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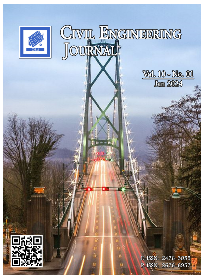

Construction Project Delay Risk Assessment Based on 4M1E Framework and Afghanistan Situation

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Abstract

In the realm of construction project management, delays present a significant impediment, particularly within complex socio-political contexts such as Afghanistan. This study endeavors to elucidate the multifaceted nature of construction project delays in Afghanistan, employing the 4M1E (Man, Machine, Material, Method, and Environment) framework to conduct a comprehensive risk assessment. The research methodology entailed the development of a structured questionnaire grounded in an extensive review of pertinent literature, targeting 30 recognized causes of project delays. This instrument was administered to a representative sample of 144 professionals across the Afghan construction industry spectrum, including clients, consultants, and contractors. Analytical rigor was applied through the deployment of frequency, severity, and importance indices to evaluate the collected data. This analysis culminated in the distillation of ten paramount delay risk factors, encapsulating elements such as governmental policy stability modifications in project scope and design alongside delays in material testing and approval processes. A comparative dimension was incorporated to benchmark these findings against global standards, thereby enhancing the robustness of the study's conclusions. Moreover, the research delineates the congruence and discordance among different respondent cohorts, bolstering the integrity of the identified delay factors through a validation of internal consistency and reliability. The strategic application of the 4M1E framework, contextualized within the Afghan construction landscape, furnishes pivotal insights for stakeholders, equipping them with a nuanced understanding necessary for the proactive mitigation of delay risks. The implications of this study are far-reaching, promising to augment project completion efficiency, budget adherence, and overall project success, with particular resonance for environments paralleling the intricacies of Afghanistan.

Keywords: Construction Project Delay Risks; Questionnaire Survey; 4M1E Framework; Critical Delay Risk; Afghanistan Situations.

1. Introduction

The construction sector plays a pivotal role in the global economy, significantly contributing to worldwide GDP and employment generation [1]. Effective construction project management, as highlighted by Abdulfattah et al. [2], is crucial in orchestrating resources, schedules, and stakeholders, ensuring projects are completed on time, within budget, and to the desired quality. Despite its importance, the construction industry faces numerous challenges impeding its growth, with project delays being a primary concern. Delays in construction are not only common but also have far-reaching consequences [2–4]. Characterized by their unpredictability, these delays can arise from a myriad of factors, including stakeholder absences or unforeseen events beyond human control [5]. They adversely impact production scheduling and monitoring [6] and are often intertwined with cost overruns [7, 8]. For instance, in South Africa, construction delays lead to time extensions, cost overruns, profit losses, and disputes [9]. These challenges are echoed

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globally, manifesting as increased costs, profit erosion, contractual disputes, and, potentially, the termination of agreements [10–12]. Similar trends are observed in Nigeria, where construction delays predominantly result in cost and time overruns [13]. The negative impact of schedule pressure often leads to decreased productivity and quality due to rushed tasks or out-of-sequence work [14, 15].

In response to these challenges, risk management has become an increasingly vital aspect of construction project management globally [16]. Effective risk management can mitigate risks impacting project quality, cost, and time [16]. The growth and sustainability of the construction sector are heavily reliant on comprehensive risk management strategies, given the inherent risks and uncertainties in construction projects [17-19].

Afghanistan's construction sector, in particular, presents a unique case study. Persistent delays in project completion are a notable issue [20], reflecting broader challenges within the sector. This study aims to reassess and identify the core delay risks in Afghanistan's construction projects. By unveiling the underlying factors contributing to these delays, the research seeks to provide insights into the specific challenges faced in high-risk geopolitical environments. The findings of this study are intended to inform construction project management professionals globally, offering them an opportunity to refine their methodologies and better address such issues in comparable contexts.

2. Literature Review

Construction delays in Afghanistan have been the subject of extensive study. Niazai & Gidado [19] utilized audit reports and field reviews to delineate these delays, categorizing the identified reasons into nine groups. Their empirical investigation identified ten critical delay factors as perceived by Afghan construction experts. This aligns with our study's findings using the 4M1E framework, further emphasizing the multifaceted nature of these delays.

In 2020, another study [21] focused on construction delays in geopolitically risky countries. They identified key factors such as economic challenges affecting both owners and contractors, consultants' inefficiencies, and material storage issues. Similarly, our research highlights environment-related factors as significant contributors to delays, underlining the impact of geopolitical risks on construction projects.

Jahanger's research [22, 23] in Baghdad further categorizes delay causes, echoing our study's approach to stratifying delay factors. Meanwhile, studies in different regions like Vietnam [24], Egypt [25], Palestine [26], India [27], Benin [28], and Uganda [29] have identified various predominant causes of delays, ranging from financial constraints to managerial challenges. These findings resonate with our study's emphasis on the diversity of delay factors across different geopolitical and cultural contexts.

In countries like Pakistan [30], China [31], and Norway [32], the causes of delays are uniquely attributed to factors such as financial constraints, competitive bidding, and ineffective planning. Our research complements these studies by providing a structured analysis of delay factors in Afghanistan's construction sector using the 4M1E framework.

The 4M1E model [33, 34] is an effective risk assessment tool in construction, emphasizing resource allocation and environmental aspects. Our study extends its application, offering a novel perspective on its use in developing countries like Afghanistan. The comprehensive understanding of delay factors within this framework provides a new lens to view and address construction delays in such high-risk environments.

To examine the primary reasons for delays, the current study conducted a comprehensive literature review of 40 selected studies, as shown in Table 1. Subsequently, they shortlisted 93 delay causes categorized under the 4M1E framework, such as Man (21 causes), Machine (17 causes), Material (16 causes), Method (18 causes), and Environment (21 causes), as shown in Tables 2 to 6.

Table 1. Summary of the findings from prior research on the causes of construction project delays

Countries	Previous Literature
Afghanistan	Kakar et al. (2020, 2022) [35, 37], Qaytmas (2020) [36], and Niazi & Painting (2017) [20]
India	Rao (2014) [38], and Muneeswaran et al. (2020) [39]
Pakistan	Ejaz et al. (2011) [40]
Nigeria	Aibinu et al. (2006) [41], and Obodoh et al. (2016) [42]
Saudi Arabia	Alzara et al. (2016) [43]
Uganda	Muhwezi et al. (2014) [29], and Alinaitwe et al. (2013) [44]
UAE	Motaleb & Kishk (2013) [45] and Choplin & Fracnk (2010) [46], Alaghbari et al. (2007) [47]
Malaysia	Mukuka et al. (2015) [9], Khan et al. (2017) [48], and Sambasivan & Soon (2007) [49]
Iran	Samarghandi et al. (2007) [50], and Islam et al. (2017) [51]
Jordan	Odeh et al. (2002) [52], Sweis et al. (2008) [53], Al-Momani (2000) [54]
Developing countries	Islam et al. (2017) [51]
Burkina Faso	Bagaya et al. (2016) [55], and Hsu et al. (2017) [56]

Egypt	Marzouk et al. (2014) [57]
Thailand	Toor et al. (2008) [58], and Toor et al. (2008) [59]
Vietnam	Le-Hoai et al. (2008) [24]
United Kingdom	Choong et al (2018) [60]
Turkey	Kazaz et al. (2012) [61]
Korea	Cho et al. (2021) [62]
Hong Kong	Chan et al. (1997) [63] and Chan et al. (2002) [64]
Singapore	Ling et al. (2008) [65], and Hwang et al. (2013) [66]
Kuwait	Koushki & Kartam (2004) [67]

Table 2. The most frequently cited causes for man related factors

No	MAN-related risks that can delay the construction Projects
1	Lack of skilled workers or inadequate training
2	Payment delays
3	Lack of physical quality
4	Lack of learning ability
5	Low morale or motivation
6	Inadequate planning, management, and leadership
7	Inadequate resource management
8	Inadequate contractor and subcontractor management and performance.
9	Inadequate problem-solving skills and slow decision-making
10	Inadequate employee engagement and feedback mechanisms.
11	Ineffective teamwork and collaboration
12	Non-compliance with labor laws and regulations
13	Low labor productivity and training
14	Shortage of labor or high turnover rates
15	Poor communication or misunderstandings
16	Delay in delivering required documentation
17	Failure to manage changes
18	Human error
19	Lack of technical capacity
20	Unreasonable expectation
21	Workplace injuries or illnesses

Table 3. The most frequently cited causes for machine related factors

No	Machine-related risks that can delay construction Projects
22	Equipment breakdown or failures
23	Equipment maintenance issues
24	Outdated equipment
25	Delay in machine setup or changeover
26	Poor quality output from machines
27	Lack of backup machines
28	Lack of machine standardization and compatibility
29	Inadequate machine safety measures
30	Inadequate equipment storage and handling
31	Inadequate machine capacity or capability
32	Improper machine utilization
33	Inadequate maintenance scheduling and tracking systems
34	Inadequate equipment availability
35	Inadequate equipment upgrades and modernization plan
36	Inefficient or improper use of equipment
37	Insufficiently trained person to maintain the Machine
38	Inadequate equipment monitoring and control systems

Table 4. The most frequently cited causes for material related factors

No	Material-related risks that can delay the construction Projects
39	Inadequate material source
40	Inadequate material equipment safety measures
41	Inadequate material storage condition
42	Inadequate material traceability and documentation
43	Material testing and approval delays
44	Inadequate material supervision
45	Material quality control issues
46	Material theft issues
47	Material damage
48	Lack of backup materials
49	Improper material handling and transport
50	Inadequate material handling waste management
51	Changes in material specification
52	Inaccurate material estimates
53	Late material deliveries
54	Poor quality materials

Table 5. The most frequently cited causes for method related factors

No	Method-related risks that can delay the construction Projects
55	Inadequate project monitoring and control process
56	Inadequate construction methods and techniques
57	Inadequate quality control (QC) and quality assurance (QA) process
58	Inadequate plant use of resources and equipment
59	Lack of coordination
60	Inadequate risk identification and contingency planning
61	Inadequate project budgeting and financial management
62	Inadequate work instruction
63	Inadequate communication of production process changes
64	Inadequate process validation and verification
65	Inadequate project documentation and record-keeping
66	Inadequate decision-making and problem-solving processes
67	Inefficient scheduling and sequencing
68	Ineffective changes in project scope or design
69	Errors in the design that result in additional work
70	Poor coordination and collaboration among project stakeholders' team
71	Inadequate project planning
72	Lack of building code and standards

Table 6. The most frequently cited causes of environmental factors

No	Environment-related risks that can delay construction Projects
73	Unfavourable weather condition
74	Community opposition (legal disputes, protests, etc.)
75	Environmental restriction, safety, and health regulations
76	Soil and land issues
77	Contamination and pollution
78	Restricted access to the site due to environmental concerns
79	Delays in obtaining necessary permits and approvals
80	Social and demographic factors
81	Exchange rate fluctuation
82	Taxation and financial regulation
83	Corruption
84	Cultural differences, social and demographic factors
85	Unfavourable international relations
86	Lack of zoning and law use regulation
87	Lack of contractual obligation
88	The occurrence of natural disaster
89	Economic recession and condition
90	Lack of material availability and market competition
91	Bad ground condition
92	Government instability and policies
93	Inflation or rising prices in goods and services

The five most frequently cited causes include low productivity (20), lack of proper planning and control (19), incompetent subcontractors (18), inadequate skilled labor (17), and weather conditions (17). After further meta-analysis, the thirty (30) most prevalent delay causes were selected as the foundation for the empirical analysis.

To address these gaps, the present study takes a fresh approach by reassessing the delay causes, incorporating importance ratings that consider both severity and frequency. Furthermore, this study aims to uncover the principal dimensions of delays, providing a more comprehensive understanding of the underlying factors that impact delayed construction projects. By doing so, the study aims to contribute to a more up-to-date and insightful understanding of delay-related issues in Afghanistan's construction industry.

3. Research Methodology

3.1. Design of Questionnaire

The 30 most often discovered delay factors were included in a main questionnaire that was drawn from a thorough literature assessment. In order to find studies investigating project delays, schedule overruns, and other critical elements impacting project performance, researchers searched academic databases using pertinent keywords. Three sections make up the final questionnaire.

In the first section, we ask respondents about themselves in terms of their organization, age, education, job experience, the types of projects they often work on, and how often they are involved in the procurement process. In sections II and III, we evaluate the 30 factors of construction delays from the perspectives of important stakeholders, such as clients, consultants, and contractors. In line with other delay studies (e.g., [24, 55, 68]), we ask these individuals to use a five-point Likert scale to rate the frequency with which each cause occurs and the severity of its effects during the construction phase. Respondents are asked to rate the recurrence of each scenario on a 5-point scale, where 1 represents (never) and 5 represents (always). A numerical number between 1 (not at all) and 5 (very severe) is assigned to indicate the level of severity.

The questionnaire was pilot-tested with 50 construction professionals representing a range of client, contractor, and consultant firms before being used as the primary study instrument. The purpose of the pilot study was to evaluate the questionnaire for clarity and eliminate any areas of ambiguity. All pilot participants were college graduates, and over 60% had worked in the construction industry for more than five years. The vast majority of people took part in initiatives that were privately funded and acquired through conventional means of contracting.

Cronbach's alpha values of 0.876 for frequency of occurrence and 0.827 for severity were calculated during the pilot test. These numbers are much above the cutoff of 0.70 [69], suggesting that the questionnaire has high levels of both internal consistency and reliability.

3.2. Data Collection

The Google Form technique was employed for the primary survey, which is statistically significant [15, 55]. To gather the data, google form links were thoughtfully distributed among the clients (property developers), consultants (architects, engineers, and quantity surveyors), and contractors (main and sub-contractor companies). This approach allowed for efficient and widespread data collection, ensuring valuable insights from key stakeholders in the construction projects. A total of 260 responses were collected from the participants. Out of the distributed questionnaires, 144 valid responses were collected, resulting in a response rate of 55.38%. While this may seem like a low response rate, it is in line with previous research among Malaysian construction professionals undertaken by Yong & Mustaffa [6] and Abdul-Aziz [70]. However, a sample size of above 100 is deemed enough for statistical testing and acceptable for factor analysis [8], guaranteeing the dependability of the acquired data for further research.

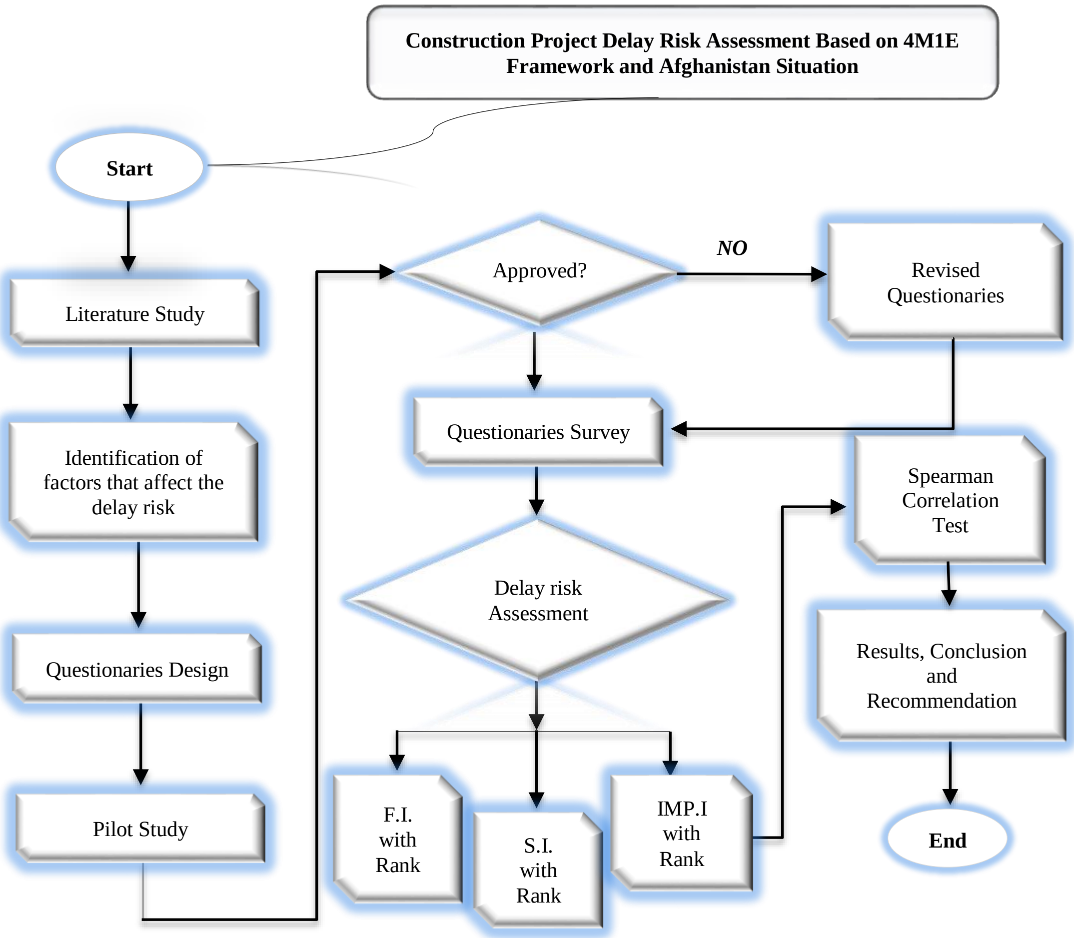

Figure 1. Technical Route

3.3. Respondent Demographic Information

As Table 7 shows, the survey involved 144 construction practitioners, comprising contractors (44.44%), consultants (36.11%), and clients (19.44%). Respondents' age distribution was 41.0% between 20-30, 22.2% between 31-40, and 36.8% above 40 years old. Regarding experience, 22.92% had less than 2 years, 33.33% had 3-5 years, 25% had 6-10 years, and 18.75% had over 10 years. Familiarity with delay issues varied, with 15.97% less than 10%, 14.58% between 11% and 30%, and 34.72% between 31% and 50% and more than 50%. Regarding the number of construction projects, 48.61% had 1 to 5 projects, 36.81% had 6 to 10 projects, and 14.58% had more than 10 projects. The observed ratios portray the current state of the Afghanistan construction industry, highlighting the substantial involvement of young professionals in meeting the high demand for construction projects. Similarly, analogous findings are reported in Vietnam by Le-Hoai et al. [24] and Nguyen & Chileshe [71], as well as in Malaysia by Yap et al. [72]. Given these characteristics, we believe that the respondents appropriately represent Afghanistan's construction industry.

Table 7. Respondent's background

Demographic Characteristics	Frequency (N=144)	Percentage (%)
Type of organization		
Contractor	64	44.44
Consultant	52	36.11
Client	28	19.44
Age		
20-30	59	41.00
31-40	32	22.20
> 40	53	36.80
Working Experience		
Less than 2 years	33	22.92
3-5 Years	48	33.33
6-10 years	36	25.00
>10 years	27	18.75
Familiarity with delay issues		
Less than 10%	23	15.97
Between 11% and 30%	21	14.58
Between 31% and 50%	50	34.72
> 50%	50	34.72
Number of construction projects		
1 to 5 projects	70	48.61
6 to 10 projects	53	36.81
> 10 projects	21	14.58

4. Approach for Index Analysis

To analyze the survey data, a methodology inspired by Assaf & Al-Hejji [68], Bagaya & Song [55], Maqsoom et al. [73], Zarei et al. [74] and Yap et al. [72] is adopted, employing three distinct sets of indices. The delay causes are prioritized based on occurrence, severity, and overall importance, determined by frequency, severity, and importance indices shown in Table 8 to 10.

Table 8. Frequency index analysis and ranking

No	Delay Risk factors	Overall (N=144)		Contractor (N=64)		Consultant (N=52)		Client (N=28)		Group
		Rank	*FI.*	Rank	*FI.*	Rank	*FI.*	Rank	*FI.*	
1	Inadequate problem-solving skills and slow decision-making	7	0.700	2	0.771	20	0.653	17	0.677	Man
2	Payment delays	4	0.721	20	0.672	2	0.785	6	0.705	
3	Inadequate resource management	17	0.670	7	0.743	8	0.723	29	0.543	
4	Delay in delivering required documentation	16	0.678	11	0.728	21	0.619	12	0.688	
5	Non-compliance with labor laws and regulations	25	0.638	24	0.631	24	0.611	18	0.672	
6	Lack of technical capacity	22	0.661	25	0.591	12	0.712	15	0.679	
7	Inadequate equipment monitoring and control systems	13	0.683	19	0.675	5	0.761	25	0.614	Machine
8	Equipment maintenance issues	21	0.661	6	0.744	28	0.538	7	0.701	
9	Equipment breakdown or failures	27	0.600	21	0.662	29	0.454	14	0.685	
10	Inadequate maintenance scheduling and tracking systems	26	0.635	28	0.565	16	0.696	21	0.643	
11	Inefficient or improper use of equipment	30	0.581	30	0.444	23	0.612	13	0.687	
12	Outdated equipment	10	0.693	27	0.578	3	0.773	4	0.729	
13	Inadequate material storage condition	24	0.642	10	0.731	14	0.703	30	0.492	Material
14	Inadequate material equipment safety measures	9	0.696	13	0.706	26	0.588	1	0.793	
15	Material testing and approval delays	5	0.704	15	0.697	13	0.708	5	0.706	
16	Inadequate material handling and supervision	29	0.582	8	0.741	30	0.412	26	0.592	
17	Material theft issues	14	0.682	5	0.750	25	0.596	8	0.700	
18	Inadequate material traceability and documentation	12	0.684	23	0.644	4	0.765	22	0.642	

19	Poor coordination and collaboration among project stakeholders' team	20	0.662	3	0.760	17	0.677	28	0.549	Method
20	Inadequate project planning	18	0.667	17	0.690	18	0.669	22	0.642	
21	Lack of coordination	11	0.688	9	0.734	15	0.700	24	0.629	
22	Inadequate project budgeting and financial management	19	0.663	18	0.684	10	0.719	27	0.586	
23	Too many changes in project scope and design	8	0.698	4	0.756	19	0.658	15	0.679	
24	Inadequate decision-making and problem-solving processes	28	0.587	29	0.509	27	0.553	8	0.700	
25	Economic recession and condition	1	0.747	1	0.825	8	0.723	10	0.692	Environment
26	Government instability and policies	3	0.734	12	0.719	6	0.746	3	0.736	
27	Bad ground condition	23	0.660	14	0.703	21	0.619	20	0.658	
28	Community opposition (legal disputes, protests, etc.)	6	0.703	26	0.588	7	0.735	2	0.786	
29	Inflation or rising prices in goods and services	15	0.680	22	0.650	10	0.719	19	0.671	
30	Corruption	2	0.737	15	0.697	1	0.823	11	0.690	

Table 9. Severity index analysis and ranking

No	Delay Risk factors	Overall (N=144)		Contractor (N=64)		Consultant (N=52)		Client (N=28)		Group
		Rank	*S.I.*	Rank	*S.I.*	Rank	*S.I.*	Rank	*S.I.*	
1	Inadequate problem-solving skills and slow decision-making	5	0.725	8	0.734	10	0.704	6	0.736	Man
2	Payment delays	16	0.689	13	0.702	21	0.651	11	0.714	
3	Inadequate resource management	13	0.695	14	0.700	2	0.750	24	0.636	
4	Delay in delivering required documentation	9	0.702	19	0.678	6	0.712	10	0.715	
5	Non-compliance with labor laws and regulations	9	0.702	21	0.669	4	0.735	14	0.701	
6	Lack of technical capacity	20	0.658	25	0.597	16	0.669	12	0.707	
7	Inadequate equipment monitoring and control systems	19	0.663	26	0.591	8	0.711	16	0.688	Machine
8	Equipment maintenance issues	25	0.628	10	0.713	28	0.515	21	0.657	
9	Equipment breakdown or failures	23	0.630	20	0.675	17	0.665	28	0.550	
10	Inadequate maintenance scheduling and tracking systems	28	0.578	22	0.668	29	0.481	27	0.586	
11	Inefficient or improper use of equipment	27	0.605	27	0.509	6	0.712	26	0.593	
12	Outdated equipment	29	0.566	30	0.388	24	0.631	19	0.678	
13	Inadequate material Storage condition	1	0.747	1	0.849	22	0.650	4	0.743	Material
14	Inadequate material equipment safety measures	18	0.678	4	0.806	27	0.577	23	0.650	
15	Material testing and approval delays	6	0.722	10	0.713	18	0.661	3	0.793	
16	Inadequate material handling, training, and supervision	30	0.512	17	0.691	30	0.438	30	0.407	
17	Material theft issues	12	0.696	9	0.725	13	0.677	18	0.685	
18	Inadequate material traceability and documentation	11	0.700	14	0.700	19	0.658	5	0.741	
19	Poor coordination and collaboration among project stakeholders' team	7	0.719	5	0.791	11	0.696	20	0.671	Method
20	Inadequate project planning	3	0.728	12	0.706	13	0.677	2	0.800	
21	Lack of coordination	17	0.684	18	0.688	9	0.707	21	0.657	
22	Inadequate project budgeting and financial management	14	0.695	23	0.640	3	0.738	12	0.707	
23	Too many changes in project scope and design	2	0.737	6	0.753	5	0.723	6	0.736	
24	Inadequate decision-making and problem-solving processes	26	0.615	29	0.440	15	0.670	6	0.736	
25	Economic recession and condition	24	0.629	2	0.831	26	0.592	29	0.464	Environment
26	Government instability and policies	4	0.727	3	0.815	12	0.681	17	0.686	
27	Bad ground condition	15	0.692	7	0.747	25	0.608	9	0.721	
28	Community opposition (legal disputes, protests, etc.)	22	0.645	28	0.494	23	0.634	1	0.807	
29	Inflation or rising prices in goods and services	8	0.708	24	0.619	1	0.808	15	0.698	
30	Corruption	21	0.650	16	0.696	20	0.654	25	0.600	

Table 10. Important index analysis and ranking

No	Delay Risk factors	Overall (N=144)		Contractor (N=64)		Consultant (N=52)		Client (N=28)		Group
		Rank	*IMPI.I.*	Rank	*IMPI.I.*	Rank	*IMPI.I.*	Rank	*IMPI.I.*	
1	Inadequate problem-solving skills and slow decision-making	4	0.508	7	0.566	16	0.460	9	0.498	Man
2	Payment delays	5	0.495	18	0.472	6	0.511	7	0.503	
3	Inadequate resource management	17	0.469	11	0.520	2	0.542	28	0.345	
4	Delay in delivering required documentation	14	0.475	15	0.494	20	0.441	11	0.492	
5	Non-compliance with labor laws and regulations	22	0.447	22	0.422	19	0.449	16	0.471	
6	Lack of technical capacity	23	0.436	26	0.353	11	0.476	12	0.480	
7	Inadequate equipment monitoring and control systems	21	0.454	24	0.399	3	0.541	19	0.422	Machine
8	Equipment maintenance issues	24	0.423	9	0.530	29	0.277	18	0.461	
9	Equipment breakdown or failures	26	0.375	20	0.447	28	0.302	25	0.377	
10	Inadequate maintenance scheduling and tracking systems	28	0.363	25	0.377	27	0.335	24	0.377	
11	Inefficient or improper use of equipment	29	0.356	28	0.226	21	0.436	23	0.407	
12	Outdated equipment	25	0.402	29	0.224	10	0.488	10	0.494	
13	Inadequate material Storage condition	8	0.481	2	0.621	17	0.457	27	0.366	Material
14	Inadequate material equipment safety measures	15	0.475	6	0.569	26	0.339	3	0.515	
15	Material testing and approval delays	3	0.509	14	0.497	14	0.468	2	0.560	
16	Inadequate material handling, training, and supervision	30	0.311	12	0.512	30	0.180	30	0.241	
17	Material theft issues	13	0.476	8	0.544	23	0.403	13	0.480	
18	Inadequate material traceability and documentation	12	0.477	19	0.451	8	0.503	14	0.476	
19	Poor coordination and collaboration among project stakeholders' team	9	0.480	3	0.601	13	0.471	26	0.368	Method
20	Inadequate project planning	6	0.485	16	0.487	18	0.453	5	0.514	
21	Lack of coordination	16	0.471	13	0.505	9	0.495	22	0.413	
22	Inadequate project budgeting and financial management	19	0.461	21	0.438	5	0.531	20	0.414	
23	Too many changes in project scope and design	2	0.515	5	0.569	12	0.476	8	0.500	
24	Inadequate decision-making and problem-solving processes	27	0.370	30	0.224	25	0.371	4	0.515	
25	Economic recession and condition	11	0.478	1	0.686	22	0.428	29	0.321	Environment
26	Government instability and policies	1	0.533	4	0.586	7	0.508	6	0.505	
27	Bad ground condition	20	0.459	10	0.525	24	0.376	15	0.474	
28	Community opposition (legal disputes, protests, etc.)	18	0.464	27	0.290	15	0.466	1	0.634	
29	Inflation or rising prices in goods and services	7	0.484	23	0.402	1	0.581	17	0.468	
30	Corruption	10	0.479	17	0.485	4	0.538	21	0.414	

The frequency index (F.I.), measuring the rate of recurrence for each cause, is expressed as follows [55, 74].

$$F.I. = \frac{\sum_1^5 a_i n_i}{5N} \tag{1}$$

The constant "a" which denotes the degree of frequency, determines the ($F.I.$), with values ranging from 1 (never) to 5 (always). In this case, "N" represents the total number of responses, and "n" represents the frequency count for each response.

Each cause of delay can be quantified using the severity index ($S.I.$), which is computed as follows [68, 75].

$$S.I. = \frac{\sum_1^5 b_i n_i}{5N} \tag{2}$$

A constant marked "b" reflects the severity level, with values ranging from 1 (indicating "not at all") to 5 (very severe), which is used to calculate the severity index ($S.I.$).

By combining how often and how severely a delay factor occurs, the importance index (IMP.I.) provides a measure of the relevance of each component. The equation for this is as follows [72].

$$IMP.I. = F.I. \times S.I. \tag{3}$$

5. Validity and Reliability Analysis

Factor analysis is employed to identify the main groupings among the 20 delay causes. To ensure the suitability of the variables for factor analysis, the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity are conducted [6, 76]. Table 11 presents the internal consistency and validity assessment of factors in the study. The table shows Cronbach's alpha values for each factor, indicating the reliability of the measurements. Factors such as "Man related," "Machine related," "Material related," "Method related," and "Environmental related" demonstrate good to excellent reliability, with Cronbach's alpha values ranging from 0.826 to 0.928.

Table 11. Internal consistency and validity assessment of factors in the study

No	Factors	Cronbach's alpha (Reliability)		KMO and Bartlett's (Validity)	
1	Man related	0.928	Excellent	0.855	Good
2	Machine related	0.826	Good	0.801	Good
3	Material related	0.874	Good	0.806	Good
4	Method related	0.884	Good	0.854	Good
5	Environmental related	0.868	Good	0.818	Good
	All	0.876	Good	0.827	Good

Additionally, the Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests are used to evaluate the validity of the factors. The KMO values, ranging from 0.801 to 0.855, indicate that the variables are suitable for factor analysis. The study shows good internal consistency and validity, with an overall Cronbach's alpha of 0.876 and an overall KMO value of 0.827.

6. Assessment and Ranking of Delay Factors

The most common reasons for delays, as reported by contractors, consultants, and clients, are listed in descending order. The IMP.I., or significance index, is a numerical value between 0.311 and 0.533. By analyzing both the frequency with which each cause is encountered and the severity of its effects, the top 10 reasons for delays are:

1. Government stability and policies (IMP.I. = 0.533)
2. Too many changes in project scope and design (IMP.I. = 0.515)
3. Material testing and approval delays (IMP.I. = 0.509)
4. Inadequate problem-solving skills and slow decision-making (IMP.I. = 0.508)
5. Payment delays (IMP.I. = 0.495)
6. Inadequate project planning (IMP.I. = 0.485)
7. Inflation or rising prices in goods and services (IMP.I. = 0.484)
8. Inadequate material storage condition (IMP.I. = 0.481)
9. Poor coordination and collaboration among project stakeholders' team (IMP.I. = 0.480
10. Corruption (IMP.I. = 0.479)

Among the causes analyzed, Environment-related factors exhibit the most substantial impact on project delays overall (combined IMP.I. = 1.50), followed closely by Method (IMP.I. = 1.48), Man (IMP.I. = 1.003), and Material (IMP.I. = 0.99). This observation aligns with similar outcomes in similar studies conducted in developing regions such as Ghana [77] and Saudi Arabia [68].

Dissimilar perspectives on delay causes are evident between clients and contractors, with both parties frequently attributing unfavorable incidents to each other [8, 78, 79]. For instance, the top five delay causes are attributed by clients to Community opposition, Material testing, and approval delays, Inadequate material equipment safety measures, Inadequate decision-making and problem-solving processes, and Inadequate project planning. Conversely, contractors express concern about Economic recession and conditions, Inadequate material storage conditions, Poor coordination and collaboration among project stakeholders' teams, Government instability and policies, and too many changes in project scope and design. On some topics, consultant and contractor viewpoints are consistent. There is a consensus among the three parties on the order of the 10 most essential delay risk factors, although the top ten reasons for delay are prioritized differently.

Furthermore, the most significant problem causing delays in construction projects, as rated with the highest severity score, is contractors' inadequate material storage conditions. This finding indicates that a higher frequency of occurrence correlates with a significantly more severe impact on the original completion date. These findings are indicative of contractors' self-awareness regarding their inadequate supply of materials. Surprisingly, while the frequency of contractors' payment delay is ranked fourth, it ranks only sixteenth regarding the severity of delay causes. Insufficient cash flow can significantly hinder work progress, as contractors may face challenges executing construction activities as per the schedule, leading to project delays [28, 57].

Notably, all parties concur on the minor significant causes of delays, which include rising costs and changes in political leadership. This alignment is likely attributed to Afghanistan's politically unstable environment, where these factors have a minimal impact on project delays.

7. A Comparative Perspective on Delay Causes

The purpose of comparing selected countries is to validate and strengthen the findings of this empirical study by establishing similarities and differences with research conducted in other developed and developing nations.

Among the selected studies listed in Table 12 and Figure 2, it becomes apparent that issues related to "Too many changes in project scope and design," "Payment delays," and "Inadequate project planning" are not unique to Afghanistan. These challenges are also prevalent in several African and Asian countries, including Iran, Benin, Jordan, and Uganda, accounting for a significant occurrence percentage of 20% and 15% among the top ten delay factors (see Figure 2). The other prominent delay factors, including "Government instability and policies," "Corruption," and "Inadequate problem-solving skills and slow decision-making," are not unique to Afghanistan. These challenges are prevalent in several countries, constituting a substantial occurrence percentage of 10% among the top 10 delay factors. The remaining four factors, namely "Material testing and approval delays," "Inflation or rising prices in goods and services," "Inadequate material storage condition," and "Poor coordination and collaboration among project stakeholders' team," collectively account for a significant occurrence percentage of 5% among the top 10 delay factors.

Table 12. Key delay factors identified in various countries/regions

No	Top 10 delay risk factors in Afghanistan (2023)	Selected Countries						Total Frequency
		Iran [80]	Uganda [44]	Egypt [79]	Malaysia [49]	Benin [28]	Jordan [53]	
1	Government instability and policies		✓				✓	2
2	Too many changes in project scope and design	✓	✓			✓	✓	4
3	Material testing and approval delays				✓			1
4	Inadequate problem-solving skills and slow decision-making	✓		✓				2
5	Payment delays		✓			✓	✓	3
6	Inadequate project planning	✓			✓	✓		3
7	Inflation or rising prices in goods and services		✓					1
8	Inadequate material storage condition				✓			1
9	Poor coordination and collaboration among project stakeholders' team			✓				1
10	Corruption			✓	✓			2

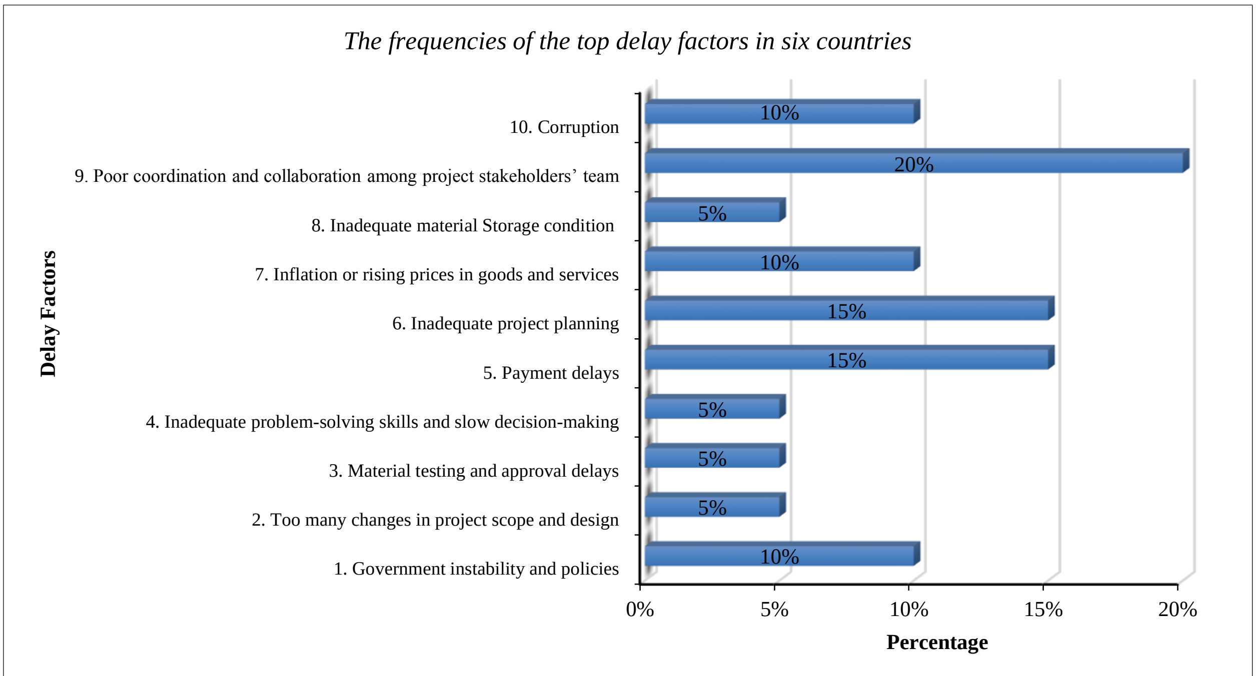

Figure 2. Distribution of top ten delay factors across six countries

8. Agreement Analysis

The Spearman rank correlation coefficient is employed to assess the agreement among pairs of respondent groups. As presented in Table 13, the results indicate a relatively good level of concordance in ranking the frequency, severity, and IMP.I. of each delay cause among the three respondent groupings. Although clients and contractors hold slightly divergent opinions, they exhibit the highest level of agreement. Conversely, the lowest level of agreement is evident between clients and consultants.

Table 13. Spearman's rank correlation analysis of delay factors

	Frequency Index		Severity Index		Importance Index	
	Correlation Coefficient (r_s)	Alpha α	Correlation Coefficient (r_s)	Alpha α	Correlation Coefficient (r_s)	Alpha α
Contractor-Client	0.792	0.001	0.832	0.001	0.802	0.001
Contractor-Consultant	0.680	0.001	0.795	0.001	0.780	0.001
Consultant-Client	0.616	0.001	0.812	0.001	0.742	0.001

Note: " r_s " represents Spearman's rank correlation coefficient, while "α" indicates the significance level.

9. Summary

This study undertook an extensive investigation into the delay risks in construction projects in Afghanistan, employing the comprehensive 4M1E framework (Man, Machine, Material, Method, and Environment). The research methodology involved a detailed questionnaire survey, which was meticulously designed to capture insights into 30 identified causes of delay commonly recognized in the Afghan construction industry. This survey garnered responses from a diverse group of 144 construction industry professionals, including clients, contractors, and consultants.

Through rigorous statistical analysis encompassing frequency, severity, and importance index calculations, the study successfully distilled these causes into ten critical delay risk factors. Among these, factors like government stability and policy fluctuations, frequent changes in project scope and design, and extended durations in material testing and approval processes were highlighted as particularly impactful. A notable observation was the significant variation in the perception of these delay causes among the different respondent groups, illustrating the complexity of stakeholder perspectives in the construction process.

The study's findings underscored the predominance of Environment-related factors as the most influential in causing project delays, a revelation that highlights the unique challenges faced in the Afghan construction sector. These were closely followed by factors categorized under Method, Man, and Material. The stratification of these factors under the 4M1E categories provided a structured understanding of the multifaceted nature of project delays in this high-risk environment.

10. Conclusions

This research has made a substantial contribution to understanding the dynamics of construction project delays in Afghanistan, a context deeply influenced by unique socio-political challenges. The utilization of the 4M1E framework not only facilitated a structured investigation into delay risks but also illuminated the multifaceted and complex nature of these challenges.

The identification of key delay factors, particularly those pertaining to government policies, scope changes, and material handling processes, offers crucial insights for industry stakeholders. These insights are instrumental for strategizing effective risk mitigation and enhancing project management practices. The disparity in stakeholder perspectives, as revealed by the study, underscores the need for improved communication channels and collaborative approaches within the industry to align perceptions and expectations.

Moreover, the study's findings are significant for their implications in high-risk geopolitical contexts. By highlighting specific risk factors and their impacts, the study paves the way for future research and practical interventions aimed at mitigating delays and enhancing efficiency in the construction sector. In essence, this research not only contributes to the academic discourse in construction project management but also serves as a vital guide for practitioners in navigating the complexities of project execution in challenging environments like Afghanistan.

10.1. Recommendations

Based on the research findings on construction project delays in Afghanistan, the following strong recommendations are proposed to address and mitigate the identified delay causes:

- Enhance Government Stability and Policy Implementation: To reduce delays caused by changes in government policies and regulations, the Afghan government needs to provide a stable and predictable business environment. Consistency in policies and their practical implementation will create a conducive atmosphere for construction projects.

- Strengthen Project Planning and Design Management: Improving project planning and design management is crucial to minimizing scope changes during construction. Emphasis should be placed on thorough planning, feasibility studies, and engaging all stakeholders early in the project to avoid costly modifications later.
- Foster Efficient Decision-Making Processes: Inadequate problem-solving skills and slow decision-making were identified as significant delay causes. Project teams must streamline decision-making processes and empower team members to make timely and informed decisions to overcome obstacles promptly.
- Implement Effective Material Testing and Approval Procedures: Delays related to material testing and approval can be mitigated by establishing efficient and transparent material selection and evaluation processes. Regular quality checks and approvals should be enforced to ensure that materials meet project specifications.
- Address Payment Delays: To tackle payment delays, clients and contractors must commit to timely and fair payment practices. Adherence to agreed-upon payment schedules and performance-based contracts can incentivize timely payments.
- Enhance Project Coordination and Collaboration: Improving communication and collaboration among project stakeholders is crucial to overcoming delays caused by poor coordination. Regular meetings, clear roles and responsibilities, and fostering a cooperative project culture can enhance coordination.
- Invest in Workforce Development and Technical Capacity: Training and capacity-building programs for construction workers and professionals can enhance their technical skills and expertise. A skilled workforce is more likely to execute projects efficiently, leading to reduced delays.
- Address Material Storages: Contractors should focus on improving their material inventory management to avoid storages that lead to delays. Strategic sourcing, reliable suppliers, and contingency planning for materials can help address this issue.
- Mitigate Environmental Risks: Conducting thorough environmental impact assessments and adopting eco-friendly practices can help minimize delays caused by adverse environmental conditions.
- Tackle Corruption: Combating corruption is essential for improving project efficiency and timely delivery. Implementing transparent procurement processes and enforcing anti-corruption measures can help create a corruption-free construction industry.
- Establish Project Monitoring and Control Mechanisms: Implementing robust project monitoring and control systems can help identify potential delays early in construction. Regular progress tracking and timely interventions can prevent further delays.
- Encourage Research and Collaboration: Encouraging research and collaboration among academia, industry practitioners, and policymakers can lead to innovative solutions and best practices for addressing delay causes in the construction sector.

By implementing these strong recommendations, Afghanistan's construction industry can enhance its project delivery capabilities, minimize delays, and contribute to its overall development and economic growth. It is essential for all stakeholders, including the government, clients, contractors, and consultants, to collaborate and take proactive measures to overcome the challenges posed by project delays and ensure successful construction projects.

11. Declarations

11.1. Author Contributions

Conceptualization, Y.D.; methodology, H.S.; software, H.S.; validation, Y.D., and H.S.; formal analysis, H.S.; investigation, H.S.; resources, H.S.; data curation, H.S.; writing—original draft preparation, H.S.; writing—review and editing, Y.D. and H.S.; visualization, H.S.; supervision, Y.D.; project administration, Y.D.; funding acquisition, Y.D. All authors have read and agreed to the published version of the manuscript.

11.2. Data Availability Statement

Publicly available datasets were analyzed in this study. This data can be found here: https://drive.google.com/file/d/1WZCd8HyxIfaH4FPDSpaslVVsVw85Nk9d/view?usp=drive_link.

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11.5. Conflicts of Interest

The authors declare no conflict of interest.

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