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CRITICAL SUPPLY CHAIN INEFFICIENCIES IN PAKISTAN'S CONSTRUCTION INDUSTRY: EMPIRICAL EVIDENCE FROM INDUSTRY PROFESSIONALS

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Abstract

The construction industry in Pakistan continues to experience persistent project delays, cost overruns, and stakeholder disputes, largely driven by inefficiencies within supply chain management practices. Despite the sector's economic importance, empirical evidence systematically identifying the nature and severity of these inefficiencies remains limited. This study investigates the critical supply chain challenges affecting construction project performance in Pakistan using a quantitative, cross-sectional research design. Data were collected through a structured questionnaire administered to 108 construction professionals, including project managers, contractors, engineers, and supply chain specialists. Descriptive statistical techniques, frequency analysis, and one-sample t-tests were employed to examine operational, financial, governance, and coordination-related inefficiencies within the construction supply chain.

The results reveal statistically significant evidence of widespread supply chain inefficiencies across all examined dimensions. Inefficient procurement processes, delayed payments, and weak contract management emerged as the most prominent contributors to cost overruns, while fragmented communication among stakeholders was identified as a major source of resource mismanagement. Governance-related challenges, particularly limited transparency and trust in financial transactions, were found to contribute substantially to dispute occurrence. Furthermore, the findings indicate that a considerable proportion of construction projects experience moderate to high schedule overruns, frequently exceeding 50% of planned timelines due to supply chain disruptions. Reliability analysis confirmed strong internal consistency of the measurement instrument, supporting the robustness of the empirical results.

This study contributes to the construction management literature by providing practitioner-based empirical evidence of systemic supply chain inefficiencies in a developing economy context. The findings offer practical insights for industry stakeholders and policymakers, emphasizing the need for improved procurement practices, strengthened contractual frameworks, and enhanced coordination mechanisms. The study also establishes a foundation for future research and

digital transformation initiatives aimed at improving construction supply chain performance in Pakistan.

Introduction

The construction industry is among the most resource-intensive and fragmented sectors globally, involving complex networks of suppliers, contractors, and regulatory stakeholders. As projects become more multifaceted and geographically dispersed, efficient supply chain management (SCM) has emerged as a vital determinant of project success. Construction supply chains differ fundamentally from manufacturing due to their project-based nature, temporary organizational structures, and reliance on multiple subcontractors. This complexity frequently leads to inefficiencies such as procurement delays, poor coordination, communication breakdowns, and cost overruns (Papadopoulos et al., 2016). Consequently, understanding and mitigating supply chain inefficiencies have become a pressing research and managerial concern in modern construction project management.

Globally, the construction industry contributes significantly to GDP, employment, and infrastructure development. However, inefficiencies in its supply chain operations continue to impede productivity and sustainability. Fragmentation within the sector has been identified as a primary barrier to effective SCM implementation (McDermotti & Khalfan, 2012). Each construction project typically involves numerous independent entities clients, contractors, suppliers, designers, and regulatory bodies whose objectives may not align. This lack of integration often results in communication delays, resource mismanagement, and suboptimal decision-making. Studies indicate that up to 30% of total project costs in construction stem from inefficiencies in materials management and logistics (Heaton et al., 2022).

Supply chain inefficiencies in construction can be categorized into operational, financial, informational, and governance-related domains. Operational inefficiencies—such as delays in procurement, inadequate resource allocation, and rework—are among the most pervasive issues. Inefficient procurement and material handling processes remain dominant contributors to project delays (Fugalis & Migilinskas, 2020). Furthermore, labor shortages and the lack of skilled professionals amplify operational bottlenecks. Financial inefficiencies manifest in delayed payments, poor contract management, and limited funding availability, leading to liquidity problems across the value chain (Jaisree & Palani, 2024). The irregularity of cash flow severely affects smaller subcontractors, often resulting in project discontinuities and disputes.

Governance and transparency are equally significant challenges. Construction supply chains are frequently marred by weak regulatory frameworks, unclear contractual obligations, and insufficient accountability mechanisms (Nazifa et al., 2019). The lack of digital transparency and traceability exacerbates disputes, particularly in financial transactions and material verification. As projects expand in scale and complexity, trust between stakeholders becomes crucial for mitigating risk and ensuring compliance. Digital technologies, including Building Information Modeling (BIM), blockchain, and data analytics, have been proposed as potential solutions to improve traceability and accountability in construction supply chains (Rehman et al., 2024). However, adoption rates remain uneven across regions and firms, largely due to cost, lack of training, and resistance to change.

Another persistent inefficiency arises in the coordination of schedules and timelines. Construction projects often face schedule overruns due to material shortages, inadequate logistics planning, and unexpected design changes. Studies show that up to 70% of construction projects experience some level of schedule overrun attributable to supply chain disruptions (Pan et al., 2011). Delays in material delivery, compounded by unreliable supplier performance, frequently force project rescheduling and resource idling. Moreover, poor forecasting and inadequate use of predictive analytics limit the ability of firms to anticipate risks and optimize logistics. As a result, project managers often react to inefficiencies

rather than proactively mitigating them (Elmughrabi et al., 2020).

Communication and coordination challenges also represent a substantial source of inefficiency. Fragmented information systems, lack of real-time updates, and siloed communication channels hinder collaboration among stakeholders (Papadopoulos et al., 2016). Many construction projects still rely on outdated communication mechanisms, such as paper documentation and unintegrated spreadsheets. This inefficiency leads to discrepancies between design and execution, duplicated efforts, and misallocation of resources. The introduction of centralized digital platforms for coordination enabled through cloud-based project management systems—has been shown to reduce such inefficiencies, improving material tracking and information flow (Doroshenko et al., 2023).

Globally, research indicates that inefficiencies in construction supply chains contribute significantly to cost overruns and reduced profitability. According to empirical evidence, inefficient coordination among project participants can result in productivity losses exceeding 25% of total project time (Cigolini et al., 2020). Furthermore, recurring issues such as contractual disputes, lack of data transparency, and weak risk-sharing mechanisms perpetuate inefficiencies across project cycles. Despite advances in SCM theory and practice, the construction sector continues to lag behind manufacturing and logistics industries in adopting integrated management frameworks (Phong, 2018). The transient nature of construction projects, coupled with the absence of standardized supply chain processes, creates barriers to sustainable efficiency improvement.

Recent studies emphasize the importance of collaboration and integration in mitigating inefficiencies. Collaborative planning, supplier relationship management, and early contractor involvement have been identified as effective mechanisms for enhancing performance and reducing waste (Wibowo & Sholeh, 2015). Integrated supply chains foster trust and knowledge sharing, enabling better synchronization of activities and more accurate forecasting. Advanced digital technologies are increasingly central to this transformation, allowing real-time data exchange and predictive analytics for decision-making (Rehman et al., 2024).

This study aims to investigate the nature and extent of supply chain inefficiencies within construction projects through quantitative analysis. By examining five key dimensions operational, financial, governance, scheduling, and coordination inefficiencies—the research seeks to provide a comprehensive understanding of the systemic challenges faced by industry practitioners. Previous research has identified these dimensions as interdependent, with inefficiencies in one domain often amplifying weaknesses in others (McDermotti & Khalfan, 2012). The study thus employs a multi-variable approach to capture the full spectrum of supply chain disruptions impacting project outcomes.

Moreover, this research contributes to the growing discourse on construction SCM by quantifying inefficiency patterns and identifying areas for strategic improvement. It highlights the role of integrated digital systems, collaborative frameworks, and governance reform as pathways toward more resilient and efficient construction supply chains. As global infrastructure demand continues to rise, optimizing construction supply chain processes becomes indispensable not only for cost and time management but also for sustainability and competitiveness (Czajkowska & Ingaldi, 2025). By bridging the gap between theoretical models and practical realities, this study seeks to inform policymakers, industry leaders, and researchers on how to develop adaptive, technology-driven strategies for mitigating inefficiencies in construction project supply chains.

1 Methodology

1.1 Research Design

This study adopted a quantitative, cross-sectional survey research design to examine critical supply chain inefficiencies within Pakistan's construction industry. The quantitative approach was selected to enable systematic measurement and statistical comparison of responses obtained from a broad range of construction professionals. A cross-sectional design was considered appropriate as the research aimed to capture industry perceptions at

a single point in time rather than tracking changes longitudinally. This design facilitated efficient data collection while allowing for the identification of prevailing patterns related to project delays, cost overruns, and dispute occurrences. The structured nature of the design ensured consistency across responses and supported objective analysis aligned with the study's research questions.

1.2 Data Collection

Data were collected using a structured, self-administered questionnaire designed to capture respondents' assessments of supply chain inefficiencies in construction projects. The questionnaire comprised closed-ended items with predefined response categories, enabling quantitative analysis through frequency and percentage distributions. It was distributed electronically to construction professionals operating in various regions of Pakistan to enhance geographical coverage and accessibility. Participation was voluntary, and respondents were assured of anonymity and confidentiality to encourage candid responses. All questionnaires were screened for completeness, resulting in a final dataset with no missing values. This approach ensured data quality and consistency for subsequent statistical analysis.

Table 1 Survey Question Themes, Coding Structure, and Response Categories

Survey Question	Main Theme	Code	Response Category
Q1	Supply Chain Operational and Workforce Inefficiencies	1	Lack of skilled labor
		2	Inefficient procurement processes
		3	Excessive use of technology
		4	Over-regulation of the industry
Q2	Financial and Contractual Management Deficiencies	1	Strict quality control standards
		2	Inefficient contract management and delayed payments
		3	Limited government funding for projects
		4	Overuse of heavy machinery
Q3	Governance, Transparency, and Trust Issues	1	Advanced digital record-keeping systems
		2	Clear and well-defined contractual agreements
		3	Lack of transparency and trust in financial transactions
		4	Strong legal frameworks for contract enforcement
Q4	Severity and Prevalence of Schedule Performance Risks	1	30% schedule overrun
		2	50% schedule overrun
		3	70% schedule overrun
		4	90% schedule overrun
Q5	Coordination, Communication, and Information Flow Inefficiencies	1	Predictive analytics for supply chain optimization

1.3 Sample Characteristics

The final sample consisted of 108 valid responses from professionals actively engaged in the construction industry. Respondents represented a diverse range of professional roles, including project managers, contractors, supply chain specialists, and engineers, ensuring broad sectoral representation. Participants' professional

experience varied from early-career professionals to individuals with more than ten years of industry experience, providing perspectives from different career stages. The inclusion of respondents with varied roles and experience levels enhanced the robustness of the dataset and supported comprehensive assessment of supply chain inefficiencies across multiple organizational functions within the construction sector.

1.4 Data Analysis

The collected data were analysed using descriptive statistical techniques, consistent with the exploratory objectives of the study. Frequency analysis and percentage distributions were employed to summarize response patterns and identify dominant supply chain issues. The analysis focused on three key areas: project delays, cost overruns, and causes of disputes among stakeholders. These techniques enabled clear representation of the prevalence and distribution of identified inefficiencies across the sample. All statistical analyses were conducted using standard statistical software, ensuring accuracy and reproducibility. The use of descriptive statistics provided an empirical foundation for presenting results in a clear and transparent manner, aligned with the study's methodological framework.

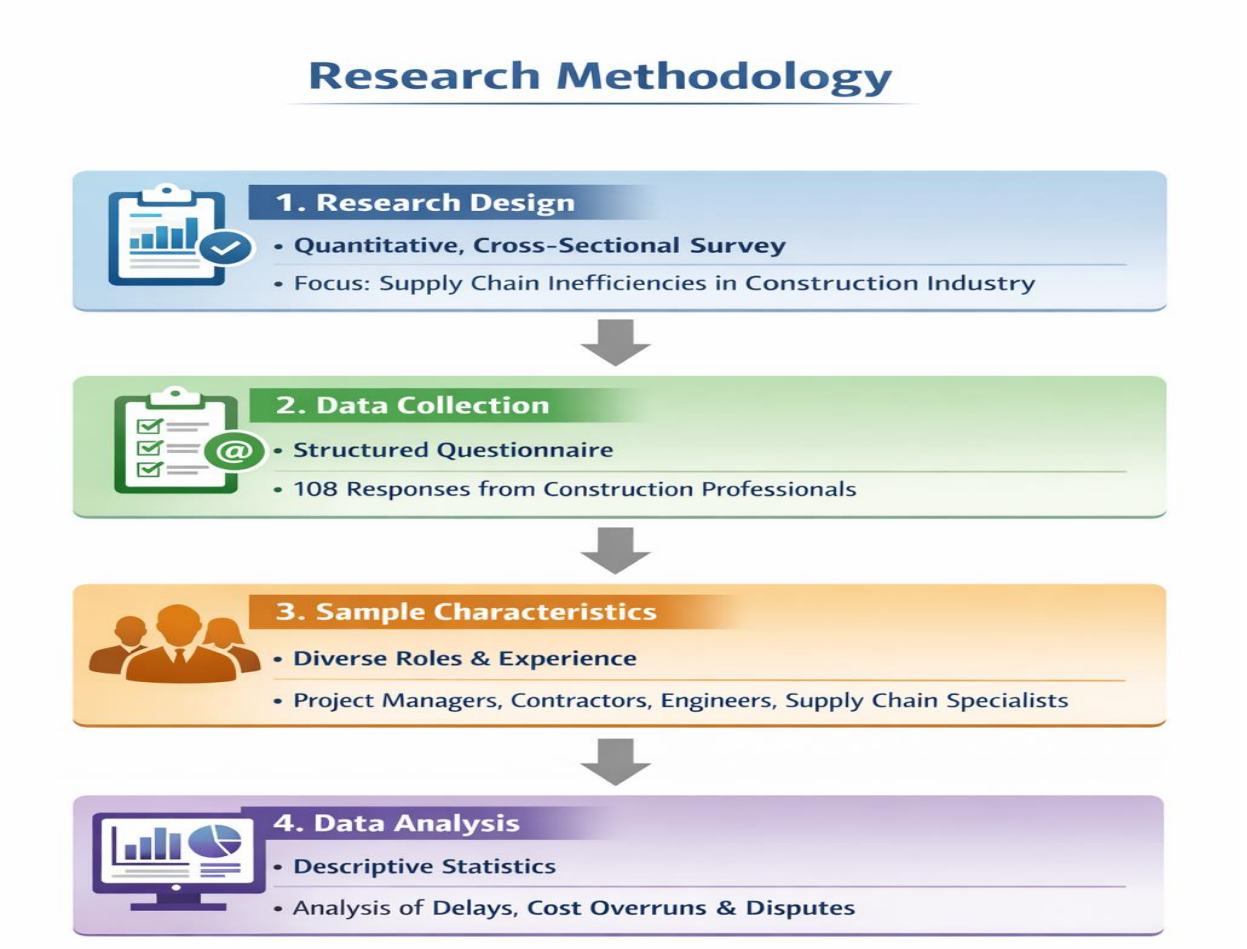


Figure 1 Flowchart illustrating the research methodology adopted in this study, showing the sequential process from quantitative cross-sectional research design and data collection through sample characteristics to descriptive data analysis of supply chain inefficiencies in Pakistan's construction industry.

Results

Demographic characteristics

The demographic profile of the respondents provides a comprehensive overview of the professional composition, experience level, and project exposure of participants within the construction industry, offering a robust foundation for interpreting subsequent analyses. The sample consisted of 108 valid responses, reflecting a diverse yet industry-representative distribution of roles. Civil engineers constituted the largest proportion of respondents (38.0%), indicating a strong technical and design-oriented perspective within the dataset. This was followed by supply chain specialists (24.1%), whose significant presence underscores the growing importance of procurement, logistics, and materials management in contemporary construction projects. Project managers accounted for 21.3% of the respondents, highlighting managerial and coordination expertise, while contractors represented 14.8%, contributing practical, execution-focused insights. A small proportion of respondents (1.9%) identified under "other" roles, suggesting minimal but relevant representation from auxiliary or hybrid positions. Collectively, this role distribution demonstrates a balanced mix of strategic, technical, and operational viewpoints, enhancing the reliability and generalizability of the study findings across multiple functional domains of the construction industry.

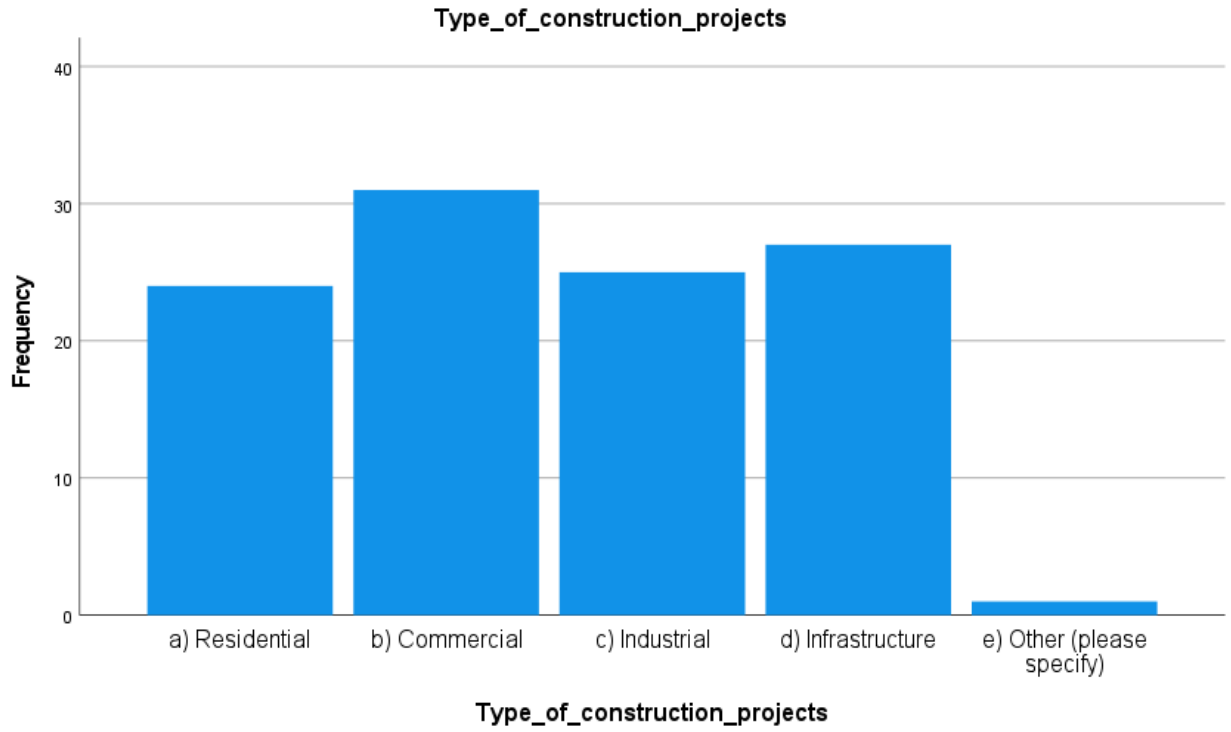


Figure 2 Distribution of Respondents by Professional Role in the Construction Industry

In terms of professional experience, the respondents exhibited a moderate to high level of industry exposure. The majority had between 6 and 10 years of experience (37.0%), followed closely by those with 2 to 5 years of experience (31.5%). This indicates that nearly 70% of the participants are mid-career professionals who are likely to possess both practical knowledge and adaptability to evolving industry practices. Respondents with less than 2 years of experience accounted for 18.5%, introducing perspectives from early-career professionals who may be more attuned to recent technological and educational developments. Conversely, individuals with more than 10 years of experience comprised 13.0% of the sample, contributing seasoned insights

grounded in long-term industry exposure. This distribution suggests a healthy mix of experience levels, reducing bias toward either novice or highly entrenched viewpoints and supporting a nuanced understanding of industry dynamics.

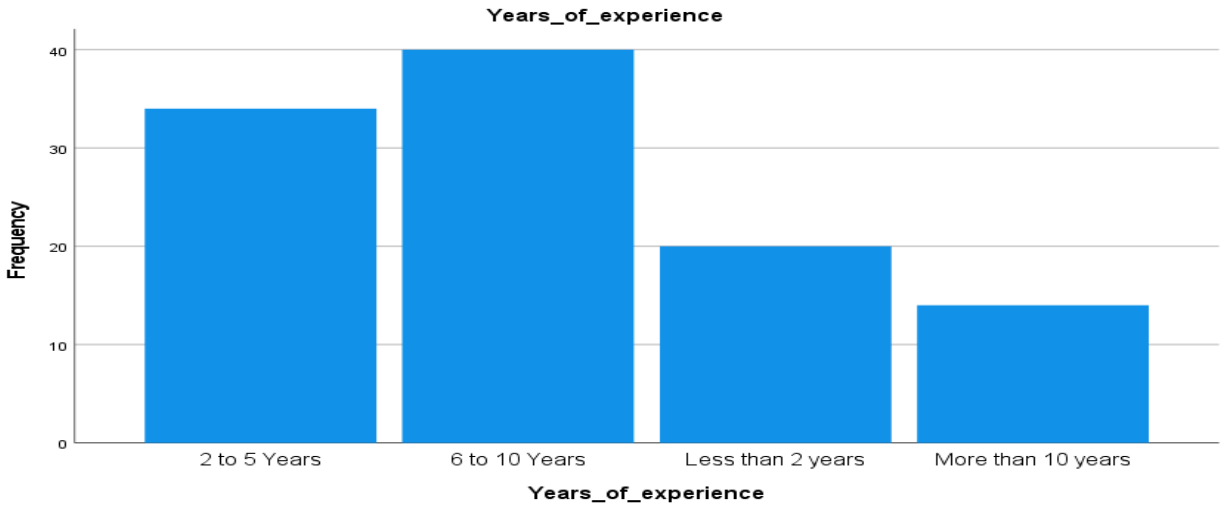


Figure 3 Years of Professional Experience of Survey Respondents

Regarding the type of construction projects handled by respondents, the sample reflects broad sectoral coverage. Commercial projects were the most frequently represented (28.7%), followed by infrastructure projects (25.0%), industrial projects (23.1%), and residential projects (22.2%). The relatively even distribution across these four major construction sectors indicates that the respondents' experiences are not concentrated within a single project type, thereby enhancing the external validity of the study. The minimal representation of "other" project types (0.9%) further suggests that the core sectors of the construction industry are adequately captured.

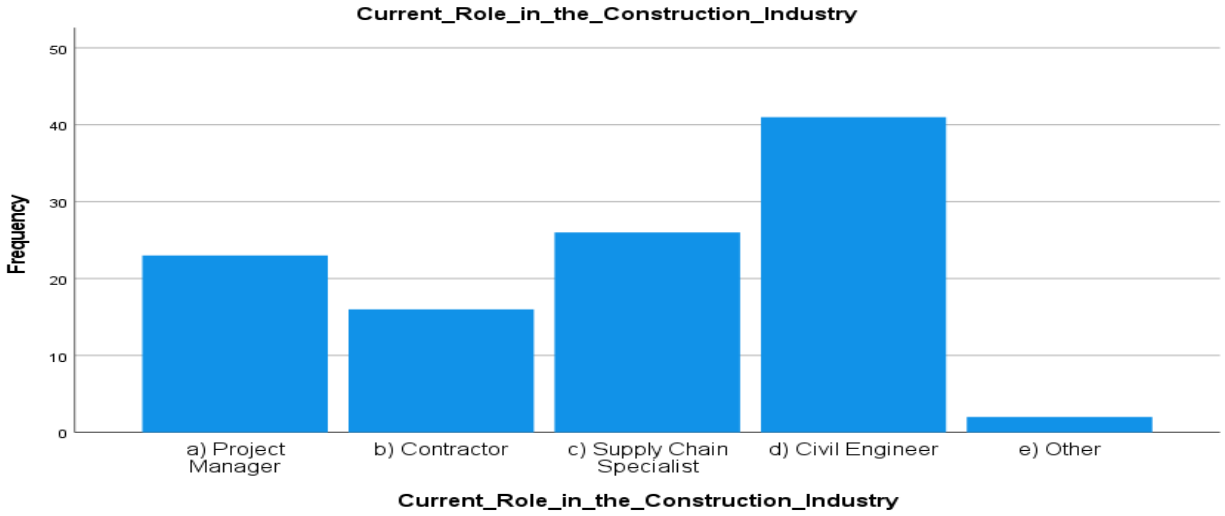


Figure 4 Primary Construction Project Types Represented by Survey Respondents

2.2 Reliability analysis

The internal consistency of the measurement instrument was assessed using Cronbach's alpha to evaluate the reliability of the five-item scale measuring supply chain inefficiencies. The analysis produced a Cronbach's alpha value of 0.873 across the five items. This value exceeds commonly accepted thresholds for reliability, indicating a high level of internal consistency among the items included in the scale. The result suggests that the five survey questions exhibit a strong degree of interrelatedness and are measuring a coherent underlying construct. The number of items included in the reliability analysis was five, and all responses were complete, with no missing data. The obtained alpha value indicates that the scale demonstrates stable and consistent measurement properties within the sample. Overall, the reliability analysis confirms that the survey instrument is suitable for subsequent statistical analyses, as the items collectively function as a reliable measure of supply chain inefficiencies within the construction industry context.

2.3 Descriptive statistics

Descriptive statistics were computed for all five survey items related to supply chain inefficiencies using a valid sample of 108 responses. All variables were measured on a four-point scale, with observed values ranging from 1 to 4 across all items. The mean scores for the variables were closely clustered, ranging from 2.30 to 2.39, indicating a comparable distribution of responses across the constructs examined. Specifically, Q1 recorded a mean of 2.38 (SD = 0.964), Q2 a mean of 2.35 (SD = 0.900), Q3 a mean of 2.39 (SD = 0.946), Q4 a mean of 2.30 (SD = 0.960), and Q5 a mean of 2.36 (SD = 0.990).

Table 2 Descriptive Statistics for Supply Chain Inefficiency Variables (N = 108)

Item	N	Mean	Std. Deviation	Variance	Skewness	Kurtosis
Q1	108	2.38	0.964	0.929	0.062	−0.958
Q2	108	2.35	0.900	0.810	0.103	−0.749
Q3	108	2.39	0.946	0.894	0.023	−0.915
Q4	108	2.30	0.960	0.921	0.147	−0.951
Q5	108	2.36	0.990	0.981	0.218	−0.958

Measures of dispersion indicate moderate variability across responses, with standard deviations ranging between 0.900 and 0.990 and variances between 0.810 and 0.981. Skewness values for all items were positive but small, ranging from 0.023 to 0.218, suggesting a near-symmetrical distribution of responses. Kurtosis values were negative for all variables, ranging from −0.749 to −0.958, indicating relatively flat distributions without extreme peakiness. The standard errors for skewness (0.233) and kurtosis (0.461) were consistent across all items. No missing data were observed, and the valid N (listwise) remained 108 for all variables.

2.4 Q1: Supply Chain Operational and Workforce Inefficiencies

The frequency analysis for Q1 indicates that operational inefficiencies dominate perceptions of supply chain challenges. Inefficient procurement processes (Category 2) were the most frequently selected response, reported by 35 respondents (32.4%), followed closely by excessive use of technology (Category 3), selected by 36 respondents (33.3%). Together, these two categories account for 65.7% of responses, indicating their prominence among perceived operational inefficiencies. Lack of skilled labor (Category 1) was identified by 23 respondents (21.3%), while over-regulation of the industry (Category 4) received the lowest frequency, with 14 respondents (13.0%). The cumulative distribution shows that over half of the respondents (53.7%) selected either lack of skilled labor or inefficient procurement processes. The distribution demonstrates a concentration of responses in procurement- and process-related inefficiencies rather than regulatory constraints,

with relatively balanced representation across categories and no extreme concentration in a single response option.

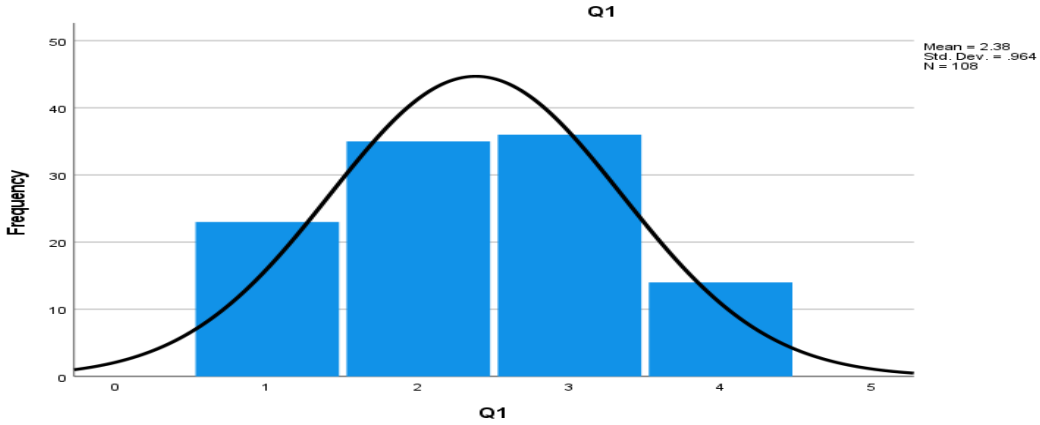


Figure 5 Distribution of Responses for Supply Chain Operational and Workforce Inefficiencies (Q1)

2.5 Q2: Financial and Contractual Management Deficiencies

Results for Q2 show that inefficient contract management and delayed payments (Category 2) represent the most frequently reported financial challenge, selected by 41 respondents (38.0%). Limited government funding for projects (Category 3) followed closely, with 36 respondents (33.3%). Combined, these two categories account for 71.3% of total responses, highlighting their dominance among perceived cost-related issues. Strict quality control standards (Category 1) were reported by 20 respondents (18.5%), while overuse of heavy machinery (Category 4) received the lowest frequency, selected by only 11 respondents (10.2%). The cumulative percentage indicates that over half of respondents (56.5%) identified either strict quality controls or contract and payment-related issues. The overall distribution reflects a clear clustering around contractual and funding-related deficiencies, with comparatively lower emphasis on equipment utilization as a contributor to cost overruns.

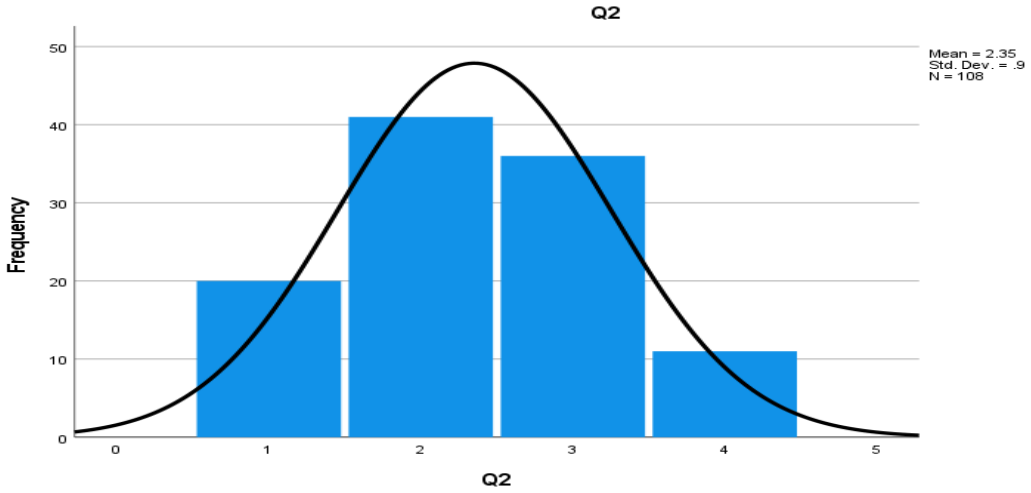


Figure 6 Frequency Distribution of Financial and Contractual Management Deficiencies Contributing to Cost Overruns (Q2)

2.7 Q3: Governance, Transparency, and Trust Issues

The frequency distribution for Q3 highlights governance and transparency concerns as key contributors to disputes in construction supply chains. Lack of transparency and trust in financial transactions (Category 3) was the most frequently selected response, reported by 38 respondents (35.2%). Clear and well-defined contractual agreements (Category 2) followed, with 35 respondents (32.4%). Together, these two categories account for 67.6% of responses, indicating their prominence in dispute-related issues. Advanced digital record-keeping systems (Category 1) were selected by 22 respondents (20.4%), while strong legal frameworks for contract enforcement (Category 4) received the lowest frequency at 13 respondents (12.0%). The cumulative distribution shows that more than half of respondents (52.8%) selected either digital records or contractual clarity. Overall, responses are concentrated around transparency and contract-related dimensions rather than formal legal enforcement mechanisms.

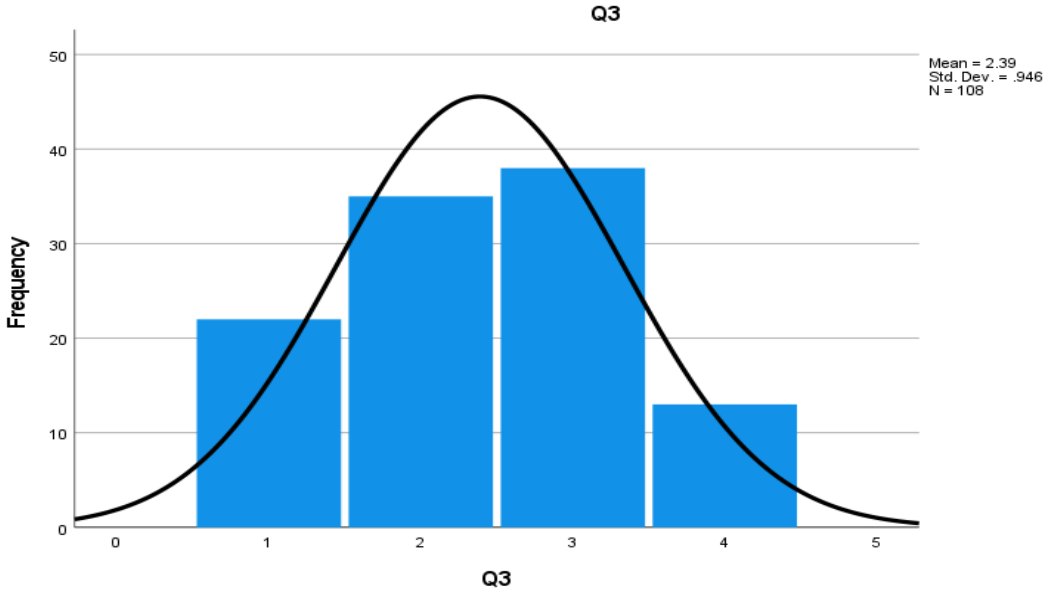


Figure 7 Response Distribution for Governance, Transparency, and Trust-Related Causes of Construction Supply Chain Disputes (Q3)

Q4: Severity and Prevalence of Schedule Performance Risks

The results for Q4 demonstrate variation in perceived levels of schedule overruns attributable to supply chain inefficiencies. The most frequently reported category was 50% schedule overrun (Category 2), selected by 36 respondents (33.3%). This was followed by 70% overruns (Category 3), reported by 34 respondents (31.5%). Combined, these two categories represent 64.8% of responses, indicating that moderate-to-high schedule overruns are widely reported. Lower overruns of 30% (Category 1) were identified by 26 respondents (24.1%), while extreme overruns of 90% (Category 4) were reported by 12 respondents (11.1%). The cumulative percentage indicates that 88.9% of respondents reported schedule overruns of 70% or less. The distribution suggests a concentration around mid-range overruns, with fewer respondents identifying extreme schedule impacts.

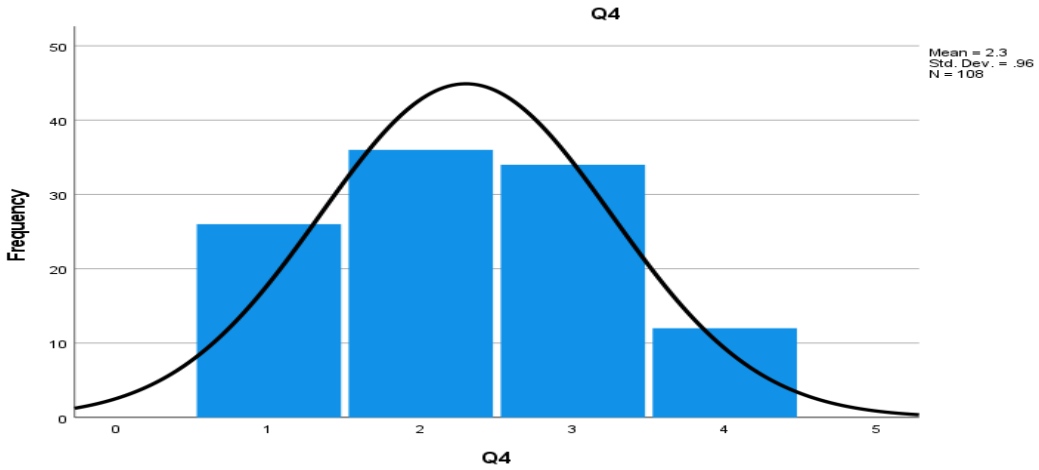


Figure 8 Reported Severity of Schedule Overruns Attributable to Supply Chain Inefficiencies (Q4)

2.9 Q5: Coordination, Communication, and Information Flow Inefficiencies

Frequency analysis for Q5 shows that fragmented communication among stakeholders (Category 2) is the most identified factor contributing to resource mismanagement, selected by 40 respondents (37.0%). Effective real-time tracking of materials (Category 3) was the second most frequent response, reported by 28 respondents (25.9%). Together, these categories account for 62.9% of responses. Predictive analytics for supply chain optimization (Category 1) was selected by 23 respondents (21.3%), while transparent procurement processes (Category 4) received 17 responses (15.7%). The cumulative distribution indicates that over half of respondents (58.3%) selected either predictive analytics or fragmented communication. Overall, responses emphasize coordination and information flow challenges more strongly than analytical or transparency-focused mechanisms, with fragmented communication emerging as the most frequently cited issue.

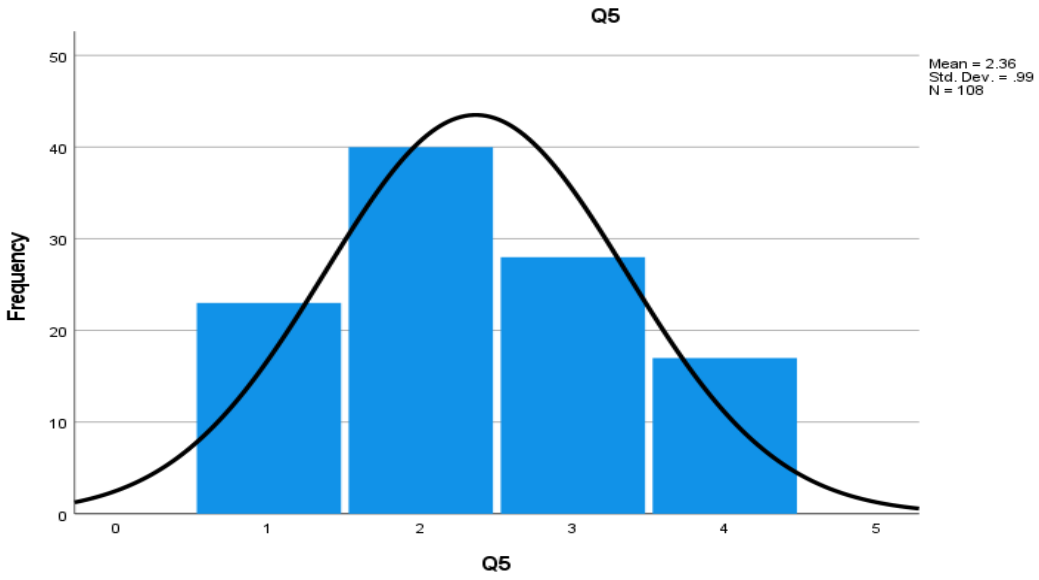


Figure 9 Frequency Distribution of Coordination, Communication, and Information Flow Inefficiencies in Construction Projects (Q5)

One-Sample t-Test Analysis

One-sample t-tests were conducted to evaluate whether the mean responses for each supply chain inefficiency variable differed significantly from the test value of zero. All five variables demonstrated statistically significant results at the 0.001 level (two-tailed), indicating that observed mean values were consistently greater than the test value. The degrees of freedom were identical across all tests (df = 107), reflecting a complete dataset with no missing observations.

For Q1, the mean score was 2.380 (SD = 0.964), producing a statistically significant result, $t(107) = 25.653$, $p < .001$. The mean difference was 2.380, with a 95% confidence interval ranging from 2.20 to 2.56. Q2 yielded a mean of 2.352 (SD = 0.900), with $t(107) = 27.163$, $p < .001$, and a 95% confidence interval between 2.18 and 2.52. Q3 recorded the highest mean score (M = 2.389, SD = 0.946), resulting in $t(107) = 26.255$, $p < .001$, with a confidence interval from 2.21 to 2.57.

Table 3 One-Sample t-Test Results for Supply Chain Inefficiency Variables (Test Value = 0)

Variable	t	df	Sig. (2-tailed)	Mean Difference	95% CI (Lower)	95% CI (Upper)
Q1	25.653	107	< .001	2.380	2.20	2.56
Q2	27.163	107	< .001	2.352	2.18	2.52
Q3	26.255	107	< .001	2.389	2.21	2.57
Q4	24.870	107	< .001	2.296	2.11	2.48
Q5	24.780	107	< .001	2.361	2.17	2.55

Similarly, Q4 demonstrated a mean of 2.296 (SD = 0.960), with $t(107) = 24.870$, $p < .001$, and a 95% confidence interval between 2.11 and 2.48. For Q5, the mean score was 2.361 (SD = 0.990), yielding $t(107) = 24.780$, $p < .001$, with the confidence interval ranging from 2.17 to 2.55. Across all variables, confidence intervals did not cross zero, confirming the robustness of the statistical findings.

Table 4 Standardized Effect Size Estimates for One-Sample t-Tests Using Cohen's d and Hedges' g

Variable	Effect Size Type	Standardiser	Point Estimate	95% CI (Lower)	95% CI (Upper)
Q1	Cohen's d	0.964	2.468	2.087	2.847
	Hedges' g	0.971	2.451	2.072	2.827
Q2	Cohen's d	0.900	2.614	2.215	3.010
	Hedges' g	0.906	2.595	2.199	2.988
Q3	Cohen's d	0.946	2.526	2.138	2.912
	Hedges' g	0.952	2.509	2.123	2.891
Q4	Cohen's d	0.960	2.393	2.020	2.763
	Hedges' g	0.966	2.376	2.006	2.744
Q5	Cohen's d	0.990	2.384	2.012	2.753
	Hedges' g	0.997	2.368	1.998	2.734

Effect size estimates further quantified the magnitude of these results. Cohen's d values ranged from 2.384 to 2.614, while Hedges' g values ranged from 2.368 to 2.595, with all corresponding confidence intervals remaining well above zero. These values indicate large, standardized effects across all five variables. The consistency between Cohen's d and Hedges' g estimates reflects minimal bias due to sample size and confirms the stability of the effect magnitude estimates across the dataset.

3 Discussion

The descriptive and inferential statistics presented indicate consistent perceptions of supply chain inefficiencies among respondents, reflecting a moderate degree of operational, financial, and informational challenges within construction supply chains. The relatively uniform mean scores across all five variables (ranging from 2.30 to 2.39) suggest a broad consensus that inefficiencies are systemic rather than isolated. This aligns with findings from prior studies emphasizing that fragmentation, inadequate integration, and poor communication are persistent barriers in construction supply chains (Papadopoulos et al., 2016).

The dispersion indicators (standard deviations between 0.900 and 0.990) show moderate variability, implying that while perceptions of inefficiencies vary, they remain generally consistent across respondents. The near-zero skewness values and negative kurtosis reveal a relatively symmetrical and flat distribution, indicating that extreme perceptions of inefficiency were rare. This suggests that inefficiencies are perceived as moderate but widespread — a pattern frequently reported in empirical studies of construction SCM, where chronic but moderate inefficiencies in procurement, scheduling, and coordination lead to cumulative performance deficits (McDermotti & Khalfan, 2012).

The results of Q1 demonstrate that operational inefficiencies—specifically inefficient procurement processes and excessive reliance on technology—constitute the primary operational barriers. These findings echo prior research showing that procurement-related fragmentation and uncoordinated technological adoption impede collaboration and value flow across construction networks (Fugalis & Migilinskas, 2020). Moreover, the combination of procurement and labor inefficiencies accounting for over half of responses reflects a broader workforce and process misalignment issue, which has been observed across global construction markets (Cigolini et al., 2020).

For Q2, financial and contractual inefficiencies, particularly delayed payments and contract mismanagement, emerged as dominant concerns. These findings are consistent with the extensive body of evidence identifying poor financial flow and contractual rigidity as critical sources of inefficiency (Elmughrabi et al., 2020). Delayed payments disrupt liquidity across the supply chain, impeding smaller subcontractors' ability to deliver on time. Furthermore, limited government funding exacerbates cost overruns, particularly in public infrastructure projects, where bureaucratic constraints and tender delays further degrade efficiency (Jaisree & Palani, 2024).

Q3 findings underscore governance and transparency deficiencies as principal causes of disputes. Lack of transparency and inadequate trust mechanisms between financial actors reflect weak institutional governance structures, particularly in developing construction markets. Similar conclusions have been drawn in comparative studies, where fragmented governance and contract opacity were found to heighten risks of miscommunication and disputes (Nazifa et al., 2019). Respondents' emphasis on transparency suggests growing awareness of digital accountability tools such as blockchain and BIM integration, which can mitigate such risks (Rehman et al., 2024).

The results for Q4, focusing on schedule performance, revealed that moderate-to-high overruns (50–70%) are prevalent, which aligns with industry trends indicating persistent scheduling inefficiencies caused by poor coordination and resource allocation (Pan et al., 2011). The fact that 88.9% of respondents reported overruns below 70% reflects that while schedule inefficiencies are pervasive, they remain manageable rather than catastrophic. The literature identifies several causal factors, including unreliable suppliers, ineffective material tracking, and poor logistics integration (Wibowo & Sholeh, 2015).

Q5 emphasized communication and coordination failures, with fragmented stakeholder communication emerging as the most critical issue. The dominance of this variable (37%) resonates with evidence suggesting that lack of information sharing is a fundamental bottleneck in construction supply chains (Heaton et al., 2022). Poor data flow between stakeholders not only hampers real-time decision-making but also fosters duplication of effort and delays.

Integration of predictive analytics and digital monitoring technologies has been proposed as a corrective strategy to enhance coordination and transparency (Doroshenko et al., 2023).

The one-sample t-test results further validate the significance of these inefficiencies, with all mean values significantly greater than zero ($p < .001$). The strong statistical significance across all constructs reinforces the reliability of perceived inefficiencies as genuine systemic issues rather than random variations. The effect sizes (Cohen's $d > 2.3$ across variables) indicate substantial magnitudes, supporting conclusions that inefficiencies have a large and consistent effect across operational dimensions. Similar strong statistical effects have been reported in comparative studies analyzing SCM maturity levels in construction, which show that inefficiencies consistently impact project cost, time, and quality (Phong, 2018).

Collectively, the findings highlight a systemic issue of fragmentation and lack of integration across construction supply chains, aligning with decades of research showing persistent structural inefficiencies (Kusumo, 2009). Empirical literature consistently emphasizes that improving supply chain integration through collaborative planning, digitalization, and trust-based partnerships can substantially enhance project performance (Elmughrabi et al., 2020).

While this dataset reflects the experiences of 108 respondents, the uniformity of results across operational, financial, and governance domains underscores a common structural weakness rather than context-specific challenges. The construction industry's heavy reliance on fragmented subcontracting structures continues to undermine transparency and accountability, a finding echoed across diverse regional contexts (Czajkowska & Ingaldi, 2025). Future interventions must prioritize integrated digital ecosystems, standardized contractual frameworks, and transparent communication systems to overcome the entrenched inefficiencies revealed by both the statistical and frequency analyses.

4 Conclusion and recommendation

4.1 Conclusion

This study set out to empirically examine the critical supply chain inefficiencies affecting construction projects in Pakistan using quantitative evidence from industry professionals. The findings demonstrate that supply chain challenges in the Pakistani construction sector are systemic rather than isolated, with recurring issues related to procurement inefficiencies, delayed payments, fragmented coordination, and governance weaknesses. The descriptive and inferential analyses consistently revealed statistically significant results across all examined dimensions, indicating that these inefficiencies are widely experienced and strongly embedded within current industry practices.

The results further confirm that moderate to high levels of schedule overruns are common, with a substantial proportion of projects exceeding planned timelines by 50–70% due to supply chain disruptions. Financial and contractual management deficiencies—particularly inefficient contract administration and delayed payments emerged as dominant contributors to cost overruns. In addition, governance-related challenges, including limited transparency and weak trust in financial transactions, were identified as major sources of disputes among stakeholders. Reliability analysis confirmed strong internal consistency of the measurement instrument, supporting the robustness of the empirical findings.

Overall, this research provides clear, data-driven evidence that Pakistan's construction supply chain performance is constrained by structural, managerial, and coordination-related inefficiencies. By grounding these findings in practitioner perspectives, the study contributes valuable empirical insight to the construction management literature and establishes a solid foundation for targeted improvement strategies.

4.2 Recommendations

Based on the empirical findings, several practical recommendations are proposed. First, construction firms should prioritize the standardization and streamlining of procurement processes to reduce operational delays and

improve workflow continuity. Clear procurement protocols and improved coordination between suppliers and contractors can help minimize inefficiencies observed across projects.

Second, improvements in financial and contractual management are essential. Timely payment mechanisms, clearer contract structures, and standardized contract administration procedures should be emphasized to mitigate cost overruns and reduce dispute frequency. Capacity-building initiatives focusing on contract management skills for project managers and procurement officers would further support these improvements.

Third, enhanced coordination and communication mechanisms should be introduced across the supply chain. Structured information-sharing practices, regular coordination meetings, and centralized documentation systems can help address fragmentation among stakeholders.

From a policy perspective, regulatory bodies should support industry-wide guidelines that promote transparency, accountability, and consistent contractual practices. Encouraging pilot initiatives for digital transformation without immediate large-scale enforcement may allow firms to gradually modernize their supply chain operations while minimizing resistance to change.

5 Future Adoption Framework

The proposed future adoption framework presents a structured pathway for addressing systemic supply chain inefficiencies within Pakistan's construction industry. Building on the empirical findings of this study, the framework integrates operational, financial, governance, and coordination reforms into a sequential, implementation-oriented model. It begins by recognizing prevailing challenges such as inefficient procurement, delayed payments, fragmented communication, and limited transparency which have been shown to significantly affect project performance. To address these challenges, the framework emphasizes targeted strategies, including digital transformation through BIM and blockchain, financial and contractual reforms to ensure timely payments, and collaborative practices to enhance stakeholder integration. These strategies are operationalized through phased implementation pathways involving pilot projects, workforce training programs, and policy advocacy for standardized industry guidelines. Collectively, the framework provides a pragmatic roadmap for transitioning from reactive supply chain management toward proactive, data-driven, and collaborative practices. By aligning technological adoption with institutional capacity-building, the framework supports improved efficiency, reduced delays, enhanced transparency, and long-term sustainability, making it particularly relevant for emerging construction markets facing persistent supply chain disruptions.

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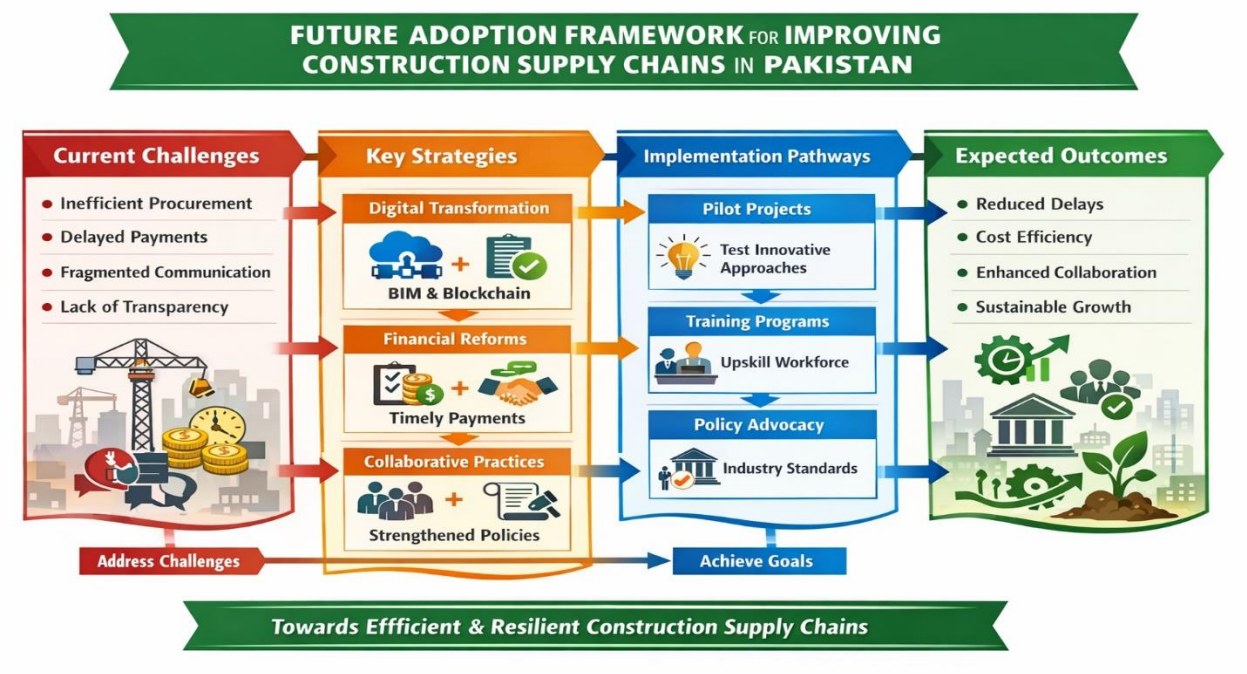


Figure 10 Future adoption framework illustrating a structured, step-by-step pathway for mitigating supply chain inefficiencies in Pakistan's construction industry, linking current challenges to strategic interventions, implementation mechanisms, and expected performance outcomes.

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