Barriers for Effective Implementation of Construction Schedule in Infrastructure Projects

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(2024)

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A thesis submitted to the National University of Sciences and Technology, Islamabad, in partial fulfillment of the requirements for the degree of

Master of Science

In

Construction Engineering and Management

Thesis Supervisor: Dr. Khursheed Ahmed

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Islamabad, Pakistan

(2024)

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Titled : "Barriers for Effective Implementation of Construction Schedule in Infrastructure Projects" be accepted in partial fulfillment of the requirements for the award of degree with B+ Grade.

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This thesis is dedicated to my mother, respected teachers, siblings and my friends.

ACKNOWLEDGEMENTS

First and foremost, all praises and gratitude to Allah Almighty Who has always supported me throughout my life and helped me to complete my thesis and research degree. I would like to thank my supervisor Dr. Khursheed Ahmed for guiding me through this challenging task. I am also extremely thankful to my G.E.C members Dr. Muhammad Usman Hassan and Dr. Khurram Iqbal Ahmed Khan for their sincere guidance to complete this research work. I would especially want to thank my friends for their support and encouragement during the course work and my initial research. Finally, I would want to convey my deep and sincere appreciation to my family for their unwavering love, patience, support, and prayers.

ABSTRACT

Schedule management and delays is one of the most crucial issue but the lack of knowledge, understanding and awareness regarding the barriers that contribute to the project delays and failure for not implementing the effective construction schedule is unclear. Construction scheduling have several benefits for enhancing timely completion of project but various barriers may affect the schedule, there is a significant gap between its theoretical importance and practical implementation in actual construction. Therefore this study aims to identify these barriers for effective implementation of construction schedule in infrastructure project through literature review and assess the relative importance of these barriers from main construction stakeholders' perspectives. First, an initial list of 45 barriers collected from the previous literature was reduced to 20 barriers using the content analysis and Delphi method. Then, an online and field questionnaire survey was performed across the Pakistan construction industry to observe and analyze the data through exploratory factor analysis and relative importance index of 20 barriers from 200 valid responses. After statistical analysis, the top five critical barriers for the schedule implementation of infrastructure projects in Pakistan are identified such as unrealistic project schedules imposed in contract from client, poor planning and scheduling, contractor financial problems, lack of proper training and experience of project manager and inadequate project scheduling software's. In order to check the findings of this research, a comparison of the barriers with 13 other countries, revealed that the top five critical barriers was not only the most common barriers in Pakistan construction industry, but also indicated up in various other nations as well. These findings can be useful for main construction stakeholders to reduce schedule delays.

Keywords: Construction Schedule, Planning and Scheduling, Infrastructure Projects

TABLE OF CONTENTS

LIST OF FIGURES

Page No.

LIST OF TABLES

Page No.

CHAPTER 1 INTRODUCTION

1.1 Research Background

The construction sector is one of the fundamental part of the economy, and it is persistently increasing to enhance its role in development (Khattak and Mustafa 2019). This area is accepted to be one of the difficult areas in which new projects convoy more details and complexities (Sarmad and Choudhary 2019). The emerging nations are showing a high attention in delivering construction projects to attain economic progress. In recent times, they have assigned significant amounts of investment to infrastructure projects (AlNasseri and Aulin 2015). These investment are mostly supported from public assets, so they are expected to be conveyed effectively (Khattak and Mustafa 2019). These projects are funded, maintained and functioned by a government for the use of the over-all public (Yang 2007). A construction project that is successful will be accomplished on schedule, contained by budget, in accord with provisions, and to the approval of all parties involved (De Snoo, Van Wezel et al. 2011). However, construction schedule are typically thorough concerns in the implementation of infrastructure projects particularly in the developing country like Pakistan construction industry (Idrees and Shafiq 2021). Therefore, it is essential to identify the barriers for effective implementation of construction schedule in infrastructure projects.

Infrastructure projects (like roads, dams, airport, bridges, housing schemes etc.) in Pakistan are seen as an important indicators of its progress and growth (Khattak and Mustafa 2019) and mostly projects have been fronting some serious issues for not completing in time (Sardar Ahsen, Memon et al. 2021). Nowadays Pakistan construction industry amongst one of the fast growing sector (AlNasseri and Aulin 2015). GDP from Construction in Pakistan be an average of 712 PKR Billion from 2000 until 2023, getting an all-time high of 1184 PKR Billion in 2018 and a record small of 373 PKR Billion in 2000 (State Bank of Pakistan). However, GDP (Gross Domestic

Product) has decreased to 890 PKR Billion in 2023 from 979 PKR Billion in 2022. A lot of construction projects are facing project delays and cost overrun due to unknown barrier in the scheduling (Nasir, Gabriel et al. 2011). For example, the Capital Development Authority (CDA) has put a hold on various projects due to lack of funding. The Housing Foundation Towers project located at Mauve Area G-13, Islamabad planned completion date was May 5, 2023, but not completed its foundation work yet. The majority of the megaprojects are either moving slowly or have not met their completion dates, indicating that the Capital Development Authority's current management has not been able to keep up the pace of development in Islamabad. The Prime Minister, Shehbaz Sharif, personally launched the Bhara Kahu Bypass project in October 2022, with an aim to finish it by January 2023. Despite many deadline extensions, the project has not yet been finished (1st October, 2022 by Dawn). One of the main barrier for Infrastructure development could be lack of implementation of effective construction schedule.

An effective construction schedule is a well-organized and realistic plan that efficiently guides the execution of a construction project from initiation to completion (Yang 2007). It incorporates essential project management principles to maximize resource allocation, reduce risks, and guarantee the project's effective completion within the given parameters, going beyond just a deadline (AlNasseri and Aulin 2015). An effective construction schedule is a dynamic and well-managed tool that integrates key project management principles. It goes beyond a simple timeline, addressing resource management, risk mitigation, and stakeholder communication to guarantee the effective and timely accomplishment of a construction project.

1.2 Research Gap

Construction scheduling have several benefits for enhancing timely completion of project but various barriers which may affect the schedule, there is a significant gap between theoretical importance and practical implementation in actual construction. While the particular details behind such problems are uncertain, but these problems caused mainly from inappropriate understanding, insufficient knowledge and awareness of the barriers that lead to schedule delays. Also it has been found that the schedule delays is considered as one of the most critical problem.

1.3 Problem Statement

Schedule management and delays is one of the most crucial issue but main problem is the lack of knowledge, understanding and awareness regarding the barriers that contribute to the project delays and failure for not implementing the effective construction schedule. There is a need to identify these barriers that occur among the planning phase in addition to implementation particularly in large infrastructure projects. For a project to be successful, this research will identify these critical barriers and provide recommendations to different stakeholders like client, contractor and consultant to overcome these barriers in infrastructure projects.

1.4 Research Objectives

1) To identify the barriers for effective implementation of construction schedule in infrastructure projects through literature review.
2) To assess the relative importance of these barriers from main construction stakeholder perspectives.
3) To provide recommendations regarding the critical barriers to reduce schedule delays.

1.5 Research Significance

Pakistan construction industry faced several challenges, in term of planning and scheduling to be effectively implemented, essential problems have to be examined and improved. Effective implementation of construction schedules is vital for attaining project success, timely completion, and cost savings. It also facilitates stakeholders to maximize project importance, reduce risks, and provide projects that meet or surpass expectations. Now, there is a need to explore identification of critical barriers regarding implementation of construction schedule from the perspectives of client, contractor, and consultant to use these observations to assess awareness of scheduling barriers in Pakistan.

1.6 Thesis structure

This thesis comprises five chapters. The order and brief description of these chapters is given below:

Chapter (1) Introduction

This section includes general study background, research gap, problem statement, research goals, research importance and thesis arrangement.

Chapter (2) Literature Review

This section covers barriers for effective implementation of construction schedule, why infrastructure projects and

Chapter (3) Methodology

This section covers content analysis, questionnaire and exploratory factor analysis.

Chapter (4) Results and discussions

This section covers the discussion of results in detail.

Chapter (5) Conclusions and recommendations

This section include future recommendation that reduce schedule delays.

CHAPTER 2 LITERATURE REVIEW

2.1 Construction Schedule

Schedule planning is a most important mission in effective construction project management (Yang 2007). Scheduling, includes defining main concern or ordering activities to happen definite requirements, restraints or objects. Scheduling is an important tool for effective project management (Zhou, Love et al. 2013). For a development project, project planning, mainly schedule planning, is at the core of good project management as it delivers the vital communication organizing the work of all stakeholders (Yang 2007). A construction schedule is a useful tool for project managers and teams managing many important parts of project management (Kar, Basak et al. 2007). They control resources, money, time, and other factors with building schedules. The construction schedule is individual of, if not the topmost, vital tools for project management since it may guarantee that the management team has access to sufficient information. Given this information on the importance of project timelines, great care should be taken in their development. A construction schedule is mostly based on the experience and background of the developer. The construction schedule, which is meant to be useful, will become a time-consuming and expensive tool if the scheduler is not well-versed on the project's scope (Idrees and Shafiq 2021).

2.2 Planning and Scheduling

2.2.1 Organizational Scheduling

Scheduling in organizational context is basically the process of assigning and adjusting a company's resources such as its personnel, equipment, vehicles, and supplies as well as the jobs or activities that staff members must do within a given time frame (Park 2021). The scheduling development involves a number of tasks, including obtaining and interpreting information, negotiating and communicating with many stakeholders, solving puzzles, coming to decisions, and addressing problems (De Snoo, Van Wezel et al. 2011).

2.2.2 Construction Project Scheduling

Over the past 20 years, the work of scheduling a construction project's execution is difficult and complex. The most crucial aspect of scheduling is choosing resources (labor, machinery, and plant), which should be done with consideration for the work that has to be done and the limitations of the location (Robu, Sadeghpour et al. 2019). Because each project is different, a planner creating a schedule for building tasks, for instance, should take a variety of factors into account, including organizational and technological constraints, resource availability, and methods of ensuring that a client's needs and demands in terms of time, cost, and quality are met (Zhou, Love et al. 2013).

2.2.3 Schedule Performance

The degree to which the scheduling objectives are satisfied and the restrictions are broken is how scheduling performance is evaluated in the majority of approaches and procedures (Iyer and Jha 2006). The anticipated execution of the schedule is connected to the metrics that are frequently used to assess scheduling performance (Hsu, Aurisicchio et al. 2020). For instance, they might include machine usage, delays, earliness, slowness, and overall completion time in production scheduling. Metrics used in workforce scheduling include total penalty costs for shift balance violations and total employee satisfaction. In other arguments, scheduling performance measurements evaluate the expected level of schedule execution quality (De Snoo, Van Wezel et al. 2011).

2.2.4 Schedule Plan Improvement and Performance

The actual performance of a timetable supports in assessing the quality of next schedules and identifying areas for development (Iyer and Jha 2006). To limit resource usage within scheduling restrictions, this work must be completed by both schedulers and planners. Main purpose of schedule control as following actual performance also to show helpful actions and contingency strategies as might be essential. To prevent mistaking the executed timetable for the planned schedule, planners and project managers should be aware of the present state, or progress, of their projects (Kakar, Hasan et al. 2020). The scope of the task is considered to include both its quantity and quality, however the latter will probably be specified in more detail in specifications and related documentation. Schedule performance according to metrics assessing the quality of deliverables from the viewpoints of other project stakeholders and end users for example, lack of scheduling expertise, poor communication, and inadequate schedule risk assessment (AlNasseri and Aulin 2015).

2.2.5 Planning and Scheduling Different Methods

Many tools and techniques are used to organize project schedules in the context of development projects, and the majority of these have their origin from World War II or even earlier times (Kakar, Hasan et al. 2020). These consist of the Program Review and Evaluation Technique (PERT), the Critical Path Method (CPM), and the Gantt chart. It has been found that these techniques are the most popular in the construction sector (Robu, Sadeghpour et al. 2019). A well-recognized visual tool for tracking work in progress is the Gantt chart, a graphical means that shows a sequence of tasks across time. Using a set of activities listed in a work breakdown structure (WBS), CPM and PERT were launched in conjunction to organize typical building projects. However, the primary difference between both is that CPM is predicated on a deterministic network, which determines schedule duration based on a single phase estimate for every activity. PERT was created as a probabilistic system to simulate the uncertainty involved in task duration prediction using three point estimations of time (AlNasseri and Aulin 2015).

2.2.6 Managerial Planning and Scheduling Understanding and Awareness

Planning cannot be successful without understanding the tasks that will be scheduled (AlNasseri and Aulin 2015). A basic prerequisite for any company trying to make planning techniques and technologies useful for project or system management is knowledge of planning and scheduling (Yang 2007). Understanding schedule management is essential from a production industry perspective and must be addressed in order to evaluate schedule issues using both knowledge and experience (Meng, Yu et al. 2022). This would make it possible to improve the connection between scheduling and planning theory and practice (Park 2021). Furthermore, there is a need for information that might make it easier for practitioners to adapt and use various scheduling techniques. It's true that not many research have tried to concentrate on conceptualizations of an information-based approach to project scheduling and planning. Implementing construction schedule to examine some of the key barriers influencing schedules for projects. According to the study's findings, most scheduling issues resulted from a lack of understanding or awareness of the planning and scheduling tools in use (AlNasseri and Aulin 2015).

2.3 Construction Scheduling Problems

The goal of construction scheduling is to allocate resources and arrange tasks in the best possible order throughout time. When assessing and choosing offers, a customer often considers the length criterion, with the project schedules being set in advance (Meng, Yu et al. 2022). It is usually the goal of contractors to shorten the project's length in order to get an edge when evaluating bids. For instance, they might assign extra resources (if adequate resources are given) to speed up construction in order to "crash" a project's duration, which is the minimum amount of time for which a task can be planned. Crashing a project's timeline, however, always results in higher costs since more resources are needed (Maqsoom, Khan et al. 2018). The reason for this is because time and cost are interdependent. For example, shortening a project's time will result in higher direct expenses (labor, materials, and plant and equipment) and lower indirect costs (project expenses), and vice versa (Zhou, Love et al. 2013).

2.4 Infrastructure Projects

2.4.1 Why Infrastructure Projects?

Large-scale building or development projects known as "infrastructure projects" are those that seek to establish, improve, or preserve the organizational and physical frameworks that are necessary for a community, economy, or society to function. Fundamental facilities and systems are usually designed, built, renovated, or expanded as part of these initiatives (Sarmad and Choudhary 2019). Any modern society would not be the same without its infrastructure, which provides the framework required for public services, economic activity, and general quality of life. Infrastructure project are very important and main role in the growth of country economy and successful completion of these projects within the require schedule will be very profitable. Therefore, infrastructure projects has the potential to degrade the barriers for effective implementation of construction schedule (Khattak and Mustafa 2019).

2.4.2 Infrastructure Projects Failure:

Schedule delays are a common concern in infrastructure projects that might cause the project to fail. For example, the Central Artery and Third Harbor Tunnel Project in Boston was eight years behind schedule, while the Sydney Opera House took 10 years longer to complete. Infrastructure projects are increasingly associated with timetable delays because to the high level of risk associated with schedule estimations (Park 2021). Assaf and Al-Hejji conducted one of the few studies in this field. To ascertain the reasons for delays, they performed an investigation on the schedule performance of various kinds of building schemes. Change orders were the most frequent cause of delay out of the 73 factors they examined. According to the report, 70% of schemes in

Saudi Arabia had schedule delays, with the usual delay being among 10% and 30% of the project's initial interval (Assaf and Al-Hejji 2006).

2.5 Construction Projects in War Affected Region

In both industrialized and developing nations, there is a serious and persistent issue with building projects not meeting their schedules (Meng, Yu et al. 2022). Given their complicated and difficult socio-political and economic situations, countries devastated by disasters or conflict may have lower timetable performance in building projects. For example, startling information on one of the biggest building projects in Afghanistan was just made public by the Special Inspector General for Afghanistan Reconstruction (SIGAR 2018). This research claims that after spending over USD 249 million, the Quasar to Leman ring road project has only made 15% development in the last 12 years. For example, Kakar et al. (2009) found that the key causes of building project postponements in the Gaza Strip include strikes, closing of borders, and material-related issues, such as shortages in markets and material supply delays to the site (Kakar, Hasan et al. 2020).
Collins (2004) suggested that project accomplishment is determined in terms of the classic project objectives, or the iron triangle (time, money, quality), and the usefulness of the finished product, according to a poll conducted among 150 project managers (Collins and Baccarini 2004). Ayer & Jha (2006) found six crucial success factors that have an influence on the schedule execution of Indian construction developments: the owner's competence, the project manager's competence, monitoring, suggestions, and organization; helpful employed conditions; assurance from all project members; and top management's and owners' support (Iyer and Jha 2006). Sineselassie et al. (2017) determined the owners' competency to be a crucial component of good schedule performance in Ethiopian public construction projects. The researchers discovered that the timetable performance is impacted by a number of elements, including participant conflict, inadequate handling of human resources, and the project manager's inexperience and lack of experience (Sinesilassie, Tabish et al. 2017).

2.6 Project Performance of U.S and U.K

It has been determined that various nations face varying degrees of risk in terms of schedule delays due to differences in personnel training, institutional monitoring, political dynamics, and procurement patterns. However, a lot of initiatives still have time as a primary problem (Prater, Kirytopoulos et al. 2017). 77% of projects initiated from 1998 and 2003 weren't done by the original baseline schedule, as reported in the findings. Fifteen years earlier, precisely the unchanged proportion, 77%, of schemes initiated from 2013 and 2018 were not completed on time. The past 20 years have seen significant efforts in the United States as well as the United Kingdom on project controls that include program assessment and review procedure, but from the standpoint of schedule, execution of projects has not changed at all (Park 2021).

2.7 Schedule Delays barriers in Other Countries

Zemra Rachid, 2019, found that Algeria has undertaken many large-scale building projects during the past 20 years in an effort to upgrade the nation's fundamental infrastructure. The study found fifty-nine reasons of delay, with the findings indicating that the top five causes include delayed change orders, unrealistic deal durations, and delayed variation guidelines in additional of quantities, compensation delays for accomplished effort, and unfortunate planning and scheduling by contractors. Conferring to the report, the primary reasons of delays are those connected to the owners (Rachid, Toufik et al. 2019). Bajjou & Chafi, 2020, revealed that as a long-lasting and a mutual difficulty worldwide, there are many construction projects, not just those in Morocco that have scheduling disruptions in greatest amounts. the top ten reasons for delays are as follows: untimely progress payments; insufficient worker training; a deficiency of a waste managing strategy; clients' impractical contract periods; rework resulting from construction mistakes; extreme subcontracting; tardiness in attaining allows as of government agencies; poor planning and scheduling; a absence of mutual planning; and an unqualified workforce. The success of the Moroccan building production may be improved by using these results as a reference for construction project managers (Bajjou and Chafi 2020).

2.8 Schedule Delays in Pakistan Construction Industry

In Pakistan, many studies were conducted in an effort to determine the barriers of construction project delays with schedule extensions. Shaikh, 2010 (Shaikh, Muree et al. 2010), examined delays encountered in the construction of high-rise buildings worldwide in demand to create a precise framework and to determine the most important barriers influencing the reasons of delays in construction schemes. Four delay barriers were identified and presented, namely client, contractor, resource, and common problems. This research was concentrated on selection of critical barriers. Nasir, (Nasir, Gabriel et al. 2011), identified a number of significant factors that affect the time and expense of a highway scheme, including the land acquirement process, the price escalation of major building materials, improper planning, the contractor's incapacity to complete the job, the delay in turning over the site to the contractor, changes to the scope or amount of work, and unacceptable government policies and priorities. Using three case studies of medium-sized Pakistani projects, time slippage among government-funded construction projects is reviewed. Jamil, (Jamil, Mufti et al. 2012), concentrated on the project owners' causes and found that "absence of understanding and reduced awareness of suitable planning throughout various stages of development schemes and their effect on time" was the most important factor. Haseeb, (Haseeb, Bibi et al. 2011), 16 major causes were identified after investigating the causes and effects of delays in large-scale construction projects in Pakistan. These causes included funding and money, imprecise time assessment, material value, unforeseen site conditions, natural disasters, poor site management, outdated technology, shortages of material, complications caused by subcontractors, modifications to designs, inappropriate equipment, unreliable estimation of costs, change orders, administrative deviations, and regulatory variations.

2.9 Time Delays in Hydro-Power Projects in Pakistan

Ayesha & Abbas, 2017, reported that the ten years' worth of hydropower projects in Pakistan have been delayed for a variety of causes. The Water and Power Development Authority (WAPDA) in Pakistan started the project in 2003, and it was finished 2.5 times more expensively and with an average time overrun of 200%. These projects were all delayed by five to six years. The majority of respondents concurred that the primary causes of these hydropower project delays were "a non-existence of political determination, delays in civil effort, suspensions in the government's issue of reserves, poor Law and Order situations, starting the project inadequate site assessment and ineffective project scheduling" (Batool and Abbas 2017). This study will promote the literature on barriers for effective implementation of construction schedule in infrastructure developments in Pakistan as specifically no research occurred on this topic. Most studies are on general delays and cost overruns in the construction sector with different methods; Collection of data through literature, Identify factor for delays from contractor, consultant and owner point of view, Rank the barriers by respondents on Relative Importance Index and Relative Severity Index using a questionnaire survey and many more but there is no specifically study on schedule delays or Time overruns in Infrastructure projects in Pakistan. This research will provide as a first stage towards the selection of barriers for effective implementation of construction schedule in infrastructure projects.

2.10 Barriers for Effective Implementation of Construction Schedule

To extract the dominant barriers reported in the published literature, an extensive review has been performed. For this purpose, important research papers dealing with effective implementation of construction schedule in infrastructure projects published between the periods of 2006-2023 have been thoroughly inspected from different journals. As a result, 45 barriers have been identified. In the next step give references to each of the barrier to easily determine frequency for content analysis.

Table 2.1: Barriers References

SN	Barriers	References
1.	Poor Scope Definition	(Assaf and Al-Hejji 2006), (Bajjou and Chafi 2020), (Shaikh, Muree et al. 2010), (Nasir, Gabriel et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Khan, Choudhary et al. 2015), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Srdić and Šelih 2015), (Kaliba, Muya et al. 2009), (Divakar and Jebin
2.	Change Order and Variations	(Assaf and Al-Hejji 2006), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Shaikh, Muree et al. 2010), (Nasir, Gabriel et al. 2011), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Srdić and Šelih 2015), (Divakar and Jebin 2018), (Idrees and Shafiq 2021), (Hanif, Khurshid et al. 2016), (Bagaya and Song 2016),
3.	Inaccurate Project Cost Estimation	(Zhou, Love et al. 2013), (Assaf and Al-Hejji 2006), (Kakar, Hasan et al. 2020), (Nasir, Gabriel et al. 2011), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Divakar and Jebin 2018), (Idrees and Shafiq 2021), (Abdul-Rahman, Wang et al. 2011), (Sarmad and Choudhary 2019), (Alamri, Amoudi et al.
4.	Unrealistic Project Schedule imposed in Contract	(Assaf and Al-Hejji 2006), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Divakar and Jebin 2018), (Idrees and Shafiq 2021), (Hanif, Khurshid et al. 2016), (Sarmad and Choudhary 2019), (Alamri, Amoudi et al. 2017)
5.	Labor Productivity Issues	(Assaf and Al-Hejji 2006), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Haseeb, Bibi et al. 2011), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Divakar and Jebin 2018), (Idrees and Shafiq 2021), (Nisar and Asif 2023), (Maqsoom, Khan et al. 2018)

6.	Limited Availability of Skilled Labor	(Khattak and Mustafa 2019), (Assaf and Al-Hejji 2006), (Kakar, Hasan et al. 2020), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Shaikh, Muree et al. 2010), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Srdić and Šelih 2015), (Idrees and Shafiq 2021), (Hanif, Khurshid et al. 2016), (Nisar and Asif 2023), (Alamri, Amoudi et al. 2017), (Sarmad and Choudhary 2019), (Maqsoom, Khan
7.	Design Error and Revisions	(Assaf and Al-Hejji 2006), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Jamil, Mufti et al. 2012), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Khan, Choudhary et al. 2015), (Choudhry, Aslam et al. 2014), (Srdić and Šelih 2015), (Idrees and Shafiq 2021), (Hanif, Khurshid et al. 2016), (Nisar and Asif 2023), (Alamri, Amoudi et al.
8.	Delays in Payments	(Assaf and Al-Hejji 2006), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Shaikh, Muree et al. 2010), (Nasir, Gabriel et al. 2011), (Jamil, Mufti et al. 2012), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Arantes, da Silva et al. 2015), (Srdić and Šelih 2015), (Divakar and Jebin 2018), (Idrees and Shafiq 2021), (Nisar and Asif 2023), (Bagaya and Song 2016), (Abdul-Rahman, Wang
9.	Contractor Financial Problems	(Assaf and Al-Hejji 2006), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Khan, Choudhary et al. 2015), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Idrees and Shafiq 2021), (Hanif, Khurshid et al. 2016), (Nisar and Asif 2023), (Bagaya and Song 2016), (Abdul-Rahman,
10.	Inflation	(Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Shaikh, Muree et al. 2010), (Nasir, Gabriel et al. 2011), (Haseeb, Bibi et al. 2011), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Kaliba, Muya et al. 2009), (Nisar and Asif 2023), (Abdul-Rahman, Wang et al. 2011), (Sarmad and
11.	Unforeseen Ground Condition	(Bajjou and Chafi 2020), (Shaikh, Muree et al. 2010), (Nasir, Gabriel et al. 2011), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Divakar and Jebin 2018), (Hanif, Khurshid et al.

12.	Political Interference and Decision Making	(Khattak and Mustafa 2019), (Kakar, Hasan et al. 2020), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Choudhry, Aslam et al. 2014), (Idrees and Shafiq 2021), (Alamri, Amoudi et al. 2017), (Sarmad and Choudhary 2019), (Karji, Namian et al. 2020), (Iyer and
13.	Insufficient Knowledge Transfer and Training	(AlNasseri and Aulin 2015), (Assaf and Al-Hejji 2006), (Bajjou and Chafi 2020), (Jamil, Mufti et al. 2012), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Kaliba, Muya et al. 2009), (Divakar and Jebin 2018), (Hanif, Khurshid et al. 2016), (Sarmad and Choudhary 2019), (Karji, Namian et al. 2020), (Iyer and Jha 2006),
14.	Poor Project Planning and Scheduling	(Zhou, Love et al. 2013), (AlNasseri and Aulin 2015), (Assaf and Al-Hejji 2006), (Kakar, Hasan et al. 2020), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Shaikh, Muree et al. 2010), (Nasir, Gabriel et al. 2011), (Jamil, Mufti et al. 2012), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Khan, Choudhary et al. 2015), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Srdić and Šelih 2015), (Divakar and Jebin 2018), (Idrees and Shafiq 2021), (Nisar and Asif 2023), (Alamri, Amoudi et al.
15.	Poor Communication and Coordination	(Khattak and Mustafa 2019), (Assaf and Al-Hejji 2006), (Bajjou and Chafi 2020), (Jamil, Mufti et al. 2012), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Srdić and Šelih 2015), (Kaliba, Muya et al. 2009), (Divakar and Jebin 2018), (Idrees and Shafiq 2021), (Nisar and Asif 2023), (Bagaya and Song 2016), (Alamri, Amoudi et al. 2017),
16.	Inadequate Contractor Experience	(Assaf and Al-Hejji 2006), (Kakar, Hasan et al. 2020), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Nasir, Gabriel et al. 2011), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Arantes, da Silva et al. 2015), (Hanif, Khurshid et al. 2016), (Nisar and Asif 2023), (Bagaya and Song 2016), (Alamri, Amoudi et al. 2017), (Sarmad and Choudhary
17.	Inadequate Project Monitoring and Control	(Kakar, Hasan et al. 2020), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Khan, Choudhary et al. 2015), (Hanif, Khurshid et al. 2016), (Nisar and Asif

18.	Lack of proper training and experience of Project Manager	(Khattak and Mustafa 2019), (AlNasseri and Aulin 2015), (Kakar, Hasan et al. 2020), (Haseeb, Bibi et al. 2011), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Srdić and Šelih 2015), (Kaliba, Muya et al. 2009), (Divakar and Jebin 2018), (Idrees and Shafiq 2021), (Maqsoom, Khan et al. 2018), (Pham, Luu et al. 2020), (Karji, Namian et al.
19.	Owner Competency	(Assaf and Al-Hejji 2006), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Jamil, Mufti et al. 2012), (Haseeb, Bibi et al. 2011), (Sardar Ahsen, Memon et al. 2021), (Idrees and Shafiq 2021), (Hanif, Khurshid et al. 2016), (Bagaya and Song 2016), (Alamri, Amoudi et al. 2017), (Pham, Luu et al. 2020), (Iyer and Jha 2006),
20.	Poor Site Management and Supervision	(Assaf and Al-Hejji 2006), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Haseeb, Bibi et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Kaliba, Muya et al. 2009), (Idrees and Shafiq 2021), (Nisar and Asif 2023), (Bagaya and Song 2016), (Alamri, Amoudi et al. 2017),
21.	Overly Complexity of Works	(Khattak and Mustafa 2019), (Kakar, Hasan et al. 2020), (Nasir, Gabriel et al. 2011), (Jamil, Mufti et al. 2012), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Nisar and Asif 2023), (Alamri, Amoudi et al. 2017), (Sarmad and Choudhary 2019)
22.	Poor Contract Management	(Nasir, Gabriel et al. 2011), (Jamil, Mufti et al. 2012), (Haseeb, Bibi et al. 2011), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sardar Ahsen, Memon et al. 2021), (Arantes, da Silva et al. 2015), (Divakar and Jebin 2018), (Hanif, Khurshid et al. 2016), (Bagaya and Song
23.	Adverse Weather Condition	(Khattak and Mustafa 2019), (Zhou, Love et al. 2013), (Shaikh, Muree et al. 2010), (Haseeb, Bibi et al. 2011), (Sardar Ahsen, Memon et al. 2021), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Kaliba, Muya et al. 2009), (Bagaya and Song 2016), (Alamri, Amoudi et al. 2017)
24.	Land acquisition Challenges	(Nasir, Gabriel et al. 2011), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Srdić and Šelih 2015), (Divakar and Jebin 2018), (Idrees and Shafiq 2021), (Alamri, Amoudi et al. 2017), (Sarmad and Choudhary 2019), (Maqsoom, Khan et al.
25.	Material Procurement Delays	(Kakar, Hasan et al. 2020), (Nasir, Gabriel et al. 2011), (Haseeb, Bibi et al. 2011), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Kaliba, Muya et al. 2009), (Nisar and Asif 2023), (Alamri, Amoudi et al. 2017), (Maqsoom, Khan et al.

26.	Delays in Obtaining Vital Permits/Approval	(Zhou, Love et al. 2013), (Assaf and Al-Hejji 2006), (Bajjou and Chafi 2020), (Nasir, Gabriel et al. 2011), (Sardar Ahsen, Memon et al. 2021), (Choudhry, Aslam et al. 2014), (Srdić and Šelih 2015), (Hanif, Khurshid et al. 2016), (Alamri, Amoudi et al. 2017)
27.	Incomplete or Inaccurate Project Data	(Kakar, Hasan et al. 2020), (Nasir, Gabriel et al. 2011), (Haseeb, Bibi et al. 2011), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Divakar and Jebin 2018), (Nisar and Asif 2023)
28.	Cultural and Language Barriers	(Kakar, Hasan et al. 2020), (Nasir, Gabriel et al. 2011), (Khan, Choudhary et al. 2015), (Choudhry, Aslam et al. 2014), (Srdić and Šelih 2015), (Sarmad and Choudhary 2019), (Saghatforoush and Zareravasan 2018)
29.	Inadequate Project Scheduling Softwares	(Khattak and Mustafa 2019), (AlNasseri and Aulin 2015), (Rachid, Toufik et al. 2019), (Shaikh, Muree et al. 2010), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Khan, Choudhary et al. 2015), (Srdić and Šelih 2015), (Kaliba, Muya et al. 2009), (Alamri, Amoudi et al.
30.	Inadequate Project Contingency Planning	(Zhou, Love et al. 2013), (Jamil, Mufti et al. 2012), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Divakar and Jebin 2018)
31.	Contract Disputes and Legal Issues	(Assaf and Al-Hejji 2006), (Kakar, Hasan et al. 2020), (Nasir, Gabriel et al. 2011), (Haseeb, Bibi et al. 2011), (Choudhry, Aslam et al. 2014), (Srdić and Šelih 2015), (Divakar and Jebin 2018), (Alamri, Amoudi et al. 2017), (Iyer and Jha 2006)
32.	Inadequate Risk Assessment and Management	(Kakar, Hasan et al. 2020), (Shaikh, Muree et al. 2010), (Batool and Abbas 2017), (Sardar Ahsen, Memon et al. 2021), (Choudhry, Aslam et al. 2014), (Nisar and Asif 2023)
33.	Low Bidding of Contractor	(Nasir, Gabriel et al. 2011), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Arantes, da Silva et al. 2015), (Divakar and Jebin 2018), (Idrees and Shafiq 2021), (Nisar and Asif 2023), (Hanif, Khurshid et al. 2016), (Bagaya and Song 2016),
34.	Labor Strikes and Disputes	(Kakar, Hasan et al. 2020), (Nasir, Gabriel et al. 2011), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Divakar and Jebin 2018), (Nisar and Asif 2023), (Maqsoom, Khan et al. 2018)
35.	Lack of Clear Project Objectives	(Kakar, Hasan et al. 2020), (Srdić and Šelih 2015), (Divakar and Jebin 2018), (Hanif, Khurshid et al. 2016), (Alamri, Amoudi et al. 2017)
36.	Economic Downturns Market Fluctuation	(Kakar, Hasan et al. 2020), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Choudhry, Aslam et al. 2014), (Divakar and Jebin 2018), (Nisar and Asif 2023)

37.	Equipment Shortages / Maintenance Issues	(Haseeb, Bibi et al. 2011), (Choudhry, Aslam et al. 2014), (Kaliba, Muya et al. 2009), (Divakar and Jebin 2018), (Hanif, Khurshid et al. 2016), (Bagaya and Song 2016), (Maqsoom, Khan et al. 2018), (Pham, Luu et al.
38.	Poor Stakeholder Engagement and Community Relations	(Zhou, Love et al. 2013), (Haseeb, Bibi et al. 2011), (Khan, Choudhary et al. 2015), (Sarmad and Choudhary 2019), (Karji, Namian et al. 2020)
39.	Supply Chain Disruption	(Nasir, Gabriel et al. 2011), (Sardar Ahsen, Memon et al. 2021), (Kaliba, Muya et al. 2009), (Divakar and Jebin 2018), (Nisar and Asif 2023)
40.	Lack of Standardized Construction Processes	(Jamil, Mufti et al. 2012), (Batool and Abbas 2017), (Alamri, Amoudi et al. 2017)
41.	Safety Incidents and Accidents	(Choudhry, Aslam et al. 2014), (Bagaya and Song 2016)
42.	Environmental Impact Assessment/Approvals	(Kakar, Hasan et al. 2020), (Nasir, Gabriel et al. 2011), (Batool and Abbas 2017), (Gomez-Cabrera, Ponz-Tienda et al. 2019), (Sarmad and Choudhary 2019)
43.	Lack of Accountability among Project Partners	(Haseeb, Bibi et al. 2011), (Sardar Ahsen, Memon et al. 2021), (Divakar and Jebin 2018), (Karji, Namian et al. 2020)
44.	Quality Control and Assurance Issues	(Zhou, Love et al. 2013), (Haseeb, Bibi et al. 2011), (Sardar Ahsen, Memon et al. 2021), (Khan, Choudhary et al. 2015), (Alamri, Amoudi et al. 2017)
45.	Lack of Waste Management Strategy	(Bajjou and Chafi 2020), (Maqsoom, Khan et al. 2018)

Table 2.1 explains the selected Forty-Five barriers for effective implementation of construction schedule in infrastructure development projects for further research steps.

CHAPTER 3 METHODOLOGY

3.1 Introduction

In order to accomplish the desired research goals, research methodology provides guidance in conducting the research. It helps researcher to highlight the relevant tools and techniques to carry out the process with the limitation of time and resources. Therefore, this chapter discusses the tools and techniques utilized in the study. Multiple techniques were used during the research process i.e. literature review and questionnaire surveys. This study, which concentrated on the essential area of barriers for effective implementation of construction schedule in infrastructure projects. Books, articles from published works, and scholarly journals were all included in the literature study. A Four-stage research methodology as shown in Fig.3.1, has been developed. The details are explained in subsequent sections.

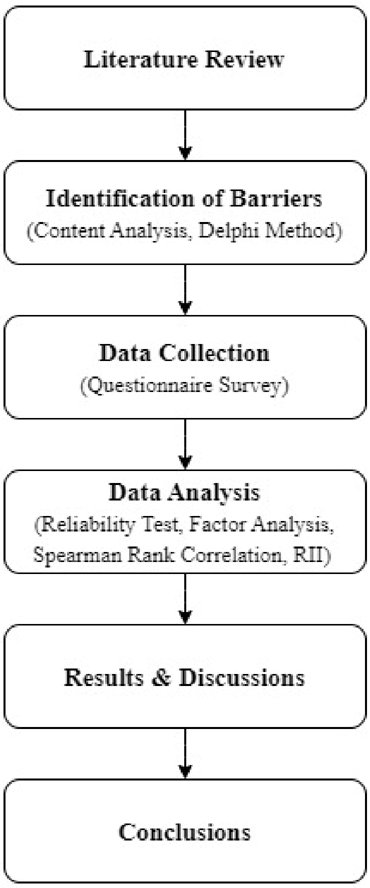

Figure 3.1: Research Deign Flow Chart

3.2 Stage-1: Literature Review

In the 1st stage, review of previous studies remained carried out to find the study gap. Research articles published in well reputed journals on barriers for effective implementation of construction schedule in infrastructure projects. This helped in identifying a research gap as no research have been carried out on this subject. Major research are on general delays and cost overruns in the construction industry. Although various strategies have been used for timely completion of infrastructure projects, they lack in many barriers which effect its construction schedule. The goals of the current study were developed with this constraint in mind in order to close the noted gap. This research will provide as a first stage towards the identification of barriers for effective implementation of construction schedule in infrastructure projects. According to the goals of the research, a wide literature review was carried out to select the barriers for implementation of construction schedule. While searching the related literature, Science Direct, Google Scholar, Scopus, Taylor and Francis were used. To cover most of the available literature, a total of 60 research papers were retrieved initially and screening was performed to select the most relevant papers, resulting in 40 papers. As a result, 45 barriers have been identified.

3.3 Stage-2: Identification of Significant Barriers

After the identification of barriers next find the most important barriers that leads to schedule delays, schedule management and not proper implementation of construction schedule in infrastructure projects. For selection of important barriers two step procedure should be used.

3.3.1 Step-1: Content Analysis

Content analysis used as a vital methodological tool to evaluate and examine literature content. There are two types of content analysis used in this research first quantitative analysis for measuring the frequency of each barriers then using the qualitative analysis from each paper ranking and score in term of its importance (Highly, Medium, Least important) for each of the barrier and in last qualitative score will be (High = 5, Medium = 3, Low = 1) which is based on selected paper ranking criteria and then literature score of each barriers were calculated from both frequency and qualitative score.

Table 3.1: Identified Barriers with Literature Score

SN	Barriers	F	H	M	L	Qualitative Score		Total Literature Score
1	Poor Scope Definition	16	8	6	2	High	5	0.833
2	Cultural and Language Barriers	7	1	3	3	Medium	3	0.219
3	Change Order and Variations	18	9	6	3	High	5	0.938
4	Inadequate Risk Assessment and Management	6	1	3	2	Medium	3	0.188
5	Inaccurate Project Cost Estimation	15	6	4	5	High	5	0.781
6	Unrealistic Project Schedule imposed in Contract	12	6	3	3	High	5	0.625
7	Poor Contract Management	10	3	3	4	Low	1	0.104
8	Adverse Weather Condition	10	1	4	5	Low	1	0.104
9	Owner Competency	13	4	7	2	Medium	3	0.406
10	Labor Productivity Issues	11	3	5	3	Medium	3	0.344
11	Overly Complexity of Works	8	2	2	4	Low	1	0.083
12	Land acquisition Challenges	9	2	3	4	Low	1	0.094
13	Limited Availability of Skilled Labor	19	9	6	4	High	5	0.990
14	Design Error and Revisions	17	8	7	2	High	5	0.885
15	Delays in Payments	18	7	5	6	High	5	0.938
16	Material Procurement Delays	9	1	5	3	Medium	3	0.281
17	Delays in Obtaining Vital Permits/Approval	9	3	2	4	Low	1	0.094
18	Contractor Financial Problems	16	8	5	3	High	5	0.833
19	Inflation	12	5	5	2	High	5	0.625
20	Unforeseen Ground Condition	13	4	4	5	Low	1	0.135
21	Political Interference and Decision Making	11	5	3	3	High	5	0.573
22	Low Bidding of Contractor	11	6	4	1	High	5	0.573
23	Insufficient Knowledge Transfer and Training	13	6	3	4	High	5	0.677
24	Labor Strikes and Disputes	7	1	3	3	Medium	3	0.219
25	Poor Project Planning and Scheduling	25	15	8	2	High	5	1.302
26	Poor Communication and Coordination	20	7	7	6	High	5	1.042
27	Safety Incidents and Accidents	2	0	1	1	Medium	3	0.063
28	Environmental Impact Assessment/Approvals	4	1	2	1	Medium	3	0.125
29	Poor Site Management and Supervision	15	6	4	5	High	5	0.781
30	Incomplete or Inaccurate Project Data	7	1	5	1	Medium	3	0.219
31	Inadequate Project Scheduling Softwares	9	6	2	1	High	5	0.469

32	Inadequate Project Contingency Planning	7	0	4	3	Medium	3	0.219
33	Contract Disputes and Legal Issues	9	3	2	4	Low	1	0.094
34	Inadequate Contractor Experience	17	6	6	5	High	5	0.885
35	Lack of Clear Project Objectives	5	1	2	2	Medium	3	0.156
36	Economic Downturns Market Fluctuation	5	1	2	2	Medium	3	0.156
37	Equipment Shortages / Maintenance Issues	8	2	4	2	Medium	3	0.250
38	Poor Stakeholder Engagement and Community Relations	5	1	3	1	Medium	3	0.156
39	Inadequate Project Monitoring and Control	10	4	3	3	High	5	0.521
40	Supply Chain Disruption	5	1	3	1	Medium	3	0.156
41	Lack of Standardized Construction Processes	3	0	2	1	Medium	3	0.094
42	Lack of Accountability among Project Partners	3	0	2	1	Medium	3	0.094
43	Lack of proper training and experience of Project Manager	14	8	4	2	High	5	0.729
44	Quality Control and Assurance Issues	5	1	2	2	Medium	3	0.156
45	Lack of Waste Management Strategy	4	1	2	1	Medium	3	0.125

Table 3.1 explains the selected Forty-Five barriers for effective implementation of construction schedule in infrastructure development projects.

3.3.1.1 Pareto Rule (80:20)

After finding literature score, then find the normalized score and cumulative percentage to apply Pareto rule (80:20). A statistical method known as Pareto analysis is applied in decision-making to pick a small number of events that have a large overall impact. It's one of the most popular and simple methods to implement. A very straightforward technique called Pareto analysis is applied to ascertain which events or features inside an association will have the greatest effect. The barriers are ordered from maximum normalized score to lowermost normalized score in a decreasing manner. The over-all normalized score is equal to 100 percent. The “vital few” barriers give a considerable extent 80 percent of cumulative score besides the “useful many” give only the residual 20 percent of normalized score, which is also famous as the 80-20 rule established by the Italian Economist Vilfrado Pareto (Talib, Rahman et al. 2010). A Pareto cart is commonly used to illustrate the findings of a Pareto analysis. The chart displays the several barriers that are being considered in a prioritized manner. This chart's layout, which consists of a bar graph arranged in descending order, makes it simple to identify the vital few essential factors by overlaying a line graph that cuts an 80 percent cumulative percentage. It also helps in identifying the factors that have the least benefits and vice versa.

Table 3.2: Barriers with Normalized Score

SN	Barriers	Total Literature Score	Normalized Score%	Cumulative %
BA1	Poor Project Planning and Scheduling	1.302	6.73%	6.73%
BA2	Poor Communication and Coordination	1.042	5.39%	12.12%
BA3	Limited Availability of Skilled Labor	0.990	5.12%	17.24%
BA4	Change Order and Variations	0.938	4.85%	22.09%
BA5	Delays in Payments	0.938	4.85%	26.94%
BA6	Inadequate Contractor Experience	0.885	4.58%	31.52%
BA7	Design Error and Revisions	0.885	4.58%	36.10%
BA8	Poor Scope Definition	0.833	4.31%	40.41%
BA9	Contractor Financial Problems	0.833	4.31%	44.72%
BA10	Inaccurate Project Cost Estimation	0.781	4.04%	48.76%
BA11	Poor Site Management and Supervision	0.781	4.04%	52.80%
BA12	Lack of proper training and experience of Project Manager	0.729	3.77%	56.57%
BA13	Insufficient Knowledge Transfer and Training	0.677	3.50%	60.08%
BA14	Unrealistic Project Schedule imposed in Contract	0.625	3.23%	63.31%
BA15	Inflation	0.625	3.23%	66.54%
BA16	Low Bidding of Contractor	0.573	2.96%	69.50%
BA17	Political Interference and Decision Making	0.573	2.96%	72.47%
BA18	Inadequate Project Monitoring and Control	0.521	2.69%	75.16%
BA19	Inadequate Project Scheduling Softwares	0.469	2.42%	77.59%
BA20	Owner Competency	0.406	2.10%	79.69%
BA21	Labor Productivity Issues	0.344	1.78%	81.47%
BA22	Material Procurement Delays	0.281	1.45%	82.92%

BA23	Equipment Shortages / Maintenance Issues	0.250	1.29%	84.21%
BA24	Incomplete or Inaccurate Project Data	0.219	1.13%	85.34%
BA25	Cultural and Language Barriers	0.219	1.13%	86.48%
BA26	Inadequate Project Contingency Planning	0.219	1.13%	87.61%
BA27	Labor Strikes and Disputes	0.219	1.13%	88.74%
BA28	Inadequate Risk Assessment and Management	0.188	0.97%	89.71%
BA29	Lack of Clear Project Objectives	0.156	0.81%	90.52%
BA30	Economic Downturns Market Fluctuation	0.156	0.81%	91.33%
BA31	Poor Stakeholder Engagement and Community Relations	0.156	0.81%	92.13%
BA32	Supply Chain Disruption	0.156	0.81%	92.94%
BA33	Quality Control and Assurance Issues	0.156	0.81%	93.75%
BA34	Unforeseen Ground Condition	0.135	0.70%	94.45%
BA35	Environmental Impact Assessment/Approvals	0.125	0.65%	95.10%
BA36	Lack of Waste Management Strategy	0.125	0.65%	95.74%
BA37	Poor Contract Management	0.104	0.54%	96.28%
BA38	Adverse Weather Condition	0.104	0.54%	96.82%
BA39	Contract Disputes and Legal Issues	0.094	0.48%	97.31%
BA40	Land acquisition Challenges	0.094	0.48%	97.79%
BA41	Delays in Obtaining Vital Permits/Approval	0.094	0.48%	98.28%
BA42	Lack of Standardized Construction Processes	0.094	0.48%	98.76%
BA43	Lack of Accountability among Project Partners	0.094	0.48%	99.25%
BA44	Overly Complexity of Works	0.083	0.43%	99.68%
BA45	Safety Incidents and Accidents	0.063	0.32%	100.00%

Table 3.2 explain all the barriers with normalized score which find from the literature score, also the cumulative percentage calculated. After applying the Pareto rule, (Wuni and Abankwa 2023), 20 barriers were selected for questionnaire.

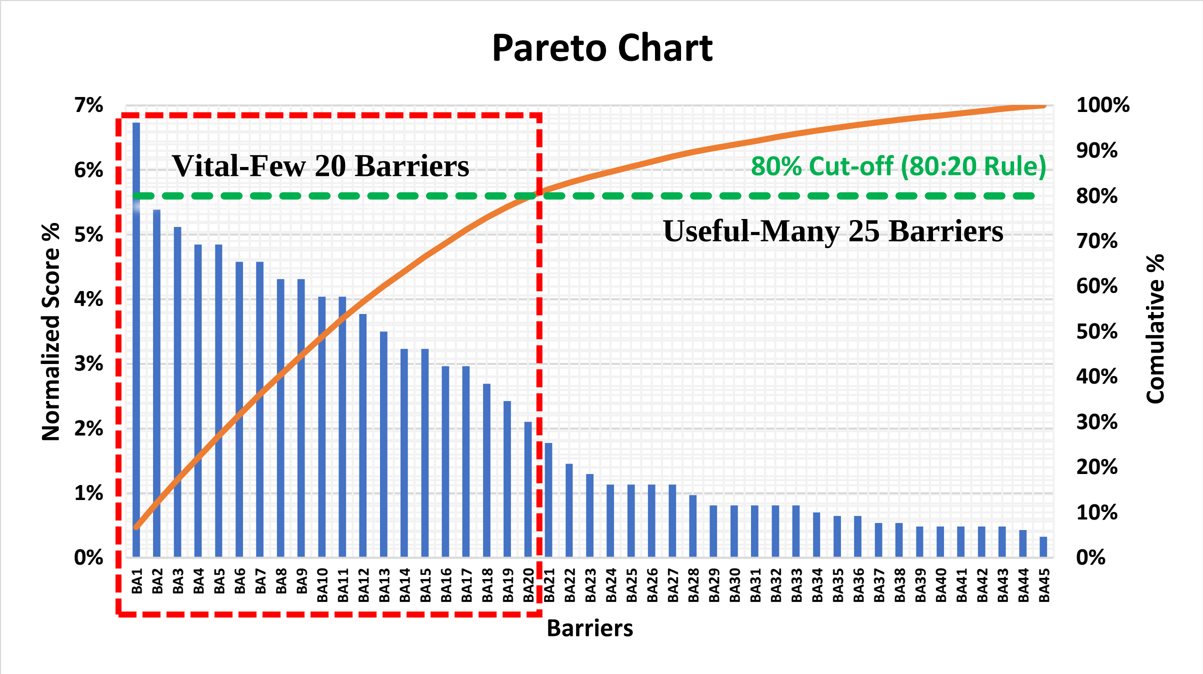

Figure 3.2: Barriers with Normalized Score

3.3.2 Step-2: Delphi Method

Next, the Delphi technique was also used to reduce the number of barriers to identify the important barriers influencing the schedule performance in construction projects in the context of Afghanistan. The Delphi technique has been extensively used in construction engineering management studies. The ideas of fifteen experts from the Pakistan construction sector were required to conclude the list of schedule implementation barriers. The preliminary list of 45 schedule implementation barriers was shared with the professionals by means of a questionnaire survey based on a 5-point Likert scale, on which 5 denoted most important and 1 denoted least important. The professionals were requested to rate each of the barriers based on its significance to the schedule implementation barriers in Pakistan construction sector. It was decided beforehand the start of the questionnaire that only barriers with an average score greater than 4 will be selected for the final questionnaire. The demographic detail of the experts are mentioned in Table 3.3 below.

Table 3.3: Expert Demographic Detail

Education	FQ	Job relation	FQ	Experience	FQ
Bachelors	12	Contractor	9	6-10 years	4
Masters	3	Client	3	11-15 years	8
PHD	0	Consultant	3	More than 15 years	3
Total	15	**Total**	15	**Total**	15

After finding the average score of all the barriers from 15 experts show all the results in the form bar graph in fig 3.3.

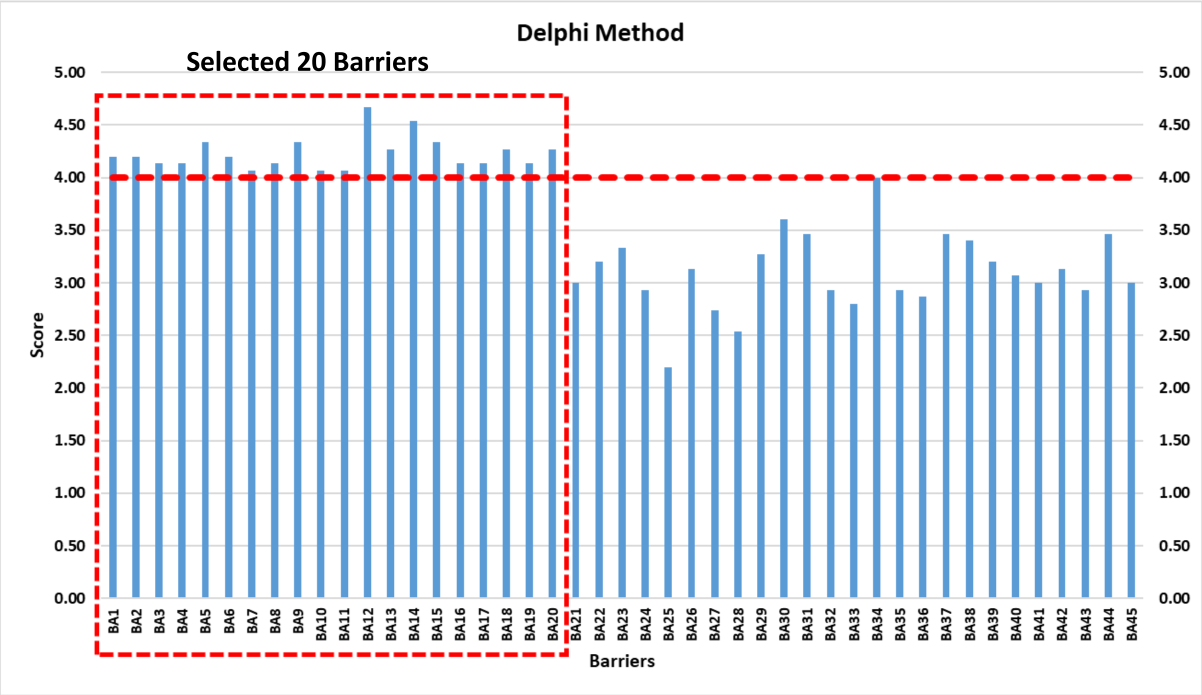

Figure 3.3: Barriers with Average Score

After applying both techniques Pareto rule and Delphi method, 20 barriers were selected for final questionnaire and are categorized according to the nature of their group through previous studies.

3.4 Final 20 Barriers for Questionnaire

Table 3.4 shows the identified 20 barriers which are reduced from 45 barriers through content analysis by Pareto principle and then through Delphi method. After identification of these barriers grouped according to their nature based on literature. From these barriers, the essential top five critical barriers will be determined through exploratory factor analysis and by relative importance index.

Table 3.4: 20 Barriers for Final Questionnaire

ID	Barriers
	Client Barriers
CLB1	Change Order and Variations
CLB2	Owner Competency
CLB3	Delays in Payments
CLB4	Unrealistic Project Schedules Imposed in Contract
	Contractor Barriers
CTB1	Insufficient Contractor Experience
CTB2	Contractor Financial Problems
CTB3	Low Bidding of Contractor
CTB4	Poor Communication and Coordination
CTB5	Insufficient Knowledge Transfer and Training
CTB6	Limited Availability of Skilled Labor
	Consultant Barriers
COB1	Inaccurate Project Cost Estimation
COB2	Design Error and Revisions
COB3	Scope Changes
	Management Barriers
MGB1	Inadequate Project Monitoring and Control
MGB2	Poor Site Management and Supervision
MGB3	Poor Project Planning and Scheduling
MGB4	Inadequate Project Scheduling Softwares
MGB5	Lack of Proper Training & Experience of Project Manager

	External Barriers
EXB1	Inflation
EXB2	Political Interference and Decision Making

3.5 Data Collection

3.5.1 Questionnaire

Questionnaire survey [(Bajjou and Chafi 2020), (Bagaya and Song 2016), (Abdul-Rahman, Wang et al. 2011), (AlNasseri and Aulin 2015), (Pham, Luu et al. 2020)] is a popular quantitative research tool for gathering information from a sample of participants or responders with experience of construction sector. Planning and scheduling is one area where theory has been sufficiently studied in the literature; so, questionnaire-based survey is a positivist technique, particularly for descriptive research aiming to study and evaluate research problems. This method was selected due to its ability to access a vast range of sources and its efficiency in terms of both time and cost. Due to the absence of real data about schedule implementation in construction sector in Pakistan, a questionnaire was planned to assess the opinions of clients, contractors and consultant on the importance of barriers in construction industry. The survey comprises two key parts. The primary part is considered to collect demographic detail about the respondents. The secondary part, participants were questioned to provide their views of the relative significance for individually of the 20 barriers for schedule implementation in the Pakistan construction industry.

Table 3.5: Likert Scale

SN	Importance
1	Little Important
2	Somewhat Important
3	Important
4	Very Important
5	Extremely Important

Likert scales used in research questionnaire to rate the selected item from 1 to 5. They deliver a consistent and organized tactic to data collection, assisting analysis and comparability through different sets or peoples. A five-point Likert scale was used to find the significance of each barrier. The sampling method used in this study was convenience and snow ball sampling. Convenience means like by friends worked in construction field and civil engineering departments and through referral networks. Many distribution methods [(Bajjou and Chafi 2020), (Abdul-Rahman, Wang et al. 2011)] has been used to guarantee the distribution of the research survey amongst the Pakistan construction experts. Former, it was directed by e-mail to private plus public construction companies either client, consultant or contractor related. Second, printed copy of questionnaires were also supplied out to numerous consulting firms and contractor. Four hundred were sent via email, 90 were individually handed out. Over a period of five months, out of the 490 questionnaires sent, 213 questionnaires were done and returned, which generated a whole response rate at 43.47% and valid questionnaire were 200. Within the 200 returned surveys, forty eight (48) remained from clients, seventy four (74) as of contractors and seventy eight (78) from consultants. Table 2 demonstrate the respondent's rate of each group. The maximum responses at 39% from consultants, followed by contractor (37%) and clients (24%).

Table 3.6: Respondents Profiles

Professional Group	Sent		Received		Valid	
	No	**(%)**	**No**	**(%)**	**No**	**(%)**
Client	120	24%	52	24%	48	24%
Contractor	250	51%	76	36%	74	37%
Consultant	120	24%	85	40%	78	39%
Total	490	100%	213	100%	200	100%

After collection of data in term of 200 valid responses then the next step will be various test for sample adequacy and reliability of questionnaire. The Statistical Package for Social Sciences (SPSS-26) was selected to analyze the gathered data. The subsequent statistical practices be there used to analyze the above data: (1) reliability analysis, (2) exploratory factor analysis, (3) relative importance index, and (4) spear rank correlation. These statistical techniques are defined in the next sections.

3.6 Data Analysis

A sequence of data analysis was performed on the collected quantitative data. The analysis of questionnaire data is done in four phases as given below;

1) Questionnaire Reliability
2) Exploratory Factor Analysis (EFA)
3) Spear Rank Correlation
4) Relative Importance Index (RII)

3.6.1 Questionnaire Reliability

The degree to which a measuring process, observation, or questionnaire produces consistent findings when tested again is known as reliability [(Bajjou and Chafi 2020), (Choudhry, Aslam et al. 2014), (Bagaya and Song 2016)]. Measuring the consistency of replies after using the same measurement tool repeatedly is possible using reliability analysis. Since the study's data included a 5-point Likert-kind response, it was judged essential to check the reliability. To ensure consistency and reliability, Cronbach’s alpha (α) applied to evaluate the reliability of the questionnaire survey. It governs the interior uniformity or else normal relationship of components in a survey tool to measure its reliability, and is typically calculated as of the given formulation:

$$\alpha = \frac{n}{n-1}\left(1 - \frac{\sum Vi}{Vtest}\right)$$

Where,

n = no of samples;

V_i = variance of scores to each samples;

V_{test} = total variance of whole scores on the complete test.

3.6.2 Exploratory Factor Analysis

In cases where there is little or no prior knowledge about the relationships between the variables, they are exploratory in their search for hidden patterns in the data. Exploratory factor analysis [(Choudhry, Aslam et al. 2014), (Bagaya and Song 2016), (Arantes, da Silva et al. 2015), (Pham, Luu et al. 2020), (Saghatforoush and Zareravasan 2018), (Doloi, Sawhney et al. 2012)] is a commonly used technique for reduction of data or proceeds a huge amount of variables and decreases or précises it to denote them in dissimilar various factors or components. Factor analysis was functional to group the major barriers of construction schedule implementation. EFA is a technique used for exploring how much a certain amount of variables are linearly associated to a minor amount of undetectable factors. This is prepared by combination of variables created on interactions between group of variables. Factor analysis has been widely used in studies for data reduction and summarization. The main aim is to review the information enclosed in a huge number of variables into a limited minor numbers of factors. A list of some common fundamental terminology used in factor analysis is provided below.

3.6.2.1 Kaiser-Meyer-Olkin (KMO)

The Kaiser-Meyer-Olkin (KMO) amount of sample appropriateness is an index applied to scrutinize the suitability of exploratory factor analysis (EFA). This statistics indicates the percentage of variance, for variables involved in the research is the mutual variance. A greater value (from 0.5 - 1) shows the suitability of the EFA for the data in hand. However a little value (less than 0.5) specifies the unsuitability of the EFA.

3.6.2.2 Bartlett Test of Sphericity

Bartlett test of sphericity is a trial statistic applied to observe the assumption that the variables are not correlated in the sample. In further arguments, the sample correspondence matrix is an identity matrix; each variable relates perfectly with itself ($r = 1$) but has no association with the other variables ($r = 0$) that we can't set composed. A value fewer than 0.05 show that the information in hand do not create an identity matrix as with an identify matrix, EFA makes no sense which means that here exists a substantial association between the variables. A significant result (Sig. less than 0.05) shows matrix is not an identity matrix so the variables do correlate to one another adequate to run a useful exploratory factor analysis.

3.6.2.3 Communality

The amount of variation that a variable shares with every other variable under consideration is known as its communality. This is also the percentage of variance that can be accounted for by the shared components. Small values suggest that a variable may need to be eliminated from the analysis since they do not match well with the factor solution. Values less than.50 are typically eliminated.

3.6.2.4 Uniqueness

Provides the percentage of the variable's common variation that is unrelated to the factors. One minus communality is equivalent to uniqueness. For an easily understood factor structure, communality should be high and uniqueness of a given component must be low.

3.6.2.5 Eigen Value

The total variance determined by each component is represented by the eigenvalue. For additional analysis, factors with eigenvalues greater than one (1) are chosen.

3.6.2.6 Scree Plot

It is a visualization of the factor number and eigenvalues based on the extraction order. To find the ideal amount of elements to keep in the final solution, utilize this graph.

3.6.2.7 Rotation Method

Enables the Loading Structures Simple to Understand: It indicates the specific dimension a certain element would belong to. Varimax is most common tool used to reduce the quantity of variables on a component that have extreme loadings (high or low) reduces the degree to which things are correlated allows a variable to be associated with a factor. Every component explains non-redundant information; components are always orthogonal. Rotations that presume no correlation between the variables are referred to as orthogonal rotations, whereas rotations that permit correlation are known as oblique rotations. While Oblimin permits the factors to not be orthogonal, Varimax only yields orthogonal factors.

3.6.3 Spear Rank Correlation

Spearman rank correlation, most of the researcher used this correlation like by [(Assaf and Al-Hejji 2006), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Bagaya and Song 2016), (Arantes, da Silva et al. 2015), (Batool and Abbas 2017)] it is a non-parametric test or another name is that tests that are free of distributions. The clear benefit of these tests is that neither the homogeneity of variance nor the supposition of normality are necessary. Because they compare medians rather than means, the impact of one or two outliers in the data is neutralized. Spearman rank correlation is the level of agreement within two distinct sets of rankings was examined in relative importance index ranking done by three leading respondent groups (client, contractor and consultant). The link between Spearman rank when evaluating the correlation, magnitude, and direction of the relation between the rankings of the two groups for all project implementation barriers, while excluding the third party, the coefficient (ρ) is computed. Here is how the coefficient may be calculated:

$$\boldsymbol{\rho = 1 - \frac{6\sum d^2}{N(N^2-1)}}$$

Whereas ρ indicates Spearman rank correlation coefficient; d shows variation in the rankings for a particular cause between two responders; and N is the magnitude of rank pairs. The value of the Spearman's rank correlation coefficient varies from +1 to -1, and +1 indicates perfect positive correlation or agreement, 0 means no agreement and -1 shows perfect negative correlation or disagreement.

3.6.4 Relative Importance Index (RII)

The mean and standard deviation of each element did not indicate any association between the barriers, making them inappropriate for determining the overall ranking for this kind of data. Instead, the summation of barriers Likert score was calculated and then divided by the no of respondents with maximum Likert score in this case which was 5. This lead to a relative importance index. On a Likert scale, respondents were asked to rate the significance of each of the 20 barriers influencing the construction sector. The project's participants gave numerical ratings to indicate how important they thought each barrier was and how it affected the project's ability to reach its deadline. The methodology was used to analyze the information gathered from the current questionnaire and categorized into several groups. For each barriers, the previously indicated five-point scale was converted to a relative relevance index. Each of the barriers for not implementing construction schedule was ranked created on the relative importance index (RII) using the below formula;

$$\text{Relative Importance Index (RII)} = \frac{\sum_{i=1}^{N} W_i}{A \times N}$$

Whereas W_i = weightage given to each barriers by the respondents, varies from 1 to 5; A = greatest score, 5 in this occasion and N = overall magnitude of respondents, which is equal to 200 for this case. The maximum RII value shows the best critical barrier with rank 1, the next best critical barrier with rank 2, and so on. If the relative importance index values are equal, the respective barrier with the lower standard deviation obtains the greater ranking. Most researcher have applied RII for calculating the relative importance of different critical barriers like in [(Assaf and Al-Hejji 2006), (Rachid, Toufik et al. 2019), (Bajjou and Chafi 2020), (Kakar, Hasan et al. 2020), (Nasir, Gabriel et al. 2011), (Choudhry, Aslam et al. 2014)].

CHAPTER 4 RESULTS AND ANALYSIS

4.1 Introduction

This chapter will discuss all the results and analysis of the above methods like demographic analysis, reliability test, and exploratory factor analysis for all the two hundred responses from questionnaire, ranking of all twenty barriers using relative importance index and find the critical barriers for effective implementation of construction schedule.

4.2 Demographic Analysis

The data gathering took five months and after returning of two hundred thirteen (213) responses, thirteen (13) were excluded and two hundred (200) valid responses were selected for final analysis of all the methods. Out of 200 responses, one hundred ninety two (192) were male which considered as 96% of the total and only eight (8) were female which considered as just 4% of the total responses also shown in the figure 4.1. The education of the respondents includes, six (6) respondents have HSSC or lower education considered as 3%, one hundred seventeen (117) were done bachelors which considered as 58%, seventy three (73) were done master which considered

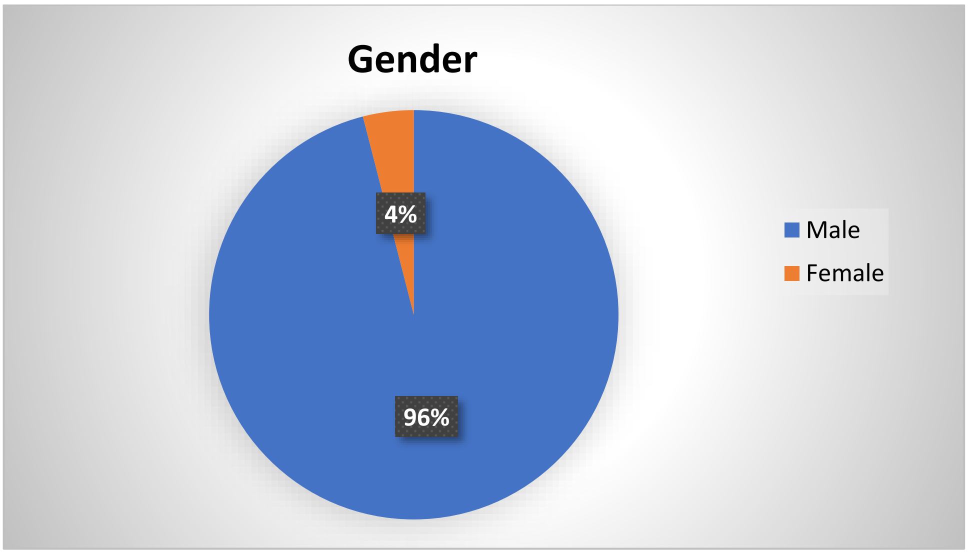

Figure 4.1: Respondents Gender

as 37% of the total and four (4) were PHD holder which were considered as 2% of all the responses also shown in the figure 4.2.

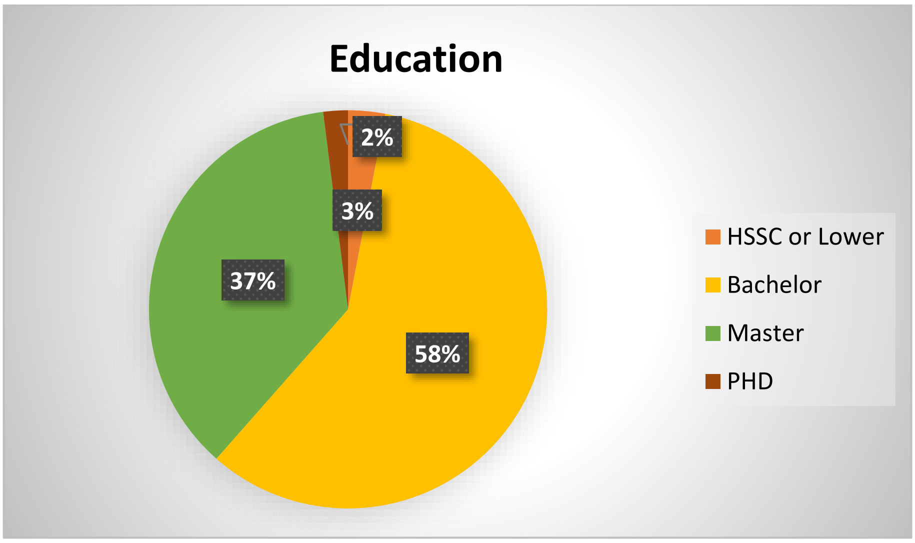

Figure 4.2: Respondents Education Detail

To evaluate the opinions of client, contractor and consultant. First of all respondents detail will share, out of 200 responses, seventy four (74) were contractor which indicate as 37%, forty eight (48) were client considered as 24% and seventy eight (78) were consultant considered as 39% of all the responses also shown in the figure 4.3.

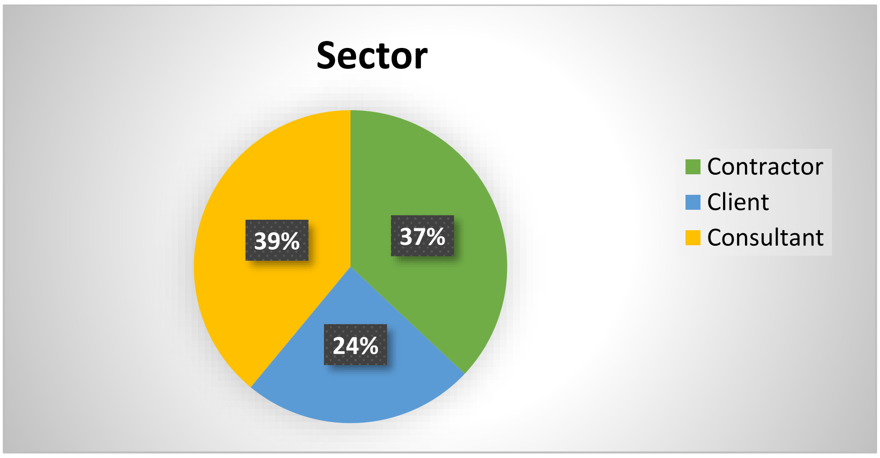

Figure 4.3: Relation with Construction Sector

The important part in the questionnaire were respondents how much working experience with construction industry/sector. Fifty (50) respondents had experience 1-5 years which considered as 25%, fifty eight (58) respondents were experience 6-10 years which considered as 29%, fifty four (54) were 11-15 years considered as 27% and thirty eight (38) respondents were more than 15 years' experience which considered as 19%.

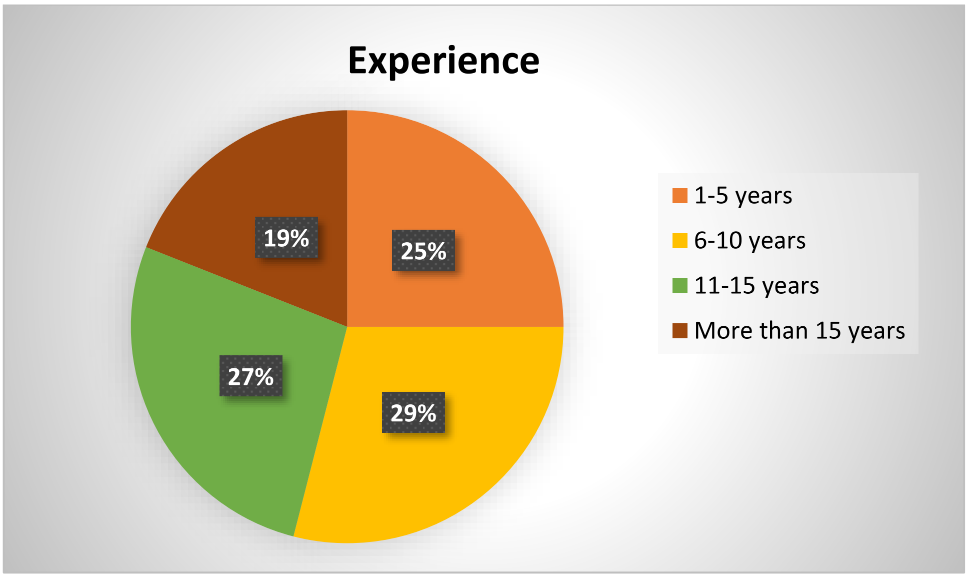

Figure 4.4: Respondents Working Experience

4.3 Reliability Test

SPSS26 was used to calculate alpha for 20 items respectively in the survey. The entire set of 20 variables in the survey was analyzed. The value of Cronbach alpha is exaggerated by a huge amount of variables, so here is no set clarification as to whatever is a satisfactory limit. But, a rule of thumb used to maximum conditions with the given limit: Cα more than 0.9 represent excellent, Cα less than 0.9 and more than 0.8 as good, Cα less than 0.8 and more than 0.7 as acceptable, Cα less than 0.7 and more than 0.6 as questionable, Cα less than 0.6 and more than 0.5 as poor and Cα less than 0.5 signifies unacceptable (Doloi, Sawhney et al. 2012). Agreeing to Reyneldo and

Santas (2013), a Cronbach alpha value more than 0.7 suggests that the tool is reliable (Bagaya and Song 2016). Therefore, based on below outcomes, in which Cronbach alpha value was 0.872 so the questionnaire was considered good, reliable and acceptable.

Table 4.1: Reliability Statistics

Cronbach's Alpha	No of Items
0.872	20

4.4 Exploratory Factor Analysis

The major barriers to schedule implementation were categorized using exploratory factor analysis. But first, it's important to look at if the data are appropriate before applying this method. An exploratory factor analysis was implemented using a principal component analysis and Varimax rotation. The least factor loading standards and criteria was set to 0.50.

4.4.1 Kaiser-Meyer-Olkin (KMO)

The KMO degree of sampling suitability, which shows the appropriateness of the questionnaire for EFA, was 0.821. In this item, statistics with KMO results above 0.50 are measured suitable for EFA. However, one barrier (CTB6: Limited availability of skill labor) loaded against a group other than its essential group. Therefore, the barrier were eliminated from furthermore steps. When the EFA reiterated without this barriers the new KMO value was 0.817 more than 0.50 so this data suitable for further analysis.

Table 4.2: KMO Results

Kaiser-Meyer-Olkin KMO Value	0.817
Suitability Limit	> 0.5
Comment	Appropriate for Factor Analysis

4.4.2 Bartlett's Test of Sphericity

An essential step elaborate considering the complete importance of the correspondence matrix over Bartlett's Test of Sphericity, which shows a degree of the numerical possibility that the correspondence matrix has substantial relationships between some of its components. The outcomes were significant having 0.000 ($p < 0.001$), indicates that the correspondence matrix is not an identity matrix, which specifies its suitability for factor analysis.

Table 4.3: Bartlett Test Results

Bartlett Test of Sphericity	0.000
Suitability Limit	Less than 0.001
Comment	Meaningful Factor Analysis

4.4.3 Communalities

The communality of the questionnaire, results indicate that all of the communalities were above 0.50 except for one CLB2 (Owner Competency which was 0.483 as shown in figure 4.7). However, the barrier, which was close to the 0.500 margin, was remained for further analysis to guarantee the content validity of the scale. Exploratory factor analysis needs some assumptions to be met. In the final analysis all communalities were above the 0.5 margin.

Table 4.4: Communalities Results

	Initial	Extraction
CLB1	1.000	0.751
CLB2	1.000	0.483
CLB3	1.000	0.689
CLB4	1.000	0.548
COB1	1.000	0.655
COB2	1.000	0.710

COB3	1.000	0.648
CTB1	1.000	0.526
CTB2	1.000	0.592
CTB3	1.000	0.655
CTB4	1.000	0.729
CTB5	1.000	0.670
CTB6	1.000	0.526
MGB1	1.000	0.601
MGB2	1.000	0.692
MGB3	1.000	0.670
MGB4	1.000	0.606
MGB5	1.000	0.578
EXB1	1.000	0.755
EXB2	1.000	0.648

4.4.4 Total Variance

When the principal component analysis method is implemented. After the exploratory factor analysis it shows that five factors derived from this analysis (with Eigen-values larger than 1). With those 5 derived factors, which accounted for 59.757% of the variation for schedule implementation. However, in this first EFA, one barrier (CT7: Limited availability of skill labor) loaded against group other than its essential group. Hence, the barrier were eliminated from furthermore steps. When the EFA reiterated without this barriers, the total variance increases up to 60.364% as shown in the table 4.5.

Table 4.5: Total Variance Explained

Component	Initial Eigen Values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	%Var	Com%	Total	%Var	Com%	Total	%Var	Com%
1	5.644	29.707	29.707	5.644	29.707	29.707	2.972	15.645	15.645
2	2.248	11.829	41.536	2.248	11.829	41.536	2.555	13.449	29.094

3	1..402	7.378	48.914	1..402	7.378	48.914	2.316	12.189	41.283
4	1.144	6.020	54.934	1.144	6.020	54.934	1.942	10.223	51.506
5	1.032	5.430	60.364	1.032	5.430	60.364	1.683	8.858	60.364

4.4.5 Scree Plot

Scree plot is the graph of Eigen-value and barriers. It can easily be shown that the factor with eigenvalue more than 1 were the five factor solution.

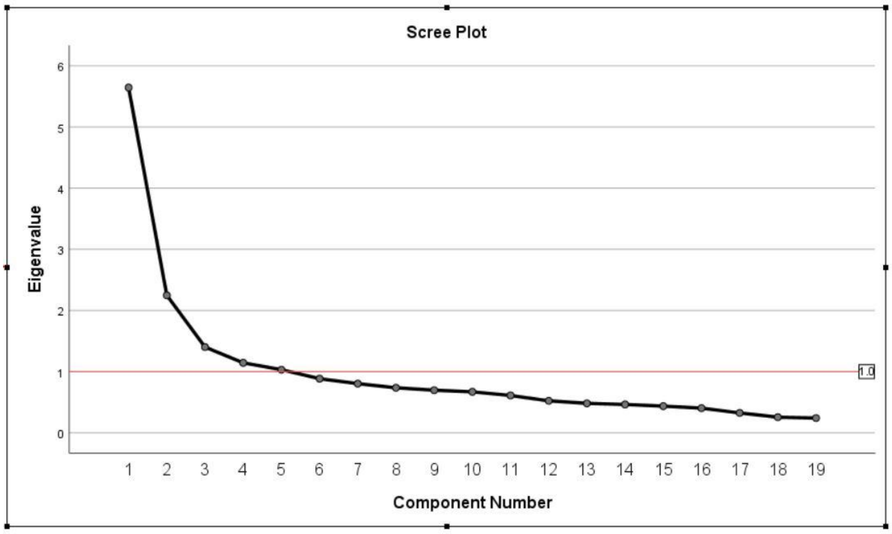

Figure 4.5: Scree Plot

4.4.6 Rotated Component Matrix

Using rotation method was Varimax most commonly used method. After initially analysis there is one barrier (CTB6: Limited availability of skilled labor) run to other factor so removed from further analysis then run the final analysis and the derived five factors as portion of this EFA associated with the hypothetical suggestion in this research. Factor one contains barriers MGB1 to MGB5, denoting to Management Barrier (MGB). Factor two collects barriers CLB1 to CLB4, which denotes Client Related Barriers (CLB). Factor three includes items CTB1 to CTB5, referring to Contractor Related Barriers (CTB). Factor four collects items COB1 to COB3, which represents Consultant Related Barriers (COB). Lastly, Factor five contains barriers EXB1 to EXB2, denoting to External Barriers (EXB). Loading of the factors are shown in table 4.6.

Table 4.6: EFA Results

ID	Barriers	Factors Loading					Variance explained
		1	2	3	4	5	
Management Barriers							
MGB1	Inadequate Project Monitoring and Control	0.592					29.7%
MGB2	Poor Site Management and Supervision	0.678					
MGB3	Poor Project Planning and Scheduling	0.753					
MGB4	Inadequate Project Scheduling Softwares	0.656					
MGB5	Lack of Proper Training & Experience of Project Manager	0.721					
Client Barriers							11.8%
CLB1	Change Order and Variations		0.790				
CLB2	Owner Competency		0.614				
CLB3	Delays in Payments		0.697				
CLB4	Unrealistic Project Schedules Imposed in Contract		0.579				
Contractor Barriers							7.4%
CTB1	Inadequate Contractor Experience			0.681			
CTB2	Contractor Financial Problems			0.515			
CTB3	Low Bidding of Contractor			0.725			
CTB4	Poor Communication and Coordination			0.567			
CTB5	Insufficient Knowledge Transfer and Training			0.545			
Consultant Barriers							6.0%
COB1	Inaccurate Project Cost Estimation				0.663		
COB2	Design Error and Revisions				0.760		
COB3	Scope Changes				0.638		
External Barriers							5.4%
EXB1	Inflation					0.668	
EXB2	Political Interference and Decision Making					0.758	
	Cumulative Variance						**60.4%**

4.5 Relative Importance Index and Ranking

The ranking of three different parties (clients, contractors and consultants) and overall ranking were used to rank all barriers for construction schedule implementation. Table 4.7 shows a list of the barriers categorized into five groups stated. Established on the relative importance index method (RII), the outcomes indicated that the 10 topmost essential critical barriers for schedule implementation in the Pakistan construction sector were unrealistic project schedules imposed in contract (RII = 0.798); poor project planning and scheduling (RII = 0.789); contractor financial problems (RII = 0.779); lack of proper training and experience of project manager (RII = 0.738); inadequate project scheduling software's (RII = 0.766); poor site management and supervision (RII = 0.747); delays in payments (RII = 0.743); poor communication and coordination (RII = 0.734); low bidding of contractor (RII = 0.728) and inflation (RII = 0.718). Among these management barriers have the highest significant consequences (combined RII = 3.777). As per the client's opinion, the five topmost essential barriers of schedule implementation were unrealistic project schedules imposed in contract; poor project planning and scheduling; lack of proper training and experience of project manager; inadequate project scheduling software's and contractor financial problems. From the contractor's opinion, the five topmost essential barriers of schedule implementation were contractor financial problems; lack of proper training and experience of project manager; unrealistic project schedule imposed in contract; poor project and scheduling and inadequate project scheduling software's. The five important barriers of schedule implementation as per consultant's point of view were poor project planning and scheduling; unrealistic project schedules imposed in contract; contactor financial problems; lack of proper training and experience of project manager and inadequate project scheduling software's.

Table 4.7: Ranking using RII

Barriers	**Client**		**Contractor**		**Consultant**		**Overall**		**Barriers Group**
	RII	Rank	RII	Rank	RII	Rank	RII	Rank	
	(Max = **1**)	(Max = 19)	(Max = **1**)	(Max = 19)	(Max = **1**)	(Max = 19)	(Max = **1**)	(Max = 19)	
Unrealistic Project Schedules Imposed in Contract	0.858	1	0.768	3	0.769	2	0.798	1	Client
Poor Project Planning and Scheduling	0.825	2	0.762	4	0.779	1	0.789	2	Management
Contractor Financial Problems	0.800	5	0.784	1	0.754	3	0.779	3	Contractor
Lack of Proper Training & Experience of Project Manager	0.817	3	0.773	2	0.738	4	0.776	4	Management

Inadequate Project Scheduling Softwares	0.808	4	0.757	5	0.733	5	0.766	5	Management
Poor Site Management and Supervision	0.783	6	0.751	6	0.708	9	0.747	6	Management
Delays in Payments	0.775	7	0.741	7	0.713	8	0.743	7	Client
Poor Communication and Coordination	0.767	8	0.714	12	0.723	6	0.734	8	Contractor
Low Bidding of Contractor	0.758	9	0.708	13	0.718	7	0.728	9	Contractor
Inflation	0.742	11	0.719	11	0.692	12	0.718	10	External
Insufficient Knowledge Transfer and Training	0.733	12	0.681	18	0.703	10	0.706	11	Contractor
Design Error and Revisions	0.750	10	0.692	16	0.672	16	0.705	12	Consultant
Political Interference and Decision Making	0.683	18	0.724	10	0.697	11	0.702	13	External
Inadequate Project Monitoring and Control	0.700	16	0.735	8	0.662	18	0.699	14	Management
Change Order and Variations	0.717	14	0.697	15	0.682	14	0.699	15	Client
Inaccurate Project Cost Estimation	0.658	19	0.730	9	0.677	15	0.688	16	Consultant
Inadequate Contractor Experience	0.725	13	0.703	14	0.631	19	0.686	17	Consultant
Owner Competency	0.692	17	0.686	17	0.667	17	0.682	18	Client
Scope Changes	0.708	15	0.649	19	0.687	13	0.681	19	Consultant

The top five most important barriers, from these three different perspectives, which are same it indicates that there is a strong level of positive agreement amongst all the stakeholders.

4.6 Spearman’s Rank Correlation

In demand to check the level of agreement among the 3 parties of participants as to the barriers for schedule implementation, the Spearman’s rank correlation was considered by means of with the above equation. Table 4.8 explains the outcomes of Spearman’s rank correlation coefficient with importance level calculations (Ramsey 1989), (Eltehiwy and Abdul-Motaal 2023). These results, as predictable, shows approximately to some degree contrary views between contractor and client, who have the lowermost level of positive agreement (67%) than the other two. This adequate positive correlation among contractor and client is significant, indicating that the respondent’s responses are probably real and not the result by chance. For contractors as well as consultants, the correlation approves a better support among these members by providing a strong level of encouraging agreement to this pair (68%). However, the highest and very strong level of positive agreement rises among clients and consultants (almost 85%). Due to overall level of positive agreement among each group of clients, contractors and consultants in ranking for critical barriers, the results of this research can be considered as reliable.

Table 4.8: Spear Rank Correlation Coefficient

Parties	Spearman's rank correlation coefficient	Critical Values	Significance level
Contractors-Clients	0.670	0.584	0.01
Contractors-Consultants	0.681	0.584	0.01
Clients-Consultants	0.846	0.584	0.01

4.7 Discussions and Comparison of Results

The results finds from the previous section are discussed in this section. First discuss the results achieved by analyzing the five critical barriers for schedule implementation in Pakistan construction sector. Based on the findings of this research, then discuss a general opinion regarding the five critical barriers for schedule implementation in other nations.

4.7.1 Unrealistic Project Schedules Imposed in Contract

Unrealistic project timelines set by contracts can have negative impacts on all parties. Working closely together during the contract negotiation process is crucial for project owners and contractors to create realistic and feasible schedules that take into account the project's resources, scope, and complexity. Effective contract discussions that give priority to practical scheduling are necessary to reduce these risks and guarantee smoother project execution. Therefore, as per result, according to the relative importance index, every respondent gave the unrealistic project schedules imposed in contract highest in ranking. This finding agrees with (Rachid, Toufik et al. 2019), who establish that unrealistic contract schedule is the main barrier that causes schedule delays in Algerian construction projects. Unrealistic contract schedule imposed by client identified as the main barrier causing schedule delays in construction sector in other countries such as Morocco (Bajjou and Chafi 2020), Portugal (Arantes, da Silva et al. 2015), Oman (AlNasseri and Aulin 2015), India (Divakar and Jebin 2018) and USA (Park 2021).

4.7.2 Poor Project Planning and Scheduling

The most essential components of any construction scheme success is effective planning and scheduling. Over partial of the planned jobs are not completed on time in the conventional planning and scheduling approach. Giving the main contractor as well as its subcontractors the work they need to complete the tasks outlined in the principal schedule without considering the features that could affect the timely completion of the schedule, such as the accessibility of workers and materials when required, guarantee of safety situations, and providing of essential financial means, leads to improper planning and scheduling. As a result in Pakistan construction sector, poor planning and scheduling have highly substantial consequence and that's why ranked second in barriers. The other nation also consider it a critical barrier for schedule implementation like Saudi Arabia (Assaf and Al-Hejji 2006), Morocco (Bajjou and Chafi 2020), Afghanistan (Kakar, Hasan et al. 2020) and Slovenia (Srdić and Šelih 2015).

4.7.3 Financial Capability of Contractor

Contractors' ability to effectively execute construction schedules is directly influenced by their financial capacity. When it comes to the quality of work, the contractor's primary responsibility is to follow the conditions of the contract. However, contractual work necessitates large financial outlays, for which the majority of contractors are frequently unable to supply the funding. Contractors would experience financial issues as a result of delayed payments caused due to complicated financial procedures in client organizations, which would also create schedule delays. Consequently, based on the relative importance index, every responder gave the contractor's financial competence critical barrier. The findings of (Bagaya and Song 2016), who revealed that a contractor's financial capacity is the main barrier of schedule delays in the implementation of development projects in Burkina Faso, are agree with this conclusion. It has been considered critical barrier by many other countries such as Malaysia (Abdul-Rahman, Wang et al. 2011), Zambia (Kaliba, Muya et al. 2009), USA (Karji, Namian et al. 2020) and Brazil (Gomez-Cabrera, Ponz-Tienda et al. 2019).

4.7.4 Lack of Proper Training and Experience of Project Manager

The overall ranking of all respondents placed lack of proper training and experience of project manager at four on the list. A competent manager possesses strong technical and monitoring skills. He motivates his team members to dedicate themselves to the project by exercising strong leadership and performing with fairness. By delegating his staff authority, he expresses his confidence in their abilities to complete the task in a timely manner. He manages resources by consistently influencing his superiors, actively participates in site-level construction control meetings, and serves as an inspiration for educating his human resources in the skills required by the project. A project manager who lacks planning tools or knowledge will be unable to recognize and keep track of the critical tasks that must be completed in order to meet the schedule. If he is ignorant of operational procedures, he fails to approach senior executives for timely assistance, which will cause the project to take longer than expected. This barrier considered critical by other nations as well like India (Iyer and Jha 2006), (Divakar and Jebin 2018) and Afghanistan (Kakar, Hasan et al. 2020).

4.7.5 Inadequate Project Scheduling Softwares

The fifth critical barriers identified was inadequate project scheduling software's. Software that is inadequate for project scheduling can be described to include features that are necessary but not sufficient for efficient project planning and management. In the absence of features like Gantt charts, tools for allocating resources, and the ability to collaborate in real-time, project teams could find it difficult to make precise schedules, distribute resources effectively, and track project progress. Due to the lack of these tools construction project do not achieve their schedule objectives. Planners and managers must to be sufficiently well-informed about scheduling and planning tools. According to Slovenian construction sector, out of 62 respondents, 25% have not using schedule tools, 30% using excel and word and only 40% using primavera p6 and MS project. There is need focused management on enhancing practitioner attitudes and offering exposure to various scheduling tools and methods. In-company training and learning, working together with software engineers and planning and scheduling specialists, is required to further develop this deep awareness. This critical barrier considered by other countries as well like Slovenia (Srdić and Šelih 2015), Oman (AlNasseri and Aulin 2015), India (Divakar and Jebin 2018), Netherland (De Snoo, Van Wezel et al. 2011) and China (Meng, Yu et al. 2022) as well.

These five critical barriers associated by the findings of a research of schedule postponements led by (Rachid, Toufik et al. 2019) in Algeria, (Bajjou and Chafi 2020) in Morocco and (Divakar and Jebin 2018) in India are nearly the same with the difference of contractor financial problem which considered the most critical by (Bagaya and Song 2016) in Burkina Faso construction sector in his study barriers generating schedule delays in public projects. Others barriers that appeared as insignificant, nonetheless of concern, are contractor poor site management and supervision and delays in payment from client. Delays in payment is ranked 8, 7 and 7 by consultants, clients and contractors individually which was overall ranked 7 (but the same barrier was ranked 2nd in Burkina Faso) also Poor site management and supervision is ranked 9, 6 and 6 by consultants, clients and contractor individually which was overall ranked 6 (but the same barrier was ranked 1st in Vietnam (Le-Hoai, Lee et al. 2008)). In Pakistan construction industry even though these barriers effects might not be very important, that’s why ranked 6^{th} and 7^{th}.

4.8 Barriers Assessment with Other Countries

After reviewing the literature, it has been concluded that the topmost essential delivery issues is construction schedule implementation. The topmost essential five critical barriers that happened in 13 countries which were marked with symbol 1 as shown in the Table 4.9.

Table 4.9: Critical Barriers in Some Other Countries

Top Five Critical Barriers for schedule implementation in Pakistan Construction Industry					
Identified Countries	Unrealistic Project Schedules Imposed in Contract	Poor Project Planning and Scheduling	Contractor Financial Problems	Lack of Proper Training & Experience of Project Manager	Inadequate Project Scheduling Softwares
Burkina Faso (Bagaya and Song 2016)	–	–	1	–	–
Algeria (Rachid, Toufik et al. 2019)	1	1	–	–	–
Morocco (Bajjou and Chafi 2020)	1	1	–	–	–
Afghanistan (Kakar, Hasan et al. 2020)	–	1	–	1	–
Portugal (Arantes, da Silva et al. 2015)	1	–	1	–	–
Slovenia (Srdić and Šelih 2015)	–	1	–	–	1
Zambia (Kaliba, Muya et al. 2009)	–	–	1	–	–
Oman (AlNasseri and Aulin 2015)	1	–	1	–	1
India (Divakar and Jebin 2018)	1	–	–	1	1
USA (Park 2021)	1	–	–	–	–
Brazil (Gomez-Cabrera, Ponz-Tienda et al. 2019)	–	1	1	–	–
China (Meng, Yu et al. 2022)	–	–	–	–	1
Pakistan (This Study 2024)	1	1	1	1	1
Frequency	7	6	6	3	5

Every barrier frequency distributions were stated as a percentage of all the identified countries as shown in the figure 4.6.

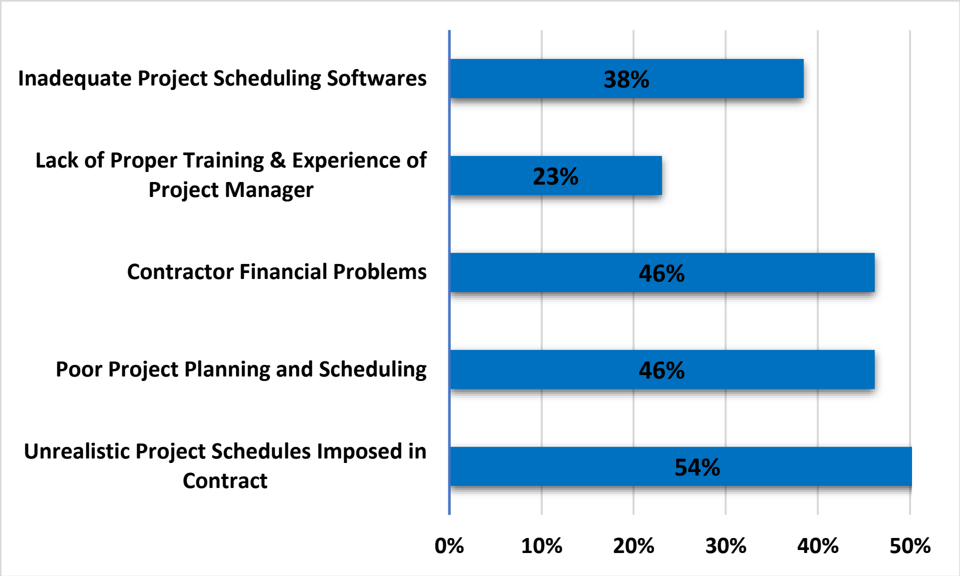

Figure 4.6: Percentage Distribution of Critical Barriers

From these particular research papers, it has been establish that the unrealistic project schedules imposed in contract from client is not only the most important critical barrier for schedule implementation in Pakistan construction sector, but also seems in various other nations, with an existence percentage of 54%. It was followed by poor planning and scheduling and contractor financial problems which equally produced 46%. Lack of proper training and experience of project manager were ranked fourth at 23% and the last ranked was inadequate project scheduling software’s of 38%.

SUMMARY OF RESEARCH WORK

Schedule management is one of the most crucial issue but the lack of knowledge, understanding and awareness regarding the barriers that contribute to the project delays and failure for not implementing the effective construction schedule is unclear. Therefore this study aims to identify these barriers for effective implementation of construction schedule in infrastructure project through literature review. An initial list of 45 barriers collected from the previous literature was reduced to 20 barriers using the content analysis and Delphi method.

Then assess the relative importance of these barriers from main construction stakeholders' perspectives by an online and field questionnaire survey was performed across the Pakistan construction industry to observe and analyze the data through exploratory factor analysis and relative importance index of 20 barriers from 200 valid responses. After statistical analysis, the top five critical barriers for the schedule implementation of infrastructure projects in Pakistan are identified such as unrealistic project schedules imposed in contract from client, poor planning and scheduling, contractor financial problems, lack of proper training and experience of project manager and inadequate project scheduling software's.

Schedule implementation and delays in Pakistan construction sector are a complex challenge with no quick solutions. The last objective was to provide recommendations for the particular barriers contributing to schedule implementation in Pakistan construction sector. The clients should specify a realistic duration and timelines imposed in the contract to prevent rework, quality problems, accidents on building sites, and time extensions, Set realistic schedules based on the complexity, scope of project, and resources available for the project. At the start of the project proper planning and scheduling is mandatory to develop a thorough monitoring and assessment system to evaluate project progress in relation to schedule milestones. In Pakistan, the lowest bidder (who may or may not be prequalified) is often granted the project. Sometimes

of the lowest bids might not have the necessary financial or technical capabilities? To ensure fair bidding, , evaluate a contractor's staff, experience, and technological skills based on the completion of certificates of accomplishment and figure out the contractor's financial strength using a yearly turnover and profitability. The ability of the project manager plays an important role in this type of situation. In order to provide project managers with the abilities, expertise and competences needed for efficient project management. Innovation in technology play an important role in construction schedule implementation schedule software's like Primavera P6, Microsoft project is mandatory for every type of project, also new innovated tools like Naviswork software's and many more.

CONCLUSION

Conferring to different perspectives of contractors, consultants and clients, this research has determined the topmost essential barriers for schedule implementation in infrastructure projects in Pakistan and ranked them relative importance index. Overall, unrealistic project schedules imposed in contract from client, poor planning and scheduling, contractor financial problems, lack of proper training and experience of project manager and inadequate project scheduling software's were identifies as the top critical barriers of schedule implementation that impact infrastructure developments in Pakistan. Spearman rank correlation shows the highest and strong level of positive agreement between clients and consultant then second level of positive agreement was between contactor and consultant and some degree of contrary views existed between contractor and clients. An assessment in 14 identified countries shows that that the unrealistic project schedules imposed in contract from client is the most critical barrier of schedule implementation, impacting 50% of other countries. It is evident from these findings that unrealistic project schedule imposed in contract from client and poor planning and scheduling are critical due to lack of understanding and awareness its role in the implementation of construction schedule in Pakistan. Without using appropriate project management techniques, several infrastructure projects have been executed out. As a result, certain necessary actions have been suggested which include client should provide realistic and possible schedule based on project scope, comprehensive risk assessment, create back up plans, risk reduction tactics, proper communication and collaboration between contractor and clients, monitoring and assessment to evaluate project progress in relation to schedule milestones. These findings could be helpful for various construction stakeholders like clients, contractor and consultant in Pakistan and other countries to reduce schedule delays and proper implementation of construction schedule in infrastructure projects.

Limitations

There are various limitation of this research which are mentioned in this section; due to lack of actual data this study was not considered for any specified project. In this research construction schedule barriers considered only for infrastructure projects other area was not covered in this study. There are various financial and referral network limitations for which the questionnaire was not followed in more detail. The main limitation of this study was only for primavera and MS project based construction schedule considered.

FUTURE RESERCH RECCOMENDATIONS

This study was barriers for effective implementation of construction schedule in infrastructure projects but the scope could be enhanced to commercial, residential and industrial projects. The scope can also be increased by proper awareness and knowledge about schedule integration with building information modelling for three dimensional visualization and efficient project management. Nowadays, globally construction industry is rapidly growing by innovated technology like artificial intelligence, robotic and algorithms so construction schedule must be integrated with these tools for effective implementation of schedule.

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APPENDIX

The questionnaire survey used in this study are mentioned below which consists of two parts In the first part respondents were asked to provide demographic detail and in the second part respondents were asked to rate the barriers for effective implementation of construction schedule in infrastructure projects by Likert scale from 1 to 5 (1 represent the least important and 5 represent most important).

PART 1: DEMOGRAPHIC DETAILS

1) **What is your Gender?**
   - □ Male
   - □ Female
2) **What is the highest academic level or degree achieved?**
   - □ HSSC or Lower
   - □ Bachelor
   - □ Master
   - □ PHD
3) **Your Job is related to which part of Construction Industry/Sector?**
   - □ Contractor
   - □ Consultant
   - □ Client
4) **How many years of experience do you have in the construction industry?**
   - □ 1-5 Years
   - □ 6-10 Years
   - □ 11-15 Years
   - □ More than 15 Years

PART 2

ON THE SCALE OF 1-5, RATE IT ACCORDING TO YOUR SATISFACTION.

Scale	1 = Little Important, 2 = Somewhat Important, 3 = Important, 4 = Very Important, 5 = Extremely Important	**1**	**2**	**3**	**4**	**5**
	Client Related Barriers					
CLB1	Change Order and Variations					
CLB2	Owner Competency					
CLB3	Unrealistic Project Schedules Imposed in Contract					
CLB4	Delays in Payments					
	Contractor Related Barriers					
CTB1	Inadequate Contractor Experience					
CTB2	Contractor Financial Problems					
CTB3	Low Bidding of Contractor					
CTB4	Poor Communication and Coordination					
CTB5	Insufficient Knowledge Transfer and Training					
CTB6	Limited Availability of Skilled Labor					
	Consultant Related Barriers					
COB1	Scope Changes					
COB2	Design Error and Revisions					
COB3	Inaccurate Project Cost Estimation					
	Management Barriers					
MGB1	Inadequate Project Monitoring and Control					
MGB2	Poor Site Management and Supervision					
MGB3	Poor Project Planning and Scheduling					
MGB4	Inadequate Project Scheduling Softwares					
MGB5	Lack of Proper Training & Experience of Project Manager					
	External Barriers					
EXB1	Inflation					
EXB2	Political Interference and Decision Making					