature and after review from experts it is shrinked to 26 delay causing factors considered for the study. The details of experts and selected delay causing factors are mentioned in Appendix 8. The factors considered before the application of the Delphi method are detailed in the corresponding table 6.5 ,providing a structured framework for informed decision-making.

Initially 35 delay factor were considered and in first round they shrink ed to 29 factors. Comments are addressed accordingly and questionnaire is again sent to them for their thorough review. They proposed their suggestions and after implementation questionnaire is closed with 26 delay factors under 7 delay causing categories in this final round. All experts get on one page and they got satisfied from the structure of questionnaire as it covers all the factors causing delays. In this way meaningful output can be generated from well structured questionnaire. It assures from the experts that questions and factors considered are most relevant and effective for the present research.

3.3.2 Sampling

The individuals within the local construction sector, including upper-level management, engineers, consultants, foremen, and quantity surveyors, have construction sector experience and are working currently on construction endeavors. Most of

the participants in this study holds important positions, extensive experience, and an engineering/technical educational background, hence have sufficient knowledge about construction industry issues, particularly causes of delay.

A total of 134 questionnaires were distributed to the management, site engineers, and consultants in local construction industry of Pakistan. And 111 valid responses were received. From these 111, 22 responses are collected by paper based survey whereas 89 responses were collected from online survey generated on google forms.

In selection of participants, we used a two-step process. First, we used a method called stratified sampling to choose representative samples from the planning engineers, owners, site engineers, and project managers as they are directly related with project performance.In stratified sampling 84.69% responses are taken successfully. Then, simple random sampling is used to further select participants randomly. Simple random sampling method is employed to assess the accuracy of estimations by measuring errors or the significance of the results obtained from the randomly chosen sample.

3.4 Methods of Data Analysis

The process of analyzing the data involves organizing the collected information in a systematic manner to easily and effectively communicate the findings. Quantitative data is collected through questionnaires and Microsoft Excel and SPSS software were used for data analysis.

Correlation: is a statistical measure that helps us understand the relationship between two variables and assesses whether they tend to change in similar or opposite directions. It quantifies the degree to which changes in one variable are associated with changes in another. A positive correlation implies that as one variable increases, the other also tends to increase, indicating a direct relationship. Conversely, a negative correlation suggests that as one variable increases, the other tends to decrease, signifying an inverse relationship. Correlation values range from -1 to 1, with -1 indicating a perfect negative correlation, 1 representing a perfect positive correlation, and 0 implying no linear relationship [72]. It's important to

note that, if just because two variables are correlated, it doesn't necessarily mean that one causes the change in other. Careful analysis and consideration of other factors are required to establish these relationships.

Regression, on the other hand,is how an independent variable is numerically related to a dependent variable and demonstrates the impact of a unit change in the independent variable (IV) on the dependent variable (DV) [73]. The regression linear equation is,

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_i X_i + e \tag{3.1}$$

Where, Y represents the dependent variable, alpha is the intercept, beta are the coefficients or parameters associated with each of the independent variables, X1, X2, X3, X4 are the independent variables or predictors that are used to explain or predict the variation in the dependent variable Y. It was utilized to explore the extent of independent variables such as delay causing factors, could explain the dependent variable of project delay.

T-test The T-value test, often referred to as the t-test, is a statistical method to assess the significance of individual coefficients (slope parameters) in a linear regression model. It measures the ratio of the estimated coefficient for a specific predictor variable to its standard error. The resulting t-value is then compared to a critical value from the t-distribution to determine whether the coefficient is statistically significant or not. If the absolute value of the t-statistic is greater than the critical value, it suggests that the predictor variable has a significant impact on the dependent variable, indicating a meaningful relationship in the regression model. In contrast, if the t-statistic is small, it suggests that the predictor variable may not be contributing significantly to explaining the variation in the dependent variable [74]. The t-value test is a crucial tool in regression analysis for identifying which predictors are relevant for predicting the outcome of interest and for making informed decisions about model selection and interpretation.

F-Value The F-value is a statistical method used in regression analysis to assess the overall significance of a regression model. It measures whether the regression model as a whole is statistically significant in explaining the variability in the

dependent variable. The F-value is typically used in the context of multiple linear regression, comparing a full model that includes all predictor variables to a reduced model with fewer predictors. By comparing the fit of these two models, the F-value helps determine whether the addition of certain predictors significantly improves the model's ability to explain the variation in the dependent variable [75]. A high F-value indicates that the full model is a better fit, suggesting that at least one of the predictors is statistically significant. In contrast, a low F-value implies that the predictors in the model do not collectively provide a significant improvement in explaining the dependent variable's variance. The F-value is a crucial tool in regression analysis for evaluating the overall significance of a model and selecting the most appropriate set of predictors.

P-value The p-value is a statistical analysis used to evaluate the significance of the relationships between independent variables (predictors) and a dependent variable (outcome) within a regression model. It assesses the outputs whether there is empirical evidence to support the hypothesis that one or more independent variables have a statistically significant impact on the dependent variable [76]. In practical terms, the p-value quantifies the probability of observing the estimated relationships between variables in the regression model if, in reality, there were no true associations. A low p-value (typically less than 0.05) suggests that there is strong evidence to reject the null hypothesis used in the model, indicating that at least one independent variable has a statistically significant influence on the dependent variable. Conversely, a high p-value suggests a lack of significant evidence for such a relationship, although it does not prove the absence of a true effect.

The data was presented using statistical tools such as tables, figures, and bar charts.

3.5 Ethical Consideration

Ethical considerations are a fundamental aspect of any field of study, including research. It is imperative to establish and adhere to ethical guidelines to ensure the well-being and rights of individuals who participate in research studies. Ethical research practices involve not only obtaining informed consent but also treating

participants with respect, safeguarding their privacy, and maintaining the confidentiality of their information during survey. These principles are essential to uphold the ethical integrity of research projects and build trust between researchers and participants.

In this particular study, the researcher has demonstrated a commitment to ethical research practices. By respecting privacy and avoiding personal questions, the researcher ensures that participants' boundaries are respected. Protecting anonymity by keeping individuals' identities unknown further safeguards their privacy and minimizes the risk of harm or social consequences. Maintaining confidentiality by keeping research information private adds another layer of protection for participants. Additionally, providing a clear introduction and instructions about the research's purpose ensures that participants can make informed decisions about their involvement. These ethical considerations collectively contribute to the ethical foundation of the research, promoting the rights and well-being of those who choose to participate. Ethical research practices are essential not only for upholding the credibility of the study but also for contributing to the broader ethical standards of the field.

3.6 Accuracy and Consistency of the Model

To ensure the survey was valid, the researcher extensively reviewed relevant literature and developed questions based on that. Feedback from professional advisors and experts was also incorporated to improve the survey questionnaire and research method before collecting data. For statistical validity, quantitative data was gathered by researcher through a questionnaire survey and used appropriate statistical analysis techniques regression and correlation analysis to examine the variables relationships and draw solid conclusions. Data set for the study is shown in Appendix 8.

The four basic assumption of linear regression model are tested before application of model. The result of test shows that data is linearly and normally distributed as shown in Figure 3.2. The variation inflation factor (VIF) value shows the multicollinearity of model. The scattered distribution of questionnaire also shows

the homoedasticity of data as shown in Figure 3.3. The above assumption test shows that data can be used for interpretation through linear regression model.

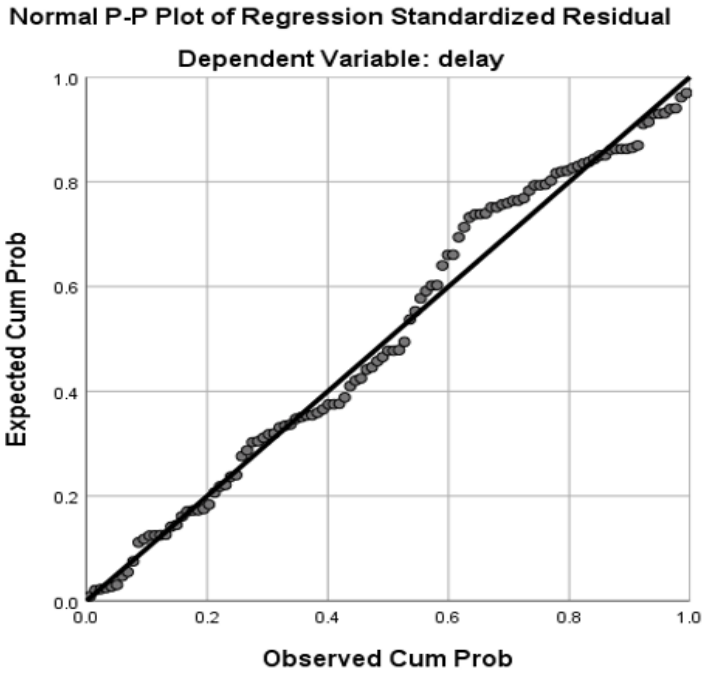

FIGURE 3.2: Linearity of Regression Model

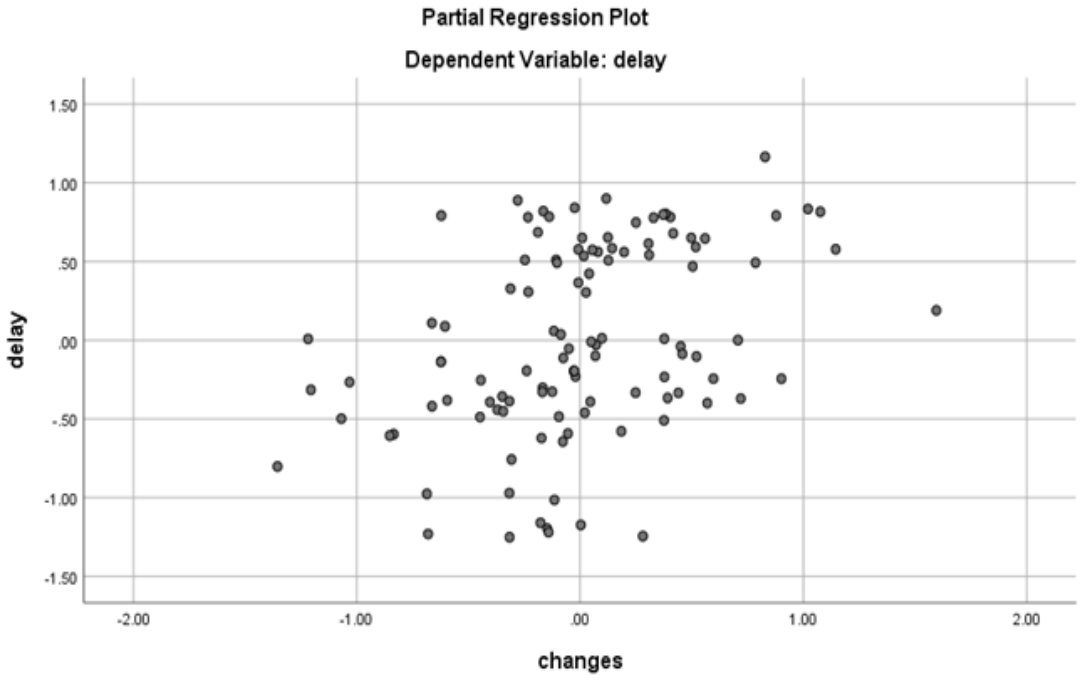

FIGURE 3.3: Homoedascity of Regression Model

Chapter 4

Result and Discussion

4.1 Introduction

In this chapter, findings from the study are shared, which were collected through a questionnaire survey. It was designed to match the study's objectives. Like-rt-type questions were included where respondents indicated their level of agreement on a scale of very low to very high impact, to enhance the obtained data quality. Coded responses are entered into a SPSS software for analysis. Tables and figures are used to present the data. This chapter includes details about the respondents' background and the findings related to the objectives and research questions, which are discussed in detail.

4.2 Analysis of Data

In this section, the aim is to share the realistic facts that the noted factors contributing to delays in local construction companies. To gather this information, the researcher collected data from managers and contractors utilizing the methods outlined in the methodology, section of Chapter Three. To do this, questionnaires are circulated among 134 people, and 111 of them filled out and questionnaires returned for interpretation. In this chapter, the collected data from the questionnaires is presented and analyzed. The data is presented using various methods

like tables, percentages, charts, and figures, which help to present the information effectively.

4.3 Analysis of Basic Participant Information

The information provided by the participants was examined by using tables, frequency distributions, and percentages. These methods facilitate the analysis of data and calculation of the values of each variable considered in the study.

4.3.1 Description of Respondents

The statistics regarding the respondents are represented by figure 4.1 and table, these statistics validate the present research. Figure 4.1(a) graphically shows the gender classification of the participants. It is clear that 95.5% respondents are male whereas only 5% are females. This indicate that the construction industry in Pakistan is heavily male dominant. Figure 4.1(b) shows the organization type of the participants, approximately equal distribution, i.e., 45.05% are working in consultant firms whereas 54.95% are from contractor side. Fortunately, this diversity in respondents' backgrounds is a positive aspect of the survey, allowing for a well-rounded exploration of both the perspectives of consultants as designers and the contractors responsible for project execution. This inclusive approach enhances the survey's richness and applicability to various stakeholders in the construction industry.

The role/designation of respondents in their firm are explained in table 4.1. It has been observed that most of the respondents have different experiences in which 44 respondents lies in 0-5 years' experience, 28 in 6-10 years' experience, 29 respondents have 11-20 years' experience while 10 respondents have greater than 20 years' experience as shown in figure 4.1(c). This shows that analysis contain responses with different experiences from less than 5 years to greater than 20 years which is indicating a good research. Figure 4.1(d) shows different positions of respondents like planning engineers (19.82%), project managers (27.03%) and site engineers (28.83%). In responses, the respondents have multiple type of experience like in

infrastructure, residential, commercial, industrial projects and some have other experiences having proportion of 19.57%, 36.60%, 31.06%, 10.64% and 2.13% respectively as shown in figure 4.1(e). These findings underscore the importance of different backgrounds of respondents in research, emphasizing the need to consider varied perspectives to enhance the validity of study outcomes. This inclusivity cultivates a nuanced comprehension of the research context, enabling researchers to draw well-rounded conclusions that account for the complexity inherent in diverse perspectives in the present research.

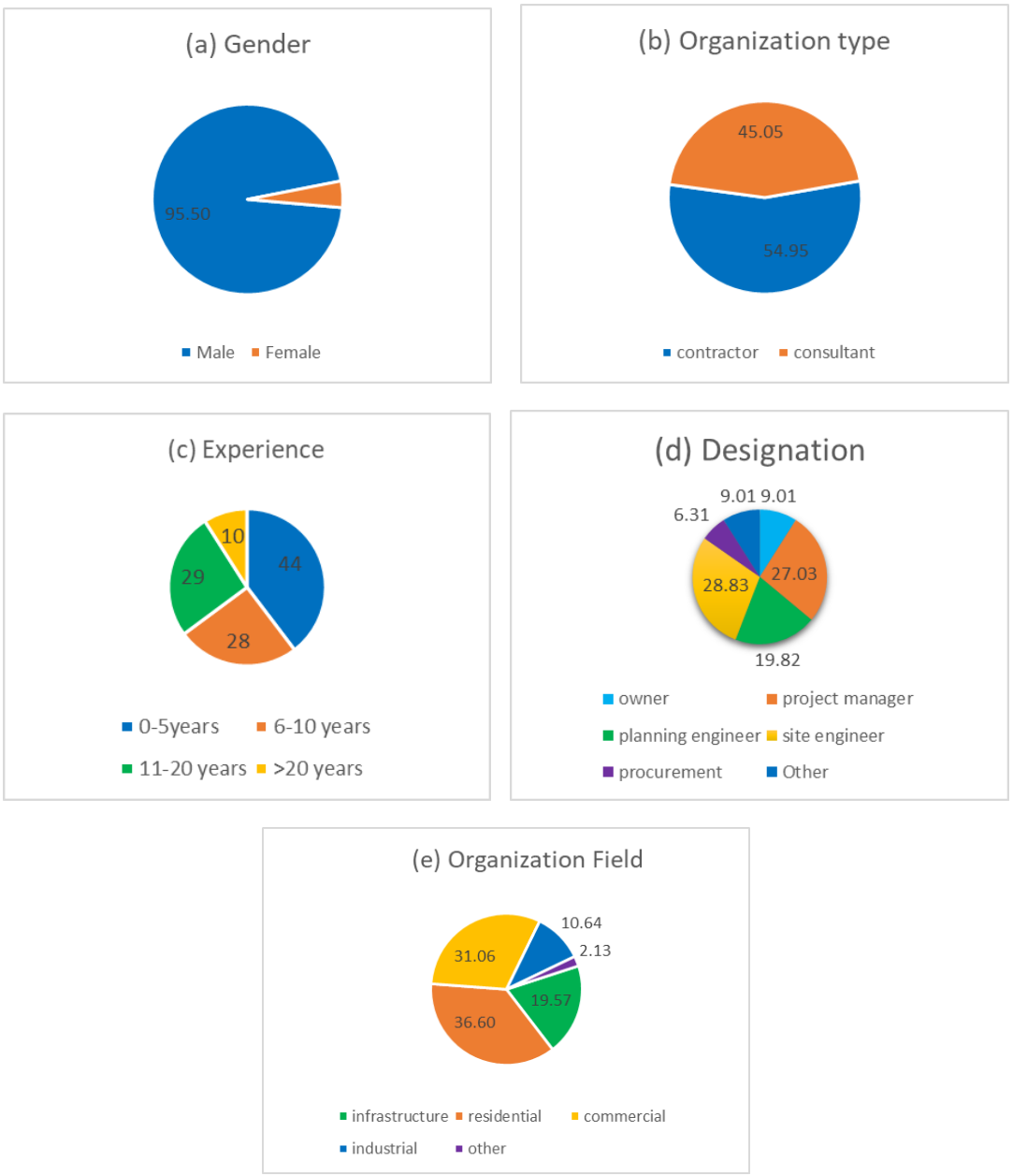

FIGURE 4.1: Respondents Details

TABLE 4.1: Summary of Respondents

Description	Frequency	Percentage
Gender		
Male	106	95.5%
Female	5	4.5%
Organization type		
Contractor	61	54.95%
Consultant	50	45.05%
Designation		
Owner	10	9.01%
Project Manager	30	27.03%
Planning Engineer	22	19.82%
Site Engineer	32	28.83%
Procurement	7	6.31%
Other	10	9.01%
Experience		
0-5 years	44	39.64%
6-10 years	28	25.23%
11-20 years	29	26.13%
20 years	10	9.01%
Organization field		
Infrastructure	46	19.57%
Residential	86	36.6%
Commercial	73	31.06%
Industrial	25	10.64%
Other	5	2.13%

4.4 Impact of Construction Delays

Figure 4.2 shows impact of construction delays on the time, cost , quality and scope as per the expert who participated in this survey. Delays severely impact the project timelines. Out of 111 respondents 99 respondents responded that the delays have very high and high impact on the project timeline. While, 32 and 66 respondents have point of view that when delays occur in a project they have very high and high impact on cost. Gonzalez et al. conducted a study with similar findings that due to lack of planning, delays occur and they strongly disturb the timelines of the project [77]. Rashid conducted a study in which 172 construction experts provide their responses about time extensions from 37 different companies working in Pakistani construction sector [42]. After analyzing the outputs through statistical tools, it has been observed that construction delays have severe impact on scheduled budget, project abandonment, considered timelines and litigation in the project.

Interestingly the quality and scope are less affected by construction delays, as per the respondents. Statistic's shows that 47 respondents are of the view that due to extension in timelines from the planned timelines, quality of work get affected with high intensity. It is because, when their is short time span to meet more targets, the speed of work usually escalated. Due to increase in speed different factors get overlooked and quality get compromised. A road project in Malaysia, was took under study in which delay factors are assessed. Findings shows that project failed to meet planned deadlines and it result in poor quality of construction works [78].

An analysis on project time extensions in construction endeavor of India shows that due to delays scope of work also increases up to some extent. As project get delayed, their are various variables which contribute in it and some important activities get missed. In rework, the scope increased due to delays but it do not significantly impact the project performance [79]. The mentioned findings and the related studies showed that construction delays have strong impact on time, then on cost. Additionally delays lead to poor quality of work and increased scope but with less influence than time and cost. Therefore, time and cost overruns often get disturbed from their planned values when discussing construction delays. Neglecting the influence of diverse perspectives may compromise the overall quality and breadth of the construction project, highlighting the pivotal role of inclusivity in ensuring its enduring success and longevity. Recognizing and incorporating varied insights enriches the project's dimensions, contributing to its resilience and effectiveness in meeting diverse challenges.

The correlation test has been performed between time, cost, quality and scope in SPSS tool as shown in Table 4.2. This test indicates the dependence of each factor on other. Correlation value 0.430 between time and cost shows that they have very strong positive correlation. The two asterisk signs (**) shows the statistical significance of model. It indicates a significance level of 0.01, which means there is only a 1% chance that the observed correlation occurred by random chance. It means that with delays in planned time, cost will also increase. A study on assessment of construction delays effect showed the similar outputs that time and cost have highest correlation value [80]. On the other hand, their is very strong negative correlation between scope and time (r=-0.202*). Here, one asterisk sign (*) shows statistical significance up to lower level than time and cost. It shows it association

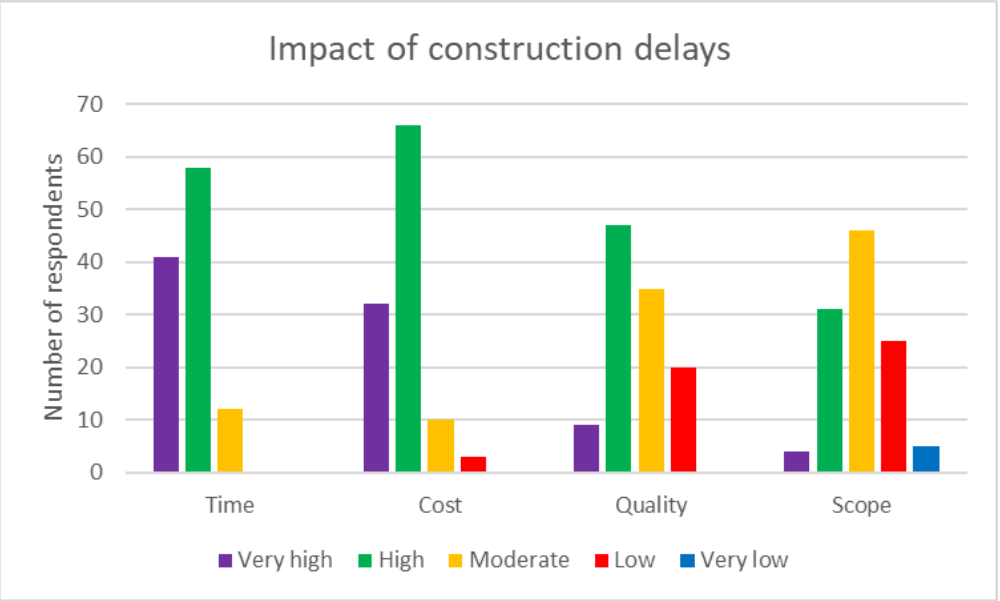

FIGURE 4.2: Impact of Construction Delays in the Project Timeline, Budget, Quality and Scope

with a significance level of 0.05, which means that there is a 5% chance that the observed correlation occurred by random chance. Their will be no significant impact on scope with time extensions of any project. Zaman et al. conducted a study in which it was observed that in time and scope are not significantly dependent on each other [81].

TABLE 4.2: Correlation between Time, Cost, Quality and Scope

	Time	**Cost**	**Quality**	**Scope**
Time	1			
Cost	0.430	1		
Quality	0.181	0.325	1	
Scope	-0.202	0.035	0.333	1

When delays occur, they often disturb the project timeline, causing extensions that disrupt planned schedules. This not only hinders project completion but can also lead to contractual disputes and penalties. The longer a project takes to complete, the more resources are required, driving up labor, material, and overhead costs. Consequently, the overall project budget escalates, putting financial strain on the stakeholders involved. Moreover, the pressure work to compensate for lost time can lead to poor work quality, leading to defects and the need for costly rework. These quality issues not only compromise the structural integrity of the project but can also damage the reputation of the construction company responsible [82].

4.5 Impact of Delay Causing Factors

In this section, the analysis contain graphs generated by the like-rt scale data obtained through questionnaire. It shows the trend of each factor under each category in contribution to delays.

4.5.1 Material and Equipment

Graph shows number of respondents in vertical axis and impact ranking against two variables of materials and equipments factor on x-axis. In this study 35 respondents are of the view that lack of material and equipment availability are more influential factors in delays while 17 respondents marked poor material quality factor as most influential factor as shown in figure 4.3. In Benin construction sector, unavailability of construction materials and equipment is among the top 10 delay causes affecting the project timelines [83]. Pakistani construction industry have similar findings in 2020 which concluded material and equipment factor have significant impact on delays in construction projects [42]. Hence, the overall statistics indicate that the unavailability of construction materials and construction equipment on construction sites has a more significant negative impact on project delays.

The correlation test between delays and material and equipment factor shows R value of 0.134. It means that this factor has positive correlation and it has moderate impact on delays. If material and equipment are not provided on time it will cause delay in ongoing projects and if quality of material is not good it will go to rework and again lead to time overrun. It can be overcome by providing proper resources and material in good quality and in specified time. Material and equipment factors play a crucial role in determining the success and efficiency of construction or project-based endeavors, emphasizing the need for strategic planning and resource management to optimize project outcomes. Attention to these factors contributes significantly to overall project effectiveness and timely completion. The absence of essential resources can significantly disrupt project timelines, leading to significant delays. Proper planning and procurement are essential to ensure smooth project execution. Additionally, poor material quality poses a risk,

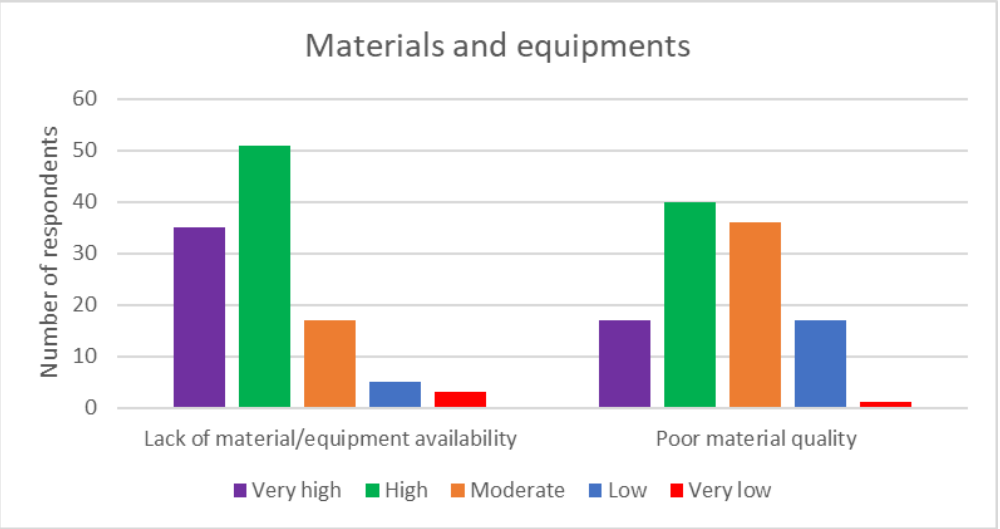

FIGURE 4.3: Impact of Material and Equipment

potentially necessitating time-consuming and costly repairs, compromising structural integrity, and raising safety and legal concerns [84]. Addressing these factors is important for effective project management within established timelines and budgets.

4.5.2 Contractual Relations

Figure 4.4 shows the effects of contracts on the possible delays in the project. Horizontal axis shows the five sub-factors in contractual relations factor with their impact ranking while vertical axis is respondents figure. It has been observed that projects are mostly delayed due to delays in decision making as 45% respondents marked it as very high impact factor on delays. Late approval and changes in government laws is also a responsible factor in time extended projects. Delay in subcontractor's work is considered among the least important delay contributing factor. Johnson and Babu conducted a research in UAE construction industry to check the delay causes behind time overrun and over budgeted projects [85]. It concluded that delayed decision making by client and late approval of permits by government are considered among the top five reasons for delays and cost overbudget.

In correlation test of contractual relations factor the value is 0.246 which shows its strong correlation with delays. It means that if a project have delayed decision making process then it might delay the ongoing activity which ultimately lag the

overall project. In order to it late approvals of any documents or contractual issues in management also cause serious delays in projects. Strong positive correlation is measure which shows the dependency of independent variable on dependent variable. So, construction delays are dependent on contractual relations factor up to larger extent. So, their is need to consider these factors in planning phases of construction projects to meet the planned deadlines of any project.

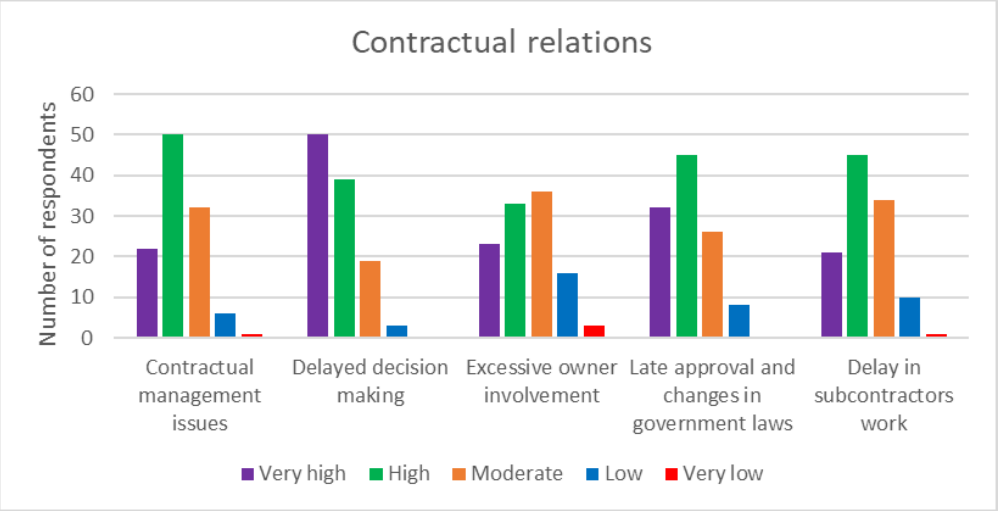

FIGURE 4.4: Impact of Construction Delays on Contractual Relations

In conclusion, contractual management and timely decision-making are paramount in the construction sector, as they significantly impact project timelines. Poor contract management can lead to misunderstandings and disputes, causing delays, while effective contract management aligns all parties with project objectives in construction projects[8]. Delayed decision-making and excessive owner involvement can also impede progress, but clear communication and well-defined decision-making processes can keep projects on track.Furthermore, staying informed about legal changes is crucial in contract management, and addressing subcontractor delays promptly enhances the ability to mitigate construction project delays effectively. Proactive management in these areas is integral to ensuring project timelines and overall success.

4.5.3 Financial Factors

Figure 4.5 shows four financial factors including price escalation, poor cost estimation, contractor/client financial crises and delayed payments to subcontractor on

x-axis with their impact intensity on delays and vertical axis include number of respondents. Statistics shows that abrupt price escalations of construction material and resources strongly effect the progress of projects. Out of total 38% responses are marked with very high impact. As budget is planned in initial stages with certain escalation clauses but frequent increase may disturb the planned capital and which ultimately effect the time allocated. After that, contractor/client financial crises factor is considered among the most influencing factor. An Iranian construction sector case study depicted that among eight major groups, contractor financial crises is considered among the most influencing issue in causing delays [86]. Here, it can be seen that financial factors in construction endeavors significantly impact in contributing time extensions.

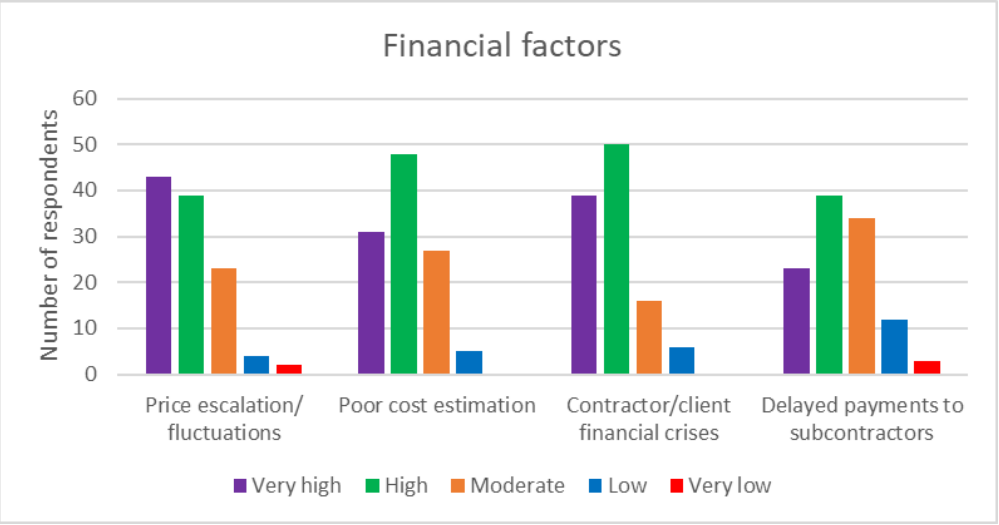

FIGURE 4.5: Impact of Financial Factors

Financial factors have not such strong positive correlation with delays. The factors considered under financial factors have their own significance but overall its impact is less. It is because these factors have strong impact than other. A study with 26 considered delay factors in Pakistani construction industry shows that goods prices and escalated transportation cost are most significant factors [87].

In conclusion, financial factors, including price fluctuations in construction materials and inaccurate cost estimates, significantly impact construction delays. Sudden price increases or fluctuations disrupt project budgets and timelines, requiring contractors to revise estimates and potentially leading to procurement delays. Furthermore, poor cost estimation results in budget shortfalls, delaying material procurement, labor hiring, and causing disputes [88]. To address these challenges,

thorough cost analysis, budget contingencies, and continuous financial monitoring are important in maintaining project progress within planned budget.

4.5.4 Environmental Factors

In environmental factors, two factors are considered severe weather condition and natural disasters which are on x-axis and number of respondents who participated are on y-axis. It has been observed from the results that these factors do not have strong impact on delays. Out of 111 responses 54 responses shows that extreme weather condition in working environment have moderate effect on timelines as shown in figure 4.6. While 51 said that natural disasters also have moderate impact on projects related to delays. As these conditions are temporary and once in a year so they do not disturb project planned deadlines with greater intensity. To mitigate these risks, construction projects often integrate contingency plans and implement weather monitoring systems, enabling them to adapt and respond to changing environmental conditions. Additionally, proactive risk assessment and the implementation of efficient communication channels among project stakeholders contribute to this strategic approach, further reinforcing the project's resilience and ensuring successful outcomes even in dynamic construction environments.

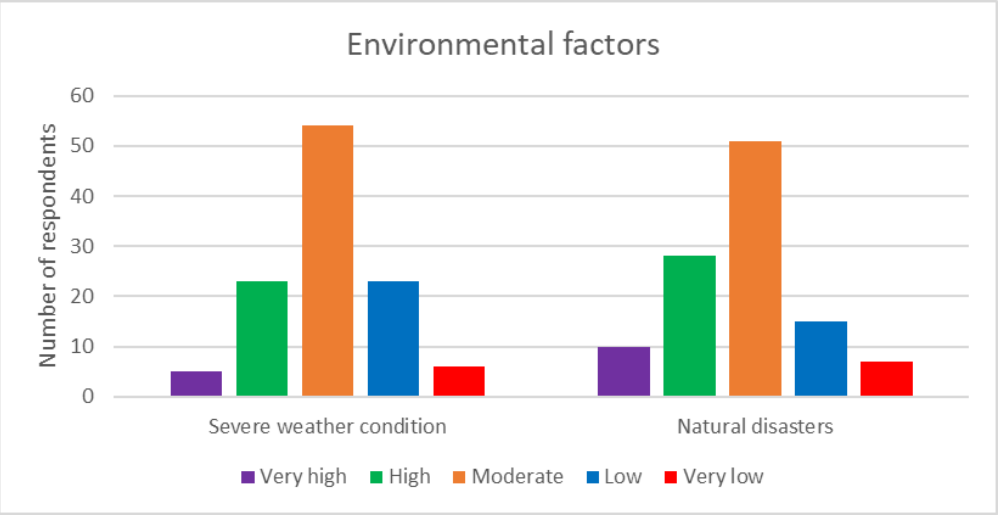

FIGURE 4.6: Impact of Environmental Factors

In environmental factor correlation analysis, it can be observed that delays and environmental factors have R- value -0.004 shows strong negative correlation. This means that environmental factors have no significant impact on delays. Rahsid

et al. conducted a research on delay causes in Pakistan having data collected from 37 different companies in province Punjab, shows that environmental factors have no significant impact on delays [89].

In conclusion, environmental factors, including natural disasters, severe weather conditions, and their unpredictable intensity, pose formidable challenges to construction projects. These events can lead to significant delays, damage to structures and equipment, and safety hazards for workers. Even less extreme weather conditions can disrupt construction timelines and inflate costs [90]. While construction projects employ contingency plans, monitoring systems, and safety protocols for mitigation, the inherent uncertainty of nature remains a persistent challenge in the construction industry. It supports the ongoing efforts to prioritize safety and adapt to environmental challenges and to achieve sustainability in environment.

4.5.5 Social Factors

In our study three main social factors are considered on x-axis and respondents figure on vertical axis. Overall it can be seen that social factors are also less contributing in delays. Figure 4.7 shows, in very high category, respondents consider political instability factor as major impact on delays. Disputes by any personal factor is also considered among the significant factor in delays. It can be seen that site accident and property damages have moderate impact as most of the respondents marked it as moderate impact factor. Tanzanian construction sector research concluded that social factors have strong impact in occurrence of delays [69].

In correlation analysis of social factor, the correlation value 0.043 shows that there is positive correlation between social factors and delays factors. Acknowledging the potential escalation of delays due to evolving social factors is crucial in strategic planning, emphasizing the need for adaptability and foresight to ensure sustainable development goals are met. Integrating a flexible approach that accounts for changing social dynamics enhances the project's resilience and contributes to its long-term success. So these social factors have a considerable influence on delays.

Social factors, including site accidents and property damages, disputes among individuals, and political instability, exert a substantial influence on construction delays. Site accidents and property damages disrupt operations, leading to injuries, equipment damage, and extended timelines. Disputes involving labor, contractors, or communities result in work interruptions due to strikes, legal actions, or protests. Additionally, political instability introduces regulatory and policy changes, adding uncertainty and delays [91]. As a result, these social factors collectively contribute to significant setbacks in construction projects, elevating costs and risking project overruns and these are barriers to achieve sustainability goals in construction sector.

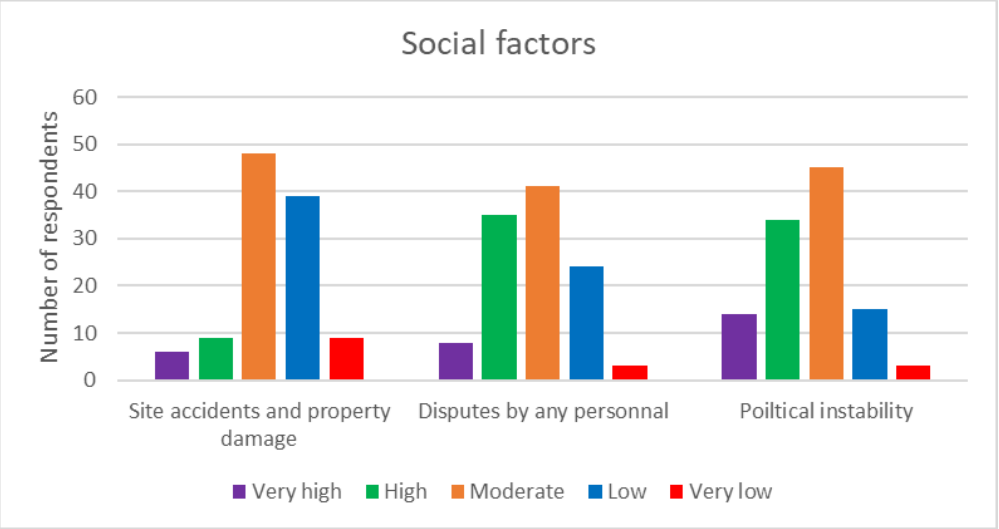

FIGURE 4.7: Impact of Social Factors

4.5.6 Changes in Design and Scope

Figure 4.8 shows the ranking of changes in design and scope factors on delays on x-axis while y-axis is numerical frequency of participants in survey. It can be observed that inadequate design (architects and structural drawings) factor is considered among very high category impact scale. Out of total participants 33% and 44% marked inadequate design factor as very high and high on impact ranking scale respectively. In high prone to delay category, 47 respondents marked error committed due to lack of experience factor. A research in Uganda on delays assessment shows that out of 81 selected delay factors, inadequate designs by consultant factor is among the top four factors which are most influencing to delays

[92]. A review of 130 articles by Siraj and Fayek depicted that poor engineering and errors due to design have significant impact on delays [92]. Altaf et al. have research in Pakistan, on change orders after selecting 32 variables and 102 respondents shows that errors in design factor is considered among the top five major factors [94]. Due to change it definitely contribute to time extensions. In above we can see that design is prepared in planning phase so it must be locked before start of execution phase. The above literature and findings shows that if things are not clear in initial stage they may result into change and that change lead to delays.

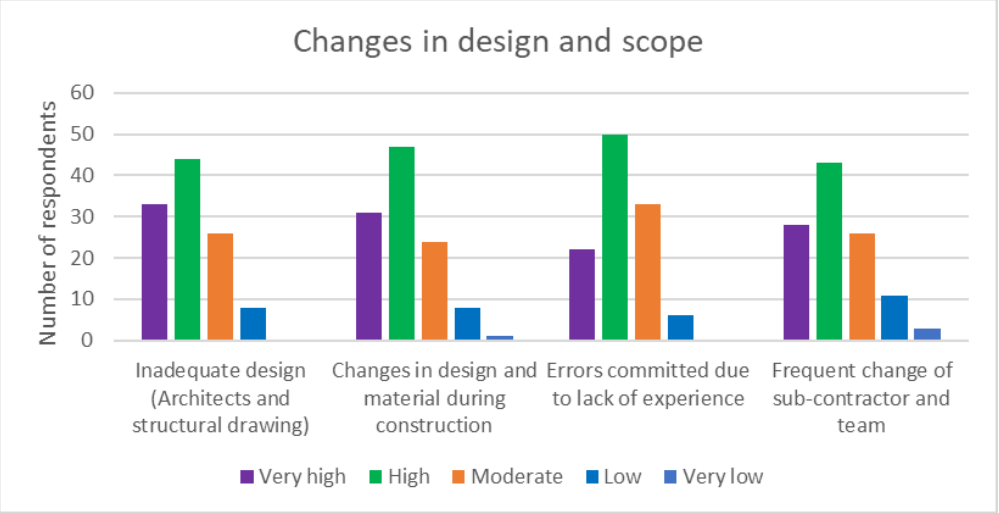

FIGURE 4.8: Impact of Construction Delays on Changes in Design and Scope

As discussed above, changes in design and scope factor has significant impact on delays. It can be justified in correlation analysis with delays. Table 4.3 shows correlation value 0.455 which means that delays and changes in design and scope factor have strong positive correlation. In planning phase of any project, this factors should be considered as it has significant impact on delays. Use of advanced tools like BIM can predict risk by taking proper planning from planning phase to design and execution level. It would be helpful to deliver expected outcome and meet planned deadlines in the planned budget and timeline considered for the project[95].

TABLE 4.3: Correlation with Changes in Design and Scope

Correlation		
Variable	Delay	Changes in Design and Scope
Delay	1	.455
Changes in Design and Scope	.455	1

As mentioned above, changes in design and scope factor significantly impact construction projects, posing challenges that affect construction timelines and budgets allocated for the specific construction project. Inadequate design, characterized by errors or omissions in architectural plans and structural drawings, leads to costly revisions and delays. These revisions require additional resources and disrupt construction workflow. To address this, stakeholders must prioritize comprehensive design reviews. Additionally, alterations during construction, driven by unforeseen challenges, necessitate swift adaptation and responsive project management [78]. The success of a construction project is dependent upon comprehensive planning, clear communication, and an experienced management team adept at handling the challenges stemming from design and scope changes. These essential factors in scheduling and control category, collectively contribute to ensuring the project's timely completion, adeptly navigating challenges, and achieving its objectives.

4.5.7 Scheduling and Control

Scheduling and control category have 6 sub factors on horizontal axis while vertical axis shows the respondents frequency against each factor. Statistics shows that inexperienced contractor or consultant have very high impact on delays while inadequate supervision, inspection, management factor is among high category ranking as shown in figure 4.9. Overall most respondents consider poor resource planning and scheduling as most influencing in very high and high category. So impact of this factor will be high on delays. In Pakistani construction industry a past research showed that 55 complete responses were taken from experienced consultant and contractors which depicts that incompetency and lack of contractor's experience is among the most influential factor in contributing project overruns [96].

Correlation test (r=0.284) of construction delays and scheduling and control factor shows that it have strong positive correlation. It means after changes in design and scope factor, scheduling and control factor have negative impact on delays. It can be observed that in planning of any future project, planners should consider above factors in design phases to avoid further delays in the future construction projects.

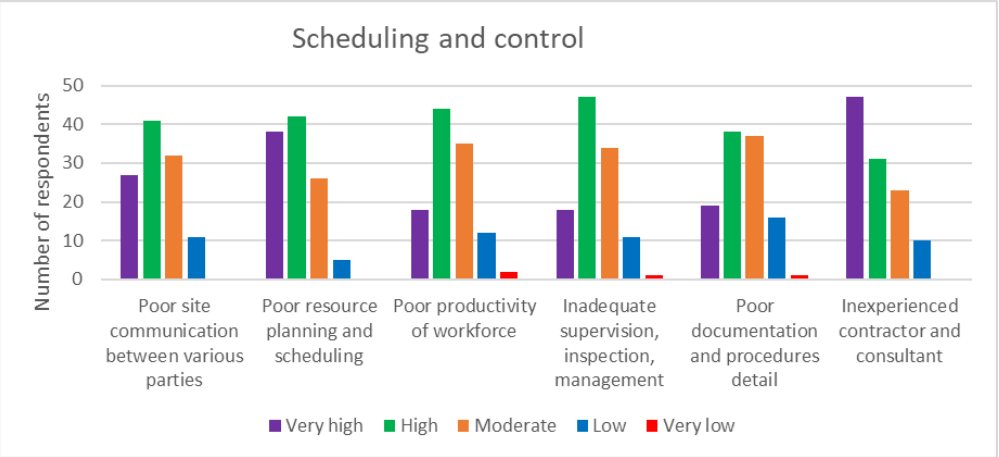

FIGURE 4.9: Impact of Scheduling and Control

It can be observed from above findings and relating literature studies that scheduling and control factors including poor site communication, inadequate resource planning, low workforce productivity, insufficient supervision and management, inadequate documentation and procedures, and inexperienced contractors and consultants, can profoundly and detrimentally impact construction projects. Poor site communication can result in misunderstandings and disputes, while inadequate resource planning can lead to cascading delays and cost overruns. Inexperienced contractors and consultants further compound these issues, increasing the likelihood of errors and inefficiencies [97]. Collectively, these factors pose significant risks, costs, and uncertainties to construction projects, underscoring the paramount importance of implementing robust management practices and fostering clear communication channels. This proactive approach is instrumental in ensuring successful project outcomes and mitigating potential challenges along the way.

4.6 Impact of Individual Delay Factors

In this section correlation between all factors has been analyzed through SPSS. In this study 26 factors are considered and their individual relationship is observed with each other. So, correlation value 0.628 shows that inadequate design factor have very strong positive correlation with changes in design and material during construction factor. After that, Inexperienced consultant and contractor factor and poor resource planning and scheduling factor have strong positive correlation

having value 0.530. In the same way correlation value 0.498 shows strong positive correlation between poor productivity of workforce and inexperienced consultant and contractor after above mentioned factors. So, correlation analysis shows that with change in above mentioned factor, its correlated factor will also change. If structural or architectural design of any project is not adequate than it means that there is need to change the design. With change in design material may also change so in this way project get out of the planned deadline.

Assaf and Al-Hejji revealed in research on Saudi Arabian construction industry that out of 73 considered factors change order is among most influencing factor in delays [98]. Therefore, the above findings underscore the importance of giving substantial consideration to factors associated with changes during the planning and execution of projects.This proactive approach is crucial for minimizing delays, fostering resilience, and ensuring the smooth progression of construction projects, ultimately contributing to their overall success.

As discussed about strong positive correlation between different factors, below is the detail of strong negative correlation between different factors. Inadequate design (architectural or structural) factor and political instability factor have very strong negative correlation having value of -0.090. This shows that with change in design of project it is of no concern either politically country is stable or not. This means change in one factor does not make impact on the other. The correlation value (-0.087) shows that delay in subcontractor work factor and lack of material factor have strong negative correlation. After that value -0.078 shows that severe weather condition factor have strong negative correlation with poor cost estimation factor. If the project cost is not estimated well it may cause delay in project and also if the weather is unfavorable, either it is raining or storm than it may lead to delays, but the both factor will not effect each other. Their behaviour with delays will be independent.

In above we can see that delays are not dependent on individual factor but also these factors are correlated with each other. Change in one factor influence the change in other factor and it may increase the delays in a project. After checking correlation their is need to check the behaviour of each factor with delays. It is imperative to identify the factors that exert a significant influence on delays and

distinguish those with less impact on time extensions in construction projects, facilitating targeted strategies for efficient project management.

To check the behaviour of individual factor the regression analysis was carried out, in which t-test was performed. It gives us values which show the significance of factors. Table 4.4 shows the t-values against the most significant and least significant variables involved in the study. It can be observed that inadequate design (Architectural and structural drawings) factor is most significant factor which contribute to delays. It has highest t-value of 2.618 among all considered variables. After that severe weather condition factor, delayed decision making factor and poor resource planning and scheduling factor have t-values 2.077, 1.079 and 1.004 respectively. Gunduz and AbuHassan performed a study, in which statistical t-value test showed that project changes by owner, delayed decision making and subcontractors delays are major contributing factors in delays [99]. This finding solidifies the use of t-test and identified factor as well.

TABLE 4.4: T-values of Delay Causing Factors

Delay Causing Factor	**T-value**
Inadequate design (Architects and structural drawing)	2.618
Severe weather condition	2.077
Delayed decision making	1.079
Poor resource planning and scheduling	1.004
Natural disasters	-1.647
Contractor/client financial crises	-1.698
Delayed payments to subcontractors	-2.313

On the other hand, negative values which are smallest values in the t-value table shows their least significance. Delayed payments to subcontractors having t-value -2.313 which means it is least important factor and there might be no effect on delays if payments of contractors might be delayed. It is because they have a contract with certain project so usually payments received after completion of project. Additionally, contractor/client financial crises and natural disaster also have no such impact on delays. These insights provide a valuable framework for assessing the specific factors responsible for project time extensions, guiding project managers in implementing targeted strategies to mitigate delays and optimize project timelines effectively. Utilizing this understanding enhances the overall project management process, fostering improved efficiency and successful project outcomes.

4.7 Impact of All Major Delay Categories

In the above sections all categories contributing to delays and their individual factors correlation are discussed. This section include the findings of impact of all major delay factors considered for the study. In present study, as discussed above seven main categories are considered including, material and equipment, contractual relations, financial factors, environmental factors, social factors, changes in design and scope factors, and scheduling and control. This intricate web of factors underscores the need for a nuanced approach, recognizing the multifaceted relationships and dependencies among sub-factors to comprehensively address project delays. Understanding the dynamic interplay within this framework allows for more precise mitigation strategies, ultimately fostering a more resilient and efficient construction project management system.

Correlation analysis was done between all major categories which shows that Scheduling and control factors category and Changes in design and scope category have positive correlation having value 0.507. As these both factors have positive correlation so both influence each other and contribute to extensions of timelines. After that contractual relations category and scheduling and control factor category have (r=0.448) positive correlation as shown in table 4.5. It means that both variables are dependent on each other. Changes in one variable influence the changes in other variable and ultimately chances of delays increases. So, above findings shows that while planning any project, it should be noticed to check correlation of above factors so they may not influence other factors. In the same way, Contractual relation factors category and social factors category have negative correlation. So, this means that they both have no significant impact on each other.

Table 4.5: Correlations between Major Categories

	Material	**Contract**	**Financial**	**Environment**	**Social**	**Changes**	**Scheduling**
Material	1						
Contract	0.302	1					
Financial	0.35	0.352	1				
Environment	0.249	0.138	0.152	1			
Social	0.065	0.093	0.042	0.25	1		
Changes	0.422	0.421	0.429	0.226	0.224	1	
Scheduling	0.349	0.448	0.285	0.092	0.242	0.507	1

Table 4.6 shows the model summary in which R-value shows the positive correlation (0.713) between delays and all major categories. In the similar way, R-square value of 0.509 shows that larger proportion of the variance in the dependent variable is being accounted for by the independent variables, indicating a better fit of the model to the data.

TABLE 4.6: Model Summary

Model	R	R Square	Adjusted R Square
1	.713a	0.509	0.475

F-statistic is large as shown in table 4.7 (15.244) indicating substantial variation between group means and the associated p-value is small (.000[b]) indicating that the observed differences are unlikely to be due to chance. In regression analysis, a high F-statistic for the overall model suggests that the model does explain a significant portion of the variation in the dependent variable, indicating a good model fit. In other words, it can be concluded that at least one group mean is significantly different from the others. This suggests that there are statistically significant differences between the groups that are comparing.

TABLE 4.7: ANOVA Table

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	17.927	7	2.561	15.244	.000[b]
Residual	17.303	103	0.168		
Total	35.230	110			

The absolute value of the beta coefficient represents the magnitude of the effect that an independent variable has on the dependent variable. Larger absolute values indicate a stronger effect and smaller values indicates the weaker impact. Table 4.8 shows the beta value of 0.284 against changes in design and scope factors which indicates its stronger effect on delays. In the same way, scheduling and control factors (0.211) and contractual relations factors (0.182) have strong impact on dependent variable after changes in design and scope.

In t-value test a large absolute t-value indicates that the coefficient is far from zero and suggests a strong relationship between the independent variable and the dependent variable. Here findings shows that changes in design and scope factor have t-value 3.147 which shows its strong relationship with delays. T-values

against scheduling and control factor and contractual relation factor are 2.441 and 2.231 respectively. A small absolute t-value suggests that the coefficient is close to zero, indicating a weak or insignificant relationship. So, environmental factor have minimum t-value (-1.342) which indicates their weak relationship with delays.

TABLE 4.8: Coefficients Table

Coefficients						
	Unstandardized Coefficients		Standardized Coefficients			
Variable	**B**	**Std. Error**	**Beta**	**t**	**Sig.**	**VIF**
(Constant)	1.353	0.384			3.522	0.001
Material	0.209	0.100	0.168	2.090	0.039	1.359
Contract	0.183	0.082	0.182	2.231	0.028	1.399
Financial	0.164	0.076	0.171	2.152	0.034	1.331
Environment	-0.105	0.078	-0.100	-1.342	0.182	1.157
Social	-0.031	0.053	-0.044	-0.593	0.555	1.152
Changes	0.209	0.067	0.284	3.147	0.002	1.706
Scheduling	0.197	0.081	0.211	2.441	0.016	1.569

The p-value shows the significance of variables involved in the regression analysis. The p-value (0.002) against changes in design and scope factor indicate its high significance. It means that this factor has very strong effect on delay. In above all test, we can observe that changes in design and scope factor is most influencing factor in delays.

A research in Asia and Europe showed that changes in design of projects and inadequate design contribute mainly to delays in construction endeavors [93]. Another research in Saudi Arabian construction sector [100], considered 38 causes of delay and 48 experts depicted that the most influencing factor in delays is client's changes in scope and design of project during construction. In Pakistan, a study on hydro-power projects shows that 31% time delays are observed and the major causes are three main factors design changes, scope changes and design errors [101]. In above findings we can observe that changes should be minimized in ongoing construction projects to avoid delays. It is alarming for design engineers and planning engineers that their designs must be concrete enough that changes should not be made during future construction projects.

The regression equation has been used to check the impact of independent variables on dependent variables. The value of Y shows the strong impact of delay causing factors on delays as shown in equation 4.1.

$$Y = 1.031 + (0.209 \times \text{material}) + (0.183 \times \text{contract}) + (0.164 \times \text{financial}) - (0.105 \times \text{environment}) - (0.031 \times \text{social}) + (0.209 \times \text{changes}) + (0.197 \times \text{scheduling}) \tag{4.1}$$

Y= 4.18

As the impact scale is considered from 0-5 so this analysis shows that the independent variables have high influence on dependent variable.

Chapter 5

Practical Implementation of Outputs

5.1 Introduction

In the above chapters, a analysis of delay causing factors within the local construction industry has been conducted. The most influencing factors are related to changes in design and scope. However, it is not enough to identify these delay factors; there is need to implement this research into practical actions within the construction sector. This chapter aims to provide concrete suggestions for the effective implementation of the research findings at multiple levels, including government policies, organizational strategies, and project management practices. To maximize the impact of these recommendations, it is important to integrate them into the early stages of project development, particularly during the planning phase. By doing so, one can proactively address potential delays, enhance project efficiency, and ultimately contribute to the overall improvement of the construction industry's performance and reputation.

At the government level, policymakers should consider incorporating the identified delay factors and mitigation strategies into construction regulations and guidelines. Moreover, governments could establish dedicated task forces or agencies responsible for monitoring and enforcing compliance with these guidelines, thus establishing accountability culture and adherence to delay causing mitigation

measures within the industry. At the organizational level, construction companies should integrate the research outputs into their project management frameworks. By implementing these recommendations, stakeholders across the construction sector can work collaboratively to minimize delay-related issues and contribute to the successful delivery of construction projects.

5.1.1 Guidelines at Government and Project Level

Mitigating delay causing factors like inadequate design, changes in design and material during construction and delayed decision making factors at government and project level needs a comprehensive approach that encompasses effective planning, proficient project management, and proactive measures to counter potential risks. To effectively tackle these challenges, it is essential to adhere to certain guidelines.

1. Comprehensive Project Planning:

Their is need to start a project with a well-defined project scope, objectives,designs and requirements. In addition to it develop a detailed project schedule and budget, considering all phases and activities. All construction materials along with their specifications should be defined in planning phase of construction projects so it cannot be changed during construction and leading to delays.

2. Risk Assessment and Management:

Thorough risk assessment is a critical step in effective project management. By identifying potential delays factor like changes in design and scope and their root causes, teams can proactively address issues before they escalate. Prioritizing risks based on their potential impact and likelihood allows for efficient resource allocation and focused mitigation efforts. To cope with high-priority risks, it is essential to develop comprehensive risk mitigation plans. These proactive measures enhance a project's performance and increase the likelihood of successful outcomes.

3. Experienced Project Team:

In the hiring process for project team, it is crucial to carefully shortlist a highly qualified and experienced group, comprising architects, design engineers, contractors, and project managers and supervisors. It must prioritize candidates with a

proven track record of successfully delivering projects similar in scope and complexity to ensure the seamless execution of our upcoming endeavor.

4. Clear Contract Documents:

In contractual relations, prepare clear and detailed contract documents that define project scope, specifications, and responsibilities of concerned individuals. It is quite workable to include provisions for penalties and incentives on any change order during execution phase.

5. Contingency Planning:

Contingency plans for potential delay factors should be developed, such as delayed decision making, inadequate design, adverse weather conditions,and poor resource planning and scheduling. It is also necessary to ensure these plans that they are well-documented and readily accessible in case of emergency.

6. Resource Allocation:

Poor resource planning and scheduling can be overcomes by allocating sufficient resources, including manpower, construction equipment, and construction materials, to meet project timelines.

7. Quality Control and Inspections:

Rigorous quality control measures should be implemented to prevent rework and delays caused by poor design. So, for timely completion of projects and to avoid changes, it is necessary to make timely inspections and quality control over the project.

8. Change Management:

Formal change management process should be established to handle scope and design changes efficiently. The impact of changes on project timelines and budgets can be evaluated and communicate these impacts clearly.

9. Lessons Learned:

It is significant to continuously gather lessons from past projects as they serves as a powerful tool for adequate future construction designs. This practice]enables

organizations to leverage historical data to better risk assessments, resulting in more effective mitigation strategies. Ultimately, it promotes a culture of continuous improvement and greater project success.

By following these guidelines and actively managing potential delay causing factors related to changes in design and scope, government construction projects can become more resilient and better equipped to stay on schedule and within budget.

5.1.2 Guidelines at Organization Level

Delays in construction projects and coping with delay contributing factors at an organizational level requires a proactive approach, effective planning, and strong project management practices. Here are some guidelines to help your organization mitigate delays and keep construction projects on track:

- **Standardized Processes:** Implementing standardized project management processes ensures consistency and efficiency across all projects, reducing confusion, changes during the construction and enhancing productivity of the project.
- **Experienced Team:** Having a team of experienced professionals means having individuals who can design complex construction projects effectively, making informed decisions and minimizing mistakes. Experienced design team have grip on design processes and encounter future design errors.
- **Technology Adoption:** Embracing construction design software improves adequate structural and architectural drawings. Also, use of advanced design software also reduce the error in designs.
- **Training and Development:** Investing in employee training and development ensures that your team remains well-equipped with the latest industry designs, knowledge and skills, leading to higher project success rates either it may be resource planning or timely decision making.
- **Bench-marking:** Regularly comparing your projects to industry standards and competitors allows you to identify areas where you can improve efficiency and effectiveness in construction project management and design.

- **Lessons Learned:** Conducting post-project lessons learned sessions helps capture valuable insights and best practices, enabling continuous improvement and informed decision-making for future projects.
- **Continuous Improvement:** Emphasizing a culture of continuous improvement encourages teams to consistently seek ways to enhance processes, adapt to changing circumstances, and deliver better results with each project.

Implementation of these guidelines at organization levels, can help you to better cope with identified delay causing factors and reduce the likelihood of delays in construction projects. It should be noted that proactive planning and communication are key to successful project management in the construction industry.

Chapter 6

Conclusion and Future Work

6.1 Research Summary

The primary aim of this study was to investigate the underlying reasons for project delays within local construction sector. Specifically, the study sought to examine the causes of project delays, focusing on seven key factors: Material and equipment related factors, contractual relations related factor, financial factors, social factors, environmental factors, changes in design and scope related factors and factors related to scheduling and control. The findings, derived from data analysis using descriptive statistics, correlation, and regression, are summarized below.

In respondents detail section, it can be observed that questionnaire is distributed among 134 respondents having different background, experiences and positions in different organizations. However, only 111 questionnaires were filled out and returned, with 5 female and 106 male respondents. This translates to a response rate of 82.83%, while 17.2% of the questionnaires remained unreturned.

In present study, there are four major findings in the study. First include the impact of construction delays on time, cost, quality and scope. Secondly, Like-rt scale data in the form of graphs and correlation test is used to find the impact of delay causing factors on delays. Third finding is to identify most influencing variables contributing to delays. Forth finding is regression analysis of all seven delay categories to find their behaviour about delays.

As it is cleared from literature review that construction delays have negative impact on time, cost, quality and scope. Questionnaire was designed in such a way to gather information from respondents about the behaviour in local construction sector. It can be observed from findings that time has delays have major impact on time and cost. While quality and scope are not significantly affected by extension in timelines. Another finding is about their correlation between time and cost which is strongly positive correlation while scope and time have strong negative correlation. So, whenever time extends it will definitely increase the budget of any construction project.

In like-rt scale data in the form of graphs we observed the trend of each delay factor towards delays. Pearson correlation analysis revealed a significant positive correlation between project delay and changes in design and scope related factors (r=0.455). Additionally, a positive relationship was identified between factors related to scheduling and control and project delays, which was statistically at 0.248. This suggests that changes in design and scope play a substantial role in project delays.

After finding the impact of delay categories, impact of all considered 26 delay factors is analyzed. In this overall correlation is found between all factors and findings shows that inadequate design factor and changes in design and material factor have very strong correlation (r=0.628). While, t-value test show the significance of each factor, it can be observed that most influencing factors are inadequate design, severe weather condition, delayed decision making and poor resource planning and scheduling.

In last regression analysis has been done to check the feasibility of study and behaviour of all major delay categories. In this environmental factors and social factors have strong positive correlation value of 0.544. After that scheduling and control factor and changes in design and scope factor have strong positive correlation. R-values showed that all independent variables have strong correlation with delays. F-test value 15.244 for the overall model suggests that the model does explain a significant portion of the variation in the dependent variable, indicating a good model fit. In the same way, beta values showed that changes in design and scope factor (0.284) have strong effect on delays.In t-value test changes in design

and scope factors (t=3.147) have strong relationship with delays. P value also shows the significance of changes in design and scope factor. This means that it have strong effect on dependent variable.

6.2 Conclusion

In this study a survey was carried out to outline the major factors causing the delays in the construction projects, especially in Pakistan.

1. The findings showed that time and cost have strong positive correlation (r=0.430) and delays have most negative impact on time, then on cost. This indicates that time delays will not only effect the time extensions but also the cost of project increases.

2. The graphical data showed that changes in design and scope factor have strong positive correlation (r=.455) with delays.

3. In individual analysis of delay factors, inadequate design factor and changes in material and design have strong correlation (r= 0.628). This means that with change in design the material also change during execution which ultimately contribute to delays.

4. It has been observed that inadequate design (architectural and structural) factor have significant impact on delays. After that, severe weather condition, delayed decision making and poor resource planning and scheduling are most influencing factors to delays.

5. In regression analysis, f-test (15.244) shows the model fitness and beta-value (0.284), t-test (3.147) and p-value (0.002) test indicates that changes in design and scope factor have most significant impact on delays.

6. Regression equation show the Y-value, 4.18 which shows the strong influence of independent variables on dependent variables.

In above findings it can be concluded that in main categories changes in design and scope factors significantly effect the project timelines. So, it is necessary for consultants and planning engineers to consider proper planning against these factors

before initiating any future project. As design drawings are basis for any project so these should be carefully analyzed and locked during planning phase. As statistics shows that inadequate design either structural or architectural have strong impact on project timelines. This is because when design changes, it ultimately changes the scope of project, which disturbs the planned timeline, planned budget, quality of project and ultimately leads to unsustainable construction environment.

6.3 Future Recommendations

A few recommendations are presented here:

1. This study is limited to responses from local construction industry of Pakistan, it is suggested to expand the study on wider scale to enhance the reliability of outputs.

2. It is suggested to carry out a future research on the changes in design and scope related factors for construction projects in Pakistan. The study could involve consultants and contractors of Pakistan Construction Industry to pinpoint what causes the inadequate design which results in project delays.

3. It is suggested to use different statistical methods or advanced machine learning techniques like Random forest model, neural network and decision tree model etc to interpret the findings to get better results.

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Appendix 1

Questionnaire

Introduction: Dear participant, I am MS Civil engineering student of CUST, Islamabad. The questionnaire is intended to assess the delay causing factors in construction projects. The questionnaire is intended for research purpose only.The outcome of this research will comprise strategies to deal with such circumstances in future. I would be grateful if you could devote few minutes of your time to fill this questionnaire.

Usman Hassan
MS Civil Engineering
Capital University of Science and Technology

Section 1: Demographics

Q1. Please specify your gender

- Male
- Female

Q2. Please specify your organization type

- Consultant

- Contractor

Q3. Please specify your role/designation in the project

- Stakeholder/owner
- Project Manager
- Planning Engineer
- Site Engineer
- Procurement/supplier
- Other: _____

Q4. Please specify your total years of experience in the construction industry

- 0–5 years
- 5-10 years
- 11-20 years
- >20 years

Q5. In which sectors does your organization work/provide services? (multiple checks are allowed)

- Infrastructure/road construction
- Residential building construction
- Commercial building construction
- Industrial construction
- Others: _____

Factor	Impact				
	Very Low	Low	Medium	High	Very High
Time					
Cost					
Quality					
Scope					

Section 2: Impact of Construction Delays

Q6. How much delays affect the performance of a construction project in terms of time, cost, quality, and scope?

Section 3: Impact of Delay Causing Factors

Q7. How much delay causing factors affect the project performance in terms of time?

Category	**Delay Causing Factors**	**Impact Ranking**				
		Very Low	**Low**	**Medium**	**High**	**Very High**
Material Equipment	Lack of material/equipment availability					
	Poor material quality					
Contractual Relations	Contractual management issues					
	Delayed decision making					
	Excessive client/owner involvement					
	Late approval and changes in government laws					
	Delay in sub-contractor's work					
Financial Factors	Poor cost estimation					
	Price escalation/fluctuations					
	Contractor/client financial issues					
	Delayed payments to subcontractors					
Environmental Factors	Severe weather condition					
	Natural disasters					
Social Factors	Site accident and property damages					
	Disputes by any personnel					
	Political instability					
Changes in design	Inadequate design (Architects and structural drawing)					
	Changes in design and material during construction					
	Errors committed due to lack of experience					
	Frequent change of subcontractor and team					
Scheduling and Control	Poor site communication between various parties					
	Poor resource planning and scheduling					
	Poor productivity of workforce					
	Inadequate supervision, inspection, management					
	Poor documentation and poor procedures detail					
	Inexperienced contractor and consultant					

Appendix 2

Questionnaire Responses

No.	Name	Time	Cost	Quality	Scope
1	Unknown	5	2	2	3
2	Bilal Aslam	4	4	3	3
3	M. Awais	4	4	3	2
4	Owais Azhar	4	4	3	3
5	M. Tehseen	5	5	4	4
6	Abdul-Waheed	4	4	3	3
7	Usama Arif	4	3	3	2
8	Pravin	4	5	4	4
9	Tahir-ullah	3	4	4	5
10	Unknown	4	2	4	4
11	Unknown	3	5	4	4
12	M. Usman Tufail	5	4	3	2
13	Danyal	4	4	4	3
14	M. Anas Azeem	3	4	2	3
15	Zeeshan	3	4	4	4
16	Muazzam Ghous	5	4	3	3
17	Abudarda	4	4	2	4
18	Muhammad Umar	4	4	2	3
19	Faizan Mehtab	5	4	2	3
20	Hasnain Zahoor	4	4	4	4
21	Junaid Javed	4	4	5	2
22	Muhammad Bilal	4	4	4	1
23	Taimur	4	5	4	5

No.	Name	Time	Cost	Quality	Scope
24	Nabeel Ahmed	4	4	4	4
25	Sibt e Ali	3	4	4	3
26	M. Hamza	4	3	3	1
27	Alina	4	3	3	4
28	Ahmad Mehar	4	3	3	3
29	Malik Adeel	3	4	4	3
30	Talha Jabbar	5	4	4	4
31	Arif Rehman	5	4	3	3
32	Anique ur Rehman	4	3	2	2
33	Moazzam Ali	4	4	3	3
34	Ahmed Ayub	4	5	3	3
35	Ali Raza	4	4	4	3
36	Faizan Khalid	4	5	4	4
37	Qamar Ali	4	4	4	4
38	M. Moazzam	4	4	2	3
39	Abdullah	4	4	2	2
40	Hassan Arshad	4	4	4	4
41	Sonaina Shafique	5	4	5	5
42	Fahad Yaqoob	3	4	2	3
43	Engineer Abdul Rafey	5	4	3	3
44	Aqil Azeem	5	3	3	4
45	Noman Shahzad	5	4	2	2
46	Muhammad Awais	4	4	3	3
47	Usama Arif	4	4	3	3
48	Ali Hamza	5	4	3	3
49	Tahir Hassan	5	3	2	4
50	Sulaiman Jan	5	5	5	4
51	Yasub ud Deen	4.5	4	3	3
52	Mohsin Yousaf	4	3	2	2
53	Ahmed Ejaz	4	4	3	3
54	Dr. Muazzam Ali	5	5	4	2
55	Unknown	5	4	4	3
56	Zulqarnain Haider	4	4	4	3
57	M. Ali	5	4	4	4

No.	Name	Time	Cost	Quality	Scope
58	Unknown	4	5	3	3
59	Unknown	5	5	4	4
60	Sohail Khalid	3	4	2	4
61	Unknown	4	4	4	1
62	Unknown	5	5	4	3
63	Ali Haider	5	4	2	1
64	Talha Malik	4	4	3	1
65	Sadia	5	5	3	3
66	Unknown	4	4	3	3
67	Irum Jawad	5	4	2	2
68	Unknown	4	4	2	2
69	Unknown	5	5	3	4
70	Tahir Ali	5	5	4	4
71	Ahmed Mujtaba	5	4	4	2
72	Furqan Ahmed	5	5	5	2
73	Unknown	5	4	4	2
74	Muhammad Sameer	4	4	3	3
75	Unknown	3	3	3	2
76	Unknown	5	5	4	2
77	Naseeb Shah	3	2	4	4
78	Hasan Zahid	4	3	2	3
79	Saqib Ali	5	4	4	3
80	Shawn Davison	5	4	5	5
81	Ali Haider	5	5	3	3
82	Adnan Zafar	5	4	4	4
83	Baber Awan	5	5	5	2
84	Rahim-ullah Khan	5	5	3	2
85	Obaid-ur-Rehman	4	4	4	4
86	Jahanzaib Ali	5	5	3	2
87	Farhan Gillani	4	5	3	3
88	Naveed Gilani	5	5	5	4
89	Tayyab Sherazi	5	5	4	2
90	Armaghan Ali	4	4	2	2
91	Aslam Marwat	5	4	4	2

No.	Name	Time	Cost	Quality	Scope
92	Rayan Malik	5	5	2	2
93	Najam Zaheer	4	4	4	3
94	Saif-ullah Ali	4	4	2	3
95	Zubair Ahmed	5	5	4	3
96	Zohaib Hassan	5	5	3	2
97	Anas Azeem	5	4	4	3
98	Malik Naseer Ahmed	5	5	5	4
99	Syed Zohair Abbas	4	5	4	4
100	Talal Chaudary	5	4	4	3
101	Mehran Yousaf	5	5	4	2
102	Faisal Bhatti	5	5	5	4
103	Wajid Shah	4	4	4	4
104	Raheel Zafar	4	4	3	3
105	Ali Yar Khan	4	4	4	3
106	Maaz Naseer	5	4	4	3
107	Khuzaim Yousaf Butt	5	5	3	3
108	Subhan Fayyaz	5	5	4	3
109	Shehzad Ali	5	4	4	4
110	Talha Hussain	4	4	4	4
111	Younas Khan	4	4	3	3

No	Name	Material and Equipment		Contractual relation				
		Lack of material /equipment availability	Poor material quality	Contractual management issues	Delayed decision making	Excessive owner involvement	Late approval and changes in government laws	Delay in subcontractor work
1	Unknown	2	2	2	3	3	3	2
2	Bilal Aslam	4	4	3	4	3	4	4
3	M. Awais	3	2	2	3	3	4	4
4	Owais A	2	3	4	5	4	5	4
5	M. Tehseen	5	4	5	5	5	5	4
6	Waheed	3	3	4	3	3	4	3
7	Usama Arif	2	2	3	4	4	4	5
8	Pravin	3	4	5	5	4	4	4

No	Name	Material and Equipment		Contractual relation				
		Lack of material /equipment availability	**Poor material quality**	**Contractual management issues**	**Delayed decision making**	**Excessive owner involvement**	**Late approval and changes in government laws**	**Delay in subcontractor work**
9	Tahir-ullah	3	4	3	3	3	5	4
10	Unknown	1	2	3	3	2	3	3
11	Unknown	4	3	3	3	4	5	4
12	M.Usman T	5	4	4	4	3	4	4
13	Danyal	5	4	2	4	3	3	4
14	M. Anas	4	5	3	4	5	4	3
15	Zeeshan	4	3	3	5	2	3	3
16	Muazzam	3	3	3	4	2	3	3
17	Abudarda	4	2	4	4	5	5	5
18	M. Umar	4	5	4	5	3	3	3
19	Faizan	4	4	4	4	5	4	4
20	Hasnain	3	3	4	5	4	4	4
21	Junaid	1	5	3	4	5	4	5
22	M. Bilal	3	3	3	5	4	4	5
23	Taimur	4	5	4	5	5	5	5
24	Nabeel	4	5	3	3	3	4	4
25	Sibt e Ali	5	5	5	4	4	4	4
26	M. Hamza	2	2	4	3	2	2	4
27	Alina	5	5	4	4	3	5	5
28	Ahmad	5	4	3	4	3	4	4
29	M. Adeel	3	4	4	4	3	3	4
30	Talha	5	5	3	3	2	2	2
31	Arif	4	2	3	4	3	4	4
32	Anique	4	2	4	5	3	5	3
33	Moazzam	4	3	4	5	5	5	3
34	Ahmed	4	3	4	4	3	5	2
35	Ali Raza	5	4	4	5	4	5	5
36	Faizan K	3	3	3	4	4	5	3
37	Qamar Ali	5	4	4	4	4	4	4
38	Moazzam	3	3	5	5	4	5	4
39	Abdullah	4	4	3	4	3	4	3
40	Hassan	4	5	4	5	5	5	4
41	Sonaina	5	5	4	4	5	4	3

No	Name	Material and Equipment		Contractual relation				
		Lack of material /equipment availability	**Poor material quality**	**Contractual management issues**	**Delayed decision making**	**Excessive owner involvement**	**Late approval and changes in government laws**	**Delay in subcontractor work**
42	Fahad	2	2	1	2	2	2	3
43	Rafey	5	5	3	4	4	4	5
44	Aqil Azeem	1	3	3	5	3	4	5
45	Noman	5	4	5	5	3	4	4
46	M.Awais	4	2	4	3	3	3	3
47	Usama Arif	5	5	4	4	2	3	3
48	Ali Hamza	5	4	4	3	3	4	3
49	Tahir	4	4	4	3	2	3	4
50	Sulaiman	3	5	2	2	3	4	5
51	Yasub	4	5	2	2	2	2	3
52	Mohsin	4	3	2	4	3	2	1
53	Ahmed	5	3	4	3	3	4	4
54	DrMuazam	5	2	4	5	1	3	2
55	Unknown	4	3	5	5	2	5	4
56	Zulqarnain	4	3	3	3	3	4	2
57	M. Ali	5	4	5	5	5	4	5
58	Unknown	3	2	4	5	3	2	3
59	Unknown	4	3	5	5	2	4	4
60	Sohail	5	2	3	4	5	3	2
61	Unknown	4	3	5	3	1	4	3
62	Unknown	4	4	3	4	3	3	2
63	Ali Haider	4	2	4	5	1	3	4
64	Talha Malik	4	3	3	5	4	4	4
65	Sadia	4	1	3	5	2	3	4
66	Unknown	4	3	3	4	2	3	2
67	Irum Jawad	4	2	5	5	3	4	2
68	Unknown	5	4	4	4	2	4	3
69	Unknown	4	3	4	5	3	4	3
70	Tahir Ali	5	3	5	4	4	4	3
71	Ahmed	5	4	5	4	4	3	2
72	Furqan	4	3	4	4	5	3	4
73	Unknown	4	3	4	4	3	5	4
74	M.Sameer	5	4	4	5	3	5	3

No	Name	Material and Equipment		Contractual relation				
		Lack of material /equipment availability	**Poor material quality**	**Contractual management issues**	**Delayed decision making**	**Excessive owner involvement**	**Late approval and changes in government laws**	**Delay in subcontractor work**
75	Unknown	4	3	4	3	4	2	5
76	Unknown	4	3	5	5	2	4	5
77	Naseeb	3	2	4	3	3	4	4
78	H.Zahid	3	3	3	3	3	3	3
79	Saqib Ali	4	4	5	5	4	2	4
80	Davison	4	3	3	3	3	4	4
81	Ali Haider	5	4	5	4	5	4	4
82	Adnan	3	4	3	5	4	4	5
83	Baber	4	3	4	5	2	5	4
84	Rahimullah	5	4	4	5	4	4	5
85	Obaid	4	3	4	4	3	3	3
86	Jahanzaib	5	4	5	5	5	5	4
87	Farhan	5	4	5	5	4	5	3
88	Naveed	4	4	4	5	4	5	5
89	Tayyab	4	4	4	4	5	5	3
90	Armaghan	4	3	5	5	4	4	4
91	Aslam	4	4	4	5	5	4	5
92	Rayan	5	4	4	5	4	4	3
93	Najam	4	4	3	4	4	3	3
94	Saif-ullah	3	5	4	5	4	5	4
95	Zubair	5	4	3	5	5	4	3
96	Zohaib	5	3	4	5	5	3	5
97	Anas	5	4	4	5	4	3	5
98	M.Naseer	5	5	5	5	5	4	4
99	Syed Zohair	5	5	5	5	4	5	4
100	Talal	4	4	5	5	4	5	4
101	Mehran	4	4	4	4	4	5	3
102	Faisal	5	4	5	4	4	5	3
103	Wajid Shah	5	4	4	4	4	5	5
104	Raheel	4	4	3	5	3	5	3
105	Ali Yar	4	3	3	5	5	5	4
106	Maaz	3	3	4	4	4	3	5
107	Khuzaim	4	4	4	4	5	4	4

No	Name	Material and Equipment		Contractual relation				
		Lack of material /equipment availability	**Poor material quality**	**Contractual management issues**	**Delayed decision making**	**Excessive owner involvement**	**Late approval and changes in government laws**	**Delay in subcontractor work**
108	Subhan	5	4	4	5	5	3	4
109	Shehzad Ali	4	3	4	5	4	5	3
110	T.Hussain	4	2	4	5	5	5	3
111	Younas	4	3	3	5	3	3	4

No.	Financial Factors				Environmental		Social Factors		
	Price Escalation/ Fluctuations	**Poor Cost Estimation**	**Contractor /Client Financial Crises**	**Delayed Payments to Subcontractors**	**Severe Weather Condition**	**Natural Disasters**	**Site Accidents and Property Damage**	**Disputes by Any Personnel**	**Political Instability**
1	2	2	3	3	2	1	3	3	3
2	4	3	4	4	3	3	3	4	4
3	3	2	3	4	3	1	2	4	3
4	4	3	5	4	4	3	2	3	3
5	4	4	4	4	5	5	5	5	4
6	2	3	3	3	3	4	3	3	4
7	5	2	2	3	3	2	1	2	2
8	3	4	4	5	3	3	4	4	4
9	4	4	3	3	2	3	2	2	3
10	1	4	2	2	3	3	2	3	2
11	5	3	5	4	3	3	3	4	5
12	3	3	4	4	3	3	3	2	4
13	4	3	4	5	4	4	3	2	3
14	3	3	2	2	4	4	2	5	4
15	5	4	4	4	4	2	3	3	4
16	5	5	4	3	3	4	3	3	5
17	4	3	5	3	3	4	2	3	4
18	5	3	4	4	4	5	3	4	3
19	4	4	4	4	3	3	4	4	5
20	3	3	4	4	4	4	5	5	5
21	4	4	4	2	3	2	1	2	3
22	4	4	5	5	3	3	2	2	3

No.	Financial Factors				Environmental		Social Factors		
	Price Escalation/ Fluctuations	Poor Cost Estimation	Contractor/Client Financial Crises	Delayed Payments to Subcontractors	Severe Weather Condition	Natural Disasters	Site Accidents and Property Damage	Disputes by Any Personnel	Political Instability
23	5	5	5	4	3	3	2	3	5
24	3	4	3	3	3	3	3	3	3
25	4	5	5	5	3	3	2	2	3
26	4	3	4	4	4	2	3	4	4
27	5	4	5	3	3	5	3	3	4
28	4	5	4	4	3	3	3	3	4
29	4	4	4	3	3	4	2	4	4
30	4	4	4	4	3	2	3	2	2
31	3	3	4	3	3	3	2	2	3
32	5	4	3	3	2	3	2	2	3
33	4	4	5	5	5	5	3	4	5
34	5	5	5	4	4	5	3	3	5
35	5	5	4	4	4	5	4	3	3
36	4	4	3	4	3	4	3	3	4
37	4	4	4	4	3	4	3	3	3
38	5	3	5	4	4	4	3	4	4
39	3	3	4	4	4	3	2	2	3
40	5	5	5	5	5	5	5	4	5
41	4	5	4	5	3	3	3	3	4
42	2	2	2	3	1	1	1	1	4
43	5	3	5	4	4	5	3	2	5
44	5	5	5	5	1	1	1	1	1
45	5	4	5	4	3	4	3	3	3
46	5	4	2	4	3	1	2	3	3
47	4	4	5	5	4	4	3	2	4
48	4	3	4	4	3	3	3	5	4
49	3	3	5	5	4	3	2	3	5
50	5	5	4	5	1	1	1	1	4
51	5	4	4	5	3	4	2	4	4
52	3	2	2	3	4	5	3	2	4
53	4	3	3	3	3	3	3	3	3
54	4	5	5	2	3	2	2	3	4
55	3	4	5	4	5	3	2	4	5
56	4	3	5	1	1	2	2	3	3

No.	Financial Factors				Environmental		Social Factors		
	Price Escalation/ Fluctuations	Poor Cost Estimation	Contractor/Client Financial Crises	Delayed Payments to Subcontractors	Severe Weather Condition	Natural Disasters	Site Accidents and Property Damage	Disputes by Any Personnel	Political Instability
57	1	3	4	4	2	4	3	2	4
58	4	5	5	4	3	3	2	3	3
59	4	5	4	3	1	4	2	4	5
60	3	3	4	2	2	3	3	2	2
61	4	5	5	3	2	3	1	3	3
62	4	5	4	4	4	3	3	2	3
63	4	5	5	2	3	2	1	4	2
64	3	3	4	2	3	4	2	3	3
65	5	4	5	3	4	3	2	3	2
66	4	3	3	2	3	2	3	3	2
67	3	4	5	3	2	2	2	4	1
68	3	4	4	4	4	3	1	3	2
69	5	5	4	3	4	3	4	3	3
70	5	4	4	3	4	3	2	5	4
71	4	5	3	3	3	2	3	4	2
72	5	4	3	4	2	2	3	4	1
73	4	5	3	4	2	2	3	2	2
74	4	5	5	3	2	3	2	5	3
75	4	4	3	5	2	2	4	3	3
76	3	3	5	2	2	1	3	2	2
77	5	4	4	5	4	5	4	4	3
78	3	3	3	3	3	3	3	3	3
79	5	4	4	5	5	4	5	4	5
80	4	5	3	4	3	4	4	3	3
81	5	4	5	5	4	3	4	4	3
82	5	4	4	4	3	3	2	3	3
83	5	4	4	3	2	3	1	4	2
84	5	4	5	5	3	3	3	2	2
85	4	3	3	4	2	4	5	4	4
86	5	4	5	3	2	3	2	4	3
87	5	5	4	3	3	4	2	4	4
88	5	5	4	4	3	3	3	4	3
89	5	5	4	5	3	4	3	4	2
90	5	5	4	4	3	4	3	5	5

No.	Financial Factors				Environmental		Social Factors		
	Price Escalation/Fluctuations	Poor Cost Estimation	Contractor/Client Financial Crises	Delayed Payments to Subcontractors	Severe Weather Condition	Natural Disasters	Site Accidents and Property Damage	Disputes by Any Personnel	Political Instability
91	5	4	4	5	4	3	2	2	4
92	5	4	5	2	3	4	3	4	3
93	3	4	4	4	3	2	2	3	4
94	4	5	5	5	2	4	2	3	3
95	5	4	5	3	2	3	3	4	4
96	5	4	4	3	2	3	4	3	4
97	4	4	4	2	3	4	3	3	3
98	5	4	4	3	2	3	3	4	4
99	5	4	4	4	2	3	3	4	4
100	5	4	4	1	1	4	2	5	3
101	5	5	4	5	2	3	2	2	3
102	5	5	4	4	3	3	3	2	3
103	3	4	4	5	3	3	2	3	3
104	3	5	5	2	3	4	5	4	4
105	5	4	5	3	3	3	2	4	3
106	4	3	5	5	3	3	2	4	4
107	3	5	5	3	3	3	3	4	3
108	2	4	5	3	3	4	3	2	2
109	4	5	5	1	2	3	2	3	3
110	3	4	5	3	3	3	3	3	3
111	3	4	4	3	2	3	2	3	3

No.	Change in design and scope				Scheduling and control					
	Inadequate design	Change in design and material	Errors due to lack of experience	Frequent change of contractor	Poor site communication	Poor resource planning	Poor productivity of workforce	Inadequate supervision	Poor documentation and procedures	Inexperienced contractor and consultant
1	3	2	3	2	2	4	3	2	3	3
2	4	3	4	4	4	4	4	3	4	4
3	2	2	3	3	5	4	3	3	2	3
4	4	4	4	2	4	5	4	4	3	4
5	4	5	4	5	4	4	5	4	4	5

No.	Change in design and scope				Scheduling and control					
	Inadequate design	**Change in design and material**	**Errors due to lack of experience**	**Frequent change of subcontractor**	**Poor site communication**	**Poor resource planning**	**Poor productivity of workforce**	**Inadequate supervision**	**Poor documentation and procedures**	**Inexperienced contractor and consultant**
6	4	4	4	3	3	3	4	3	3	4
7	2	5	3	2	3	2	3	3	2	2
8	4	4	5	5	5	4	5	4	5	4
9	3	3	4	4	3	3	4	3	3	3
10	2	3	2	1	2	3	2	1	1	2
11	3	3	3	4	3	3	3	3	3	3
12	3	4	3	4	3	4	3	3	3	4
13	3	4	4	4	3	4	4	3	3	4
14	3	4	3	3	5	4	4	4	2	2
15	3	3	3	3	2	3	3	2	3	2
16	4	5	3	5	5	5	4	5	4	5
17	4	5	4	4	4	4	3	4	3	4
18	3	4	5	4	4	4	4	4	4	4
19	4	4	3	4	4	4	3	3	3	3
20	3	3	4	3	5	5	5	4	5	4
21	2	2	2	2	2	2	2	2	2	2
22	4	4	4	5	5	5	4	5	5	5
23	4	4	3	4	4	5	5	4	4	5
24	4	3	3	4	2	3	3	4	2	3
25	4	4	5	5	4	4	3	3	3	3
26	3	4	4	4	4	4	4	4	4	3
27	3	3	4	5	5	5	5	5	5	5
28	3	3	3	3	4	4	4	4	4	4
29	4	3	3	4	3	4	4	3	4	4
30	5	4	4	4	3	4	4	5	4	5
31	4	4	4	4	4	4	4	4	3	4
32	4	3	4	3	4	3	3	3	3	5
33	3	4	4	4	3	4	5	5	5	3
34	3	4	4	5	3	4	3	4	3	5
35	5	5	5	5	4	4	4	4	4	5
36	3	3	4	4	4	4	4	4	5	5
37	4	5	4	4	5	5	5	5	5	5
38	4	3	3	4	4	4	4	4	4	5

No.	Change in design and scope				Scheduling and control					
	Inadequate design	**Change in design and material**	**Errors due to lack of experience**	**Frequent change of subcontractor**	**Poor site communication**	**Poor resource planning**	**Poor productivity workforce**	**Inadequate supervision**	**Poor documentation and procedures**	**Inexperienced contractor and consultant**
39	3	2	3	3	3	3	2	2	3	2
40	5	5	4	5	5	5	5	5	5	5
41	5	5	4	4	3	4	4	5	3	5
42	2	2	1	1	2	3	3	3	3	2
43	4	5	4	5	3	3	3	3	3	3
44	4	4	3	3	3	3	3	3	3	3
45	4	5	5	4	4	5	5	4	4	5
46	3	3	4	4	3	3	4	4	3	5
47	3	4	3	4	4	5	5	4	4	5
48	4	5	3	4	4	3	4	3	4	3
49	5	5	5	5	4	5	4	4	3	4
50	2	1	3	2	4	5	4	2	5	4
51	3	4	3	4	3	4	4	5	4	4
52	4	3	2	3	3	4	3	4	3	4
53	4	2	2	4	4	3	4	4	3	5
54	5	5	5	5	4	5	4	4	2	5
55	3	3	4	4	4	5	2	3	4	4
56	4	4	4	2	3	4	3	5	4	5
57	5	5	5	5	4	5	5	4	4	5
58	4	4	4	4	2	4	3	4	3	5
59	5	5	4	4	3	5	2	5	4	5
60	4	3	3	2	3	4	3	3	2	3
61	4	4	3	3	4	4	3	4	5	4
62	5	4	3	4	5	4	4	4	4	3
63	4	5	3	4	3	5	3	4	2	5
64	4	4	3	3	2	4	3	5	2	5
65	4	5	4	5	3	5	3	4	2	5
66	4	3	4	3	4	3	2	2	3	4
67	4	4	5	3	4	5	2	4	5	4
68	5	5	4	4	4	3	4	3	5	3
69	4	4	3	3	4	5	4	4	4	3
70	5	4	4	3	3	3	5	4	4	3
71	5	5	4	4	5	5	3	3	5	5

No.	Change in design and scope				Scheduling and control					
	Inadequate design	**Change in design and material**	**Errors due to lack of experience**	**Frequent change of subcontractor**	**Poor site communication**	**Poor resource planning**	**Poor productivity workforce**	**Inadequate supervision**	**Poor documentation and procedures**	**Inexperienced contractor and consultant**
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73	5	4	4	3	4	5	2	4	4	5
74	5	4	4	3	4	5	3	3	4	5
75	4	3	4	1	3	1	3	4	2	5
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80	5	4	3	4	4	4	5	5	4	5
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84	5	5	5	5	4	3	4	4	5	5
85	5	5	4	4	4	5	4	4	3	4
86	5	5	4	4	5	5	4	4	5	4
87	4	4	3	3	2	5	5	5	3	4
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91	5	5	5	5	3	3	3	4	4	5
92	4	4	3	3	5	5	5	4	3	5
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97	4	4	3	3	4	4	4	4	4	4
98	5	5	5	5	4	5	5	5	5	4
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101	5	5	4	4	5	5	4	4	4	5
102	5	5	5	5	5	4	4	4	5	4
103	5	4	4	3	3	4	3	4	5	5
104	5	5	5	5	4	5	3	3	4	5

No.	Change in design and scope				Scheduling and control					
	Inadequate design	**Change in design and material**	**Errors due to lack of experience**	**Frequent change of subcontractor**	**Poor site communication**	**Poor resource planning**	**Poor productivity of workforce**	**Inadequate supervision**	**Poor documentation and procedures**	**Inexperienced contractor and consultant**
105	5	5	5	5	5	4	3	4	3	3
106	5	5	5	5	3	5	3	4	2	4
107	3	2	5	2	5	4	3	4	3	2
108	5	4	5	4	5	4	4	2	2	4
109	5	5	3	3	5	4	4	2	2	4
110	4	4	3	3	3	5	5	3	5	3
111	3	3	4	4	3	3	4	4	4	3

Appendix 3

Delphi Method Details

The details of experts in delphi method are as follow:

- Dr. Qaiser Javed, having 20+ years experience in design and execution of construction projects.
- Dr. Sohail Khalid, with 12 years experience in high rise building projects.
- Engr. Arif-Rehman, with 8 years experience in Golf countries and 5 years in local construction sector.

Table 6.5: Selected Delay Causing Factors before Delphi Round 1

Category	**Delay Factors**
Material and Equipment	• Lack of material availability • Lack of equipment availability • Poor material quality • Inaccessibility to sites
Contractual Relations	• Short contract period • Errors in contract • Delayed decision making • Excessive client/owner involvement • Issues between stakeholders • Late approval and changes in government laws • Delay in subcontractors' work
Financial Factors	• Poor cost estimation • Price escalation/fluctuations • Contractor/client financial issues • Delayed payments to subcontractors • Inflation
Environmental Factors	• Severe weather conditions • Natural disasters • Unpredicted surface conditions
Social Factors	• Disputes by any personnel • Political instability • Public objections
Changes	• Inadequate design • Changes in design and material • Errors committed due to lack of experience • Frequent change of sub-contractor and team
Scheduling and Control	• Poor site communication • Poor resource planning and scheduling • Poor productivity of workforce • Lack of labor • Inadequate supervision, inspection • Poor documentation and poor procedures • Inexperienced contractor and consultant • Site accidents and property damages • Lack of interest by execution team

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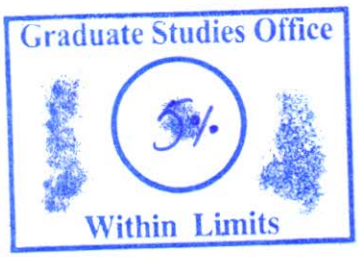

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