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Article

Exploring the factors contributing to public sector building construction delays and mitigation solutions in Pakistan

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Abstract: The construction industry worldwide experiences significant project delays, particularly in the public sector of the construction industry. Construction delays have a substantial effect on the economic development of areas and employment opportunities for the local population, particularly in underdeveloped regions like Balochistan, Pakistan. This research examines the most significant and influential factors causing delays in government building construction within Balochistan, Pakistan. The study presents mitigation solutions and strategies proposed by experts using a Delphi technique for the critical and influential delay factors. The questionnaire survey to collect responses from participants consists of 24 delay factors, which are derived from existing literature and experts' consultation. A satisfactory degree of data reliability was demonstrated by the survey's 78% response rate. Cronbach's alpha and split-half reliability tests were used in SPSS to assess internal consistency. Delay factors were categorized and ranked based on perceived relevance using the Relative Importance Index (RII). Additionally, to provide an alternate prioritizing of delay variables, the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) was used with Microsoft Excel and common mathematical formulations. To confirm the stability and robustness of the rankings, a comparison of the RII and TOPSIS results was done. The results establish the groundwork for further studies on building delays and give insightful information for decision-making in the public sector.

Keywords: construction delays; public sector; mitigation solutions; data analysis; expert stakeholders; Pakistan

1. Introduction

The construction sector is crucial for a nation's economic growth. Nations with robust economies invariably possess highly advanced construction sectors [1]. The worldwide construction industry is experiencing rapid expansion, with its market value projected to rise from USD~15.2 trillion in CY23 to USD~16.0 trillion in CY24, demonstrating a compound annual growth rate (CAGR) of ~5.1%. In fiscal year 2023, Pakistan's construction industry reached a market size of roughly PKR 2190 billion, accounting for 2.7% of the country's overall GDP [2]. Balochistan, Pakistan's largest and resource-rich province, offers significant potential for trade and connectivity. The China-Pakistan Economic Corridor (CPEC) is creating new job opportunities for locals in various sectors [3], particularly construction and transportation. Numerous infrastructure projects, encompassing road networks, port facilities, and power generation plants, are employing skilled workers, which in turn benefits the local community and contributes to the Country's economy.

Construction projects usually take a long time to complete and are carried out on temporary sites by teams that are brought together just for that specific job. These teams often include multiple parties with different goals and priorities, and they disband once the project is finished, making the construction process even more complex and unpredictable. The construction industry is project-based, highly complex, and often slow to embrace change. Its processes are typically fragmented, which contributes to frequent delays. These delays usually stem from a mix of causes that are often interconnected [4]. While the main stakeholders in a construction project, the owner, consultant, and contractor, are often seen as the primary sources of delays, it's important to recognize that other parties involved can also play a role in causing delays [5]. In the field of construction, a delay is defined as an extension beyond the agreed-upon completion date or a time overrun in project delivery that exceeds the timeline established by all involved parties. Most construction projects fail to meet their scheduled completion dates. Globally, the construction industry faces significant challenges due to these delays in project timelines [6]. A construction delay is generally understood as the failure to complete a project within the agreed timeframe. Even with modern technology and advanced project management and engineering tools, delays remain a common and challenging issue in the industry [7–9]. In Pakistan, numerous projects have experienced delays in the past and continue to face delays. These projects include the reconstruction of roads damaged by earthquakes and floods, the development of Chinese industrial zones in Punjab, the CPEC roadways in Sindh, KPK, and Baluchistan, the Port Tower Complex by KPT, Pakistani Motorways and National Highways, and the Kalabagh Dam, among others. These instances highlight a widespread pattern of construction delays and challenges in Pakistan's infrastructure development efforts [10, 11]. China's Belt and Road Initiative is a major infrastructure development effort across Asia, with large-scale projects like the China-Pakistan Economic Corridor (CPEC) at its core. Valued at over USD 60 billion, CPEC is primarily aimed at boosting infrastructure development in Pakistan [12]. Clients and contractors are affected differently by construction delays. Negative outcomes for clients include lower income, lower productivity, prolonged dependency on current facilities, and a lack of available rental spaces. Conversely, contractors have to deal with issues such as greater labor prices, longer workdays, higher material and equipment costs, and increased expenses [10]. Construction delays frequently result in disagreements, schedule and money overruns, and even project termination. These detrimental effects demonstrate the necessity of efficient methods for delay analysis and management. Accurately identifying delay mitigation strategies is critical for project success because proactive project management helps prevent issues early and promotes continual improvement [7].

The authors investigated the reasons behind building delays in cold storage projects in the Philippines. The study found a number of key causes of these setbacks, such as labor shortages, permit delays, rework requirements, procurement problems, and challenges with testing protocols. The study emphasized the importance of anticipatory risk management using the Relative Importance Index (RII) approach.

In order to improve project efficiency, it also urged industry stakeholders to address these key delay drivers [9]. The 37 major causes were found in a study on delay factors in public, mixed, and private construction projects in Bangladesh. Weather, contract modifications, and construction errors were the main causes of delays, which varied depending on the form of funding. The study provided professional recommendations for reducing delays in various situations [1]. Workforce shortages, decreased productivity, budgetary difficulties, and client-requested modifications were shown to be the main causes of delays in Indian building construction. In order to reduce setbacks and improve project outcomes in the residential building industry, they promoted improved project organization, supervisory procedures, and continuous monitoring using the RII technique [13]. Another study on construction delays in Malaysia analyzed 52 common causes and identified 20 critical factors. A survey of 148 professionals revealed top causes like poor planning, client changes, financial issues, and communication failures. The study highlighted the significant role of contractor-related problems and provided valuable insights for improving project management and reducing construction delays [14]. The authors studied delays in Sri Lanka's public-sector building projects. A survey of clients, consultants, and contractors identified key delay causes, with improper project management topping the list. Other factors included labor shortages, financial issues, scope changes, delays in payments, approvals, and communication breakdowns. Spearman's test showed agreement among stakeholders [15]. A similar study investigated delay causes in Indonesia's EPC projects, surveying 41 owners, 14 contractors, and 12 consultants. Key factors included procurement delays, financial issues, poor planning, and communication problems. The study found contractor-related delays were most significant, with strong agreement among respondents on the ranking of factors [16]. Another research conducted in Nigeria investigated the factors contributing to construction project delays. The study identified several causes, including modifications to designs, financial challenges, and ineffective management practices. These delays resulted in various negative outcomes, such as prolonged project durations, cost overruns, and conflicts in resource allocation. To improve the performance of the construction industry and reduce disruptions, the researchers suggested implementing more effective budgeting strategies, ensuring prompt communication, finalizing designs before commencement, and enhancing project management techniques [17]. Another study investigated delay factors in Iran's construction industry using hierarchical analysis and data from 64 experts. Key issues include sanctions, government policies, financial insolvency, design flaws, managerial inefficiencies, and technical challenges. The study prioritized these factors and proposed solutions to optimize project timelines and costs [18]. Similarly, another study discovered critical causes of delays. They studied and arranged them into three categories: contractor delays, owner delays, and external delay factors. This study was concluded that Contractor-related delays are the most common and often cause the most serious disruptions to construction projects. In addition, delays caused by owners and material shortages are also considered major risks. On the other hand, delays related to labor, equipment, and external factors are seen as less critical concerns [5]. The reasons behind delays and disruptions in construction projects were explored along with their effects. The study adopted the relative importance index to identify and rank the delay factors. The study discovered that poor project management, funding problems, design changes, delay in payment to contractors, information delays, disagreement on the valuation of work done, and compensation issues are the main reasons for construction delays and disruption [19]. The causes of the delay factor and their interaction in construction projects were explored which identified 65 causes of delays and categorized them as client, plant or equipment, labour, design team or consultant, external factors, communication, and contractor issues. The top 4 delay factors in this study, identified and ranked, are Contractors' excessive workload, poor planning and scheduling by the contractor, change orders by the client, and financial issues [20]. The study determined the critical factor of delays using Z-number theory for the evaluation and prioritization of delay factors. The critical delay factors identified and ranked are cost inflation, contractor financial issues, inadequate project supervision and management, adverse weather conditions, insufficient skilled labour, delays in government document approvals, and unforeseen cost escalations [21]. The authors investigate the causes of time overruns in residential construction projects across Pakistan, using the Relative Importance Index (RII) to evaluate key factors identified by industry experts. The study identified that material price fluctuation, financial difficulties of contractors, and underestimation of project duration are the key factors in the construction industry [22]. The study conducted to explore the main factors causing delays in high-rise project delivery in Nigeria, using a case study approach to identify the core reasons behind these delays. The collected data were analyzed using the Relative Importance Index (RII), mean score, Kruskal–Wallis test, and content analysis. Lack of credit facilities, cash flow problems, and client-related issues are critical delay factors identified in this study [23]. The examined delays in Pakistan's construction industry identified key causes like poor coordination, material shortages, compressed schedules, inexperienced contractors, and an unskilled workforce. The study provides valuable insights to help stakeholders address these issues and improve project outcomes effectively [24].

There are studies conducted on the construction industry of Pakistan, but there is no single study on the construction industry of Balochistan due to multiple reasons, like security concerns. Our research discovered a region-specific delay factor in the construction industry of Balochistan. Flood, security challenges, political unrest, and lack of development are the delay factors that exist in Balochistan. The World Bank [25] granted a $213 million fund for reconstruction in Balochistan to recover from the loss of the flood that occurred in 2023. The Asia development Bank and Japan [26] granted a $5 million fund for loss recovery in Balochistan due to the flood that occurred in 2023. Similarly, security challenges, political unrest, and lack of development are the delay factors unique and specific to this region. The study [27] highlights that the China-Pakistan Economic Corridor (CPEC), particularly through the development of Gwadar Port in Balochistan, is expected to significantly boost the region's growth. However, the study also points out that security threats pose a serious challenge to the successful implementation and overall impact of this major project.

While a lot of research has been done on construction delays in developing nations, political unrest and security threats are typically considered minor considerations. This work fills an obvious research vacuum because there is still a dearth of empirical research on areas where these elements are structural rather than incidental. This study is based on an institutional and project governance viewpoint, which holds that political, institutional, and socio-environmental elements, in addition to technical and managerial ones, influence the performance of construction projects. Project delays are exacerbated in volatile and undeveloped areas like Balochistan by the interaction of traditional contractor and client-related factors with ineffective government, security limitations, and political meddling.

Even though building delay studies are well-established in the literature, the majority of current research sees delay factors as essentially universal across geographies, paying little consideration to places with weak institutional capability, political instability, and security issues. By presenting empirical data from Balochistan, where governance limitations, security threats, and sociopolitical impacts are structural rather than incidental. This study contributes to the body of knowledge on construction management. In addition to validating often-reported delay reasons linked to contractors and clients, the study shows how region-specific factors, including political meddling, insecurity, bureaucratic rigidity, and post-disaster recovery pressures, intensify and modify these factors. The study provides a strong framework for prioritization and validation while incorporating contextual interpretation through the integration of the Relative Importance Index (RII), TOPSIS, and expert-based Delphi analysis. The results extend the applicability of delay research beyond traditional technical explanations, both theoretically by connecting construction delays to institutional and political-risk dimensions and practically by providing mitigation strategies specific to fragile and underdeveloped regions.

2. Methodology

In order to examine delay issues in public-sector building construction projects in Balochistan, Pakistan, this study used a mixed-methods research methodology that combined quantitative prioritizing techniques with qualitative expert validation. To guarantee the findings' robustness, triangulation, and contextual relevance, the methodological framework incorporates three well-known tools: the Delphi approach, the approach for Order Preference by Similarity to Ideal Solution (TOPSIS), and the Relative Importance Index (RII). Although the rankings produced by RII and TOPSIS were identical, the application of TOPSIS served as a robustness and validation exercise, reinforcing the consistency and reliability of the prioritization results. The qualitative phase used expert consensus to refine and validate mitigation techniques, and the quantitative phase identified and rated important delay reasons. The qualitative aspect involves extracting data from existing literature and expert opinions. Concurrently, the quantitative component utilizes a 4-point Likert scale questionnaire survey to gather clear responses from participants based on their level of agreement or disagreement. The study was conducted in Balochistan, Pakistan, an underdeveloped and unexplored region prone to construction delays. Responses were collected from various stakeholders in public sector building construction projects, including clients, contractors, consultants, and designers. The responses were collected in the same order from the client, contractor, consultant, and designer. The survey was distributed to experienced professionals in the construction industry. To ensure participant comfort and willingness to share construction sector information, the questionnaire's demographic section excluded personal and confidential information, focusing only on age, education, experience, and participant names. The study imposed no limitations or restrictions on data collection, accepting input from any project stakeholders currently involved in construction projects or with relevant experience. **Figure 1** represents the research methodology applied in this study.

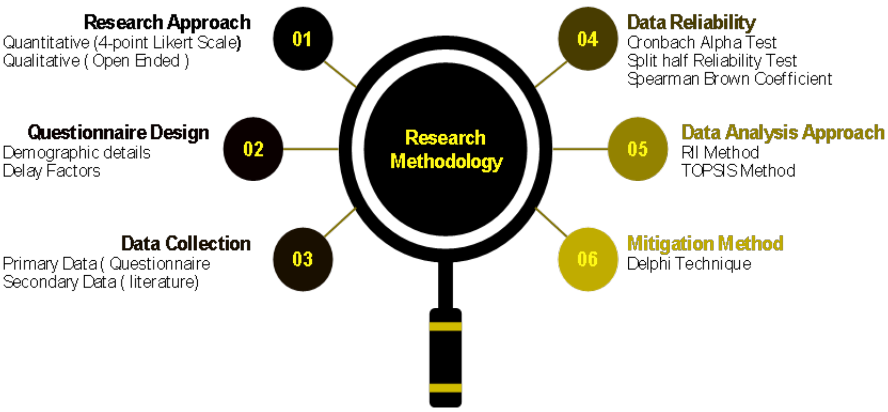

Figure 1. Hybrid methodological framework integrating quantitative prioritization (RII and TOPSIS) with qualitative expert validation (Delphi technique) for context-sensitive delay analysis.

2.1. Questionnaire design

The survey instrument is divided into two parts. The initial segment gathers demographic information from participants, including their age, experience, name, and educational background. The subsequent portion presents twenty-four construction delay factors identified through the literature review. An additional open-ended space is provided at the survey's conclusion for respondents to note any unlisted delay factors. The twenty-four delay factors are structured as closed-ended questions with multiple-choice options. A 4-point Likert scale was adopted to eliminate neutral responses and encourage respondents to express a clear position, an approach commonly used in construction management perception studies. A 4-point Likert scale is employed, offering four response options ranging from strong agreement to strong disagreement for each delay factor. The research focused on developing nations and countries neighboring Pakistan, and those with construction environments similar to Balochistan, Pakistan, for an extensive literature review. Twenty-one construction delay factors were selected from this review based on their RII ranking. Research conducted in India, Bangladesh, Pakistan, Malaysia, KSA, Sri Lanka, Ethiopia, Afghanistan, Indonesia, Nigeria, Egypt, Iran, and South Africa identified these 21 factors contributing to construction delays. The remaining three factors were added after consulting construction experts familiar with Balochistan's construction industry. These additional factors include impractical allocation of resources, insecurity and warlord intervention, and influence of social disturbance and local culture.

2.2. Data collection

This study consists of primary data, which is collected through a questionnaire survey, and secondary data, which is extracted from existing literature. The survey instrument was distributed to participants via various channels, including Google Forms, email, and social media platforms. Additionally, researchers conducted face-to-face interviews by visiting respondents' locations to administer the questionnaire. To address language barriers, the English questionnaire was translated into Urdu, the local language. Researchers expressed gratitude for the participants' cooperation and willingness to provide data. In some instances, further clarification was necessary to reassure respondents about data confidentiality. The questionnaire was distributed to 120 individuals, with 94 completed responses received, yielding a satisfactory response rate of 78%. However, due to political unrest, accessing government organizations and officials occasionally proved time-consuming.

2.3. Data reliability

Reliability analysis assesses the internal consistency and stability of data collected through survey scales [28]. To analyze the questionnaire data, this study employed the Statistical Package for Social Sciences (SPSS) software. In this research, the initial test performed using SPSS was a cleaning test. This procedure was carried out to ensure the absence of missing data and typographical errors throughout the entire dataset. As reported [29], in-depth interviews with industry experts offer valuable insights, while a pilot test helps spot any issues with data collection. Additionally, multicollinearity tests are used to ensure the data is reliable and consistent.

2.3.1. Cronbach's alpha test

To evaluate the reliability and internal consistency of the survey questions related to Construction Delay factors, researchers employed the Cronbach's alpha test using SPSS software [30]. A Cronbach's alpha value exceeding 0.7 is considered acceptable for further analysis, indicating sufficient internal consistency within the questionnaire [9]. This study utilized Cronbach's alpha to measure the coherence of participants' responses across all delay-related questions. A high alpha score suggests that respondents' answers to individual delay factors are consistent, implying a strong interconnection among these factors within the broader context of construction delays [9]. This consistency demonstrates that participants view these various factors as interrelated causes of delay, validating the sets of delay factors as a reliable and unified group for analysis [9]. The overall Cronbach's alpha (α) value calculated in this study is 0.837. The observed coherence indicates that the 24 construction delay factors examined in this research function effectively as a dependable set, collectively representing respondents' understanding of the causes behind construction project delays. The standard ranges used for the Cronbach's alpha value are given in **Table 1**.

Table 1. Cronbach's alpha (α) and internal consistency.

Cronbach's alpha	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

2.3.2. Split-half reliability test

To evaluate the internal consistency of a questionnaire, a split-half reliability test was conducted using SPSS software. This method involves dividing the questionnaire into two equal parts and assessing their correlation. The test aimed to examine the consistency between these two data sets and served as a cross-validation measure alongside Cronbach's alpha. The questionnaire in this study comprised twenty-four [24] construction delay factors. The items were separated into two halves, and their correlation was determined. A split-half coefficient exceeding 0.7 is considered acceptable, allowing the study to proceed with confidence [31]. In this case, the calculated split-half reliability coefficient was 0.810. The correlation provides an initial indication of consistency between the two halves of the questionnaire, with a higher correlation suggesting better reliability. The delay factors were divided into odd and even parts, with Part 1 containing odd-numbered factors and Part 2 containing even-numbered factors. Using SPSS software, Cronbach's alpha was calculated for each half and then compared.

2.3.3. Spearman-Brown coefficient

In addition to the split-half reliability test, the Spearman-Brown coefficient was computed as an enhanced reliability measure. Split-half reliability testing typically underestimates the true reliability of the entire data set because it uses only half of the items in each section of the questionnaire. The Spearman-Brown coefficient addresses this shortcoming by evaluating the consistency between two halves of a test, combining their scores, and treating them as a single data set [32]. This method helps assess the reliability of the complete data set. In this study, the Spearman-Brown coefficient value of 0.895, which exceeds 0.7, indicates strong internal consistency.

3. Data analysis

3.1. Relative importance index (RII)

In construction management research, RII is frequently used to rank ordinal survey data and enable direct comparison of factor significance. A greater perceived impact on project delays is indicated by higher RII scores. RII was the main technique used in this study to determine the most important delay factors influencing public-sector projects in the study area. The RII values range from 0 to 1, with values closer to 1 considered more significant and those near zero deemed less important [33–35]. The standard ranges used for the RII are given in **Table 2**.

Table 2. RII values and importance level.

RII values	Importance level
0.8 < RII < 1.0	Very High
0.6 < RII < 0.8	High
0.4 < RII < 0.6	Average
0.2 < RII < 0.4	Low
0.0 < RII < 0.2	Very low

Equation (1) is used for the calculation of RII values.

$$\mathrm{RII} = \sum \mathrm{W}/(\mathrm{A} \times \mathrm{N}) \tag{1}$$

Where W represents the weight assigned by respondents to each delay factor, ranging from 1 to 4. N denotes the total number of participants, which is 94 in this case. A signifies the highest weight on the Likert scale, set at 4 for this research [33]. The survey was structured to gauge respondents' level of agreement or disagreement. For calculating the RII values, the questionnaire offered four options: 'Strongly agree' was given a weight of 4, 'Agree' was assigned 3, 'Disagree' received 2, and 'Strongly Disagree' was allocated 1.

3.2. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The research employed complementary multi-criteria validation method to evaluate construction delay factors using the TOPSIS score, also referred to as the closeness coefficient (CCi). TOPSIS did not generate rankings different from RII, its application strengthened confidence in the stability of the prioritization. The study utilized the RII approach. The ranking of construction delay factors produced by RII was identical to that generated by TOPSIS. The procedure for implementing this method is outlined in the following steps [36–38].

Step 1: Using Microsoft Excel, a matrix was created to evaluate delay factors based on respondent ratings using a Likert scale. Initially, the average score for each delay factor was determined by considering all participant responses.

Step 2: To facilitate easy comparison, the original values for each delay factor were transformed into a scale ranging from 0 to 1 using a specified Equation (2). This process, known as normalization, was employed to calculate the standardized value of each delay factor.

$$\text{Normalized Score} = \frac{Mean\ Score\ of\ Factor}{\sqrt{\sum (Mean\ scores)^2}} \tag{2}$$

Step 3: The normalized values of the delay factors were used to determine the Ideal (A^{+}) and Negative Ideal (A^{-}) solutions. The highest normalized value represented the Ideal solution (A^{+}), while the lowest normalized value corresponded to the Negative Ideal solution (A^{-}).

Step 4: The distance to the ideal solution, represented by (D^{+}) signifies the delay factor with the closest proximity to the ideal solution. Conversely, (D^{+}) also denotes the delay factor furthest from the ideal solution, which is considered the least significant and critical. The distance to the negative ideal solution is symbolized by (D^-). The delay factor nearest to the negative ideal solution is deemed the least impactful, while the one farthest from it is regarded as the most influential and critical. Calculations for both the distance to the ideal solution and the distance to the negative ideal solution were performed using Equations (3) and (4).

Distance to Ideal Solution (D^+)

$$D^+ = \sqrt{\sum(Normalized\ score - Ideal\ Solution)^2} \quad (3)$$

Distance to Negative Ideal (D^-)

$$D^- = \sqrt{\sum(Normalized\ score - Negative\ Ideal\ Solution)^2} \quad (4)$$

Step 5: The TOPSIS score, also known as the closeness coefficient, falls between 0 and 1. A delay factor with a closeness coefficient of 1 represents the optimal solution, indicating the most significant and prevalent delay factor. Conversely, a delay factor with a closeness coefficient of 0 signifies the negative ideal solution, representing the least impactful and least common delay factor. The TOPSIS Score (Closeness coefficient CCi) was determined using Equation (5).

$$\text{CCi} = \frac{D^-}{D^+ + D^-} \quad (5)$$

Step 6: The construction delay factors were arranged in descending order according to their TOPSIS score or closeness coefficient. Factors with the highest closeness coefficient (CCi) were placed at the top of the list, while those with the lowest CCi were positioned at the bottom. This ranking system organized the factors from most significant to least significant in terms of their impact on construction delays.

4. Delphi technique for ranked factors

The Delphi technique is a structured way to gather expert opinions and reach a consensus. It involves multiple rounds of questionnaires, where participants receive feedback between each round, helping to identify and rank the most important delay factors [39]. The Delphi method was used in this study to create mitigation plans for the delay reasons that were found. The top 10 criteria were chosen for additional analysis after being ranked using the RII and TOPSIS methodologies. These ten criteria were then subjected to the Delphi technique to produce mitigation strategies. There were two survey rounds in the study. In the first phase, experts were asked to provide remedies for the mentioned delay sources using an open-ended questionnaire. The experts were tasked with selecting and prioritizing the suggested mitigation strategies after receiving summarized replies in the second round. However, consensus stabilization was observed by the second round.

5. Results and discussion

The proposed conceptual framework, which sees construction delays as the result of interacting contractor-related, client-related, external, and institutional-governance issues, informs the structure of the findings discussion. This highlights how government capability, political influence, and security conditions combine with traditional project management shortcomings to exacerbate delays in vulnerable areas like Balochistan. The investigation employs descriptive statistics (including Mean and standard deviation), reliability assessments (split-half and Cronbach's Alpha), TOPSIS, RII, and Delphi techniques. The findings are showcased to illustrate the fundamental characteristics of the survey data, verify the questionnaire's reliability, categorize and prioritize delay factors, and ultimately, outline mitigation strategies proposed by experts in the construction industry.

The current study concentrated exclusively on Balochistan's construction industry in Pakistan. A survey was distributed to 120 individuals with relevant experience in the region's construction sector, resulting in a 78% response rate. Participants included various stakeholders such as property owners, building contractors, and consultants directly involved in the local construction industry. **Figure 2** indicates that the majority of respondents possess at least 16 years of formal education. **Figures 3** and **4** demonstrate that most respondents have substantial professional experience and age. Respondents' experience levels were recorded; no weighting or stratified analysis was applied; therefore, experience is reported descriptively only.

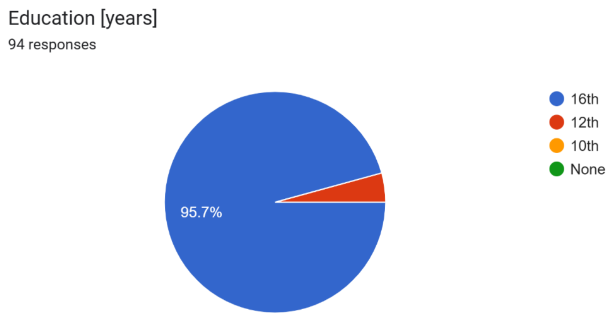

Figure 2. Education of respondents.

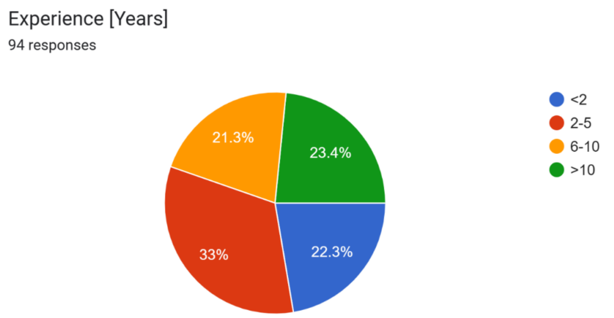

Figure 3. Experience of respondents.

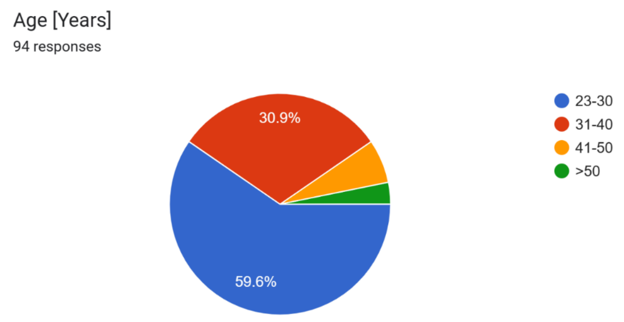

Figure 4. Age of respondents.

In this study, basic data characteristics are established through descriptive statistics such as mean and standard deviation, laying the groundwork for more sophisticated data analysis. These statistics provide an initial overview of the data. The mean represents the central value around which the data cluster, while the standard deviation indicates the data's spread from this central point [40]. All 24 construction delay factors, along with their calculated mean and standard deviation values, are presented in **Table 3**. A low standard deviation value suggests that most responses for those delay factors are concentrated near the mean, whereas a high standard deviation value indicates that survey responses are widely dispersed from the mean. While the top-ranked delay factors have high mean values, **Figure 5** shows that several also have wider dispersion, suggesting that stakeholder views vary depending on the project circumstances. The error bars in the chart represent the general range within which a significant portion of survey responses are expected to fall. Factors with higher standard deviation values indicate greater disagreement among respondents, suggesting variability in perceived impact across projects and stakeholders.

The SPSS software was utilized to clean the data gathered through a questionnaire survey, ensuring its accuracy and reliability. The data cleaning test confirms that all data entries are valid, with no typographical errors or missing values present. For each delay factor, this test demonstrates the validity and distribution of responses. This test confirms the distribution of participants' responses across the Likert scale for each factor. Additionally, it includes histograms that visually represent the distribution of responses for each delay factor based on their frequency.

Cronbach's alpha (α) was computed for the complete dataset comprising 24 construction delay factors. The overall Cronbach's alpha (α) value of 0.837 is deemed satisfactory based on the criteria outlined in **Table 1**. This suggests that the data gathered through the questionnaire survey for this research exhibits strong internal consistency. **Table 4** presents the construction delay factors along with their corresponding Cronbach's alpha values if the item were to be removed. The study's overall Cronbach's alpha (α) value is 0.837. **Table 4** demonstrates how each delay factor influences the data's internal consistency. The overall Cronbach's alpha (α) value is compared against the individual Cronbach's alpha (α) values for each delay factor. If a delay factor's Cronbach's alpha (α) value in the 'Cronbach's alpha if item deleted' column surpasses the overall value of 0.837, removing that factor would improve the entire dataset's internal consistency. Conversely, if the value in this column is lower than 0.837, eliminating that factor would diminish the overall internal consistency. The study reveals that removing the 'financial difficulties of the contractor' factor, which has a Cronbach's alpha (α) exceeding the overall value, would enhance the data's internal consistency. Conversely, eliminating any other factor would reduce the internal consistency of the dataset.

Table 3. Mean and standard deviation of delay factors.

No	Delay factors	Mean	Std. deviation
1	Ineffective planning and scheduling by a contractor	3.277	0.809
2	Slow decision by the client	3.096	0.734
3	Poor site management and supervision by a contractor	3.117	0.746
4	Unskilled workforce and poor labor productivity	3.213	0.815
5	Financial problems and payment delays by client	3.181	0.855
6	Financial difficulties of the contractor	2.989	0.680
7	Shortage of material	2.606	0.870
8	Inadequate contractor experience	2.862	0.756
9	Delay due to subcontractor	2.681	0.845
10	Delay in preparation and approval of drawing	2.734	0.930
11	Delivery of material to site	2.702	0.902
12	Escalation (increase) of material prices	3.266	0.691
13	Obtaining a permit from the municipality (Government)	2.883	0.828
14	Natural calamities (floods, heat waves, snowfall)	2.904	0.749
15	Changes by client	2.787	0.815
16	Mistakes and defective works during construction	2.894	0.710
17	Political influence	3.053	0.955
18	Equipment and machinery shortage	2.830	0.728
19	Mistakes & discrepancies in design documents by the consultant	2.766	0.835
20	Lack of communication and coordination b/w project parties	3.032	0.725
21	Excessive bureaucracy of client organization	3.096	0.734
22	Impractical allocation of resource	3.234	0.835
23	Insecurity and warlord intervention	2.872	0.820
24	Influence of social disturbance and local culture (poor stakeholder management)	2.957	0.815

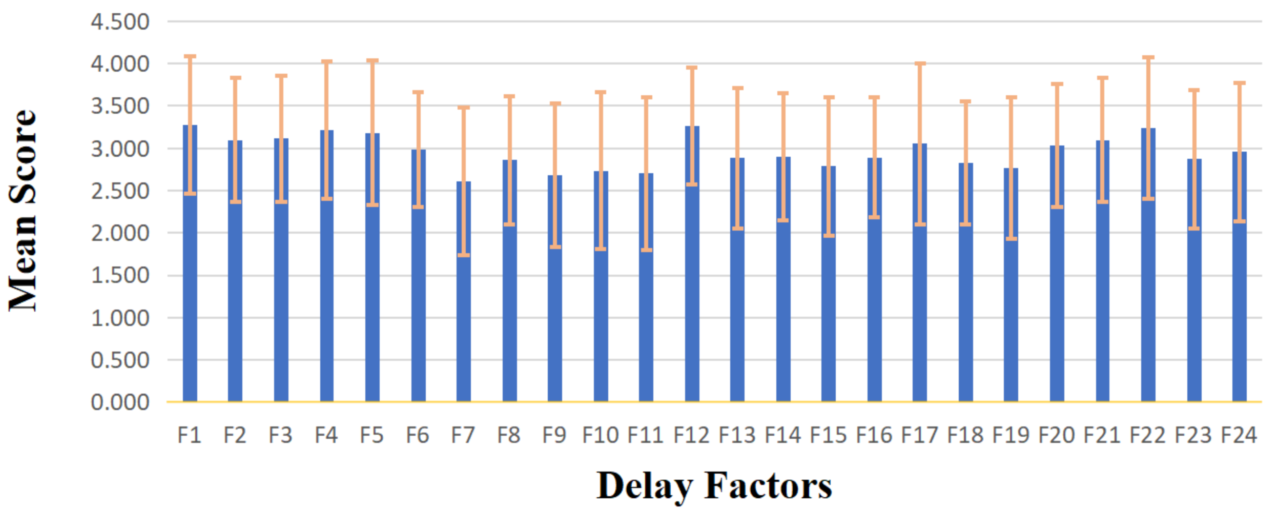

Figure 5. Mean scores and variability (standard deviation) of the top 10 construction delay factors, highlighting relative dispersion in stakeholder perceptions.

Table 4. Cronbach's alpha if an item is deleted.

No	Construction delay factors	Cronbach's alpha if item deleted
1	Ineffective planning and scheduling by a contractor	0.837
2	Slow decision by the client	0.837
3	Poor site management and supervision by a contractor	0.830
4	Unskilled workforce and poor labor productivity	0.828
5	Financial problems and payment delays by client	0.831
6	Financial difficulties of the contractor	0.839
7	Shortage of material	0.835
8	Inadequate contractor experience	0.830
9	Delay due to subcontractor	0.833
10	Delay in preparation and approval of drawing	0.829
11	Delivery of material to site	0.837
12	Escalation of material prices	0.834
13	Obtaining a permit from the municipality (Government)	0.832
14	Natural calamities (floods, heat waves, snowfall)	0.836
15	Changes by client	0.831
16	Mistakes and defective works during construction	0.831
17	Political influence	0.829
18	Equipment and machinery shortage	0.828
19	Mistakes and discrepancies in design documents by the consultant	0.824
20	Lack of communication and coordination between project parties	0.827
21	Excessive bureaucracy of client organization	0.830
22	Impractical allocation of resources	0.831
23	Insecurity and warlord intervention	0.826
24	Influence of social disturbance and local culture (poor stakeholder management)	0.830

The findings of Cronbach's alpha for Part 1 and Part 2, along with the Correlation between forms and Spearman-Brown Coefficient values, are presented in **Table 5**. The initial 12 Odd delay factors, categorized as Part 1, yield a Cronbach's alpha value of 0.714, which is considered acceptable. Similarly, the even delay factors, grouped as Part 2, produced a Cronbach's alpha value of 0.707, also falling within the acceptable range. The total item count of 24 represents the number of construction delay factors examined. As indicated in the table, the correlation between forms is 0.810, suggesting a strong consistency and relationship between the two parts. The split-half test (Correlation between Forms) demonstrates the consistency and correlation between the two halves. The Spearman-Brown Coefficient, which measures the consistency and reliability when both halves are combined into a single dataset. This value indicates a strong internal consistency within the entire dataset.

Table 6 presents 24 factors contributing to construction delays, along with their corresponding RII values and rankings. The rankings are determined by the RII values, with the highest value assigned rank 1 [41]. This table organizes the delay factors based on responses from a questionnaire survey. Contractor-related planning deficiencies emerged as the most influential delay factor, indicating their significant impact on public sector building construction projects in Balochistan, Pakistan. Conversely, 'Shortage of material' has the lowest RII value of 0.654, suggesting it has the least impact among the identified delay factors. These rankings help identify which factors require immediate attention and mitigation strategies to address construction delays effectively.

Table 5. Split-half correlation.

Cronbach's alpha	**Part 1**	**Value**	**0.714**
		N of Items	12[a]
	Part 2	Value	0.707
		N of Items	12[b]
		Total N of Items	24
Correlation Between Forms			0.810
Spearman-Brown Coefficient			0.895

Note: [a] The items are: F1, F3, F5, F7, F9, F11, F13, F15, F17, F19, F21, F23; [b] The items are: F2, F4, F6, F8, F10, F12, F14, F16, F18, F20, F22, F24; The letter F denotes the Factor of delays.

Table 6. RII ranking of construction delay factors.

No	**Delay factors**	**RII**	**Ranking**
1	Ineffective planning and scheduling by a contractor	0.819	1
2	Escalation (increase) of material prices	0.816	2
3	Impractical allocation of resources	0.806	3
4	Unskilled workforce and poor labor productivity	0.803	4
5	Financial problems and payment delays by client	0.795	5
6	Poor site management and supervision by a contractor	0.785	6
7	Excessive bureaucracy of client organization	0.777	7
8	Slow decision by the client	0.774	8
9	Political influence	0.761	9
10	Lack of communication and coordination between project parties	0.761	10
11	Financial difficulties of the contractor	0.747	11
12	Influence of social disturbance and local culture (poor stakeholder management)	0.745	12
13	Natural calamities	0.734	13
14	Obtaining a permit from the municipality (Government)	0.726	14
15	Mistakes and defective works during construction	0.723	15
16	Insecurity and warlord intervention	0.718	16
17	Inadequate contractor experience	0.715	17
18	Equipment and machinery shortage	0.710	18
19	Changes by client	0.702	19
20	Mistakes and discrepancies in design documents by the consultant	0.691	20
21	Delay in preparation and approval of drawing	0.684	21
22	Delivery of material to site	0.673	22
23	Delay due to subcontractor	0.673	23
24	Shortage of material	0.654	24

Table 7 presents construction delay factors along with their normalization (D^+), and (D^-) values. The normalization values were derived from a decision matrix created in Microsoft Excel using the TOPSIS method's normalization equation. The ideal solution (A^+) of 0.226 and the negative ideal solution of 0.179 were calculated from this matrix. (D^+) represents the distance to the ideal solution. In this analysis, 'Ineffective planning and scheduling' has a (D^+) of 0.000, indicating it as the most prevalent and crucial factor among the 24 identified delay factors. Conversely, 'Shortage of material' has the largest (D^+) of 0.046, signifying it as the least common and critical factor. (D^-) denotes the distance to the negative ideal solution. The table indicates that 'Shortage of

Material' has the smallest (D^{-}) of 0.0, confirming its status as the least common and impactful factor. Meanwhile, 'Ineffective planning and scheduling' has the greatest (D^{-}), reinforcing its position as the most common and critical delay factor among the 24 identified.

Table 7. Normalized decision matrix and distances.

No	Delay factor	Normalization	D^{+}	D^{-}
1	F1	0.226	0.000	0.046
2	F2	0.213	0.012	0.034
3	F3	0.215	0.011	0.035
4	F4	0.221	0.004	0.042
5	F5	0.219	0.007	0.040
6	F6	0.206	0.020	0.026
7	F7	0.179	0.046	0.000
8	F8	0.197	0.029	0.018
9	F9	0.185	0.041	0.005
10	F10	0.188	0.037	0.009
11	F11	0.186	0.040	0.007
12	F12	0.225	0.001	0.045
13	F13	0.198	0.027	0.019
14	F14	0.200	0.026	0.021
15	F15	0.192	0.034	0.012
16	F16	0.199	0.026	0.020
17	F17	0.210	0.015	0.031
18	F18	0.195	0.031	0.015
19	F19	0.190	0.035	0.011
20	F20	0.209	0.017	0.029
21	F21	0.213	0.012	0.034
22	F22	0.223	0.003	0.043
23	F23	0.198	0.028	0.018
24	F24	0.204	0.022	0.024

Note: **Table 7** utilized the identical order of delay factors as **Table 6**. Within the table, the letter F denotes the Factor of delays.

The outcomes and conclusions of the TOPSIS method are presented in **Table 8**. This encompasses the TOPSIS scores, represented by the closeness coefficient (CCi), and the subsequent ranking of construction delay factors. The proximity of each delay factor to the ideal solution is indicated by its closeness coefficient, which forms the basis for the ranking. This reveals that 'Ineffective Planning and Scheduling' has the highest closeness coefficient (CCi) of 1, identifying it as the most significant and widespread delay factor among those considered. In contrast, 'Shortage of Material' has the lowest closeness coefficient (CCi) of 0, marking it as the least common and impactful delay factor. The findings emphasize the need for immediate corrective actions and strategies to address the highest-ranked construction delay factors. Moreover, a Delphi method was employed to suggest appropriate measures for addressing the delay factors. **Figure 6** visually synthesizes the top-ranked delay factors within the stakeholder-based structure of the conceptual framework. While the top delay factors were grouped by stakeholder responsibility, this study does not model causal interactions among factors. Future studies may apply structural modeling techniques to explore interdependencies.

Table 8. Ranking of delay factor based on TOPSIS score.

No	Delay factor	TOPSIS score (CCi)	Rank
1	Ineffective planning and scheduling by the contractor	1.000	1
2	Escalation (increase) of material prices	0.984	2
3	Impractical allocation of resources	0.937	3
4	Unskilled workforce and poor labor productivity	0.905	4
5	Financial problems and payment delays by client	0.857	5
6	Poor site management and supervision by a contractor	0.762	6
7	Excessive bureaucracy of client organization	0.730	7
8	Slow decision by the client	0.730	8
9	Political influence	0.667	9
10	Lack of communication and coordination between project parties	0.635	10
11	Financial difficulties of the contractor	0.571	11
12	Influence of social disturbance and local culture (poor stakeholder management)	0.524	12
13	Natural calamities (floods, heat waves, snowfall)	0.444	13
14	Mistakes and defective works during construction	0.429	14
15	Obtaining a permit from the municipality (Government)	0.413	15
16	Insecurity and warlord intervention	0.397	16
17	Inadequate contractor experience	0.381	17
18	Equipment and machinery shortage	0.333	18
19	Changes by client	0.279	19
20	Mistakes and discrepancies in design documents by the consultant	0.238	20
21	Delay in preparation and approval of drawing	0.190	21
22	Delivery of material to site	0.143	22
23	Delay due to subcontractor	0.111	23
24	Shortage of material	0.000	24

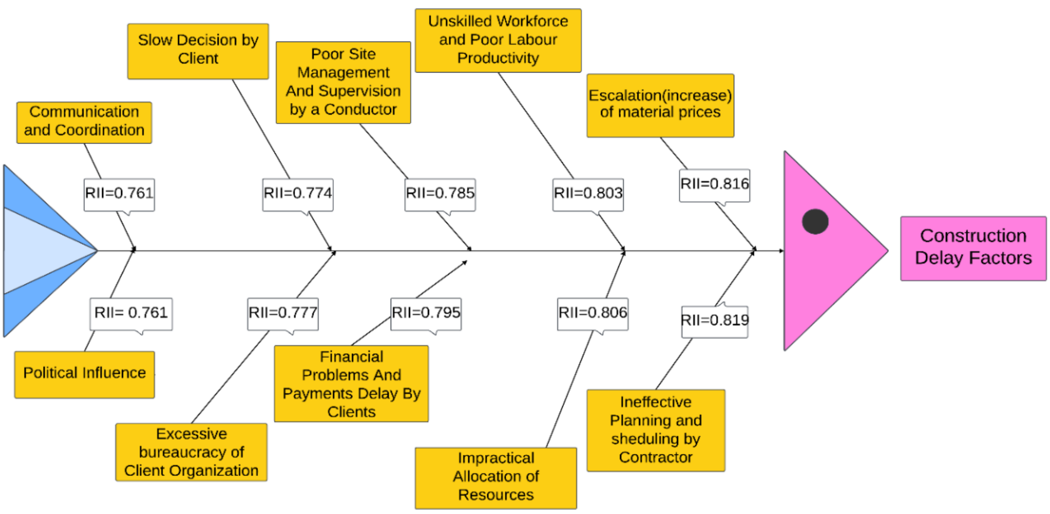

Figure 6. Fishbone diagram of top 10 delay factors using the RII method.

Tables 9 and **10** present the significant delay factors ranked according to their RII and TOPSIS scores, respectively. A delay factor 'Ineffective planning and scheduling by the contractor', with a Relative importance index (RII) of 0.819 and a TOPSIS score of 1, this contractor-related factor exerts the greatest influence on project duration and contributes very highly to delays. This factor ranked first, indicating its dominant influence on project delays. The delay factor 'Escalation (increase) of material prices' has an RII value of 0.816 and a TOPSIS score of 0.984. This is an external-related delay factor that contributes significantly to project delays. The ranking of this delay factor is 2nd in the top ten delay factors. 'Impractical allocation of resources (Misuse, corruption)' with an RII value of 0.806 and a TOPSIS score of 0.937, this client-related delay factor contributes very highly to causing project setbacks. It ranks 3rd amongst the top ten delay factors. 'Unskilled workforce and poor labor productivity' is the 4th ranked delay factor and has a high contribution to project delays. This contractor-associated delay factor has an RII value of 0.803 and a TOPSIS score of 0.905. 'Financial problems and payment delays by clients' have been associated with clients playing a substantial role in project setbacks, as demonstrated by its RII of 0.795 and TOPSIS score of 0.857. It ranks fifth amongst the leading ten delay factors. The factor 'Poor site management & supervision by the contractor' is associated with contractors playing a substantial role in project duration, as demonstrated by its RII of 0.785 and TOPSIS score of 0.762. Ranking 6th amongst the top ten delay factors, this particular delay has a high contribution to project timelines. 'Excessive bureaucracy of client organization' is a contractor-related delays that significantly impact project timelines, as evidenced by the RII of 0.777 and TOPSIS score of 0.730. This particular delay factor ranks 7th among the top ten causes of project delays, indicating its high contribution to project delays. A delay factor, 'A slow decision by the client', is ranked 8th among the top ten causes of project delays, highlighting its high contribution to project delays. It is a client-related delay factor with a 0.774 RII and 0.730 TOPSIS score. A delay factor, 'Political influence', associated with external factors significantly impacts project schedules, as evidenced by the RII of 0.761 and the TOPSIS score of 0.667. This particular delay factor ranks 9th among the top ten causes of project setbacks, underscoring its high contribution in hindering project progress. The delay factor 'Lack of communication and coordination between project parties' is related to contractors having an RII of 0.761 and a TOPSIS score of 0.635. This specific cause of delay is ranked 10th amongst the primary reasons for project holdups, highlighting its high contribution to project delays.

Table 9. Top 10 key delay factors using RII values.

Rank	Delay factors	RII	Group related	Contribution
1	Ineffective planning and scheduling by contractor	0.819	Contractor	Very high
2	Escalation of material prices	0.816	External	Very high
3	Impractical allocation of resources	0.806	Client	Very high
4	Unskilled workforce and poor labor productivity	0.803	Contractor	Very high
5	Financial problems and payment delays by client	0.795	Client	High
6	Poor site management & supervision by contractor	0.785	Contractor	High
7	Excessive bureaucracy of client organization	0.777	Contractor	High
8	Slow decision by the client	0.774	Client	High
9	Political influence	0.761	External	High
10	Lack of communication and coordination between project parties	0.761	Contractor	High

The Delphi technique was utilized to formulate strategies for mitigating the identified delay factors. Following the ranking of these factors using RII and TOPSIS methodologies, the top 10 were chosen for in-depth examination. Subsequently, the

Delphi method was applied to these 10 factors to organize mitigation solutions. The mitigation approaches based on the opinion of experts for the leading 10 delay factors are presented below. Although several mitigation measures are commonly reported in the literature, their effectiveness in Balochistan depends on addressing governance bottlenecks, security coordination, and political interference, which are structurally embedded challenges in the region.

Table 10. Top 10 key delay factors using TOPSIS score.

No	Delay factor	TOPSIS score (CCi)	Rank
1	Ineffective planning and scheduling by the contractor	1.000	1
2	Escalation of material prices	0.984	2
3	Impractical allocation of resources	0.937	3
4	Unskilled workforce and poor labor productivity	0.905	4
5	Financial problems and payment delays by client	0.857	5
6	Poor site management and supervision by a contractor	0.762	6
7	Excessive bureaucracy of client organization	0.730	7
8	Slow decision by the client	0.730	8
9	Political influence	0.667	9
10	Lack of communication and coordination between project parties	0.635	10

Ineffective planning and scheduling by the contractor:

- Ensuring adequate time for feasibility and detailed design studies;
- WBS, critical activity identification, and risk mitigation strategies;
- Proper project management by contractors;
- Gantt chart and performance bond requirement;
- Providing funds and securing a design lock upon the award of the tender;
- Pre-qualification of the contractor;
- Liquidated damages charges are imposed;
- Utilizing construction management software and pert.

Escalation of material prices:

- Inclusion of escalation clause in contract agreement;
- Timely execution with a focus on critical activities, teamwork, and resource readiness;
- Advance release for early purchase of major project items;
- Fixed price range with compensation;
- Consider alternative materials;
- Adding the expected inflation rate on materials during designing and tendering.

Impractical allocation of resources:

- Securing funds based on financial phasing;
- Efficient resource management;
- Restructuring government departments for modern efficiency;
- Client or end-user should deploy their experts;
- Implementation of cost control techniques;
- Strict policies for violations of discipline;
- Empowering decision-makers;

- Ensure attentive on-site monitoring;
- Pre-work surveys and quality management.

Unskilled workforce and poor labor productivity:

- Establishing continuous learning initiatives;
- Offering competitive salaries;
- Hire skilled workers and assign tasks accordingly;
- Ensure pre-qualification of contractors;
- Using performance metrics and incentives;
- Ensuring proper supervision;
- Communication through literature, surprise visits.

Financial problems and payment delays by clients:

- Adopt FIDIC contracts with fixed timelines for IPC review and payment processing;
- Timely allocation of funds and payments;
- Ensure full project funding and streamline processes using modern technology;
- Exclude non-strategic and low-impact projects from public programs;
- Including third-party investment;
- Renegotiating payment terms and implementing penalties.

Poor site management & supervision by the contractor:

- Engaging qualified engineering staff and implementing capacity-building programs;
- Discouraging excessive subcontracting;
- Implementing a robust progress-tracking system;
- Appointing a client supervisor over the contractor's team;
- Effective contractor selection and clear communication strategies;
- Penalizing contractors as per tender clauses.

Excessive bureaucracy of the client organization:

- Ensure EPC or turnkey contract;
- Promoting independent departmental functioning;
- Using the latest software;
- Enforce time-bound NOCs and compliance;
- Clear and well-defined contract terms;
- Implementing an E-Filing system.

A slow decision by the client:

- Conducting periodic meetings with the client;
- Minimize interventions by the unrelated top hierarchy;
- Confirming design and material approvals before execution;
- Using BIM;
- Adjustment of completion period for client-caused delays;
- Accurate data collection from the site.

Political influence:

- Training political leaders;

- Defining and specifying labor unions' roles;
- Contingencies in estimates;
- Effective stakeholder engagement;
- Reducing MPA involvement;
- Stay informed on local politics and adapt risk plans;
- Win-Win Solution: Collaborative conflict resolution for mutual benefit;
- Correct clauses inclusion in the contract.

Lack of communication and coordination between project parties:

- Establishing a project steering committee;
- Digital communication channels and involvement of technical experts;
- Using BIM;
- Establishing a clear communication chain;
- Conduct weekly or monthly meetings.

6. Conclusion

This paper presents delay analysis beyond generally accepted causes and contextualizes it inside politically fragile and institutionally limited places by empirically demonstrating how governance- and security-related issues fundamentally interact with conventional delay drivers. The results validate the continued dominance of contractor- and client-related factors, but they are greatly amplified by region-specific factors such as political meddling, institutional inefficiencies, security issues, and post-disaster recovery pressures. Balochistan differs from other areas studied in earlier delay studies due to this contextual amplification. This study carefully investigated the reasons behind public-sector building construction delays in Balochistan, Pakistan, utilizing a mixed-methods approach that includes RII, TOPSIS, and the Delphi technique. The findings confirm the ongoing dominance of factors relating to contractors and clients, but they are significantly exacerbated by region-specific factors such as institutional inefficiencies, political intervention, security concerns, and post-disaster recovery demands. Balochistan varies from other areas analyzed in past delay studies due to this contextual amplification. These results imply that delays are not only operational mistakes but rather are ingrained in larger administrative and political systems, supporting the institutional and project governance viewpoint that forms the basis of the conceptual framework. The suggested mitigation solutions should be understood in the context of Balochistan's governance and security, where institutional reforms, political coordination, and security-conscious planning must be added to traditional project management techniques.

A disaggregated comparative study among customers, contractors, and consultants was not carried out, despite the fact that delay reasons were characterized by stakeholder responsibility. The sample size and the requirement to maintain statistical robustness are the causes of this restriction. As a result, rather than statistically distinguished group-specific rankings, the results represent the opinions of all stakeholders. To investigate stakeholder-level divergences, future research with larger stratified samples may use structural modeling or multi-group analysis.

In summary, this study adds to the body of knowledge on building delays by including regional institutional characteristics into delay analysis. It also lays the groundwork for future scholarly research in fragile and underdeveloped construction environments as well as policy-oriented reforms.

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