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An Investigation into Critical Causes of Cost and Schedule Overrun in Construction of Small Dam Projects

by

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I want to dedicate this achievement my parents, teachers and friends who always encourage and support me in every crucial time

CERTIFICATE OF APPROVAL

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Abstract

As a contributor to the country GDP, the construction industry also has become a major source of income. However, an unforeseen circumstance such as construction cost & schedule overrun has had a significant impact on the construction industry. Construction cost & schedule overruns are a regular occurrence in most projects. The main target of this study is An Investigation into Critical Causes of Cost and Schedule Overrun in Construction of Small Dam Projects by taking into account all perspectives from various project execution agencies involved in the construction process of small dam projects, such as clients, contractors, consultants, and others.

Literature reviews, questionnaires, and personal interview approaches were employed to collect data during the study in order to achieve research objectives. A survey was conducted to acquire the results of the questionnaire among project execution agencies in Pakistan who work in construction of small dam projects. A total of 120 people were contacted to participate in the study, all of whom had varying levels of expertise in the sector. Statistical tools were utilized to examine survey findings and draw conclusions based on the information gathered.

The findings of this study show that in this government department's construction of small dam projects, delay in land acquisition, project planning, controlling, and management, as well as project design error, lack of expert and qualified staff for project management by client, poor site management and obstacle technology uses by contractor, poor qualified, skills and experience staff for designing of projects by consultant are critical issue that hints to project success and which causes contributing to frequent incident of cost & schedule overrun in small dam projects in Pakistan. Therefore, it is proposed that by applying suitable project management tools and methodologies, these essential aspects can be better managed.

This research will improve competency of departments and decision-makers in understanding the significant causes of cost & schedule overruns in small dam projects in terms of cost-benefit analysis and development procedures. The research study's findings provide a long list of significant causes of cost & schedule

overrun to departmental decision makers, allowing them to take proactive measures early in the project to limit the impact of cost & schedule overrun in small dam construction projects.

Keywords: Construction of Small Dams, Cost & Schedule Overrun, Mitigation Measure of Overrun.

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Abbreviations

CPEC	China Pakistan Economic Corridor
GDP	Gross Domestic Product
GFCF	Gross Fixed Capital Formation
MWR	Ministry of Water Resource
PES	Pakistan Economic Survey

Chapter 1

Introduction

Construction business is a fast-paced industry that contributes significantly to a country's economic development. It has a huge impact on every country's economy. According to Ling Zhijia & Klau, (2015), construction sector is a significant contributor to the economy's growth and employment of all countries, and it has effect on other industries such as manufacturing, professional services, and financial services. The success of a construction project is governed by a variety of aspects, including planning, budgeting, value engineering, construction methods, and development technique, among others. Projects are always beset with problems that prevent them from being completed on time. While a project is complete on schedule and within defined cost as per the specification of customers satisfying all stakeholders, it is considered a successful project (M.Hayat, 2020).

Cost & schedule overrun has become serious and critical issue, the inability to finish projects within schedule and within budget has been a long-standing universal problem. Alamri, Amoudi and Omar Njie Gibril, (2017) state that cost & schedule overrun are worldwide issue, with emerging countries bearing a disproportionate share of the blame. Because the construction sector in developing countries is still growing stage and construction project subjected to planning and budgeting issues. It is a recurring problem for a project to fail to finish within time and budget constraint (Klau, 2015). As a result, it's critical to identify the elements that contribute to cost overruns and take steps to prevent and mitigate these problems in the future.

Flyvbjerg et al, (2004) conduct a study in Chicago and state that, 90% state construction projects have cost and schedule overruns. According to Rubenstein, (2007) approximately 46% of projects had cost overruns or did not meet the requirements or needs of customers and users. Furthermore, Saudi Arabian experts of constructions project who studied the variables that cause of delays discovered that only thirty percent projects were completed in time limits, with the average time overrun ranging between 10% and 30% (Kadry et al., 2017).

Hence, cost & schedule overrun are two of the most common challenges of this construction business. To investigate this phenomenon, this study pursues to regulate the cost & schedule overrun reasons that associated with construction of small dam projects in Pakistan. This chapter provides a general summary of the study, including the background of research, problem statement, study's aim and objective, methodology, significance, and study layout.

1.1 Background of Study

The geographical region of Pakistan has been blessed with abundant water reserves but the demand for water by the passage of time in industrial, irrigation, and household sectors has grown with the increase of country population. The World Resources Institute (Magazine, 2019) explicit that Pakistan is a water stress country and in section 7 of Nation Water Policy states: the criticality availability of fresh water is a basic need for human life, coupled with scarcity warrants recognition of water conservation to be accorded the highest national priority.

It is recognized that a large annual and seasonal variability of fresh water availability makes it necessary to: build large dams for system augmentation with the consensus of all federating units; build small and medium dams for local and regional use; build check dams and delay action for recharge of aquifers and to reduce the flow velocities and erosion; recharge the underground aquifers during floods and surplus water flow periods for later use and provide subsurface dams, where feasible (Resources Ministry of Water, 2018). The construction of small dam projects will be the focus of this research. These projects, known as ADP,

PSDP, and umbrella projects, were begun by the Punjab government's irrigation and power department under the name of small dams organization, which consists of four districts (Islamabad/Rawalpindi, Attock, Chakwal, and Jehlum) in Punjab province, Pakistan. Thirteen small dams projects are under construction, that will build further gross storage capacity of 153,717 Aft & 52,600 acres of CCA will be added. Small dam construction projects are encountering serious cost & schedule overruns. In this organization, causes of cost & schedule overrun are fairly common, and the construction business is no exception. However, it has been discovered that in recent years; there is no comprehensive research conducted on cost & schedule overrun causes of this industry. Natural disasters in Pakistan, such as floods and earthquakes, as well as financial and payment issues, improper planning, poor site management, slow decision making, are the most common causes of cost & schedule overruns (Hayat, 2020). According to small dams department, the construction of small dam projects in Pakistan experienced schedule overrun ranging from 10 to 43 months and cost overruns ranging from 6% to 111% (Source: Small Dam Department). Tables 1.1 and 1.2 provide the details of certain small dam projects that have been started in Pakistan over the previous 17 years, including the date and cost of completion and cost & schedule overruns.

Table 1.1: Details of Cost Overrun of Some Small Dam Projects (Source: Small Dam Department)

Sr. No	**Name of Dam**	**Dam Height (Ft)**	**Estimate Cost (Million)**	**Actual Completion Cost (Million)**	**Cost Overrun(%)**
1	Thatti Syedan	43	39.13	41.862	7
2	Sawal Dam	95	96.7	107.841	12
3	Jamal Dam	87	78.47	84.237	7
4	Haji Shah Dam	66.25	175.988	358.24	104
5	Jabba Dam	83.6	41.7	44.064	6
6	Jalwal Dam	60	95.03	101.8	7
7	Basal Dam	61.4	15.56	31	99
8	Sowra Dam	105	537	866.222	61
9	Taja Bara Dam	97	203.18	312.046	54
10	Sadrial Dam	69	97.12	205.58	112
11	Shahbazpur Dam	70	104.68	105.953	1

TABLE 1.2: Add captionDetails of Schedule Overrun of Some Small Dam Projects (Source: Small Dam Department)

Sr. No	**Name of Dam**	**Dam Height (Ft)**	**Time limit (In Month)**	**Plan Start Date**	**Plan Finish Date**	**Actual Finish Date**	**Schedule Overrun (In Month)**
1	Thatti Syedan	43	24	01/09/2004	31/08/2006	26/06/2007	10
2	Sawal Dam	95	12	18/10/2004	17/10/2005	09/12/2006	13
3	Jamal Dam	87	18	13/11/2004	12/05/2006	21/10/2007	17
4	Haji Shah Dam	66.25	18	12.06.2005	12.12.2006	07.09.2007	9
5	Jabba Dam	83.6	18	25/08/2001	24/02/2003	31/05/2006	39
6	Jalwal Dam	60	12	25/08/2004	24/08/2005	09/12/2006	16
7	Basal Dam	61.4	12	25/08/2003	24/08/2004	13/06/2005	12
8	Sowra Dam	105	36	16/04/2012	15/04/2015	30/10/2018	43
9	Taja Bara Dam	97	36	01/03/2006	28/02/2009	Under construction	-
10	Sadrial Dam	69	36	01/03/2006	28/02/2009	Under construction	-
11	Shahbazpur Dam	70	36	02/03/2006	28/02/2009	Under construction	-

It is observed that there is no relevant literature available in Pakistan that discusses this department's challenges. Therefore, this study will conduct to investigate the critical causes of cost & schedule overruns in the completion of these projects in Pakistan and rank these causes from the perspectives of the client, consultant, and contractor.

1.2 Problem Statement

Due to construction businesses failing to meet project objectives in the set time and budget, poor time and cost performance is a key issue facing today's construction sector (Enshassi et al., 2009). The most significant characteristics of successful projects are time and budget, which serve to reduce problems for all parties and provide new opportunities to create another connected project. It also aids in the growth and profitability of the building sector (Al-Najjar, 2008).

According to small dam department, most small dam projects in Pakistan are prone to schedule overruns from 10 to 43 months by their set time allotted shown in table 1.2. Cost overruns are also a major issue that stymies project progress because they reduce contractor profit, resulting in significant losses and putting the project in jeopardy.

The vital and significant characteristics of successful projects are time and budget, which serve to reduce problems for all parties and provide new opportunities to create another connected project. It also aids in the growth and profitability of the building sector (Al-Najjar, 2008).

Small dam department face critical issues because of lack of hard political situation, weak economy, lack of managerial skills, poor labor productivity, poor planning, rising material prices, the environment, the type of project, and a lack of updated information about how cost overrun factors can cause project delays at various stages.

Both cost & schedule overrun are challenges that can directly lead to a project's failure, as stated in the preceding sentences. If the challenges are not addressed, they can damage both the project agencies and the small dam projects.

Therefore, due to the lack of research on the causes of cost & schedule overruns in small dam projects, this study aims to conduct comprehensive research to investigate critical causes of cost & schedule overruns in the construction of small dam projects in Pakistan. This study will assist clients, contractors, and consultants in comprehending the relevance of money and time in a project, as well as resolving financial and time-related challenges to ensure the project's success.

1.3 Aim of Study

The primary goal of this study is to define key causes of cost & schedule overruns in small dam construction projects, as well as their relative relevance.

1.4 Objectives of Study

There are following key objective of this study:

- An investigation into critical causes that lead to cost & schedule overrun in the construction of small dam projects and will suggest mitigation measures for the most critical causes.
- These causes will be linked to the project execution agencies to check out who agency is responsible for a particular cause and with that, it will also be checked at what stage of the project they are found e.g. planning stage, design stage, estimation stage, tender stage, and execution stage with the help of expert opinion and interviews that is associate this industry.
- It will examine the frequency and severity of each cause and prioritize or rank it according to its importance and discuss the topmost 20 causes that will prioritize as per responded feedback.

1.5 Significance of Study

Lack of systematic studies was observed for investigating causes of cost & schedule overrun in small dam projects in Pakistan. As a result, this study can enlighten and motivate organizations about the elements that cause cost overruns & schedule overruns in construction sector.

The benefits of this study include the ability to create statistical results using SPSS, and it may be used as a guideline or reference for project managers, site managers, or contractors to understand how important the cost overrun element is in project schedule overrun. As a result, the findings of this research will be useful for small dam organization and contractors.

1.6 Layout of Study

The study is divided into five chapters as follows:

Chapter One: The need for this investigation is discussed in this chapter. It includes the study's background, problem statement, study's objectives, and significance of this study.

Chapter Two: This chapter presents a summary of previously published research papers for a relevant study on cost and schedule overrun.

Chapter Three: adopted methodology for analysis is described. It includes information on the various data analysis methodologies plus data collection strategy used.

Chapter Four: This chapter discusses finding of descriptive analysis, including a hierarchical assessment of cost & schedule overrun causal elements and a comparison of findings with similar studies conducted in other countries.

Chapter Five: The final chapter examines the study's recommendations and conclusions, as well as advice on possible advancements and courses of action for future work in order to bring further benefits in cost & schedule control of small dam projects.

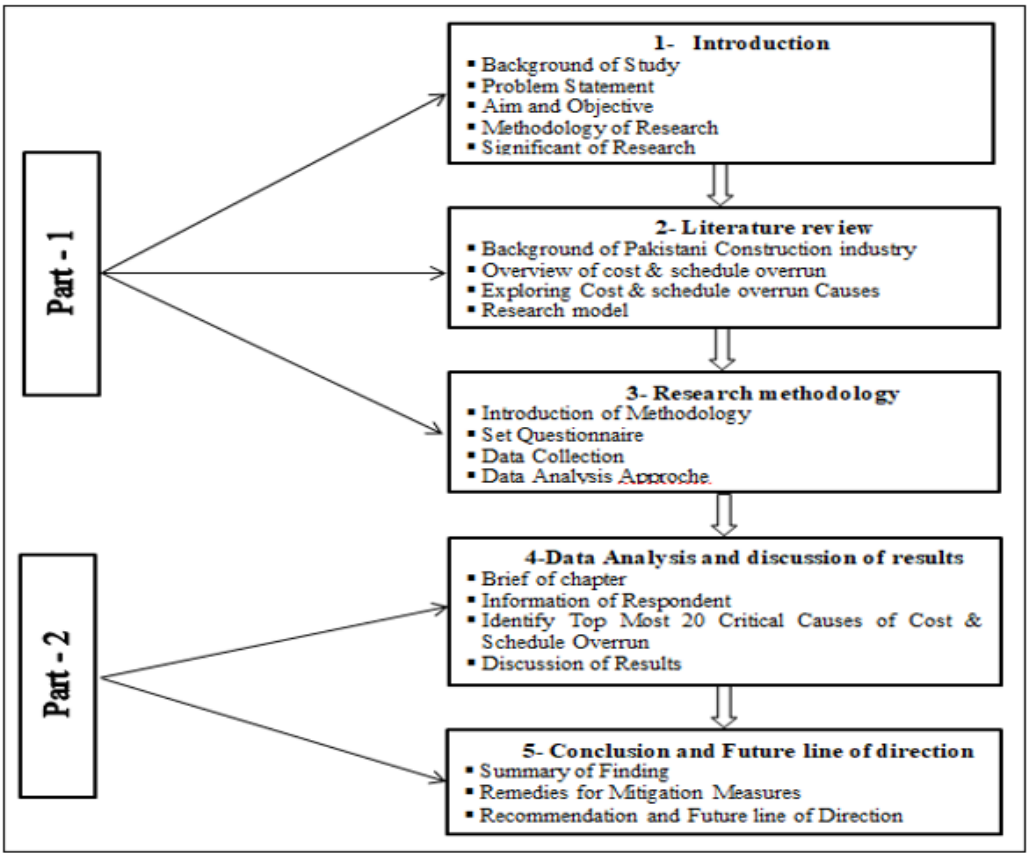

FIGURE 1.1: Layout of This Research

1.7 Ethical Contemplation

The ethical considerations of this study included recognizing industry workers whose work had been acknowledged and thus contributed to the literature. Participants who filled out the research questionnaire were promised that their responses would be kept private and solely utilized for academic purposes. Without any coercion, respondents to the questionnaire had freedom to avoided answering any questions they believed were inappropriate.

1.8 Summary

The current study will provide a review of the critical causes of cost & schedule overrun in small dam projects that have been observed by experts. A questionnaire

study of Pakistani industry would combine the lessons learned by various public and private companies during the development and execution of such projects in Pakistan. Professional experience will be transformed into lessons learned about such reasons in Pakistan for future researchers' reference. Future research will benefit from the step-by-step strategy used in this work.

Chapter 2

Literature Review

2.1 Brief of Pakistani Construction Industries

The construction sector represents a community's foundation. We might not have any institutions, hospitals, and even homes if the industry didn't exist. Moreover, significantly, no workplaces, factories, or stores would exist. These structures represent the key pillars of a healthy economy (Ismail T. 2017).

With 220 million people, a working force of more than 60 million, and a burgeoning middle class, Pakistan is the world's fifth most populated country. Urban areas account for 36.38 percent of the population, while rural areas account for 63.62 percent. Due to a 2.4 percent yearly population growth rate, according to census 2017, there is a growing demand for housing. Based on the current Pakistan Economic Survey, the construction industry accounts for 2.53% of total country GDP. The industry employs 7.61 percent of Pakistan's working population. From FY2019 to FY2020, the private industry's GFCF increased about 20.6 percent. Over 95% of the overall GFCF came from the private sector. Through the flow of infrastructural projects such as highways, power plants, dams and CPEC has boosted the construction sector (BOI.2020). The country's yearly housing need is expected to be over 700,000 units, with just approximately half of that being met at the moment. Pakistan is ranked 22nd in the world for the length of its road network, which is 263,775 kilometers (13,000 km of National Highways and

Motorways, 93,000 km of provincial highways, and rest are District and Rural Roads) (Ali et al., 2018).

Construction, which includes operations connected to the construction of physical infrastructure and allied activities, is critical to any country's economy. It is estimated that the sector's output accounts for 40-60% of gross fixed capital formation. Furthermore, study has revealed that the building and housing industries are linked to more than 60 other industries. Now days the construction business in Pakistan is fastest increasing economic sectors in terms of infrastructure development.

It has grown to become the country's second-largest industry in terms of GDP and workforce. In recent decades, this sector has included a variety of initiatives in the road development sector, such as smart motorways, highways, and other key district roads. Pakistan's construction industry is vital to the country's economic development and labor force. According to current (provisional) estimates provided in Pakistan's economic survey, the construction industry rose last year (2017), contributing 9.1% to the economy and 20% of GDP (GDP) (Baloch et al., 2019).

Despite the fact that construction sector had already made a contribution about 2.3 percent and 2.85 percent of Pakistan's GDP on average during last five financial years, according to the PES report 2019-20 valued it at Rs. 316 billion, most economists believe it is worth among 10 to 12 percent of the country's total GDP. This is because it fosters more than 42 ancillary industries, including aluminum, brick, cables, cement, fixtures, glass, kitchen and bathroom fixtures, marble, paint, steel, tiles, transportation, warehousing, and wood. As a result, because it employs 8% of the overall workforce, it has a significant economic impact. (Iqbal et al, 2021).

Pakistan's construction sector is still in its development. It is critical to eliminating industry bottlenecks, such as corrupt practices, conducting extensive digitalization of land ownership records increased transparency, developing a robust land regulatory and building control, rationalizing and enforcing building laws around across board, and instill cutting-edge skills in students for the industry's future.

Despite the industry's stellar performance in recent years, there are certain flaws. A grim political outlook, widespread industry corruption, and a gloomy economic and corporate climate are among them (Urbański et al., 2019).

According to (Batool & Abbas, 2017), a number of studies have been conducted in Pakistan to identify factors that source cost overrun and delay reasons in construction projects. The majority of this research focused on construction projects in general, such as building or highway construction. It is true that a project that is completed within the specified time limit is considered a success. However, for such a multitude of reasons, Pakistani construction projects fail to meet the specified deadlines. Construction project delays are a severe issue that sends a negative message to investors since projects take a long time to finish (Tumi & Omran, 2017).

The Previous investigations/writing show that there are numerous bits of examination accessible on the Pakistan Construction industry particularly on building development projects and on expressways/gas pipelines/water pipeline and groundwater projects just as cost and delay factor for build project however lamentably not very many investigations were directed on Dams projects. Along these lines, the principle point of this examination functions just as it will be the initial move towards improving the writing on cost & schedule overrun in Small dam construction projects in Pakistan.

2.2 Cost Overrun

The gap between actual and budgeted expenditures is known as cost overrun. Cost overrun typically described as "cost escalation", "cost increase", and "budget overshoot". The change in contract amount divided by the initial contract award amount is known as cost overrun. To make comparisons easier, this calculation can be converted to a percentage. Cost overruns may also be compute distinct among project's original cost estimate and the actual construction cost at the completion of the project's works in the commercial sector (Al-Najjar, 2008). Cost escalation, budget overrun or cost rise are all terminologies that can be used to express cost

overrun. Cost overrun is variation in the initial estimated or projected cost and the ultimate cost at the project's completion. Final costs are the total expenses actually spent on a construction project as assessed at the time of completion, whereas projected or initial costs are the anticipated or forecasted costs at the time of project approval (Ullah et al., 2017).

The total expense whereby actual expense exceeds to predicted cost, assessed in local currency, constant pricing, at beside consistent baseline, is known as cost overrun. Overrun is usually said as a ratio of expected cost, through a positive number showing cost overrun and a negative number showing cost under run. When calculating cost overrun for a specific investment type, the size, frequency, and distribution of cost overrun should all be taken into account. The gap between actual and expected capital costs for a venture is known as cost overrun. The distinction might be expressed in absolute or relative terms. In absolute terms, price overruns are calculated by deducting the particular price from the planned worth. Overrun is outlined because of the distinction between actual and calculable prices or actual and calculable prices (Flyvbjerg et al., 2018). According to (M Dlakwa & F Culpin, 1990), A cost overrun, additionally called a value increase or budget overrun, happens once sudden prices arise. These terms check with prices that surpass budgeted levels by means of sarcasm of real prices throughout the budgeting method. Value overruns square measure common in infrastructure, construction, and technological comes. Value step-up, on the opposite hand, is that the expected increase during a foretold value because of factors like inflation. cost may be outlined during a sort of ways that, besides the following: In terms of the share of total defrayal, As a share of the whole budget, each within and outdoors of the first budget As a share of the initial budget, value overruns (Aslam et al., 2019).

Callegari, Szklo & Schaeffer (2018) studied, the megaprojects for power generation play a crucial role in energy planning and policy. Many mega projects, on the other hand, fall short of the scale and efficiency goals set forth at the outset. The construction expenses were 97.53 percent more on average than the initial estimates. Cantarelli et al., (2012) conducted a study on the Netherlands construction project and described that Cost overruns square measure as prevailing

as price under runs, however through price overruns square measure larger, comes on the average have a sixteen.5 % cost. It became discovered, majority of price overruns within the European country occur throughout the pre-construction part (the amount between the formal call to make and therefore the beginning of construction). Pre-construction price overruns occur a lot of oft and with a larger scale than throughout the building part. Complexity in cost overruns besides complexness in engineering Projects: aforesaid that cost could be a worldwide development in engineering, associated with urban infrastructure development indicated low complexity; associated with transport infrastructure medium complexity; and associated with the special construction, containing high uncertainty, shown great complexness. The computed collective mean of price overruns recommended that comes with high complexness square measure liable to have higher cost overruns average 25.6 percent; low complexness comes showed a price overrun of eight.0% on the average, and medium complexness comes showed a price overrun of 90% on the average (Bohórquez, Jherson Mejía, Guillermo, 2019).

Table 2.1: Show some popular countries' cost overrun percentage (Study by (Literate & Indonesia, 2020)

Country Name	**Cost Overrun Percentage**
Pakistan	Cost overruns ranged from 10% to 60% of the original budget.
India	Cost overruns occurred at a rate of 73 percent of the project's contracted price.
Korea	95 percent of road projects saw cost overruns of 50 percent of the project cost. Whereas all rail projects experienced cost overruns of 50 percent of the project cost.
Nigeria	Cost overruns affected 55 percent of projects, ranging from 5% to 808 percent of the total project cost. In infrastructure projects, the minimum percentage of cost escalation was 14 percent of the budgeted cost.
Thailand	The cost performance of 53% of highway projects was bad.
UK	Overruns accounted for 55% of all projects. Cost overruns affect more than 10% of projects.
USA	At an average of 24.8 percent of the project was overrun by 84 percent.
Netherlands	Cost overruns account for 10.3 percent of the project's total cost.

2.2.1 Types of Construction Cost

Many cost elements are composed on many cost of a work unit. Labor costs, material costs, plant and machinery costs, administration costs, and other charges are among these cost categories. Construction expenses are divided into two categories: "direct costs" and "indirect costs" or "overhead costs" to assess costs related with a specific activity. Costs incurred directly: Direct costs are costs that may be linked to a single activity or work item that is being performed or manufactured. The direct cost of a permanent work item is comprise of the direct material cost and the direct labor cost, as well as any other direct charges. All costs associated with materials that are included into the project's permanent works are covered by direct material costs. Direct labor costs include all expenses related to the procurement, maintenance, and pay of all types of personnel engaged on work place to accomplish a project item. All additional expenses on account of services given that might be directly ascribed to and clearly identified with the execution of an activity or work item are classified as other direct expenses. Costs incurred indirectly: All costs that are due to a project but cannot be linked to the completion of a specific activity or work package are classified as indirect expenses. In other words, indirect costs cover all costs other than direct expenses. (Subramani, 2014).

Bovsunovskaya Maria (2016) described The three primary categories of project cost are "direct cost," "general conditions", and "profit and overhead". Heavy equipment, construction material, and labor are all direct costs that may be directly ascribed to the physical product's manufacture on site. The unseen or indirect expenses of a project are known as general conditions. Preconstruction expenses, construction organization costs, and project operations expenses are the three sorts of general conditions. Profit can express difference between what is earned and what is spent. It is express of project's overall cost percentage. Project cost, timing and duration, risk factors, taxes, financing, and the contractor's workload are all aspects that go into determining profit percentage.

Any construction project has direct and indirect costs, which add up to the entire costs and expenses incurred consequently of using primary components to complete

projects. The direct costs are the costs of labor, materials, and equipment, among other things. Project Overhead Costs and General Overhead Costs are examples of indirect costs. Indirect costs might be constant or variable (Arbuckle et al., 2021).

2.3 Schedule Overrun

The term "schedule overrun" refers to a delay in the completion of a project beyond the time indicated or agreed upon by all parties involved. A schedule overrun could be described as the amount of time that passes after a contract's completion date or after the parties agree on a delivery date for a project (Blloku & Öztaş, 2013).

"Slippage of project schedules" is another term for time overrun in a construction project. The time overrun is also described as amount of time it takes to complete a construction project after anticipated completion date, which is influenced by both internal and external factors (Ullah et al., 2017).

Delay in construction known as the actual progress of a project's phases is slower than expected, or while project is finished late (CIOB, 2008). The term "delay in construction setting" refers to a protracted-time of construction and interruptions of events that cause the construction programmer to become distracted. Only when a project's estimated completion time has been met is it termed delayed (Alex, 2016).

2.3.1 Effects of Cost and Schedule Overrun

The construction sector is a project-based industry that makes a significant contribution to a country's economic development. As a result, delays in building projects are extremely destructive to all project stakeholders. According to Sambasivan & Soon (2007), time overrun, cost overrun, dispute, arbitration, outright abandonment, and lawsuit are the six key repercussions of delays.. Furthermore Ramya and Divya (2015), mentioned There are two more effects: low quality in

project completion and unfavorable public relations. However, cost & schedule overrun are the two most significant effects. According to Yang & Kao (2012) also revealed that time overrun in infrastructure projects have the following impacts: bad public impact, misconceptions leading to disputes, late delivery, waste of resources (both equipment and labor), and work exceeding price.

2.4 Cost and Schedule Overrun Factors Discussed in Previous Studies

It is true that a project that is completed within the specified time frame is considered a successful project; but, due to a variety of factors, Pakistan's dam projects have failed to meet the specified deadlines. Tumi & Omran, (2017) conduct a study, delay in dam project's construction in Pakistan, find out nine critical factors that contribute to schedule overruns: slowness in material delivery, natural disasters, contractor financial troubles, conflicts at site, inefficient site management, rapidly changes in design, unqualified contractor, lack of skilled workers and inaccurate time estimation.

Schedule overrun in building projects is a massive concern including both developing and developed countries, based on the investigation by (Ahmed Soomro et al., 2019) , that identified the key reasons for project delays in Pakistan. According to this study contractor financial, contractor has insufficient experience, weather effects, delayed in material delivery, design errors, lack of skilled labor, inadequately trained subcontractor, and failures in time calculation were well-known as top sources of schedule and cost overrun in construction sector projects in Pakistan.

Batool & Abbas (2017), examining the construction delays for Pakistani hydropower projects, constructed over the last five years. They were completed with a 200 percent time overrun and 2.5 times the cost of the original estimate. According to that research work, the review finds that lack of interest political will, delays in works, delays in the government's issue of funds, bad situation in

law & order, project start without proper site investigation, and poor project time management are primary sources of delays in these Hydro Power projects.

Construction projects are the lifeblood of any country's economic growth because they meet the basic needs of housing, transportation, connection, and social infrastructure. According to (Prasad et al., 2019), India's infrastructure development needs to be accelerated. Construction projects in India, on the other hand, are beset by global phenomena known as "Delays/Time Overruns" and found that (a) land acquisition and utility related delays were the main causes for delays in transportation projects, (b) public interruptions, labor shortages, and poor productivity were the main source of time overrun in power projects, (c) design-related delays were found to be critical factor in building projects, and (d) land acquisition and public interruptions were found to be critical source of delays in water projects. Cost overruns have become a global concern in recent years. Cost overruns have been quantified in several studies, and main causes for cost overruns have been identified in others. One of these issues that scholars and experts have focused on is building complexity. Because construction complexity affects decision-making and has quite negative effect on project cost performance, some authors advocate for more research into the link between project complexity and project success. Bohórquez & Mejía, (2019) said, low complexity was observed in projects involving urban infrastructure development, medium complexity in projects involving transportation infrastructure, and high complexity in projects involving unique construction with significant uncertainty. In addition to, cost overruns are more probable in high-complexity projects at 25.6 percent on average, while low complexity projects have an average cost overrun of 8.0 percent and medium complexity projects have an average cost overrun of 9.0 percent, according to mean of cost overruns.

Infrastructure becomes essential to a country's economic growth, particularly in Asia, where development has been widely concerned. Cost overruns or under runs are equally common in Asia, with the overall cost overrun (26.24 percent) outnumbering the overall cost under run (12.24 percent). A study conducted on 102 major infrastructure projects in Asia, including trains, highways and energy

industry. The theoretically, assertions on the effect of project contextual variables are tested, illustrating the influence of size of the project, project type, locations, and the duration of a project's project life, as well as political, financial, strategic, and expertise in infrastructure delivery factors that differ across countries. (Andrić et al., 2019).

2.5 Responsibilities of Project Parties

2.5.1 Project Stages

To achieve a successful output from each construction project, it needs to follow a few steps and processes. These steps and processes can be described as Project Stages which can vary from simplest to the most complex for every project and very demanding process. These stages are known as "Concept of a project, Design of project, Pre-construction stage, Procurement stage, Construction stage, Post-construction stage" (Koutsogiannis, 2018).

Pathak, (2020) said, Management of a project is entirely helpful to accomplish a project that categorized through a number of phases. Each Phase has categorized a certain set of tasks or activities that complete the project from beginning to end. As per perception, every project has 5 different phases namely "initiation, planning, execution, monitoring, and project closure".

There are two distinct phases in a construction project: the first one is the pre-construction phase, i.e. the period from the initial conception of the project to the signing of principal contract between the public client and the main contractor; and the construction phase, which is the period after award of the contract up to completion, i.e. While construction is actually going on (M Dlakwa & F Culpin, 1990).

According to (Rubin, 2019), every construction project has 3 primary stages, a) Preconstruction stage, b) Construction stage, c) PostConstruction stage. The preconstruction stage consists of making a strategic plan, constructing a design, getting permits or rights, site evaluation, cost estimate of the Project, estimation

for labor and resources for construction and preconstruction phase is considered critical to every project's success. Construction stage takes from the physical moment of the beginning of project till physical ends. In this construction stage, most people are physically associate with a project, and include execution of work, monitoring and measure performance, and take essential decisions to accomplish their gold. Post- Construction stage is a period that starts when a physical project ends till project revenue to the owner takes place. It consists of site cleaning, moving of equipment, and typically demobilization, preparations of necessary documents that are associated with a project and handed over to the owner.

There are several different schools of thought that exist about the number of stages of a project. Several writers claim the stages of a project consist of 2 phases, 3 phases, and 5 phases. Based on the above explanations, it can conclude a project consist of 2 phases (PreConstruction phase and Construction phase) and 5 stages (Planning stage, Design stage, Estimation Stage, execution and Controlling stage, and project close stage).

2.5.2 Client's Role in Project

The client is an individual or organization that manages the facility or structure upon completion of the project. The client has a position on the decision to use the money to implement the project and funds will utilize on his decision (JHA, 2013).

In a project, a client takes the initiative to build a project, project design, and pays for it in exchange. In construction projects, clients come in a variety of shapes and sizes, each with their own goals and motives. A client may be inspired to construct projects for them by a variety of motivations, such as an individual's desire to build their own home, a municipality's response to a need, or investors' desire to profit. Whatever the reason for the construction project, it is a direct answer to the client's needs. National and municipal governments, public firms, cooperatives, public enterprises, enterprise groupings, the military, and individuals are examples of clients (Egemen & Mohamed, 2010).

Clients play a vital role to build construction projects and these roles change frequently according to the needs of different stages of a project. Client Skills and knowledge is attributed to the success of the project by determining the project outcomes. The duties of client include initiation and managing, preparation project definition & project brief, Organizing management team, preparation project design, risk assessment and analysis, safety controlling, preparation tenders documents and award criteria, performance measurement, and review and evaluation, change control, coordination with various stockholders (Chigangacha, 2016).

According to Sivadass Thiruchelvam, (2020), client has a major impact on construction process, which will decide whether a project succeeds or fails. As a consequence, the owner aims to achieve the desired outcomes through good design, planning, and construction. Owners' perceptions of their roles affect their decision to complete tasks as soon as possible. (COAA, 2018), defined roles of owners/client: that deal with design, construction & Management, select the project site, choice architects, consultant & contractors, arranging funds, manage the design, and execution processes, planning to keep projects within budget, and resolve conflicts during the lifecycle of the project.

2.5.3 Consultant's Role in Project

Consultancy is a profession that deals with high engineering credentials. It is provided by individual or public body who have a specialized background, and extensive experience who can prepare, design, supervise, and assist in the maintenance of any form of structure based on the client's needs. Every construction project has its own set of goals and objectives, as well as a set of six basic parameters: Size, complexity, quality, productivity, timeliness, and cost. These criteria must be strictly assessed to achieve project goals within specified time and cost. The consultant advises to client on the planning, controlling, and evaluation of these criteria that conclude the final result and consulting engineer may make a long-term contribution based on his ability, experience, and knowledge (Nikumbh & S.S. Pimplikar, 2014).

Consulting provides specialist guidance on civil construction project design, planning, and management, for all forms of residential and commercial construction, as well as large-scale public infrastructure projects. The main objectives of a consultant are cost estimation, Preparation of drawings & designs, organizing tender procedures, supervising and controlling the quality of works as per standards, ensure safety, and provide economic analysis (Wen et al., 2017).

2.5.4 Contractor's Role in Project

In construction, a contractor is an organization or in some cases, a person hired by the client to complete the work necessary for the project's completion and Contractors may contribute to a construction project in a variety of ways. Contractors' primary duties include planning, managing, and handling all work performed by their employees, determining the material and equipment specifications and making plans for their purchase, predicting potential changes and formulating risk-mitigation plans, taking care of any legal and regulatory problems that might arise, ensure that all project members are communicating effectively. These duties extend from the start to the finish of the project, regardless of its range and making regular decisions on a daily basis to ensure project within budget and time limit.

Contractor monitors all stages of construction project. It will manage manpower, materials, tools, and jobs required for accomplishment of projects within allocated budget and on time. A good contractor is inquisitive, confident, and enthusiastic about his job. There are important duties of contractor are: to plans all stages of a project from starting to finish, prepares a schedule to present to clients in order to show them the progress of a project, on a job site ensures the safety of staff and other personnel, organizing and managing materials equipment and work team, inspecting the work quality which executed by staff and subcontractors, ensures that a project site is up to date by following laws and regulations maintaining correct financial reports is important, obtaining permits and licenses for construction, schedules are being kept track of.

2.6 Summary

To establish the causes of construction delays in small dams, thorough literature review was undertaken using conferences, international journals, and books. According to the previous study, the reasons and consequences of project delays vary by region due to variances in environmental conditions and construction practices.

The study of literature found a small number of research studies associated with the analysis of cost & schedule overrun factors in the construction projects as well as construction of hydropower projects in Pakistan and internationally. However, it was no studies to date carried out to find and ranked the delay factors affecting the construction of small dams in Pakistan industry. In addition, there were limited studies carried out in relation to analysis cost overrun and time overrun in Pakistan hydropower project which aim to minimize the effects of delay to construction industry. Furthermore, there are no research studies that have developed a relationship between project executed agencies and project stages and equally, there is no publication developed a framework of a delay analysis system to minimize cost and schedule delay issues in construction of small dam projects in Pakistan.

Finally, A total of seventy-five cost overrun and delay factors were listed from the literature review. These factors will be considered during the design of a questionnaire that aimed to rank these factors according to project stages as well as project representative parties' responsibilities, responses will be collected from construction industry representatives, including consultants, contractors, and owners. The possible delay causes in construction of small dam projects will also categorize into project executed agencies.

Chapter 3

Research Methodology

3.1 Introduction

Many factors contribute to cost & schedule overruns in construction projects. Each reason of cost and schedule overruns has a different rate of incidence and impact on the final project cost. Some reasons may occur frequently, although their costs & schedule consequences may be less severe. Other factors, on the other hand, may occur seldom but have a significant impact. As a result, in order to rank their overall effects on cost overrun, it is required to identify cost and schedule overrun sources based on both occurrences and their impact. This aids in the prioritization of the elements and, as a result, the determination of the mitigating activities to be done.

This chapter explains comprehensive methods and process that was implemented and performed in this research for proper results. This research was conducted on construction of small dam projects in Pakistan. The primary data was collected with the help of appropriate instrumentation and data analysis is done by statistical tools. Likewise, a brief discussion of the strategy used in the questionnaire design, the target respondents, the sample size required, tests of reliability of questionnaire and the questionnaire administration. Finally, the mode of data presentation in addition to the statistical tools to be used for the critical analysis of the data gathered is discussed.

3.2 Research Design

The development of a plan or strategy that will guide the collection and analysis of data is referred to as research design. Designing a research study entails the development of a plan or strategy that will guide the collection and analysis of data (Poilt and Hungler, 1985).

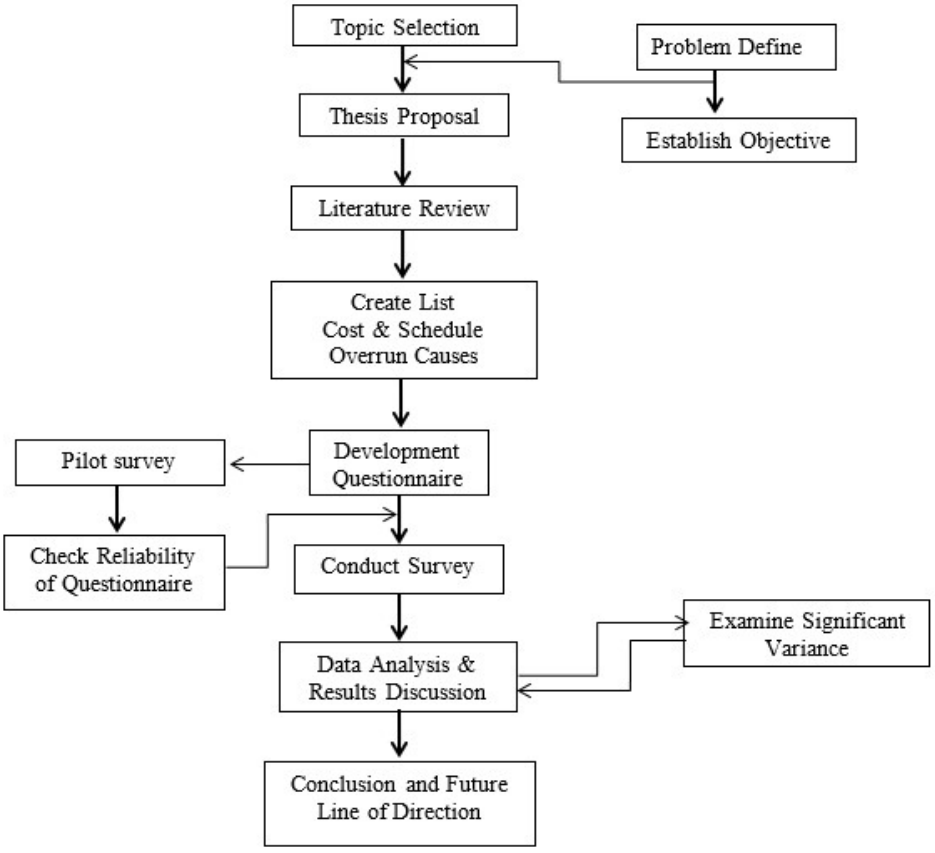

FIGURE 3.1: Research Methodology Flow Chart

The proposal for identifying and characterizing the difficulties, as well as the formation of the study's objectives and the development of a research plan, are the first parts of this study. The literature review is the second element of the investigation. A review of the literature on cost and schedule overruns was conducted. A field survey was conducted in the third part of the research, which included the firm of owners, contractors, and consultants, as well as some actual situations. The questionnaire design fourth part of the research is followed by the distribution of the questionnaire to a sample of local contractors, consultants, and owners' firms. A pilot study will be conducted to see the questionnaire questions are clear

enough to answered in a way that helped the study achieve its goal. Based on the findings of the pilot study, the questionnaire was tweaked.

The distribution of questionnaires was the research's fifth phase. The questionnaire was used to gather the information needed to complete the study project. The research's sixth phase concentrated on data analysis and discussion. The required analysis was carried by using statistical methods. The conclusions and recommendations are presented in the final part of the investigation.

3.3 Research Model

This study is based on a model that clearly defines the roles of different project executed agencies (client, consultant, and contractor) and correlates its relation with project stages. The foregoing discussion of the literature review that preceded it provided direction and enabled the establishment of a conceptual framework for recognizing and integrating the links between project identities and stages that tend to cause cost & schedule overrun in small dam department projects.

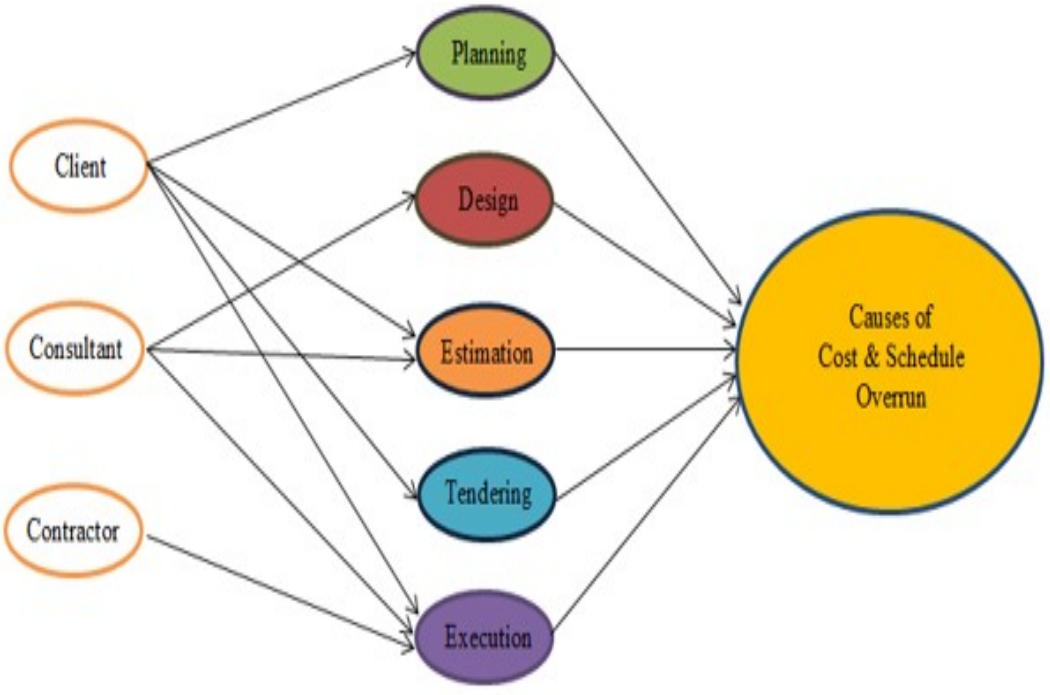

FIGURE 3.2: Research Model

3.4 Data Collection

The main goal of this study is to identify the critical causes of cost & schedule over-runs, and to link these causes to project execution agencies, as well as to provide remedies for mitigation measures for each cause in the small dams construction industry, especially in the Pothohar region of Pakistan. Link these reasons to project stages, such as the planning, design, estimating, tendering and execution stages, and evaluate the severity of each cause, prioritizing or rating is based on its importance index. Small dams organization and previous case study were focused in this regard to acquire the necessary data for appropriate findings.

3.4.1 Research Area

This study focused on the development of small dams in Pakistan's Potohar region. The Potohar region is made up of four districts: Rawalpindi, Attock, Chakwal, and Jhelum, and it is located in Pakistan's north-east, in the province of Punjab. The Potohar Plateau is located between 32.5°N and 34.0°N latitude and 72°E and 74°E longitude. Potohar has a total area of 5.55 million acres.

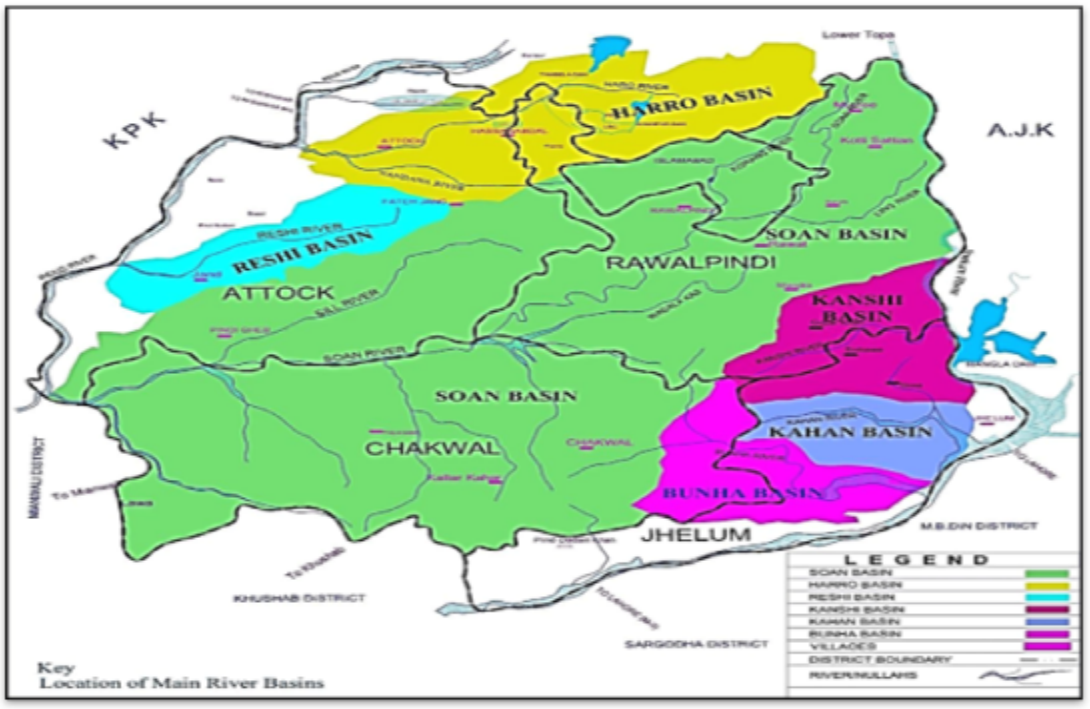

FIGURE 3.3: Research Area

Currently, 35-45 percent of the land is cultivated. Potohar has a population of 10.007 million people (2017 census data). 70% of the population lives in rural areas. Irrigation systems are installed in 11% of the area. During the monsoon, rain falls at a rate of 60-70 present. 2.31 billion Cubic metres of runoff (1.88 MAF). The Pothohar region is separated into six basins based on major rivers and streams: Soan Basin, Haro Basin, Kanshi Basin, Reshi Basin, Kahan Basin, and Bunha Basin. Annually, roughly 1.88 MAF runoff is generated in the Potohar area of Punjab. Construction of small to medium dam projects across various tributaries of main rivers has tapped roughly 0.26 MAF runoff so far. The balance run-off of 1.218 MAF (approximately) continues to flow unutilized to the sea. Total 58 dams have been completed to date, with a gross storage capacity of 252,619 aft and a CCA of 72,209 acres. There are 13 small dam projects now under construction, with a total gross storage capacity of 153,717 acre-feet and 52,600 acres of CCA to be added once they are completed.

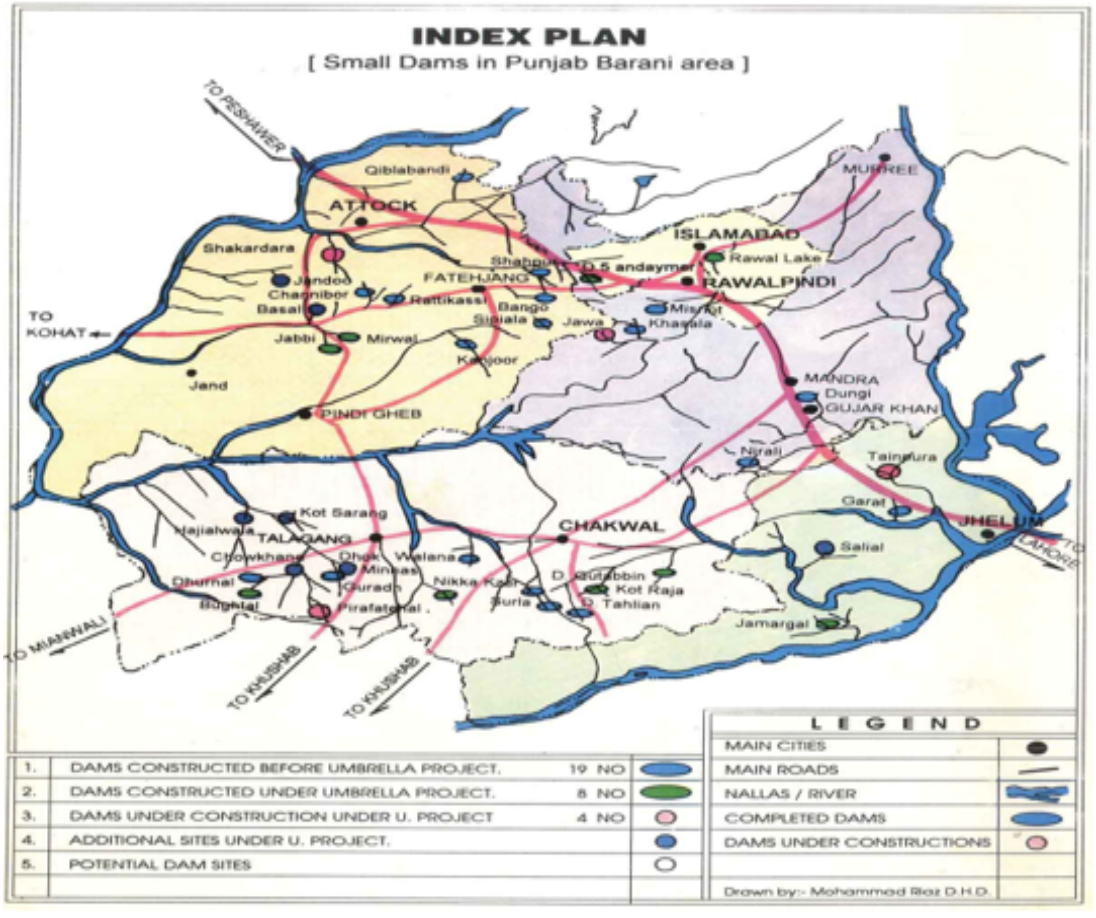

FIGURE 3.4: Index Plan of Small Dam Organization in Pakistan

3.4.2 Sampling Technique and Data Collection Procedure

To find a representative sample, social scientists use a variety of sampling tactics, and there are various sorts of sampling approaches. The degree of accuracy necessary in the study, as well as the cost, are two elements that influence the choice of sampling strategy (Shebob et al., 2012). The convenience sampling strategy was utilized in this study. Because of the time constraints, this technique was used because it is more about non-probability sampling, and all participants were chosen based on the same criteria: they had to be construction professionals with experience in construction of small dam projects.

After the principal supervisor of the current study authorized the questionnaire for data collection, a list of potential respondents was prepared. The questions were delivered to respondents using online medium (email, Whatsapp), and when respondents completed the questionnaires, feedback was automatically provided via online system. Data was collected using this technique from small dam organization agencies (client, contractor, and consultant) in four districts: Rawalpindi, Attock, Chakwal, and Jhelum, in order to investigate the causes of cost & schedule overruns.

Data collection took about 27 days because respondents were able to take their time filling out the questions without being pressured, however one questionnaire took an average of 30 minutes to complete. The respondents completed and returned a total of 98 questionnaires.

3.5 Preparation of Questionnaire

After conducting a literature review, a total of 120 causes from various research studies that affect cost & schedule overruns in different construction projects in various nations throughout the world and over time have been compiled. Some of the 120 causes overlapped, and not all of these causes are consistent with the conditions and circumstances surrounding the construction of small dam projects from an economic standpoint, project type, or geographic region, so causes commensurate with the nature of construction projects and problems in the construction of

small dams have been chosen. Following an interview with experienced construction executives, modifications and new questions were incorporated to fit the local construction sector.

The thesis supervisor reviewed the draft questionnaire. The questionnaire was then submitted to five experts in dam construction, who were requested to analyses it and make recommendations. The final survey includes 63 criteria that influence cost and schedule overruns. Following the completion of the critical causes, these causes were linked to project execution agencies, such as the client, consultant, and contractor, as well as external factors, and then to project stages, such as the planning stage, design stage, estimation stage, tendering stage, and execution stage, under the supervision of the thesis supervisor and with the assistance of dams construction professionals. The respondents were requested to complete the survey, and they were told that the information would be kept private and used solely for research purposes.

3.5.1 Most Important Causes Found in Literature Review

Table 3.1 outlines the most prominent reasons of cost & schedule overruns that have been investigated by various authors, as gathered from a literature review.

Table 3.1: Important Causes of Cost and Schedule Overrun from Literature Review

Sr.No.	Important Causes	References
1	i. Lack of prompt payment by agencies to contractors ii. Inadequate budget allocation iii. Frequent variation/change orders iv. Deficiencies in public organizations Structure v. Large quantities of extra work vi. Inadequate pre-planning	(M Dlakwa & F Culpin, 1990)
2	i. Premature tender documents ii. Too many changes in owners' requirements or definitions	Rosenfeld, 2014)

	ii. Too many changes in owners' requirements or definitions	
	iii. Tender-winning prices are unrealistically low	
	iv. Un-constructible design	
	v. Unclear division of responsibilities	
3	i. Poor planning	(Tebeje Zewdu,)
	ii. Fluctuation of price of materials	2015
	iii. Poor productivity	
	iv. Inflationary pressure	
	v. Economic instability	
	vi. Wrong estimation method	
	vii. Long period between design and time of tendering	
	viii. Frequent changes in design	
	ix. Poor financial control on site	
4	i. Rapid changes in design	Tumi & Omran,
	ii. Error in time estimation	2017)
	iii. Inexperience contractor	
	iv. Poor site management	
	v. Shortage of skilled labor	
5	i. Severe weather conditions	(Alamri et al.,
	ii. Change orders	2017)
	iii. Uncertainty in ground condition	
	iv. Poor site management	
	v. Executive bureaucracy in client organization	
	vi. Feasibility study did not cover all aspects	
	vii. Mistakes in soil investigation	
	viii. Natural effects during construction work	
	ix. Difficulty of defining project requirement	
	x. Slowness of decision making process	

	xi. Delay of obtaining approval from the different government authorities	
	xii. Land acquisition	
	xiii. Unrealistic durations imposed by client	
6	i. Ignorance and lack of knowledge of the Engineers	(Blloku & Oztaş,
	ii. Reluctance in Timely decision	2013)
	iii. Improper or Lack of formal scheduling techniques	
	iv. Aggressive completion at tendering stage	
	v. Hostile Social and Economic Factors	
7	i. Lack of political will	(Batool &
	ii. Delay in civil work	Abbas, 2017)
	iii. Delays in release of funds by the Government	
	iv. Bad Law and order situation	
	v. Project start without proper site investigation	
	vi. Poor project time management	
8	i. Slow change orders	(Rachid et al.,
	ii. Unrealistic contract duration	2019)
	iii. Slow variation orders in extra quantities	
	iv. Delays in payment of performed work	
	v. Ineffective planning and scheduling by contractors	
	vi. Lack of owner's management skills	
	vii. Slowness in reviewing and approving design documents by owner	
	viii. Work start before design completion	
	ix. Obsolete technology used by contractor	

9	i. Legal disputes b/w various parts ii. Delay in approving shop drawings and sample materials iii. Improper construction methods implemented iv. Poor qualification of the contractors technical staff v. Delay in performing inspection and testing vi. Delay in approving major changes in the scope of work vii. Mistakes and discrepancies in design documents viii. Delays in producing design documents ix. Insufficient data collection and survey before design x. Inadequate design-team experience xi. Changes in material types and specifications during construction xii. Effects of subsurface conditions (e.g., soil, high water table, etc.)	(Assaf & Al-Hejji, 2006)
10	i. Settlement of claims by owner ii. Contractor's financial difficulties iii. Delay in payment for extra work/ variations iv. Late payment from contractor to subcontractors/suppliers v. Ineffective project Monitoring, evaluation and controlling technique during construction vi. Design errors and omissions made by designers vii. Poor site management and supervision	(Prasad et al., 2019)
11	i. Omissions and mistakes in design ii. Insufficient scope of work for contractor iii. Change in government regulations. Defects in works executed iv. Inaccurate estimates or PC-I	(Hanif et al., 2016)

3.6 Questionnaire Characteristics

The questionnaire is divided into three sections, the first of which contains general information about the responder, the second of which aims to discover various reasons of cost & schedule overruns in small dam projects, and the third of which assists in identifying various mitigation and parameters.

3.6.1 General Information of Respondent

The current study's target demographic included clients, contractors, consultants, civil engineers, and construction project managers involved in the development of small dam projects in Pakistan's Potohar region. Respondents were discovered through professional networking sites and professionals of small dams. Ten items questions were prepared asking for information about respondent and its organization such as gender, education level, type of organization, respondent position level, working experience, completed projects, software use for project management, risk matrix register creation and lesion learn.

3.6.2 Causes of Cost and Schedule Overrun in Small Dam Projects

This component of the questionnaire is divided into four sections, which contains 63 causes for cost and schedule overruns. These divisions are the client, consultant, contractor, and external factor. The respondents were requested to complete the survey, and they were told that the information would be kept private and used only for research purposes.

3.6.3 Respondent Suggestion for Mitigation's Measure

This section of the questionnaire is for collecting information on various mitigation and parameters that, in the opinion of respondents, can help in reducing or eliminating cost and schedule overruns in the construction of small dam projects in the future.

3.7 Data Analysis Technique

After gathering the raw data from the questionnaire, the data was imported into a computer spreadsheet and analyzed using the SPSS application. The mean and percent are used to calculate the result and to compare the opinions of the client, contractor, and consultant for the critical causes of cost & schedule overrun. The following processes are used for data analysis:

a) For data analysis, the questionnaires that were filled out correctly were chosen.

b) In a survey instrument, Cronbach's alpha is utilized to check the reliability of accountable project execution agencies.

c) The respondents were asked to rank the severity and frequency of occurrence. The causes were rated overall based on the values of importance index recorded from the highest to the lowest value using frequency and severity tables.

d) A one-way ANOVA test was performed to examine the any significant differences in perceptions of three separate groups of respondents: contractors, clients, and consultants.

e) Finally, using Pareto's principle (80%-20%), a total of 63 causes were rated, with the outcome being an analysis and discussion of the top 20 causes. Furthermore, it depicts various causes as well as how each of the project parties was placed in relation to the overall causes. The ranking was done based on the priorities of each source of cost & schedule overrun, from the highest to the lowest percentage.

Chapter 4

Analysis of Data and Results Discussion

4.1 Brief of Chapter

This chapter discusses the results of a questionnaire survey on cost & schedule overruns in construction of small dam projects from the perspectives of Client, contractors and consultants. This chapter contains the following information: the data was analyses using Statistical Packages for Social Science (SPSS) in order to determine the level of significance or agreement of the structured questions. This chapter describes the characteristics of the respondents. To investigate and examine any significant differences in individual project execution agencies' points of view, a one-way ANOVA test was utilized. Finally, the top most 20 causes of cost & schedule overrun were ranked using Pareto's principle.

4.2 Section: A General Information of Respondent

This section is mostly intended to provide general information about the responders, such as the organization's name, gender, finished project, qualification, position level in the organization, and contact person's experience.

4.2.1 Gender of Respondents

Gender equality is represented by the gender aspect, which is always a significant factor in society. As a result, it is a crucial aspect of demography since it distinguishes between male and female populations. Gender equality was privilege in this civilization. **Table 4.1** and show the male-to-female ratio for the evidence, which shows that 94% of respondents were male and 6% were female.

TABLE 4.1: Ratio of Gender Respondent

Gender	Frequency	Percentage
Male	92	94
Female	6	6
Total	**98**	**100**

4.2.2 Project Execution Agencies

The purpose of this part is to offer context for the respondents' experiences and, as a result, to reflect the degree of credibility of the information they provide. **Table 4.2** show that 53 percent of owners, 25 percent of contractors, and 22 percent of consultants took part in the survey.

TABLE 4.2: Ratio of Respondent Agencies

Organization	Frequency	Percentage
Owner	52	53
Contractor	24	25
Consultant	22	22
Total	**98**	**100**

4.2.3 Respondent's Qualification

Education is an important sector and a vital component of the economy that ensures the nation's prosperity. It is a crucial aspect of demographics.

Every person of the country has the right to education since it opens up new paths to achievement and allows them to gain a competitive advantage on a national and worldwide level. **Table 4.3** shows that DAE education is the most common among respondents, accounting for 45 percent of all respondents. While 33 percent of respondents have a Bachelor's degree, 19 percent have an MS/M.Phil. degree, and 3 percent have a Ph.D. degree.

Table 4.3: Details of Respondent's Qualification

Qualification	**Owner**		**Contractor**		**Consultant**		**Total**	
	Frequency	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**	**Frequency**	**Percentage**
DAE	23	44	14	58	7	32	44	45
Graduation	18	35	6	25	8	36	32	33
Master	9	17	4	16	6	27	19	19
Ph.D.	2	4	0	0	1	5	3	3
Total	52	100	24	100	22	100	98	100

4.2.4 Respondent's Experience

The construction of small dams necessitates prior experience. It is thought to be one of the most productive groups. The respondents' years of experience are shown in Table 4.4. It reveals that 5 percent of respondents had more than 20 years of experience, 17 percent had between 11 and 20 years of experience, 29 percent had between 6 and 10 years of experience, while the remaining 49 percent had between 1 and 5 years of experience.

Table 4.4: Details of Respondent's Experience

Experience	**Frequency**	**Percentage**
01-05	48	49
06-10	28	29
11-20	17	17
Above 20	5	5
Total	98	100

4.2.5 Respondent's Position Level

Table 4.5 reveal that out of 98 responses, 43 percent were sub engineers/site supervisors, 35 percent were SDO/Site, 17 percent were office XEN/project managers and 5 percent were project directors for the three parties.

Table 4.5: Details of Respondent's Position Level

Position Level	**Frequency**	**Percentage**
Sub Engineer/Site Supervisor	42	43
SDO/Site Engineer	34	35
XEN/PM	17	17
Project Director	5	5
Total	98	100

4.2.6 Respondent's Completed Projects

Table 4.6 reveal that 48 percent of the respondents were involved in 1-3 number projects, 40 percent were involved in 4-6 number projects, 12 percent were involved in 7-10 number initiatives, and 0.0 percent were involved in more than 10 number projects.

Table 4.6: Details of Respondent's Completed Projects

Completed Projects	Frequency	Percentage
01-03	47	48
04-06	39	40
07-10	12	12
Above 10	0	0
Total	98	100

4.3 Section B: Critical Causes of Cost & Schedule Overrun in Small Dam Projects

This section contains the findings and discussion of Critical Causes that influence cost & schedule overruns in construction of small dam projects. The causes were divided into four categories: owners' responsibilities, contractors' responsibilities, consultants' responsibilities, and external factors, with five project stages: planning stage, design stage, estimation stage, tendering stage, and execution stage. Respondents were asked to rank the main causes of cost & schedule overrun in construction of small dam projects and how each contributes to the cost & schedule overrun in this study.

The pivotal Sixty-three causes of cost & schedule overruns were identified, all of which were found to be significant. The significance index was designed to determine the importance of the elements that cause cost & schedule overruns. This suggests that the first twenty positions were crucial. As demonstrated in **Table 4.12,** the first two causes, namely delays in land acquisition with an important index of 61.6 percent and lack of expert and qualified staff for project management with an important index of 59.9 percent, were the top most critical causes

of cost & schedule overrun. The third and fourth were equally essential, thus it was unrealistic preparing pc-1 cost with an index of 58 percent and express inadequate scope of work with an index of 57.4 percent. **Table 4.11** lists the remaining criteria in order of importance.

4.3.1 Data Measurement

In this research, measuring scales refer to the many ways in which variables are defined and categorized. It explains the nature of the values allocated to the variables in a data set and is also known as the level of measurement. The level of measurement must be known in order to determine the right method of analysis. There are an acceptable methods for each sort of measurement that can be used and others that cannot (Klau, 2015).

In this research, ordinal scales were used. Ordinal scale is a ranking or a rating data that normally uses integers in ascending or descending order. A five point Likert-type scale was uses to determine frequency & severity of causes of cost & schedule overrun in small dam projects. Based on Likert scale researcher has the following:

Table 4.7: Scale Use for Questionnaire

Scale	Frequency	Severity
1	Never	Very low
2	Rarely	Below average
3	Sometime	Average
4	Very often	Above average
5	Always	Very high

4.3.2 Pilot Testing

These structured questionnaires should be built around a well-crafted collection of questions that have been piloted and refined until the researcher is satisfied with their accuracy. As a result, prior to finalizing the questionnaire, pre-testing is a crucial step in the questionnaire design process. It entails distributing the questionnaire to a small group of possible respondents as well as other qualified people

in order to detect and correct design issues (Al-Najjar, 2008). The questionnaire was written in English for testing purposes to ensure that the questions were understandable. Six drafts of the questionnaire were distributed as part of the test (2 to contractors, 2 to consultant and 2 to owners). In general, they agreed that the questionnaire is appropriate for achieving the study's objectives. The specific suggestions and changes have been made that given from experts.

4.3.3 Reliability Scale

The degree of consistency with which an instrument measures the attribute it is designed to assess is the instrument's dependability. The lower the fluctuation in repeated measurements of an attribute, the more reliable the instrument. A measuring tool's reliability might be defined as its stability, consistency, or dependability. The test is administered twice to the same group of participants, and the results are compared by computing a reliability coefficient (Ghule, 2020).

For the current study's reliability test Cronbach's Alpha was used, whose significant range of dependability is 0 to 1. Since it is assumed that the scale is more dependable when is bigger than 0.7. As a result, the reliability scale of the questionnaire between each set of project execution agencies was examined in table 3.3, i.e., client, consultant, contractor, and external factor, with Cronbach's Alpha values of = 0.904, = 0.881, = 0.838, and = 0.702 respectively. As a result, these values are more than 0.7, indicating that all goods have a high reliability rating and are safe to use.

Table 4.8: Reliability Results Among Responsible Agencies

Responsible Agency	**Cronbach's Alpha**	**No. Of Items**
Client	0.904	27
Consultant	0.881	15
Contractor	0.838	9
External Factor	0.702	12

4.3.4 Data Analysis Technique

The acquired data was evaluated using the following statistical techniques and indices, and the occurrence and effect degree of each reason of small dam project delays were stated in a questionnaire form by ticking one. The formula below was utilized by a number of authors, including (Alamri et al, 2017; Assaf & Al-Hejji, 2006; Batool & Abbas, 2017;). As a result, it can be used to rank the reasons for cost & schedule overruns in small dam construction projects. The following are the specifics of the formula that was employed.

Frequency index: A formula is used to rank causes based on frequency of occurrence as identified by the participants;

Frequency Index = F.I = $\frac{\sum \alpha(n)}{A \times N}$

Where α is the constant expressing weighting for each response ((1= Never, 2= Rarely, 3= Sometime, 4= Very often and 5= Always).), n is the frequency of the responses, A highest weight that given to responses is 5 and N is total number of responses.

Severity Index: A formula is used to rank causes of delay based on severity as indicated by the participants;

Severity Index = S.I= $\frac{\sum \alpha(n)}{A \times N}$

Where α is the constant expressing weighting for each response ((1= Very Low, 2 = Below average, 3= Average, 4= Above average and 5= Very high).), n is the frequency of the responses, A highest weight that given to responses is 5 and N is total number of responses.

Importance index: The importance index of each cause is calculated as a function of both frequency and severity indices, as follows:

Importance Index = II = F.I x S.I

From the owners, contractors, and consultants perspectives, the frequency index, severity index, and importance index were used to rank cost & schedule overrun causes. The three sides also rank each other on a scale of one to five. The data of the respondents was divided and analyzed individually in order to analyses the

causes by each party independently. **Tables 4.9–4.11** illustrate the top most 20 cost & schedule overrun causes from the owner, contractor, and consultant perspectives, respectively. **Table 4.13** indicates the importance index for each source of cost & schedule overrun in the construction of small dam projects in Pakistan, as well as the overall ranking of these causes based on the combined data of the project execution agencies

Table 4.9: Top Most 20 Causes by Client Point of View

Sr. No.	Description of Causes	F.I	S.I	II	Rank
4	Unrealistic preparing PC-1 Cost	0.812	0.702	0.57	1
10	Slowness in appraising and approving design documents	0.838	0.677	0.567	2
23	Lack or improper uses of project indicators showing actual project progress	0.821	0.677	0.556	3
19	Lack of Expert and qualified staff for project management	0.719	0.77	0.554	4
26	Project staff have lack facilities to manage proper site	0.77	0.719	0.554	5
1	Insufficient budget allocation	0.829	0.66	0.547	6
45	Inadequate qualification of the contractors technical staff	0.778	0.702	0.547	7
5	Apply Wrong estimation technique	0.77	0.702	0.541	8
12	Delays in land acquisition	0.821	0.626	0.514	9
29	Errors and omissions in design	0.719	0.711	0.511	10
44	Poor site management by contractor	0.736	0.694	0.511	11
31	Faults and discrepancies in design documents	0.728	0.694	0.505	12
34	Lack of experience of the design team	0.711	0.702	0.499	13
55	Delay in issues of funds by government	0.728	0.685	0.499	14
25	Unclear division of responsibilities and lack of clear requirements for professional management	0.745	0.668	0.498	15
21	Ineffective technique use for project Monitoring, evaluation and controlling during execution	0.762	0.652	0.496	16

TABLE 4.10: Top Most 20 Causes by Contractor Point of View

Sr. No.	Description of Causes	F.I	S.I	II	Rank
22	Unaware or Lack uses of project management Software or New technology	0.77	0.643	0.495	17
32	Feasibility study did not cover all aspects	0.745	0.66	0.491	18
52	Fluctuation in rates of materials	0.77	0.635	0.489	19
47	Obsolete technology used by contractor	0.736	0.66	0.486	20
12	Delays in land acquisition	0.86	0.76	0.654	1
22	Unaware or Lack uses of project management Software or New technology	0.94	0.62	0.583	2
19	Lack of Expert and qualified staff for project management	0.84	0.68	0.571	3
7	Large quantities of extra work	0.92	0.62	0.57	4
37	Delay in approving shop drawings and sample materials	0.88	0.62	0.546	5
51	Lack of communication and cooperation b/w project execution agencies	0.82	0.66	0.541	6
29	Errors and omissions in design	0.74	0.72	0.533	7
9	Work start earlier design completion	0.76	0.7	0.532	8
52	Fluctuation in rates of materials	0.78	0.68	0.53	9
32	Feasibility study did not cover all aspects	0.74	0.7	0.518	10
35	Inadequate design-team experience	0.7	0.74	0.518	11
41	Delay in approving major changes in the scope of work	0.74	0.7	0.518	12
15	Long period between design and time of tendering	0.86	0.6	0.516	13
25	Unclear division of responsibilities and lack of clear requirements for professional management	0.82	0.62	0.508	14
13	Premature tender documents	0.7	0.72	0.504	15

Table 4.11: Top Most 20 Causes by Consultant Point of View

Sr. No.	Description of Causes	F.I	S.I	II	Rank
45	Inadequate qualification of the contractors technical staff	0.72	0.7	0.504	16
27	Employees tenure matter	0.76	0.66	0.502	17
28	Prepare Un-constructible design	0.66	0.76	0.502	18
6	Express Inadequate scope of work	0.78	0.64	0.499	19
48	Obsolete construction methods / technology used by contractor	0.8	0.62	0.496	20
12	Delays in land acquisition	0.953	0.697	0.664	1
6	Express Inadequate scope of work	0.868	0.697	0.605	2
34	Lack of experience of the design team	0.807	0.746	0.601	3
21	Ineffective technique use for project Monitoring, evaluation and controlling during execution	0.892	0.672	0.6	4
45	Inadequate qualification of the contractors technical staff	0.831	0.721	0.599	5
19	Lack of Expert and qualified staff for project management	0.88	0.672	0.592	6
14	Tender-winning prices are unrealistically low	0.843	0.697	0.588	7
23	Lack or improper uses of project indicators showing actual project progress	0.843	0.684	0.577	8
10	Slowness in appraising and approving design documents	0.856	0.672	0.575	9
26	Project staff have lack facilities to manage proper site	0.856	0.672	0.575	10
33	Unsuitable project site	0.758	0.758	0.574	11
20	Ineffective technique use for project planning and scheduling	0.88	0.648	0.57	12
47	Obsolete technology used by contractor	0.831	0.684	0.569	13
5	Apply Wrong estimation technique	0.77	0.733	0.565	14
43	Ineffective pre-planning	0.807	0.697	0.562	15
44	Poor site management by contractor	0.843	0.66	0.557	16
35	Inadequate design-team experience	0.758	0.733	0.556	17
4	Unrealistic preparing PC-1 Cost	0.77	0.721	0.555	18
1	Insufficient budget allocation	0.856	0.648	0.554	19
22	Unaware or Lack uses of project management Software or New technology	0.831	0.66	0.549	20

4.3.5 Examine Significant Variances in Perceptions of Respondents

For examine significant variances in perceptions among three groups of respondents: client, contractors, and consultants. A one-way ANOVA test were conducted and analyzed and compared to see if there were any significant variations in the perspectives of three categories of respondents: clients, contractor, and consultants. The one-way ANOVA test was performed with a 95% confidence level and identifies differences across contractors, clients, and consultants at the 0.05 significant levels.

Table 4.12 summarizes the findings, which show that out of a total of 63 possible causes for frequency 60 causes (95%) and severity 59 causes (93%) were determined to have no statistically significant variance, implying that the three groups of respondents mainly agree.

Table 4.12: Results of One Way-ANOVA Test for Checking Significant Variance

Sr. No.	Description of Causes	F.I	S.I
1	Insufficient budget allocation	0.83	**0.02***
2	Delay in interim payment of contractor	0.97	**0.04***
3	Delay in settlement of contractor claims	0.82	0.62
4	Unrealistic preparing PC-1 Cost	0.51	0.9
5	Apply Wrong estimation technique	0.21	0.82
6	Express Inadequate scope of work	0.19	0.69
7	Large quantities of extra work	**0.02***	0.41
8	Recurrent variations & change orders	0.99	0.92
9	Work start earlier design completion	0.29	0.65
10	Slowness in appraising and approving design documents	0.2	0.56
11	Legal disputes b/w different project's components	0.33	0.24
12	Delays in land acquisition	0.19	0.41
13	Premature tender documents	0.41	0.47
14	Tender-winning prices are unrealistically low	0.06	0.79

15	Long period between design and time of tendering	0.54	0.82
16	Allocation of tender to Inexperience contractor	0.43	**0.03***
17	Poor financial control on site	0.17	0.67
18	Unrealistic contract durations imposed	0.63	0.27
19	Lack of Expert and qualified staff for project management	0.07	0.34
20	Ineffective technique use for project planning and scheduling	0.14	0.99
21	Ineffective technique use for project Monitoring, evaluation and controlling during execution	0.2	0.63
22	Unaware or Lack uses of project management Software or New technology	0.15	0.92
23	Lack or improper uses of project indicators showing actual project progress	0.15	0.62
24	Deficiencies in organizations Structure hierarchy	0.37	0.58
25	Unclear division of responsibilities and lack of clear requirements for professional management	0.54	0.62
26	Project staff have lack facilities to manage proper site	0.29	0.23
27	Employees tenure matter	0.64	0.37
28	Prepare Un-constructible design	**0.02***	0.49
29	Errors and omissions in design	0.76	0.32
30	Regular alterations in structure design	0.45	0.24
31	Faults and discrepancies in design documents	0.37	0.29
32	Feasibility study did not cover all aspects	0.93	0.9
33	Unsuitable project site	0.25	0.48
34	Lack of experience of the design team	0.14	0.59
35	Inadequate design-team experience	0.31	0.63
36	Slowness in appraising and ratifying design documents	0.09	0.89

37	Delay in approving shop drawings and sample materials	**0.01***	0.95
38	Inadequate site supervision	0.34	0.92
39	Deprived inspection and testing techniques applying during execution	0.34	0.7
40	Delay in performing inspection and testing	0.05	0.63
41	Delay in approving major changes in the scope of work	0.91	0.83
42	Frequent Changes in material types and specifications during construction	0.65	0.21
43	Ineffective pre-planning	0.15	0.52
44	Poor site management by contractor	0.25	0.91
45	Inadequate qualification of the contractors technical staff	0.43	0.96
46	Shortage of skilled labor	0.62	0.53
47	Obsolete technology used by contractor	0.36	0.75
48	Obsolete construction methods / technology used by contractor	0.76	0.7
49	Defective work or faults during construction	0.97	0.79
50	Fraudulent practices and kickbacks	0.26	0.96
51	Lack of communication and cooperation b/w project execution agencies	0.24	0.51
52	Fluctuation in rates of materials	0.67	0.78
53	Outside work round site because of public agencies	0.34	0.92
54	Inevitable changes throughout execution because of unexpected geological conditions	0.41	0.41
55	Delay in issues of funds by government	0.51	0.61

56	Uncertainty in ground condition	0.57	0.71
57	Delay of obtaining permit/approval from the different government authorities	0.93	0.58
58	Economic instability	0.56	0.66
59	Change in government regulations	0.3	0.54
60	weather condition	0.27	1
61	Bad Law and order situation	0.64	**0.04***
62	Lack of political will	0.3	0.53
63	Corruption	0.37	0.48

**Show considerable variance in client, contractor, and consultant perceptions at the 0.05 level.*

4.3.6 Summarized Result for Overall Ranking of Critical Causes of Cost & Schedule Overrun

Table 4.13 summarized all of the calculations for each cause of cost & schedule overruns, with average importance index sorted by project execution agencies client, contractor, and consultant. For example, Row 2 depicts the client's insufficient budget allocation as a result of the financial process cause; this cause is categorized as a client-related cause.

In addition, the cause displayed each respondent's important index (i.e., Column 3 represents client, Column 4 represents contractor, Column 5 represents contractor, and Column 6 represents overall), which included the frequency, severity, and importance index, as well as column 7 displaying the overall rank based on the overall importance index recorded from the highest to the lowest value. As a result, row 1 shows the client respondent as FI (0.829), SI (0.660), and II (0.547), followed by contractor FI (0.880), SI (0.460), and II (0.405), and consultant FI (0.856), SI (0.648), and II (0.554), with the overall II at (0.546), ranking 11th out of 63 causes of cost & schedule overrun in construction of small dam projects.

Table 4.13: Summarized Result for Overall Ranking of Critical Causes

Sr.No	Description of Causes	Client			Contractor			Consultant			Overall			Overall Rank Position
		F.I	S.I	II	F.I	S.I	II	F.I	S.I	II	F.I	S.I	II	
1	Insufficient budget allocation	0.829	0.66	0.547	0.88	0.46	0.405	0.856	0.648	0.554	0.848	0.644	0.546	11
2	Delay in interim payment of contractor	0.719	0.652	0.469	0.74	0.56	0.414	0.721	0.599	0.432	0.724	0.644	0.466	39
3	Delay in settlement of contractor claims	0.736	0.575	0.424	0.76	0.6	0.456	0.709	0.636	0.451	0.732	0.627	0.459	45
4	Unrealistic preparing PC-1 Cost	0.812	0.702	0.57	0.72	0.68	0.49	0.77	0.721	0.555	0.78	0.736	0.58	4
5	Apply Wrong estimation technique	0.77	0.702	0.541	0.62	0.76	0.471	0.77	0.733	0.565	0.74	0.757	0.56	5
6	Express Inadequate scope of work	0.736	0.643	0.473	0.78	0.64	0.499	0.868	0.697	0.605	0.788	0.69	0.574	13
7	Large quantities of extra work	0.711	0.55	0.391	0.92	0.62	0.57	0.684	0.623	0.427	0.744	0.615	0.457	46
8	Recurrent variations & change orders	0.753	0.601	0.452	0.76	0.6	0.456	0.746	0.623	0.465	0.752	0.636	0.478	35
9	Work start earlier design completion	0.702	0.626	0.44	0.76	0.7	0.532	0.819	0.636	0.52	0.752	0.673	0.506	27
10	Slowness in appraising and approving design documents	0.838	0.677	0.567	0.7	0.58	0.406	0.856	0.672	0.575	0.816	0.686	0.56	6

11	Legal disputes b/w different project's components	0.685	0.558	0.383	0.68	0.68	0.462	0.782	0.623	0.488	0.716	0.631	0.452	47
12	Delays in land acquisition	0.821	0.626	0.514	0.86	0.76	0.654	0.953	0.697	0.664	0.872	0.707	0.616	1
13	Premature tender documents	0.736	0.635	0.467	0.7	0.72	0.504	0.794	0.684	0.544	0.748	0.698	0.522	21
14	Tender-winning prices are unrealistically low	0.736	0.652	0.48	0.62	0.64	0.397	0.843	0.697	0.588	0.748	0.694	0.519	24
15	Long period between design and time of tendering	0.762	0.592	0.451	0.86	0.6	0.516	0.807	0.636	0.513	0.796	0.636	0.506	28
16	Allocation of tender to Inexperience contractor	0.643	0.711	0.457	0.74	0.62	0.459	0.733	0.599	0.439	0.692	0.686	0.475	37
17	Poor financial control on site	0.728	0.643	0.468	0.68	0.58	0.394	0.843	0.648	0.546	0.756	0.661	0.5	30
18	Unrealistic contract durations imposed	0.643	0.66	0.424	0.68	0.6	0.408	0.721	0.562	0.405	0.676	0.644	0.435	57
19	Lack of Expert and qualified staff for project management	0.719	0.77	0.554	0.84	0.68	0.571	0.88	0.672	0.592	0.796	0.753	0.599	2
20	Ineffective technique use for project planning and scheduling	0.736	0.652	0.48	0.74	0.66	0.488	0.88	0.648	0.57	0.784	0.682	0.534	14
21	Ineffective technique use for project Monitoring, evaluation and controlling during execution	0.762	0.652	0.496	0.84	0.58	0.487	0.892	0.672	0.6	0.82	0.673	0.552	10
22	Unaware or Lack uses of project management Software or New technology	0.77	0.643	0.495	0.94	0.62	0.583	0.831	0.66	0.549	0.824	0.673	0.555	9

23	Lack or improper uses of project indicators showing actual project progress	0.821	0.677	0.556	0.68	0.6	0.408	0.843	0.684	0.577	0.8	0.694	0.555	8
24	Deficiencies in organizations Structure hierarchy	0.719	0.567	0.408	0.68	0.62	0.422	0.794	0.538	0.427	0.736	0.594	0.437	56
25	Unclear division of responsibilities and lack of clear requirements for professional management	0.745	0.668	0.498	0.82	0.62	0.508	0.807	0.611	0.493	0.78	0.669	0.522	22
26	Project staff have lack facilities to manage proper site	0.77	0.719	0.554	0.72	0.58	0.418	0.856	0.672	0.575	0.788	0.707	0.557	7
27	Employees tenure matter	0.685	0.592	0.406	0.76	0.66	0.502	0.733	0.55	0.403	0.716	0.619	0.443	51
28	Prepare Un-constructible design	0.601	0.652	0.391	0.66	0.76	0.502	0.782	0.684	0.535	0.672	0.715	0.481	34
29	Errors and omissions in design	0.719	0.711	0.511	0.74	0.72	0.533	0.77	0.623	0.48	0.74	0.715	0.529	19
30	Regular alterations in structure design	0.702	0.652	0.458	0.78	0.56	0.437	0.77	0.538	0.414	0.74	0.623	0.461	44
31	Faults and discrepancies in design documents	0.728	0.694	0.505	0.78	0.56	0.437	0.819	0.66	0.54	0.768	0.686	0.527	20
32	Feasibility study did not cover all aspects	0.745	0.66	0.491	0.74	0.7	0.518	0.77	0.684	0.527	0.752	0.707	0.531	17
33	Unsuitable project site	0.643	0.66	0.424	0.68	0.68	0.462	0.758	0.758	0.574	0.688	0.728	0.501	29
34	Lack of experience of the design team	0.711	0.702	0.499	0.62	0.64	0.397	0.807	0.746	0.601	0.724	0.736	0.533	15

35	Inadequate design-team experience	0.66	0.677	0.447	0.7	0.74	0.518	0.758	0.733	0.556	0.7	0.74	0.518	25
36	Slowness in appraising and ratifying design documents	0.626	0.643	0.403	0.7	0.66	0.462	0.782	0.623	0.488	0.692	0.669	0.463	42
37	Delay in approving shop drawings and sample materials	0.66	0.601	0.397	0.88	0.62	0.546	0.746	0.599	0.447	0.732	0.631	0.462	43
38	Inadequate site supervision	0.685	0.609	0.418	0.68	0.58	0.394	0.782	0.587	0.459	0.716	0.623	0.446	49
39	Deprived inspection and testing techniques applying during execution	0.702	0.652	0.458	0.76	0.6	0.456	0.807	0.599	0.483	0.748	0.652	0.488	33
40	Delay in performing inspection and testing	0.635	0.567	0.36	0.74	0.62	0.459	0.794	0.623	0.495	0.708	0.623	0.441	54
41	Delay in approving major changes in the scope of work	0.728	0.652	0.474	0.74	0.7	0.518	0.758	0.66	0.5	0.74	0.694	0.514	26
42	Frequent Changes in material types and specifications during construction	0.668	0.677	0.452	0.72	0.54	0.389	0.733	0.648	0.475	0.7	0.669	0.468	38
43	Ineffective pre-planning	0.66	0.66	0.436	0.76	0.58	0.441	0.807	0.697	0.562	0.728	0.686	0.499	31
44	Poor site management by contractor	0.736	0.694	0.511	0.72	0.68	0.49	0.843	0.66	0.557	0.768	0.711	0.546	12
45	Inadequate qualification of the contractors technical staff	0.778	0.702	0.547	0.72	0.7	0.504	0.831	0.721	0.599	0.784	0.74	0.58	3
46	Shortage of skilled labor	0.719	0.601	0.432	0.68	0.68	0.462	0.77	0.623	0.48	0.728	0.652	0.475	36

47	Obsolete technology used by contractor	0.736	0.66	0.486	0.76	0.62	0.471	0.831	0.684	0.569	0.772	0.69	0.533	16
48	Obsolete construction methods / technology used by contractor	0.753	0.626	0.472	0.8	0.62	0.496	0.794	0.574	0.456	0.776	0.636	0.493	32
49	Defective work or faults during construction	0.719	0.575	0.414	0.74	0.56	0.414	0.721	0.611	0.441	0.724	0.611	0.442	53
50	Fraudulent practices and kickbacks	0.702	0.567	0.398	0.84	0.58	0.487	0.697	0.587	0.409	0.728	0.602	0.438	55
51	Lack of communication and cooperation b/w project execution agencies	0.677	0.584	0.395	0.82	0.66	0.541	0.721	0.562	0.405	0.72	0.619	0.446	50
52	Fluctuation in rates of materials	0.77	0.635	0.489	0.78	0.68	0.53	0.831	0.623	0.518	0.792	0.669	0.53	18
53	Outside work round site because of public agencies	0.66	0.609	0.402	0.62	0.62	0.384	0.746	0.587	0.437	0.68	0.631	0.429	58
54	Inevitable changes throughout execution because of unexpected geological conditions	0.618	0.609	0.376	0.62	0.7	0.434	0.709	0.599	0.425	0.648	0.652	0.423	60
55	Delay in issues of funds by government	0.728	0.685	0.499	0.7	0.7	0.49	0.782	0.636	0.497	0.74	0.703	0.52	23
56	Uncertainty in ground condition	0.66	0.601	0.397	0.7	0.66	0.462	0.733	0.636	0.466	0.692	0.652	0.451	48

57	Delay of obtaining permit/approval from the different government authorities	0.685	0.626	0.429	0.68	0.64	0.435	0.709	0.574	0.407	0.692	0.64	0.443	52
58	Economic instability	0.668	0.618	0.413	0.68	0.56	0.381	0.746	0.562	0.419	0.696	0.615	0.428	59
59	Change in government regulations	0.66	0.55	0.363	0.58	0.5	0.29	0.709	0.587	0.416	0.66	0.577	0.381	62
60	weather condition	0.685	0.626	0.429	0.66	0.62	0.409	0.782	0.623	0.488	0.712	0.652	0.464	40
61	Bad Law and order situation	0.609	0.508	0.309	0.62	0.66	0.409	0.672	0.513	0.345	0.632	0.565	0.357	63
62	Lack of political will	0.77	0.499	0.384	0.66	0.56	0.37	0.807	0.562	0.454	0.76	0.556	0.423	61
63	Corruption	0.677	0.694	0.47	0.7	0.58	0.406	0.574	0.733	0.421	0.648	0.715	0.463	41

4.3.7 Evaluate the Results to Find Out Top Twenty Critical Causes

The Pareto principle method was used to evaluate the results to find out top 20 critical causes of cost & schedule overrun in the construction of small dam projects in Pakistan. **Figure 4.1** depicts the Pareto principle's 80-20 rule for achieving excellent results.

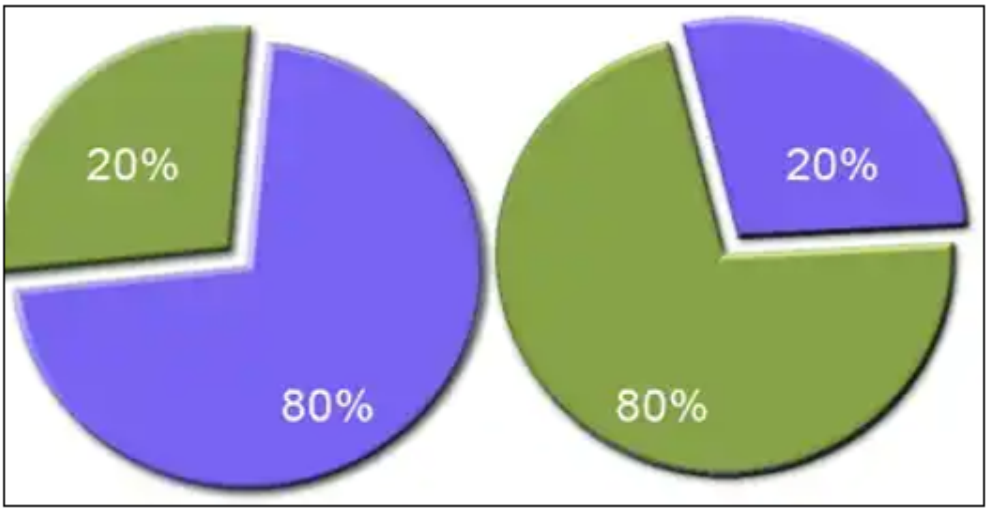

FIGURE 4.1: Pareto Principle, 20% of input (Time, Resources, Effort) account for 80% of the output (Result, Reward)

A total of 63 causes of cost & schedule overrun were evaluate using Pareto's principle (80%-20%), with the outcome being an analysis and discussion of the top 20 causes, as shown in table 4.14. In addition, table 4.13 depicts various causes as well as how each of the project participants was placed in relation to the overall causes. The ranking was done based on the responses to the questionnaire and the priorities were assigned to each cause from the highest to the lowest overall important index. For instance table 4.14 shows that delays in land acquisition caused by client in row 2 is ranked as the first cause of cost & schedule by respondents in Column 4, while the client is ranked ninth in Column 3, but the contractor and consultants are ranked first in Column 3, as well as in overall ranked. Similar results were found for lack of expert and qualified staff for project management in row 3 as a result of the client, which was ranked second overall by respondents and highlighted.

Table 4.14: Top 20 Critical Causes in Construction of Small Dam Projects

Sr. No	Description of Causes	Ranked by Project Execution Agencies			Overall Rank	Responsible
		Client	Contractor	Consultant	Position	Agency
12	Delays in land acquisition	9	1	1	1	Client
19	Lack of Expert and qualified staff for project management	4	3	6	2	Client
45	Unrealistic preparing PC-1 Cost	7	16	5	3	Client
4	Express Inadequate scope of work	1	22	18	4	Client
5	Feasibility study did not cover all aspects	8	27	14	5	Consultant
10	Slowness in appraising and approving design documents	2	52	9	6	Client
26	Apply Wrong estimation technique	5	45	10	7	Client
23	Lack or improper uses of project indicators showing actual project progress	3	51	8	8	Client
22	Errors and omissions in design	17	2	20	9	Consultant

21	Ineffective technique use for project Monitoring, evaluation and controlling during execution	16	25	4	10	Client
1	Insufficient budget allocation	6	54	19	11	Client
44	Poor site management by contractor	11	23	16	12	Contractor
6	Project staff have lack facilities to manage proper site	24	19	2	13	Client
20	Ineffective technique use for project planning and scheduling	22	24	12	14	Client
34	Lack of experience of the design team	13	56	3	15	Consultant
47	Obsolete technology used by contractor	20	28	13	16	Contractor
32	Inadequate qualification of the contractors technical staff	18	10	25	17	Contractor
52	Fluctuation in rates of materials	19	9	27	18	External factor
29	Unaware or Lack uses of project management Software or New technology	10	7	37	19	Client
31	Faults and discrepancies in design documents	12	41	23	20	Consultant

4.3.8 Proportion Obtained of Top 20 Critical Causes by Project Execution Agencies

Table 4.15 shows the proportion of the causes of cost & schedule overrun in the construction of small dam projects, which is divided into four groups based on their responsibilities. Furthermore, the top first cause was agreed upon by two project agencies (contractor and consultant) as Delays in land acquisition.

Overall, the top twenty most critical causes of cost & schedule overrun were discussed along with their respective responsibilities. The following causes are discussed in relation to the project agencies client, consultant, contractor, and external influences.

TABLE 4.15: Proportion of Top 20 Causes of Cost & Schedule Overrun Accordingly Project Execution Agencies

Responsible Agency	**No. of Related Causes**	**Percentage**	**Rank**
Clients related causes	12	60%	1st
Consultants related causes	4	20%	2nd
Contractors related causes	3	15%	3rd
External Factors related causes	1	5%	4th
Total	20	100%	

Table 4.13 displays the proportion of different project execution agencies. From the overall top twenty critical causes of cost & schedule overrun that entail in the construction of small dam projects, this table elaborates that 12 No. causes rated with client and categories as the largest percentage (60%) of the overall most twenty critical causes of cost & schedule overrun.

4.3.9 Link of Top 20 Critical Causes with Project Stage

For showing the link of top most 20 critical causes of cost & schedule overrun into project stages according to their hierarchical position within the construction process a fishbone chart was applied in this research as presented in figure 4.2.

Table 4.16 displays the proportion of different project stages. From the overall top twenty critical causes of cost & schedule overrun that entail in the construction of small dam projects, this table elaborates that 9 causes rated to project planning stage and categories as the largest percentage of 42.85%.

The second largest influential stage is design stage, with percentage of 19.05%. The tender stage and execution stage was found as third number respectively, with percentage of 14.29%. The least influential stage is estimation stage that have only 2 causes, with percentage of 9.52% of the overall most twenty critical causes.

Table 4.16: Proportion of Top 20 Causes of Cost & Schedule Overrun Accordingly Project Stags

Project Stages	**No. of Related Causes**	**Percentage**	**Rank**
Planning Stage	9	42.85%	1st
Design Stage	4*	19.05%	2nd
Estimation Stage	2	9.52%	4th
Tender Stage	3	14.29%	3rd
Execution Stage	3*	14.29%	3rd
Total	21	100%	

*One causes commonly exist in above two stages.

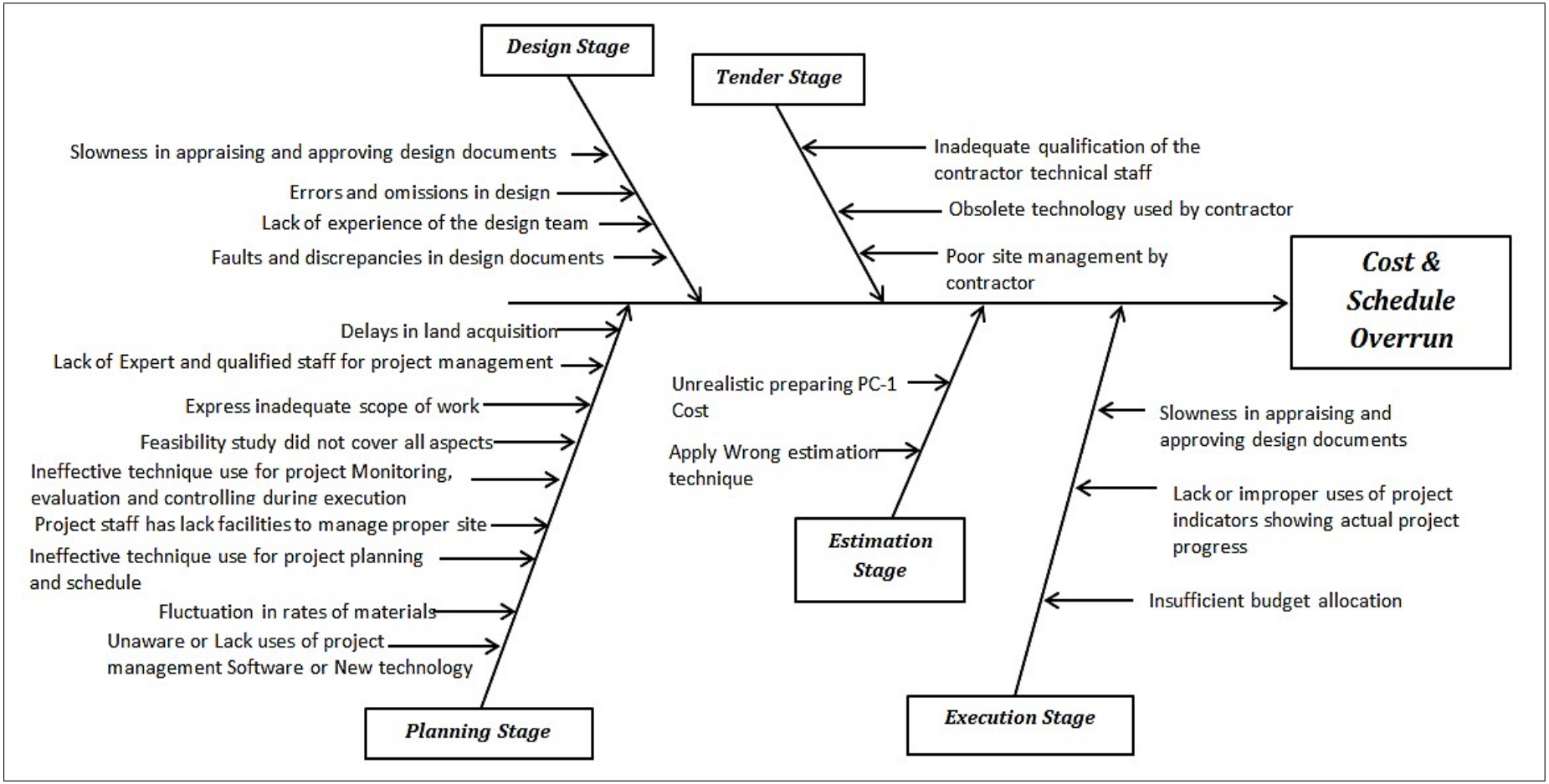

FIGURE 4.2: Link of Top 20 Critical Causes with Project Stages

4.3.10 Determine Degree of Agreement among Respondents

The degree of agreement/disagreement in Importance Index ranking done by three main respondent categories was checked using Spearman's rank correlation coefficient in this study i.e. client, consultant and contractor. This test has neither the obvious advantage of requiring normality nor homogeneity of variance assumptions.

They compare medians rather than means, so if the data contains one or two outliers, their impact is diminished (Assaf & Al-Hejji, 2006). Correlation is a measure of the intensity and direction of a link between two or more parties or elements. It is utilized in this study to demonstrate the degree of agreement amongst the various stakeholders.

The correlation coefficient ranges from +1 to -1, with +1 denoting a perfect positive link (agreement) and -1 denoting a perfect negative relationship (disagreement) (disagreement). As a result, sample correlation estimates close to unity in magnitude reflect good correlation, whereas values approaching 0 imply little or no connection.

Results have been shown in **Table 4.17** which is depicting significant agreement between each two categories of respondents. Highest degree of agreement is between client and consultant 67.3 percent and lowest is between contractor and consultant 50.3 percent. Based on agreement shown in the calculations, results of this study is dependable.

TABLE 4.17: Show Degree of Agreement Among Respondents (By Using Spearman's Rank Correlation Coefficient)

Respondent	**Correlation Coefficient**	**Significance Level**
Client - Contractor	0.624	0.054
Client - Consultant	0.673	0.033
Contractor - Consultant	0.503	0.138

4.4 Discussion of Results

Table 4.11 shows the results of the survey, which identified critical causes of cost & schedule overruns in the construction of small dam projects in Pakistan. From theses causes: delays in land acquisition, lack of expert and qualified staff for project management, unrealistic preparing pc-1 cost, express inadequate scope of work, feasibility study did not cover all aspects, slowness in appraising and approving design documents, apply wrong estimation technique, lack or improper uses of project indicators showing actual project progress, errors and omissions in design, ineffective technique use for project monitoring, evaluation and controlling during execution, insufficient budget allocation, poor site management by contractor, project staff has lack facilities to manage proper site, ineffective technique use for project planning and scheduling, lack of experience of the design team are found to be most critical causes of cost & schedule overrun. The results indicate estimation of projects and management related causes as most critical in construction of small dam projects in pakistan.

The most critical causes of cost and schedule overrun discovered by this research work will be discussed in this section, which are categorized and illustrated in table 4.13 according to the proportion of responsible agencies clients, consultants, contractors, and external factors related to cost and schedule overrun.

Delays in Land Acquisition

With an overall important index of 61.63 percent, all project execution agencies agreed on the most and highest overall rating on delays in land acquisition. This cause for the delay follows the same pattern as three earlier studies (Abbas. 2017; Alamri. 2017, Bozorg-Haddad. 2016). Due to a lack of adequate communication channels between clients and local people throughout the planning stage studies, there is a lot of misunderstanding among the community. In Pakistan, land acquisition is always a major issue in small dam construction. Whenever the government embarks on a project, the price of land in certain places skyrockets, and residents complain about exorbitant land costs.

Lack of Expert and Qualified Staff for Project Management

With an overall important index of 59.92 percent, all project stakeholders agreed that a lack of expert and qualified staff for project management was the second-most important cause of cost & schedule overrun in small dam projects. From above top 20 causes, "ineffective technique use for project monitoring, evaluation and controlling during execution, poor site management by contractor, lack or improper uses of project indicators showing actual project progress, ineffective technique use for project planning and scheduling, unaware or lack uses of project management software or new technology" are also related to project management cause. The project management section one of the most major sources of cost & schedule overrun in small dam projects is this part from the client and contractor's perspective. Small dam organizations in Pakistan do not have a dedicated project management unit that can adequately plan and supervise dam project construction. The lack of competent and trained project managers is the most obvious factor contributing to cost & schedule overruns in the construction of a small dam projects in Pakistan. Due to this cause, key challenges and problems on site for the department (client) resulted in scope creep, a lack of communication, a lack of clear goals and success criteria, budgeting issues, insufficient team member skills, insufficient risk management, lack of accountability, limited stakeholder engagement, and unrealistic deadlines.

Unrealistic Preparing PC-1 Cost and Apply Wrong Estimation Technique

Project parties ranked this client responsibility-related cause third and seventh, respectively, with an overall important index of 58.03 percent and 55.69 percent of the top twenty causes. This is the most common cause of cost & schedule overruns in small dam construction projects in Pakistan. Unrealistic estimates while preparing pc-1 and project start without a thorough site study are two major causes contributing to the cost & schedule overrun in construction of small dam projects in Pakistan. As a result of these causes, contractors confront unforeseen challenges and issues on the job site, resulting in additional work, changes in work, and increased costs and time spent on project completion.

Feasibility Study Did Not Cover All Aspects

With a percentage of 56.01 percent of the overall ranked, feasibility study cause has a significant impact on project cost & schedule overrun. The client spends a lot of money on feasibility studies, especially for dam projects. However, most consultants do not address all areas during this stage. There are a variety of causes for this, including insufficient consultant team experience, insufficient client information, or, in other words, issues establishing project needs from the client's perspective. Furthermore, there is a time gap between the feasibility study stage and the execution stage, which might result in the need to update and reassess the initial feasibility study owing to daily changes and the introduction of new construction technologies. Furthermore, during the feasibility study stage, there is sometimes a lack of participation from the local community.

Slowness in Appraising and Approving Design Documents

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Slowness in Appraising and Approving Design Documents Clients are to blame for the delay in the dam project, which was placed sixth overall important index with 55.96 percent. Because of the prolonged decision-making procedures in this respective department in Pakistan, the client has significant responsibility of cost & schedule overrun in the small dam projects. This is owing to the fact

that most client representatives do not have the authority or right to make timely choices. Those with the authority to make decisions typically have advanced degrees in management and a lack of technical knowledge.

Express Inadequate Scope of Work With 57.41 percent, this cause was placed 4th out of the top twenty critical causes. The difficulty in defining the scope of work from the client, according to both consultants and contractors, is a key cause of cost and schedule overruns in small dam projects. Many clients face challenges in this area for a multitude of reasons, including a lack of experience with dam projects and requests from high-ranking government officials to change the dam's intended use from the original design to something else. As a result of this cause, the number of modification orders increases, resulting in increased time and cost.

Insufficient Budget Allocation It is a reality that when issues such as insufficient budget allocation occur, delays in payment cause the contractors to incur more costs or cause the project to be delayed, resulting in cost overrun. As a result, providing other mechanisms such as working capital availability and others can be a way out.

Poor Site Management and Obsolete Technology Used by Contractor It was placed 12th and 16th in this study as another prevalent source of overrun in small dam projects. Several studies have highlighted this factor as a major contributor to construction project schedule overruns caused by contractors. Alamri et al., (2017) rated this cause sixth in Oman's public sector, and Soliman, (2011) in Pakistan's big construction industry given fifth ranked of this cause. In general, poor site management and outdated technology are the result of the contractor's inability to adequately manage the site in small dam projects, as opposed to other major development projects. It's also because of the conflicts that emerge during the construction site phase, with the project partners unable to respond and control the risk in a timely manner.

Price Fluctuation of Materials

Another prominent reason of cost overrun in small dam projects is material price fluctuation, which is ranked 18th in this study. Regardless of the fact that the situation is partially external and difficult to handle, better planning can lead to

a better understanding of the extent of material price fluctuation. This could be attributed to the country's growing construction and contractor population. Increasing the supply of materials could be one solution. In conjunction with this, (Kamaruzzaman, 2010) found that raw material price fluctuations are the 9th most common cause of cost overruns in Malaysian construction projects, and suggests expanding materials supply. The most common cause of cost overruns is the rapid fluctuation in exchange rates; preparing the necessary materials for a large construction site can be difficult, and any change in the rates can result in a project costing significantly more than its original budget.

Lack of Experience of Design Team

Another major reason of cost and time overruns is a lack of design team experience, which falls under the consultant duty categories agreed upon by all project execution agencies, with an overall important index of 52.29 percent. Many authors have also identified this cause (Abbas. 2017; Alamri. 2017, Bozorg-Haddad. 2016). This issue emerged as a result of poor project planning and management of the design process, resulting in design errors and omissions, design flaws, and design document conflicts. Create an indestructible design. During construction, there were numerous changes in material types and specifications, as well as a large amount of extra work. Stakeholders must understand the need of bettering the integration, planning, and control of their designs and manufacturing processes.

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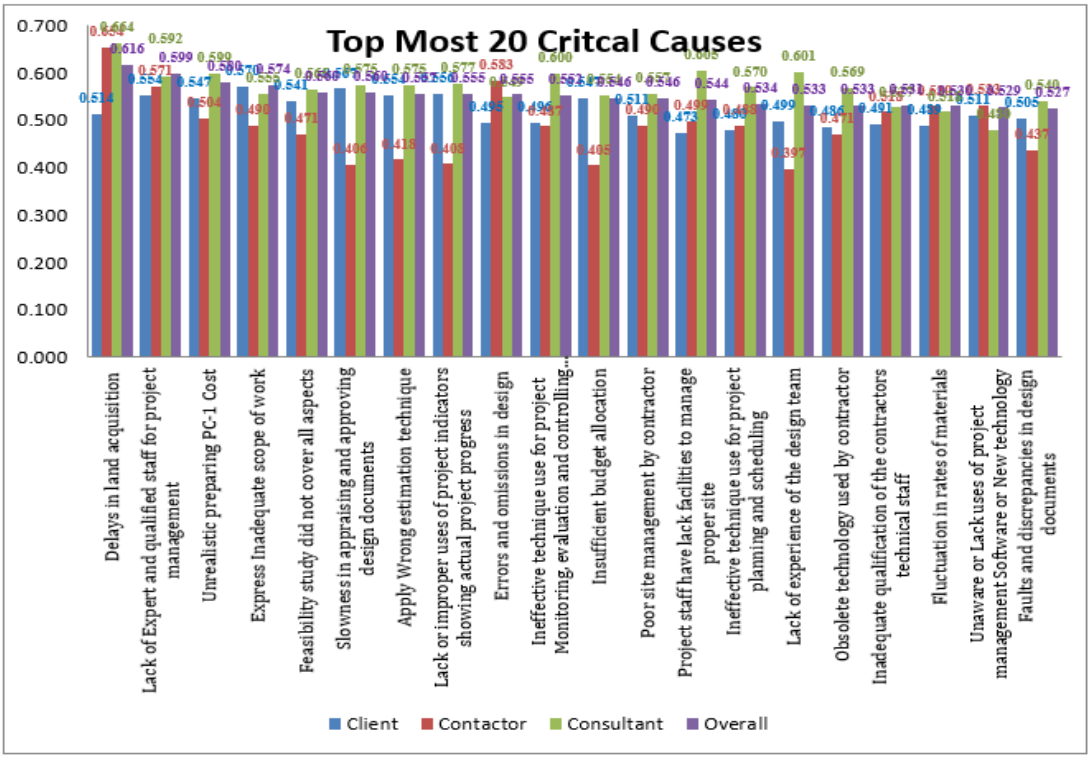

FIGURE 4.3: Top Most 20 Critical Causes of Cost & Schedule Overrun Comparing with Respondent Feedback

Chapter 5

Conclusion and Future Line of Direction

5.1 Brief of Chapter

The study's main goals were to identify the critical causes of cost & schedule overrun that exist in the construction of small dam projects in Pakistan, to investigate how project management knowledge, tools, and techniques are currently being used to manage these causes in small dam projects, and to propose mitigation measures to reduce construction cost & schedule overrun in small dam projects.

This chapter contains a summary of the findings, mitigation measures, future directions, and conclusions that will aid in the solution of the problems of cost and schedule overruns in the construction of small dam projects in Pakistan. The study's initial goal was to identify the fundamental causes that contribute to cost & schedule overruns in small dam construction projects. The second goal was to link these causes to a specific identity, such as Client, consultant, and contractor. The third goal was to connect these causes to project stages, such as the planning, design, estimating, tendering, and execution stages. The fourth objective of this research work was to investigate the frequency & severity of each cause and prioritize or ranking it according to its importance and investigate the collective group perspectives on the relative significance of these factor from owner, consultant, and

contractor point view was the third objective. To propose mitigation measures of top most critical causes was the fifth objective of this study and finally evaluate the degree of agreement /disagreement regarding the ranking of these factors and the last one was to formulate recommendations to improve construction performance.

5.2 Summary of Findings

Based on the ranking process using the frequency index (FI), severity index (SI) and important index (II) for the listed causes of small dam projects cost & Schedule overruns, it was observed that the most dominant top most causes include: delays in land acquisition (FI=0.872, SI=0.707, II=0.616, R=1), lack of expert and qualified staff for project management (FI=0.796, SI=0.753, II=0.599, R=2), unrealistic preparing pc-1 cost (FI=0.784, SI=0.740, II=0.580, R=3), express inadequate scope of work (FI=0.784, SI=0.736, II=0.574, R=4), feasibility study did not cover all aspects (FI=0.740, SI=0.757, II=0.560, R=5), slowness in appraising and approving design documents (FI=0.816, SI=0.686, II=0.560, R=6), apply wrong estimation technique (FI=0.788, SI=0.707, II=0.557, R=7), lack or improper uses of project indicators showing actual project progress (FI=0.800, SI=0.694, II=0.555, R=8), errors and omissions in design (FI=0.824, SI=0.673, II=0.555, R=9) and ineffective technique use for project monitoring, evaluation and controlling during execution (FI=0.820, SI=0.673, II=0.552, R=10). These findings were comparable to those of (Shebob et al., 2012), who discovered that the leading reasons of construction project cost overruns were material costs, inaccurate planning, and poor contract management. Similarly, the findings matched those of a research by (Klau, 2015), which identified planning and scheduling flaws as the leading source of construction project cost overruns.

5.2.1 Propose Remedies for Mitigation Measures

Cost & schedule overruns are unavoidable in the construction projects; therefore, based on the findings of this study, the following mitigation measures are recommended to assist professionals working on small dam projects in dealing with

and managing cost & schedule overruns. This study discovered that all causes of cost & schedule overruns are due to respective departments' poor planning and management of projects, beginning with the initial planning stage and continuing through all project execution stages such as planning, design, estimation, tending, and execution stages.

Finally, the mitigating measures for this research project were mostly related to project planning and management: It entails managing poor planning and scheduling, as well as the instruments that will be used to manage them.

Delay in Land Acquisition

Clients, along with the local government, who has a formal legal right, and local landowners, sit down and give a brief explanation of the Dam's purpose and aims, as well as the expected returns to the state and society. Prior to the construction of dams, the client should keep accurate records of all land owners who will be impacted by the dam project, with different compensation choices available in the compensation process to guarantee the land owners get the settlements they want. Accelerate the compensation process prior to the start of the project.

Slowness of Decision Making Process

Setting the number of real based alternatives associated to important selected criteria develops the decision making process. Construction of small dam projects are planned using the same principles as other projects, focusing on cost, time, quality, and risk management. To minimize this steady occurrence, decision-makers should be knowledgeable about small dam projects and follow the following guidelines: examine the existing circumstances, establish benchmarks, define KPIs, Implementing processes and making data more accessible and transparent can aid in decision-making process. Through these steps can be improve and fasten decision making process in construction of small dam projects.

Feasibility Study Did Not Cover All Aspects

A feasibility study examines all of a project's pertinent aspects, including economic, technical, legal, and scheduling issues, in order to determine the project's chances of success. A feasibility analysis is a detailed procedure for determining

the factors that will influence whether a project succeeds or fails. Following are some recommended practices for doing a feasibility study that must be followed in order to execute a full and successful feasibility research;

- Conduct a preliminary analysis, which includes gathering feedback from relevant stakeholders on the new concept; evaluate alternative situations and concepts.
- Analyze and question the data collected throughout the early stages of the study to ensure that it is reliable.
- Prepare an income statement that contains revenue, operating costs, and profit projections.
- Identify potential hurdles and vulnerabilities, as well as how to address them.
- Make a preliminary "go" or "no-go" decision regarding carrying out the strategy.

Poor Site Management

The main contractor should make every effort to properly and efficiently manage their employees. To be able to lead the work team as well as subcontractors, the project manager should have a thorough understanding of the management system. The client should choose the correct contractors with the necessary capabilities and experience in dam project construction, rather than going with the lowest bidder without a recommendation.

Ineffective Technique Use for Project Planning and Scheduling

For successful execution, every project requires appropriate planning, and the Critical Path Method (CPM) is regarded as an excellent time management technique for complicated projects. CPM aids in the logical display of the sequence and timing of each activity. In addition, tools and procedures such as Program Evaluation Review Technique (PERT) and Earned Valued Management (EVM) are advised for controlling project activities against the plan and schedule.

Lack of Expert and Qualified Staff for Project Management

Project management tools can be used to deal with a lack of experienced and qualified project management people. Potential employees should be vetted to ensure they have the necessary experience to carry out the job. Each team member might be vetted once again to ensure that they all have the necessary skills to execute the duties or activities assigned to them by the system. Members of the project team might receive regular training to improve their capacity and soft skills.

5.3 Conclusion of this Study

The findings of this study show that in this government department's construction of small dam projects, project planning, controlling, and management, as well as project design error are critical issue that leads to project success and which causes contributing to frequent incident of cost & schedule overrun in small dam projects in Pakistan are lack of expert and qualified staff for project management by client, poor site management and obstacle technology uses by contractor and poor qualified, skills and experience staff for designing of projects by consultant. Furthermore, it has been suggested that by applying suitable project management tools and methodologies, these essential aspects can be better managed. An extensive literature study was used to develop a list of causes of cost & schedule overruns from the three responsible agencies and five project stages. The study's findings backed up previous research and scholars' findings that cost & schedule overruns on construction projects are caused by a variety of factors.

Furthermore, findings revealed that cost and schedule overruns have a negative impact on the construction of small dam projects in Pakistan. The study did, however, identify measures that construction professionals can take to avoid and eventually reduce small dam project cost & schedule overruns. The empirical study indicate findings of the causes, effects and methods of minimizing small dam projects cost & schedule overruns in Pakistan. Therefore, the results revealed in this study contributes to the body of knowledge and gives valuable suggestions on running projects in way that minimizes cost & schedule overruns.

5.4 Recommendation

To minimize and control cost & schedule overruns in construction of small dam projects, all project execution agencies should consider the following points.

5.4.1 Client Considerations

- To avoid time and cost overruns, client should evaluate the project's required length and enforce a reasonable duration. It is recommended that client hire technical employees who can oversee the various stages of a project, track performance percentages, and compare actual performance to projected performance.

- It is recommended that client thoroughly revise bid papers such as technical specifications, drawings, bill of quantities, and project design. This is because any inconsistency in bid paperwork will result in disagreements between project components, causing cost & schedule overrun. Pay the contractor on time for progress payments because it affects the contractor's capacity to fund the project.

- It is recommended that clients identify the contractor's accessible materials and analyses his financial capabilities to complete the project. It is also recommended that the client does not rely on the lowest-cost contractor to complete the project. They are urged to interview personally in the event of a dispute between the contractor and the consultant in order to avoid the impact of such issues on the project's completion and quality.

  In last, it is suggested that client assist in the emergence of licenses required to begin project activity. He also needs to keep change orders to a minimum in order to avoid cost & schedule overruns. Enhances communication and coordination between local construction agencies and international financing agencies in order to resolve financial concerns.

5.4.2 Contractor Considerations

- To avoid test failures, contractors should be able to control the majority of project activities, employ permitted materials, and work mechanisms. Contractors should regularly evaluate the quality of their operations and implement the needed quality system in each of the project's activities to avoid any errors that could result in rework and, ultimately, cost & schedule overruns. To avoid time and expense overruns, contractors are advised to set up storage for essential construction supplies, particularly those that are scarce or in limited supply in the marketplaces.

- They should also set up a computerized system to complete the documentation process for all of the operations on the job site, so that they can detect work performance and keep track of the time schedule. It should establish a time schedule that outlines their equipment requirements on the job site so that it is available when needed.

- To avoid financial troubles, contractors should have enough cash on hand before starting any project. It's also a good idea to keep track of the project's financial spending and payments because any financial issues will result in cost & schedule overruns.

5.4.3 Consultant Considerations

- Consultants are recommended to recruit a trained technical staff to effectively manage the project, so that he can address any technical or management issues that arise. It is also recommended that the consultant has a high level of qualification in order to provide appropriate instruction at the appropriate time and to be able to respond to any question posed by the contractor in order to avoid cost & schedule overruns.

  The consultant should also be capable of reviewing and approving design documents, shop drawings, and contractor payments in order to avoid any delays on the project.

- It is suggested that consultants avoid centralizing decisions, particularly those relating to consultant work, as this may cause project delays. This could lead to the site engineer's marginalization, which could lead to a slew of issues on the job. Inflexibility: When reviewing contractor work, consultants should be flexible. It's important to think about how to strike a balance between affordability and good quality.

5.4.4 Project Parties: General Recommendations

- The following suggestions are made in general to lessen the impact of cost & schedule overrun in construction of small dam projects;

- Obtain early clearance from the various government agencies and government procedure for getting clearances for dam projects should be assessed on a regular basis.

- To avoid any misunderstandings or subsequent disputes, client should create and formulate a good channel of communication amongst all project execution agencies during construction work. For avoid negative impact on project operations, client change orders should be issued simultaneously during the project's duration.

- Contractors should have sufficient experience with Dams projects, as well as qualified teams for work, and have a project management system in their organizations, which includes thorough planning, scheduling, and supervision of the work to minimize any delays.

- Consultants should verify that all construction work is carried out according to the plan explicitly and correctly on a daily basis, keeping in mind that time, cost, and quality are the most important elements.

- Project stakeholders collaborate to pass unforeseen risk to insurance providers, reducing the impact of delays.

5.5 Practical Implementation of this Research

This research was carried out in a Pakistani environment with the goal of identifying and investigating critical causes of cost & schedule overruns in the construction of small dam projects in Pakistan through a case study, understanding, and perspective from project execution agencies.

The findings of the literature analysis, case study, and questionnaire survey reveal that many internal and external elements in a project might cause cost & schedule overruns. The findings aid in the reduction of potential cost & schedule overrun in project by implementing proposed mitigation measures and increasing quality standards across the project. As a result, having a well-defined plan in place from the start of a project can help to reduce risk and speed up the project's cycle time. Additionally, the project's efficiency will be improved as a result of this.

The recommended strategy will improve competency during the project's project management phase. The approach aims to raise the degree of experience of experts and workers by implementing such techniques on a constant basis through training and audit. This will allow them to make more informed judgments when developing short- and long-term construction strategies and policies aimed at improving industry processes and operations.

Furthermore, this research aids departments and decision-makers in understanding the significant causes of cost & schedule overruns in small dam projects in terms of cost-benefit analysis and development procedures. The research study's findings provide a long list of significant causes of cost & schedule overrun to departmental decision makers, allowing them to take proactive measures early in the project to limit the impact of cost & schedule overrun in small dam construction projects.

5.6 Limitation of this Research

Every study has limits, and the current study has some since the sample was limited to small dams organization department engineers (client) and those who work with small dams organizations, such as consultants and contractors with

experience in this field. In Pakistan, this department is made up of only four districts (Rawalpindi/Islamabad, Attock, Chakwal, and Jehlum). The study was limited to small dam projects in Pakistan so that the findings might be applied to comparable projects in Pakistan and possibly other nations with similar projects.

When the sample size is large, the statistical study's dependability is high. A small sample size can lead to unexpected results. Because the sample size for small dam projects was so tiny in this study, caution should be exercised when interpreting and generalizing the results of statistical analysis for these projects. Despite the limitations mentioned above, this study contributes to closing the knowledge gap in terms of identifying significant causes of cost & schedule overruns in Pakistani projects, as well as relevant mitigation methods. As a result, the study's suggested findings for these project categories should be investigated further using bigger sample sizes to better validate and develop the findings.

5.7 Future Line of Direction

Planning and scheduling are ongoing activities that match the resources and time available to develop the task in order to avoid cost overruns and disagreements. Site management & supervision: as soon as the project is granted, administrative and technical people should be allocated to establish plans to complete it on time and on budget.

The study concludes with the following future line of direction for further studies,

- Due to time constraints and respondent availability, the data collection was limited to only 120 people those working in small dams organizations, it should be expanded to all provinces and cities in Pakistan to provide a more complete picture of the causes of cost & schedule overruns that can be applied across the country.
- According to the current study, project planning, controlling, and management is the main cause of cost and schedule overruns. As a result, the scope of this research can be expanded to include how effective project plan and

management tools & techniques are used in individual departments as well as dam construction projects.

- More research should be done to see how much cost & schedule overruns are reduced if better project planning and management tools and procedures are implemented in their particular organizations.

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Appendix-A

Questionnaire

Dear Respondent

I am MS Scholar at Capital University of Science and Technology. A short survey conducted for "**An Investigation into Critical Causes of Cost & Schedule Overrun: That Associate Construction of Small Dam Projects in Pakistan**" for the completion of my research thesis. This survey conducted Study & research work only and please answer every question honestly and to the best of your knowledge. All the information obtained for this research will be used only for academic purposes. Thank you very much. Your active contribution is the real strength of this research study.

Profound Regards:

Hafiz M. Awais Anwar

MSEM Research Scholar

Faculty of Engineering

Capital University of Science and Technology, Islamabad

Section A: Demographics

1- Male	2- Female
3- Types of Organization	1 (Client), 2 (Consultant), 3 (Contractor)
2- Education Level	1 (DAE), 2 (Graduate), 3 (Master), 4 (PhD)
4- Position Level in Organization	1 (Site Supervisior), 2 (Graduate), 3 (XEM/PM), 4 (Project Director)
5- Overall Work Experience	1 (1–5), 2 (6–10), 3 (11-20), 4 (20 and above)
6- No. of Completed Projects	1 (1-3), 2 (4-6), 3 (7-10), 4 (10 and above)

Section B: Causes of Cost & Schedule Overrun

Please tick the relevant choices: Frequency: 1= Never, 2= Rarely, 3= Sometimes, 4= Very often, 5= Always Severity: 1=Very low, 2=Below average, 3= Average, 4=Above average, 5=Very high.

Sr. No	**Description of Causes**	**Frequency**					**Severity**				
1	Insufficient budget allocation	1	2	3	4	5	1	2	3	4	5
2	Delay in interim payment of contractor	1	2	3	4	5	1	2	3	4	5
3	Delay in settlement of contractor claims	1	2	3	4	5	1	2	3	4	5
4	Unrealistic preparing PC-1 Cost	1	2	3	4	5	1	2	3	4	5
5	Apply Wrong estimation technique	1	2	3	4	5	1	2	3	4	5
6	Express Inadequate scope of work	1	2	3	4	5	1	2	3	4	5
7	Large quantities of extra work	1	2	3	4	5	1	2	3	4	5

8	Recurrent variations \& change orders	1	2	3	4	5	1	2	3	4	5
9	Work start earlier design completion	1	2	3	4	5	1	2	3	4	5
10	Slowness in appraising and approving design documents	1	2	3	4	5	1	2	3	4	5
11	Legal disputes b/w different project's components	1	2	3	4	5	1	2	3	4	5
12	Delays in land acquisition	1	2	3	4	5	1	2	3	4	5
13	Premature tender documents	1	2	3	4	5	1	2	3	4	5
14	Tender-winning prices are unrealistically low	1	2	3	4	5	1	2	3	4	5
15	Long period between design and time of tendering	1	2	3	4	5	1	2	3	4	5
16	Allocation of tender to Inexperience contractor	1	2	3	4	5	1	2	3	4	5
17	Poor financial control on site	1	2	3	4	5	1	2	3	4	5
18	Unrealistic contract durations imposed	1	2	3	4	5	1	2	3	4	5
19	Lack of Expert and qualified staff for project management	1	2	3	4	5	1	2	3	4	5
20	Ineffective technique use for project planning and scheduling	1	2	3	4	5	1	2	3	4	5
21	Ineffective technique use for project Monitoring, evaluation and controlling during execution	1	2	3	4	5	1	2	3	4	5
22	Unaware or Lack uses of project management Software or New technology	1	2	3	4	5	1	2	3	4	5

23	Lack or improper uses of project indicators showing actual project progress	1	2	3	4	5	1	2	3	4	5
24	Deficiencies in organizations Structure hierarchy	1	2	3	4	5	1	2	3	4	5
25	Unclear division of responsibilities and lack of clear requirements for professional management	1	2	3	4	5	1	2	3	4	5
26	Project staff have lack facilities to manage proper site	1	2	3	4	5	1	2	3	4	5
27	Employees tenure matter	1	2	3	4	5	1	2	3	4	5
28	Prepare Un-constructible design	1	2	3	4	5	1	2	3	4	5
29	Errors and omissions in design	1	2	3	4	5	1	2	3	4	5
30	Regular alterations in structure design	1	2	3	4	5	1	2	3	4	5
31	Faults and discrepancies in design documents	1	2	3	4	5	1	2	3	4	5
32	Feasibility study did not cover all aspects	1	2	3	4	5	1	2	3	4	5
33	Unsuitable project site	1	2	3	4	5	1	2	3	4	5
34	Lack of experience of the design team	1	2	3	4	5	1	2	3	4	5
35	Inadequate design-team experience	1	2	3	4	5	1	2	3	4	5
36	Slowness in appraising and ratifying design documents	1	2	3	4	5	1	2	3	4	5
37	Delay in approving shop drawings and sample materials	1	2	3	4	5	1	2	3	4	5
38	Inadequate site supervision	1	2	3	4	5	1	2	3	4	5

39	Deprived inspection and testing techniques applying during execution	1	2	3	4	5	1	2	3	4	5
40	Delay in performing inspection and testing	1	2	3	4	5	1	2	3	4	5
41	Delay in approving major changes in the scope of work	1	2	3	4	5	1	2	3	4	5
42	Frequent Changes in material types and specifications during construction	1	2	3	4	5	1	2	3	4	5
43	Ineffective pre-planning	1	2	3	4	5	1	2	3	4	5
44	Poor site management by contractor	1	2	3	4	5	1	2	3	4	5
45	Inadequate qualification of the contractors technical staff	1	2	3	4	5	1	2	3	4	5
46	Shortage of skilled labor	1	2	3	4	5	1	2	3	4	5
47	Obsolete technology used by contractor	1	2	3	4	5	1	2	3	4	5
48	Obsolete construction methods / technology used by contractor	1	2	3	4	5	1	2	3	4	5
49	Defective work or faults during construction	1	2	3	4	5	1	2	3	4	5
50	Fraudulent practices and kickbacks	1	2	3	4	5	1	2	3	4	5
51	Lack of communication and cooperation b/w project execution agencies	1	2	3	4	5	1	2	3	4	5
52	Fluctuation in rates of materials	1	2	3	4	5	1	2	3	4	5
53	Outside work round site because of public agencies	1	2	3	4	5	1	2	3	4	5

54	Inevitable changes throughout execution because of unexpected geological conditions	1	2	3	4	5	1	2	3	4	5
55	Delay in issues of funds by government	1	2	3	4	5	1	2	3	4	5
56	Uncertainty in ground condition	1	2	3	4	5	1	2	3	4	5
57	Delay of obtaining permit/approval from the different government authorities	1	2	3	4	5	1	2	3	4	5
58	Economic instability	1	2	3	4	5	1	2	3	4	5
59	Change in government regulations	1	2	3	4	5	1	2	3	4	5
60	weather condition	1	2	3	4	5	1	2	3	4	5
61	Bad Law and order situation	1	2	3	4	5	1	2	3	4	5
62	Lack of political will	1	2	3	4	5	1	2	3	4	5
63	Corruption	1	2	3	4	5	1	2	3	4	5

Section C: Suggestions Related to these Causes

Kindly give your suggestion about mitigation measure & parameters which can reduce cost and schedule overrun in the construction of small dam projects by adopting such tools in the construction organization.