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Research Article

Assessing Key Delay Factors in Construction Projects in Palestine: Cause-Effect Relationships Utilizing Construction Experts' Insights

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Abstract

The performance of construction projects is crucial, yet many faces significant delays, failing to meet scheduled targets. These delays have severe economic and operational impacts, making it essential to identify and understand the underlying causes. This research aims to comprehend the causal relationships among key delay factors, using insights from construction experts, to ensure timely project completion. An extensive literature review on construction delays in Palestine and other similar developing countries identified 26 causes to prioritize key delay factors in Palestine. A process involving questionnaires distributed to 13 experts was used to Prioritize 11 key delay factors for Decision Making Trial and Evaluation Laboratory (DEMATEL) analysis. The DEMATEL analysis, involving 12 experts, revealed the influence weights of these factors. Occupation and political obstacles (F7) were identified as the most significant factor (10.770%), followed by lack of sufficient financing (F3) at 10.649%, and delay in payments (F4) at 10.619%. The analysis emphasizes the need for better financial management and improved internal processes to mitigate delays. The findings in this study can provide structural visualization of complex causal relationships among key delay factors and also allow construction experts to prioritize the resource allocation to achieve project objectives.

Keywords: *Construction Industry; Key Delay Factors; Decision Making Trial & Evaluation Laboratory (DEMATEL).*

1. Introduction

The construction industry is vital for socioeconomic development in both developed and emerging economies (Owusu & Aggrey, 2020), providing essential infrastructure and housing (Imad et al., 2018). Governments invest heavily in infrastructure projects to enhance their countries 'socioeconomic development (Andric et al., 2019). The sector contributes significantly to per capita income growth and employs a significant fraction of the active labour force (Malaj & Shuli, 2015). The global construction industry accounts for 40% of total GDP and is expected to increase in the next 30 years (Solis, 2007).

The construction sector, despite its economic benefits, is plagued by delays, indicating subpar project performance (Jalal & Yousefi, 2017). In Saudi Arabia, 30% of projects adhere to schedules (Assaf & Al-Hejji, 2005), while Nigeria faces seven out of ten delays (Ibironke et al., 2013). Delays have detrimental effects in various countries, including Palestine.

Construction delays can have severe social and economic impacts on a project, causing time and cost overruns, reduced contractor profits, owner losses, strained relationships, legal disputes, and project abandonment (Khattri et al., 2016). Delays can also lead to contract termination, arbitration, and litigation (Gebrehiwet & Luo, 2017). Addressing these issues is crucial for the successful completion of construction projects, as studies have identified their root causes.

Construction delays have been a major problem in the past, leading to numerous investigations to determine the factors responsible for these delays. Key factors include law and order situations, design changes, and insufficient availability of funding (Gardezi et al., 2014). The persistent problem of construction delays highlights the need for an effective solution that goes beyond identifying factors. Intensive efforts are needed to mitigate this problem.

The building sector is the heart of the Palestinian economy, yet it is laden with danger. Many obstacles and limits have an impact on the construction business and shape it. The long-term interaction between construction parties (owners, consultants, and owners) is still a severe issue (Suprapto et al., 2015). According to PCBS (2022), the building sector and value-added (% of GDP) in Palestine are expected to be 16.78% in 2022. In 2009, the construction sector contributed 7.4% to job creation, which climbed by 3% in 2018, reaching 10.4% in the Occupied Palestinian Territory (9.3% in the West Bank and 1.1% in the Gaza Strip).

Delays in Palestinian construction projects are complicated and caused by a variety of circumstances. Political developments, such as disputes and limitations, have a substantial impact on project schedules, generating disruptions and impediments to progress (Mahamid et al., 2012). Delays are also worsened by concerns linked to cost and time compliance, which make it difficult to keep project timelines (Albatsh, 2015). Skilled labour shortages and broader global construction sector issues exacerbate project delays in the region (Hamzah et al., 2011). To ensure the successful and timely completion of construction projects in Palestine, it is necessary to address these complicated concerns in a comprehensive manner that takes into account both local and global aspects.

In recent years, multi-criteria criteria decision-making (MCDM) techniques, such as Analytic Hierarchy Process (AHP), Grey Relational Analysis (GRA), Vise Kriterijumska Optimizacija Kompromisno Resenje (VIKOR), and Elimination Et Coix Traduisant la REalite (ELECTRE). Decision-Making Trial and Evaluation Laboratory "(DEMATEL) analysis is particularly useful for understanding cause-and-effect relationships among factors. DEMATEL's advantages include analyzing mutual influences among factors, establishing interrelationships, determining rankings, identifying critical evaluation criteria, and measuring their weights (Si et al., 2018). Its use has grown recently, especially for prioritizing delay factors in construction and industrial projects (Ji et al., 2018).

The current study aims to prioritize key delay factors in Palestinian construction projects using the DEMATEL technique. This approach will help understand the relationships and interactions between these factors, contributing significantly to the development and management of construction projects and serving as a valuable tool for stakeholders.

2. Literature review

Alaghbari et al. (2007) conducted a study in Malaysia to identify the causes of construction delays. The study identified three types of delays: excusable and non-compensable, non-excusable, and excusable compensable. Non-excusable delays were attributed to contractors, subcontractors, and suppliers. Client responsibilities included slow decision-making, poor coordination, contract changes, lack of project knowledge, and financial challenges. Contractor responsibilities encompassed material delivery delays, construction errors, and labour shortages. External factors involved material shortages, unfavourable weather conditions, poor site topology, and changes in government regulations. In Afghanistan's construction business, Abbas and Gidado (2012) looked into what causes delays in construction projects. They determined the top ten contributing variables, which included client-related issues like late payments, site delays, order modifications, and delays in design documents. Subcontractor delays, inadequate communication, and financial difficulties were among the contractor's problems. Conflicts, poor communication, and insufficient expertise were consultant factors. Short contract period, little fines for delays, and legal conflicts were project factors. Inexperienced developers, inadequate communication, and intricate project design were among the designer factors. Strikes, a young workforce, and labour shortages were among the labour factors. Majid and Caffer (1998) study in Aceh, Indonesia identified 57 reasons for delays in construction projects, including staff availability, outside variables, equipment and technology delays, site contractor delays, customer delays, resource shortages, and industry consultants. Odeh and Battaineh (2002) study in Jordan explored the causes of delays. They identified several factors contributing to delays, including client-related issues like delayed payment and sluggish decision-making, contractor-related variables like poor planning and site management, consultants' role in contract management, quality assurance, and drawing approval, and labour and material components, including disagreements from real building work and discrepancies in contract papers. Ogunlana et al. (1996) conducted a study in Thailand to understand the causes and effects of delays in building sectors. The study identified three main challenges in the construction industry: infrastructure deficiencies, resource provision issues, and contractor experience. Williams (2003) highlighted the high cost of schedule overruns in construction work, including direct damages like lost production, overhead, and insurance coverage. Marzouk and El-Rasas (2014) study on the Egyptian construction sector identified several factors contributing to project delays. The result revealed that inadequate site management, transportation issues, and a shortage of skilled workers were major causes of delays. Other factors included slow decision-making, client-initiated modifications, insufficient contractor expertise, and inadequate site supervision. Clients also reported lower labour efficiency, poor planning, and design modifications. Holt et al. (1995) found that time and cost overruns are the main causes of delays in Hong Kong's construction sector. Factors such as inflation-related increases in material costs, imprecise estimates, and complex opinions contribute to these delays. Inadequate labour enrolment, design modifications, inadequate planning, and resource shortages also contribute to delays. Frimpong et al. (2003) studied the causes of spending oversights and delays in Ghana's construction sector, focusing on water projects. Surveys revealed five common problems affecting the industry: rising costs, challenges in timely payment, poor contractual supervision, inadequate resources, and outdated technology. Gwinn (2006) study on South Carolina's construction industry revealed challenges in meeting transportation needs. Despite implementing effective initiatives to ensure timely project completion, high costs led to delays, increased contractor demands, and unresolved traffic congestion. Assaf et al. (1995) study analysed the causes of delays in significant building projects in Saudi Arabia. A survey questionnaire revealed that financial problems were the top cause of delays. The study identified several reasons, including adoption of documentation, payment delays, changes in engineering designs, conflicts due to sub-contractor schedules, slow decision-making, design mistakes, and shortages and lack of employment experience. Assaf and Al-Hejji (2005) studied construction project delays in Saudi Arabia from the perspectives. Change orders was the most common cause. The main reasons for delays include delay in progress payments, ineffective planning, poor site management, labour shortages, and financing difficulties. Mezher and Tawil (1996) analysed the causes of construction project delays in Lebanon's construction industry. Identified financial problems as the most common. The survey also revealed that contractual relationships, project management, and consultant involvement were the most significant factors. A study investigated the primary reasons for delays in Hong Kong. It discovered that mismanagement, delays in material processing, slow decision-making, and insufficient communication among different stakeholders are the leading causes of delays in Hong Kong (Chan &Kumarswamy, 1998). Frimpong et al. (2003) identified monthly payment difficulties, poor sub-contractor management, material supply and collection, poor project management technical performance, and material price changes as common causes of construction project delays in Ghana. Koushki et al. (2005) identified Kuwaiti building project delays as a result of lack of experience, poor financial potential, inadequate materials, and poor quality. Hindawi and Awad (2007) studied the causes of construction project delays in Iraq using a questionnaire. The most significant causes were referring bids to the lowest price, contractors' financial incompetence, and material price changes. Sambasivan and Soon (2007) conducted a study in Malaysia to understand the causes of delays and their impact on project completion. The study identified the top ten causes of delay as poor planning, site management, insufficient contractor experience, inadequate funding, sub-contractor issues, and implementation phase errors. Abd El-Razek et al. (2008) identified three main causes of construction project delays in Egypt: contractor financing, owner design changes, and partial payments, from the perspectives of contractor, consultant, and owner. Tumi et al. (2009) studied building project delays in Benghazi, Libya. He found the causes of delays include lack of effective communication, design errors, material shortages, slow decision-making, financial issues, cash-flow problems during construction, and increased quantities. Al-Najjar et al. (2009) conducted a study on delays and cost overruns in building projects in Palestine-Gaza Strip. They found that political issues, particularly strikes and border closures, were the most significant causes. The primary reasons for time delays were strikes and border closures, market shortages, and delays in material delivery to the site.

This literature review examines delays in construction projects in various countries, highlighting factors such as client issues, contractors, consultants, external factors, labour, and project design. Common causes include slow decision-making, financial challenges, changes in project specifications, inexperienced workforce, material shortages, poor site management, and external factors like weather conditions and government regulations. The review emphasizes the need for effective communication, proper planning, and financial issues to mitigate delays and improve project efficiency. The summary of factors contributing to delays in construction projects is presented in Table 2.1.

Table 2.1 Key factors affecting construction delay

No.	Key factors affecting construction delay	Related to	Reference
1	Referral of bids to the lowest price	Owner	(Sambasivan & Soon, 2007), and (Hindawi & Awad, 2007).
2	Irregular cash flow for the project on owner's side		(Alaghbari et al., 2007), (Abbas & Gidado, 2012) (Al-Najjar et al., 2009), (Odeh & Battaineh, 2002) (Gwinn, 2006), (Asnssshari et al., 2009) (Abd El-Razek et al., 2008), (Koushki et al., 2005), and (Assaf et al., 1995).
3	Delay in payments		(Abd El-Razek et al., 2008), (Koushki et al., 2005), (Assaf et al., 1995), (Odeh & Battaineh, 2002), (Alaghbari et al., 2007), and (Abbas & Gidado, 2012).
4	variation orders		(Alaghbari et al., 2007), (Abbas & Gidado, 2012) (Odeh & Battaineh, 2002), (Assaf & Al-Hejji, 2005),

			(Abd El-Razek et al., 2008), and (Chan &Kumarswamy, 1998).
6	Contractor Lack of sufficient experience	Contractor	(Alaghbari et al., 2007).
7	Lack of sufficient financing for the project		(Abd El-Razek et al., 2008) and (Al-Najjar et al., 2009).
9	Unavailability of required equipment when demanded or delayed availability behind schedule		(Abd El-Razek et al., 2008) and (Sambasivan & Soon, 2007).
10	Problem/ Mistakes during implementation		(Odeh & Battaineh, 2002) and (Marzouk & El-Rasas, 2014).
11	Slow decision-making	Consultant	(Marzouk & El-Rasas, 2014), (Chan &Kumarswamy, 1998), (Alaghbari et al., 2007), (Assaf et al., 1995), and (Mezher and Tawil, 1996).
12	Missing or lack of incentives for workers institution		(Abbas & Gidado, 2012), (Odeh & Battaineh, 2002), (Assaf et al., 1995), and (Alaghbari et al., 2007).
13	Mistakes in design		(Alaghbari et al., 2007), (Abbas & Gidado, 2012), (Odeh & Battaineh, 2002), and (Marzouk & El-Rasas, 2014).
14	Delays in the approval of adjustments during the execution phase		(Marzouk & El-Rasas, 2014), (Odeh & Battaineh, 2002), and (Abbas & Gidado, 2012).
15	Weakness in the management of the project, and the estimation of the accurate needed period for completion		(Marzouk & El-Rasas, 2014), (Alaghbari et al., 2007),and (Abbas & Gidado, 2012).
16	Deficiencies, errors, contradictions, and ambiguity or variation in the contract documents or their incompleteness	Contract	(Abbas & Gidado, 2012), (Odeh & Battaineh, 2002), (Marzouk & El-Rasas, 2014), and (Alaghbari et al., 2007).
17	Insufficient procedures in the contracts needed to be taken to settle disputes if they occur		(Assaf et al., 1995), (Odeh & Battaineh, 2002), and (Abbas & Gidado, 2012).
18	Problems in the contract documents		(Assaf et al., 1995).
19	Duties, responsibilities, and rights of the parties undefined accurately in the contract		(Assaf et al., 1995).
20	Problems with neighbours	Project	(Hindawi & Awad, 2007).
21	The specified period for the implementation of the project is very few		(Holt et al., 1995).
22	Conflicts and differences among the project documents		(Abbas & Gidado, 2012) and (Odeh & Battaineh, 2002).
23	Occupation and political obstacles	External	(Al-Najjar et al., 2009).
24	Economic stability		(Al-Najjar et al., 2009).
25	Weather condition		(Marzouk & El-Rasas, 2014), (Abbas & Gidado, 2012), and (Gwinn, 2006).
26	Inflation / price fluctuations		(Sambasivan & Soon, 2007), (Hindawi & Awad, 2007), (Holt et al., 1995), and (Assaf et al., 1995).

3. Research Methodology

The proposed study attempts to elicit the specific key delay factors with as much expert judgment as possible through interviews and pre-structured questionnaires, analysing each identified key delay factor. It is possible to accomplish this by doing the following:

- Identified the most common key delay factors facing construction projects in Palestine through extensive literature review.
- Prioritizing identified key delay factors based on Content Validity Index (CVI) to be used in decision-making trial and evaluation laboratory (DEMATEL) approach.
- Creating causal relationships among components using the DEMATEL approach.

4. Data Collection

❖ **To Prioritizing the key delay factors:**

A list of factors influencing time delays in Palestinian building projects was compiled and an expert questionnaire survey was created using the Delphi survey technique (Brady, 2015; Sarvari et al., 2019; Olawumi et al., 2018). Chadwick et al. (1984) proposed that at least eight (8) participants should be in the evaluation of content validity index (CVI). Hence, in the present study, 13 individuals assess the questionnaire content validity. Table 3.1 contains information about knowledgeable participants.

❖ **To apply the Decision-Making Trial and Evaluation Matrix (DEMATEL) analysis:**

The primary construction delay factors were identified using the Delphi survey questionnaire technique. These factors will then guide the formulation of new questionnaire aimed at gathering information for DEMATEL analysis. Key considerations such as sample size requirements, data collection methods, and participant experiences play crucial roles in this data collection process (Abbas & Gidado, 2012; Dennis, 2014). Data collection involves using binary comparison-oriented questionnaires distributed to the expert's office. DEMATEL studies involve sample sizes ranging from 10 to 12 selected experts (Susanty et al., 2019; Morteza et al., 2014). For this study, 12 leading experts from construction companies in Gaza, Palestine, provided data for the analysis. This number of experts is considered adequate (Susanty et al., 2019; Mohiuddin et al., 2017; Kumar & Dash, 2016). Table 3.1 provides information about respondents.

Table 3.1 Respondent's Information's

No / Percentage	Experience [years]			
	Under 5	Between 5 to 10	Between 11 to 15	Above 15
No	3	2	3	5
Percentage	23,08%	15,38%	23,08%	38,46%
No / Percentage	Type of work			
	Contractor		Owner	Consultant
No	6		4	3
Percentage	46,15%		30,77%	23,08%
No / Percentage	Type of sector			
	Government		Private	
No	5		8	
Percentage	38,46%		61,54%	
No / Percentage	Site organization / company / office			
	South Gaza	North Gaza	Centre Gaza	East Gaza
No	6	1	4	2
Percentage	46,15%	7,69%	30,77%	15,38%

5. Data Analysis Method

❖ **Prioritizing the key delay factors:**

After compiling a list of factors affecting time delays in Palestinian building projects from the literature review, a three-step questionnaire technique is proposed, following the methodologies outlined by (Brady, 2015; Sarvari et al., 2019; Olawumi et al., 2018; Chadwick et al., 1984; Lawshe, 1975; Pezshki et al., 2017; Fadavi-Ghaffari et al., 2017; BERTEA & ZAIŢ, 2004). This approach will be used to prioritize the key delay factors for the DEMATEL analysis.

- Step 1: Experts were asked to score the item which was identified in the literature review (see table 2.1), using a 4-point Likert scale. using 1 ("irrelevant"), 2 ("Somewhat relevant"), 3 ("relevant") and 4 ("fully relevant").

Table 4.1 Experts Opinions about Key Factors Delay

Item	Key Factors of Delay	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13
F1	Problem/ Mistakes during implementation	3	3	3	4	4	4	3	3	2	3	3	3	2
F2	Irregular cash flow for the project on owner's side	2	3	2	3	2	4	3	4	3	3	3	4	3
F3	Lack of sufficient financing for the project	4	4	3	4	3	4	4	4	4	4	4	3	3

F4	Delay of due payments	4	4	3	4	4	4	3	4	4	4	4	4	4
F5	Lack of attention to the training and development of human elements in charge of the project	2	1	2	3	3	2	2	1	1	3	1	3	1
F6	Slow decision-making	3	3	4	4	3	3	4	2	4	3	3	4	3
F7	Occupation and political obstacles	3	4	4	4	4	4	4	3	3	4	4	3	4
F8	Contractor failure to regulate the cash flow of the project	3	3	2	4	3	3	3	2	4	3	4	2	3
F9	Unavailability of required equipment when demanded or delayed availability behind schedule	2	2	4	2	2	2	2	3	4	2	2	4	3
F10	variation orders	3	4	4	4	3	3	4	3	3	3	3	4	3
F11	Referral of bids to the lowest price	3	3	2	3	4	4	4	4	4	3	3	3	4
F12	Missing or lack of incentives for workers institution	3	1	3	1	1	1	1	2	1	1	2	1	3
F13	Problems in the contract documents	3	3	3	3	2	4	3	4	3	3	2	4	3
F14	Delays in the approval of adjustments during the execution phase	3	2	4	4	3	3	2	2	2	2	3	4	3
F15	Weakness in the management of the project, and the estimation of the accurate needed period for completion	2	3	2	1	1	2	3	3	1	3	1	2	1
F16	Deficiencies, errors, contradictions, and ambiguity or variation in the contract documents or their incompleteness	2	3	2	2	1	3	1	1	1	1	2	4	2
F17	Insufficient procedures in the contracts needed to be taken to settle disputes if they occur	3	2	4	4	3	3	2	2	2	2	2	2	3
F18	Contractor Lack of sufficient experience	3	4	2	3	2	4	3	4	3	3	3	4	3
F19	Duties, responsibilities, and rights of the parties undefined accurately in the contract	3	2	4	4	2	3	2	2	2	2	2	2	3
F20	Mistakes in design	2	3	4	3	4	4	3	2	4	3	3	3	4
F21	The specified period for the implementation of the project is very few	2	3	4	3	4	4	3	2	2	2	3	2	2
F22	Conflicts and differences among the project documents	3	3	2	4	2	2	3	4	4	3	4	2	3
F23	Problems with neighbour's	4	3	3	4	3	4	3	3	4	4	3	4	2
F24	Economic stability	1	1	3	1	3	1	3	3	1	2	2	3	2
F25	Weather condition	3	3	3	2	4	4	3	3	3	2	3	3	4
F26	Inflation / price fluctuations	1	2	2	1	2	3	1	3	2	2	2	3	2

- step 2: Calculate Content Validity Index using equation (1):

$$\textbf{Content Validity Index (CVI)} = \frac{\textbf{Number of experts giving 3 and 4 scores}}{\textbf{total number of experts}} \qquad (3.1)$$

The calculations are provided in Table 4.2. For example, the CVI for “referral of bids to the lowest price” is (6 + 6) / 13 = 0,92.

Table 4.2 Content Validity Index for Key Factors Delay

Item	Key Factors of Delay	Number of experts giving 3	Number of experts giving 4	CVI
F1	Problem/ Mistakes during implementation	8	3	0,85
F2	Irregular cash flow for the project on owner's side	7	3	0,77
F3	Lack of sufficient financing for the project	4	9	1,00
F4	Delay in payments	2	11	1,00
F5	Lack of attention to the training and development of human elements in charge of the project	4	0	0,31
F6	Slow decision-making	7	5	0,92
F7	Occupation and political obstacles	4	9	1,00
F8	Contractor failure to regulate the cash flow of the project	7	3	0,77
F9	Unavailability of required equipment when demanded or delayed availability behind schedule	2	3	0,38
F10	variation orders	8	5	1,00
F11	Referral of bids to the lowest price	6	6	0,92
F12	Missing or lack of incentives for workers institution	3	0	0,23
F13	Problems in the contract documents	8	3	0,85
F14	Delays in the approval of adjustments during the execution phase	5	3	0,62
F15	Weakness in the management of the project, and the estimation of the accurate needed period for completion	4	0	0,31
F16	Deficiencies, errors, contradictions, and ambiguity or variation in the contract documents or their incompleteness	2	1	0,23
F17	Insufficient procedures in the contracts needed to be taken to settle disputes if they occur	4	2	0,46
F18	Contractor Lack of sufficient experience	7	4	0,85
F19	Duties, responsibilities, and rights of the parties undefined accurately in the contract	3	2	0,38
F20	Mistakes in design	6	5	0,85
F21	The specified period for the implementation of the project is very few	4	3	0,54
F22	Conflicts and differences among the project documents	5	4	0,69
F23	Problems with neighbour’s	6	6	0,92
F24	Economic stability	5	0	0,38
F25	Weather condition	6	3	0,69
F26	Inflation / price fluctuations	3	0	0,23

Step 3: Items with scores exceeding the minimally acceptable CVI threshold of 0.79 were selected, as indicated in Table 4.3 (Pezshki et al., 2017; Fadavi-Ghaffari et al., 2017). These factors will be further examined in the DEMATEL analysis.

Table 4.3 Key Factors Delay with CVI greater than 0.79

Factor	Key Factors of Delay	CVI
F11	Referral of bids to the lowest price	0,92
F4	Delay in payments	1,00
F10	variation orders	1,00
F18	Contractor Lack of sufficient experience	0,85
F3	Lack of sufficient financing for the project	1,00
F1	Problem/ Mistakes during implementation	0,85
F6	Slow decision-making	0,92
F20	Mistakes in design	0,85
F13	Problems in the contract documents	0,85
F23	Problems with neighbour’s	0,92
F7	Occupation and political obstacles	1,00

❖ DEMATEL Analysis Results:

12 experts' judgments for the prioritized key factors in table 4.3 serve as the basis for the computation utilizing the DEMATEL approach. Each respondent was asked to rate the direct influence of each factor on other factor using an integer score between 0 and 4, representing "no effect," "low effect," "medium effect," and "high effect," respectively. By default, the influence of a component on itself is zero. To include all the viewpoints from respondents, then the following steps were applied:

First step*:* the direct-relation matrix A was computed using data from all 12 experts, as shown in Table 4.5. In matrix A, the element z_{ij}^{k} represents the effect that factor i has on factor j according to expert k (refer to Equation 3.2). For instance, the sum of the values in the "F1" row is calculated as

0.000+3.917+2.000+2.000+3.083+1.000+3.000+1.000+3.000+1.08+2.000=22.083.

The sum value (S) is the highest sum among all eleven rows, which are 22.083, 24.417, 20.833, 23.583, 23.750, 18.417, 17.500, 19.250, 20.833, 17.250, and 22.833, with the highest being 24.417 (refer to Equation 3.3).

$$A = [a_{ij}] = \frac{1}{H}\sum_{k=1}^{H} z_{ij}^{k} \qquad (3.2)$$

$$S = Max\left[max_{1\le i\le n} \sum_{j=1}^{n} a_{ij}\ , max_{1\le i\le n} \sum_{j=1}^{n} a_{ij}\right] \qquad (3.3)$$

Table 4.5 Direct-Relation Matrix A Calculation

Direct-Relation Matrix A Calculation												Sum
Factors	F1	F7	F3	F4	F10	F23	F11	F13	F6	F20	F18	
F1	0,000	3,917	2,000	2,000	3,083	1,000	3,000	1,000	3,000	1,083	2,000	22,083
F7	3,667	0,000	3,667	2,917	1,083	1,000	3,000	2,000	3,000	2,083	2,000	24,417
F3	2,000	3,750	0,000	3,000	2,083	1,000	2,917	2,000	2,000	1,083	1,000	20,833
F4	3,000	3,083	3,667	0,000	1,083	1,000	3,667	2,000	2,000	2,083	2,000	23,583
F10	3,000	3,083	3,000	2,917	0,000	2,000	1,917	2,000	2,833	2,000	1,000	23,750
F23	2,000	3,083	3,667	1,917	2,000	0,000	1,917	0,917	0,917	1,000	1,000	18,417
F11	1,000	1,083	3,000	3,583	2,000	1,000	0,000	1,917	0,917	1,000	2,000	17,500
F13	2,000	2,083	2,000	2,917	3,000	0,417	1,917	0,000	2,000	1,000	1,917	19,250
F6	2,000	2,083	3,000	1,917	3,000	1,000	1,917	0,917	0,000	2,000	3,000	20,833
F20	1,000	2,083	2,000	1,917	3,000	0,417	2,917	1,000	1,917	0,000	1,000	17,250
F18	2,000	2,000	3,000	2,917	2,000	2,000	2,917	2,000	1,917	2,083	0,000	22,833
S												24,417

Second step: the normalized initial direct-relation matrix D is built (see Equation 3.4) by dividing A values by S value (see Table 4.5). The results are as stated in Table 4.6. For instance, by dividing the A value of 3.917 (from F1 to F7 in Table 4.5) by S value of 24.417, the value of 0.160 is achieved (see Table 4.6 from F1 to F7).

Table 4.6 Normalized Initial Direct-Relation Matrix D Calculation

Normalized Initial Direct-Relation Matrix D											
Factors	F1	F7	F3	F4	F10	F23	F11	F13	F6	F20	F18
F1	0,000	0,160	0,082	0,082	0,126	0,041	0,123	0,041	0,123	0,044	0,082
F7	0,150	0,000	0,150	0,119	0,044	0,041	0,123	0,082	0,123	0,085	0,082
F3	0,082	0,154	0,000	0,123	0,085	0,041	0,119	0,082	0,082	0,044	0,041
F4	0,123	0,126	0,150	0,000	0,044	0,041	0,150	0,082	0,082	0,085	0,082
F10	0,123	0,126	0,123	0,119	0,000	0,082	0,078	0,082	0,116	0,082	0,041
F23	0,082	0,126	0,150	0,078	0,082	0,000	0,078	0,038	0,038	0,041	0,041

F11	0,041	0,044	0,123	0,147	0,082	0,041	0,000	0,078	0,038	0,041	0,082
F13	0,082	0,085	0,082	0,119	0,123	0,017	0,078	0,000	0,082	0,041	0,078
F6	0,082	0,085	0,123	0,078	0,123	0,041	0,078	0,038	0,000	0,082	0,123
F20	0,041	0,085	0,082	0,078	0,123	0,017	0,119	0,041	0,078	0,000	0,041
F18	0,082	0,082	0,123	0,119	0,082	0,082	0,119	0,082	0,078	0,085	0,000

Third step: the total-relation matrix T is calculated, as indicated in Table 4.7 (see Equation 3.5). Multiplying Matrix D by the inverse of the difference between the Identity matrix (I) and Matrix D results in Table 4.6.

$$T = [t_{ij}]_{nxn} = D(I - D)^{-1} \qquad (3.5)$$

Table 4.7 Total-Relation Matrix T Calculation

Total-Relation Matrix T											
Factors	F1	F7	F3	F4	F10	F23	F11	F13	F6	F20	F18
F1	0,587	0,825	0,828	0,767	0,678	0,340	0,801	0,483	0,667	0,466	0,540
F7	0,759	0,738	0,936	0,848	0,656	0,359	0,856	0,549	0,706	0,529	0,576
F3	0,630	0,781	0,709	0,762	0,610	0,320	0,760	0,493	0,599	0,440	0,479
F4	0,714	0,823	0,909	0,718	0,633	0,348	0,853	0,535	0,650	0,513	0,557
F10	0,729	0,840	0,902	0,833	0,600	0,389	0,804	0,540	0,692	0,519	0,530
F23	0,569	0,694	0,765	0,653	0,548	0,251	0,655	0,409	0,504	0,392	0,426
F11	0,509	0,594	0,711	0,684	0,526	0,279	0,555	0,429	0,479	0,376	0,444
F13	0,595	0,684	0,738	0,718	0,610	0,284	0,684	0,392	0,568	0,413	0,482
F6	0,626	0,725	0,815	0,723	0,644	0,323	0,724	0,454	0,523	0,473	0,544
F20	0,498	0,613	0,663	0,615	0,554	0,253	0,649	0,388	0,507	0,330	0,402
F18	0,662	0,766	0,865	0,803	0,646	0,376	0,805	0,521	0,628	0,501	0,465

Fourth step: the sums of rows (R) and columns (C) are calculated from a total-relation matrix T (see Table 4.8, and Equations 3.6 and 3.7). The total of "F1" row of 6.981 is, for example the sum value of 0.587, 0.825, 0.828, 0.767, 0.678, 0.340, 0.801, 0.483, 0.667, 0.466, and 0.540 in table 4.7. The total of "F1" column of 6.878 is, on the other hand, achieved by the summing of 0.587, 0.759, 0.630, 0.714, 0.729, 0.569, 0.509, 0.595, 0.626, 0.498, and 0.662 in table 4.7.

$$R = \left[\left(\sum_{j=1}^{n} t_{ij}\right)\right]_{nx1} = [t_i]_{nx1} \qquad (3.6)$$

$$C = \left[\left(\sum_{j=1}^{n} t_{ij}\right)\right]_{1xn} = [t_i]_{1xn} \qquad (3.7)$$

Table 4.8 Ri, Ci, (Ri + Ci) and (Ri - Ci) calculation

Factors	Ri	CI	Prominence (Ri + Ci)	Relation (Ri - Ci)
F1	6,981	6,878	13,859	0,103
F7	7,514	8,083	15,597	-0,570
F3	6,582	8,840	15,422	-2,258
F4	7,254	8,125	15,379	-0,870
F10	7,378	6,706	14,084	0,672
F23	5,866	3,520	9,387	2,346
F11	5,585	8,147	13,732	-2,561
F13	6,167	5,193	11,360	0,974

F6	6,574	6,525	13,099	0,049
F20	5,473	4,951	10,423	0,522
F18	7,038	5,444	12,482	1,594

Fifth Step: the vectors (Ri + Ci) and (Ri - Ci) are calculated by summing each Ri with each Ci in the same row (see Table 4.8). For example, the (Ri + Ci) value of the F1 row is 6.981+ 6.878= 13.859. The (Ri - Ci) value, on the other hand, is 6.981 - 6.878 = 0.103.

Sixth step: in this study, the threshold value (α) is derived using Equation 3.8 in Chapter 3 to weed out trivial effects and bias. All T values in Table 4.7 are combined and divided by the total amount of data (which is 121). The α value is thus 0.6. According to Rezahoseini et al. (2019), it is crucial to build Matrix F by setting element Tij in Table 4.7 that is equal or higher than the threshold (α) of matrix T to 1, and element Tij in Table 4.7 that is less than threshold (α) of matrix T to 0. For example, the T value from F1 to F1 in Table 4.7 is 0.587, which is lower than the α value of 0.6. This brings the F value from F1 to F1 in Table 4.9 to 0. On the other hand, the T value from F1 to F7 in Table 4.7 of 0.825 bring its F value to 1, as it is higher than the α value (see Table 4.9).

Table 4.9 Matrix F (for α = 0.6)

F											
Factors	F1	F7	F3	F4	F10	F23	F11	F13	F6	F20	F18
F1	0,00	1,00	1,00	1,00	1,00	0,00	1,00	0,00	1,00	0,00	0,00
F7	1,00	1,00	1,00	1,00	1,00	0,00	1,00	0,00	1,00	0,00	0,00
F3	1,00	1,00	1,00	1,00	1,00	0,00	1,00	0,00	1,00	0,00	0,00
F4	1,00	1,00	1,00	1,00	1,00	0,00	1,00	0,00	1,00	0,00	0,00
F10	1,00	1,00	1,00	1,00	1,00	0,00	1,00	0,00	1,00	0,00	0,00
F23	0,00	1,00	1,00	1,00	0,00	0,00	1,00	0,00	0,00	0,00	0,00
F11	0,00	0,00	1,00	1,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
F13	0,00	1,00	1,00	1,00	1,00	0,00	1,00	0,00	0,00	0,00	0,00
F6	1,00	1,00	1,00	1,00	1,00	0,00	1,00	0,00	0,00	0,00	0,00
F20	0,00	1,00	1,00	1,00	0,00	0,00	1,00	0,00	0,00	0,00	0,00
F18	1,00	1,00	1,00	1,00	1,00	0,00	1,00	0,00	1,00	0,00	0,00

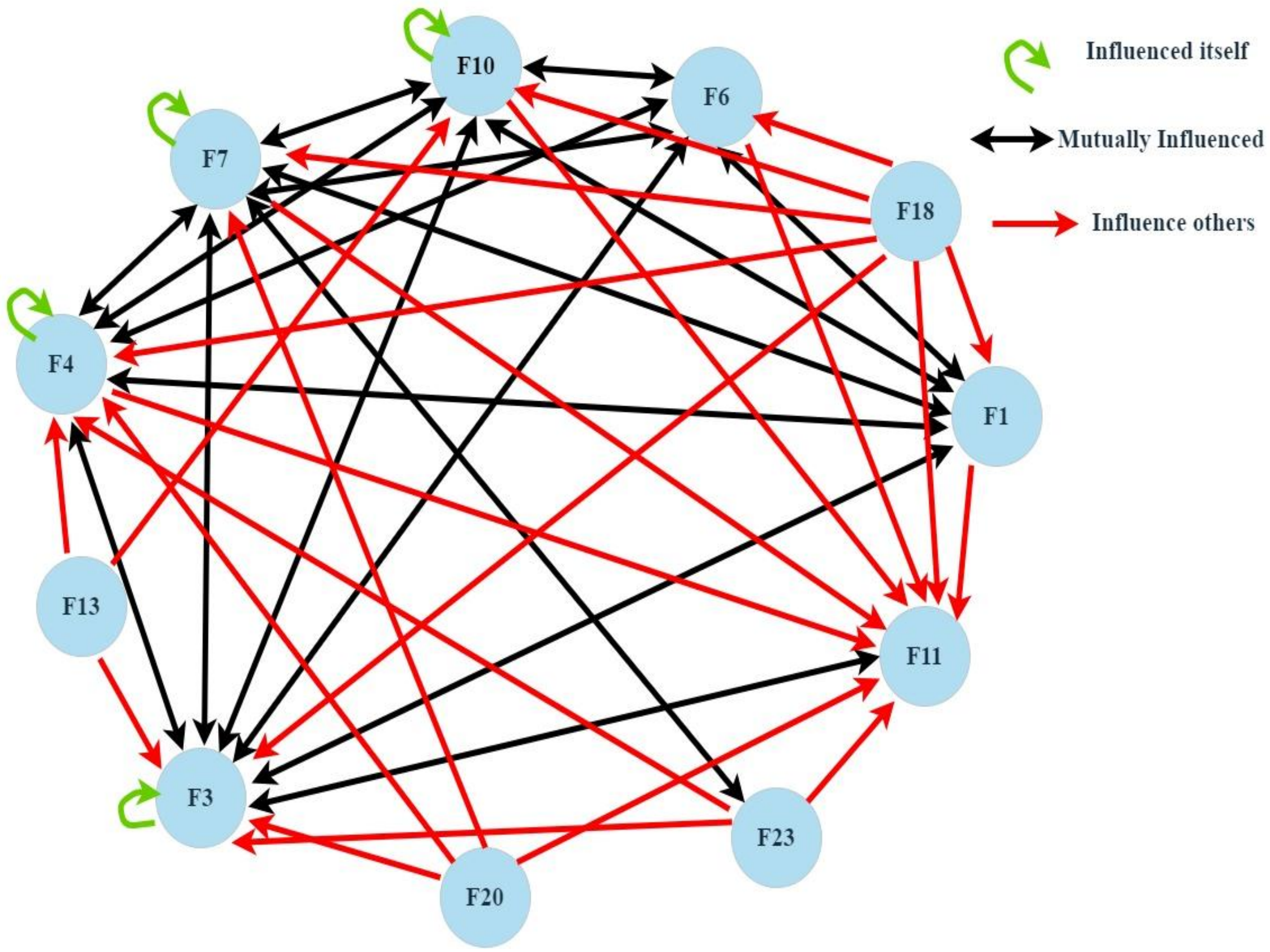

Figure 3: Diagraph of construction delay

The DEMATEL digraph provides a visual representation of the relationships between various factors, in the context of construction delays. Here's an explanation of the digraph:

1. Mutual Influences:
   - Factors that mutually influence each other are connected by black arrows pointing in both directions.
   - F1 has mutual influences with F7, F3, F4, F6, and F10.
   - F7 has mutual influences with F3, F4, F10, and F6.
   - F3 has mutual influences with F4, F10, F11, and F6.
   - F4 has mutual influences with F10, and F6.
   - F10 has mutual influences with F6.
   - F23 also has mutual influences with F7.

2. Influence Others:
   - Factors influencing other factors are represented with red arrows pointing outward.
   - F18 influences F1, F7, F3, F4, F10, F11, and F6.
   - F20 influences F7, F3, F4, and F11.
   - F13 influences F4, F10, and F11.
   - F23 influences F3, F4, and F11.
   - F6 influences F11.
   - F10 influences F11.
   - F4 influences F11.
   - F7 influences F11.
   - F1 influences F11.

3. Self-Influences:
    - Factors influencing themselves are depicted with green arrows looping back to the same node.
    - F3, F4, F7, and F10 have self-influence, indicating that these factors have an impact on themselves.

Seventh step: the cause-effect diagram is built using the coordinates (Ri + Ci) and (Ri – Ci) in Table 4.8. The values of (Ri + Ci) stand for the degree of impact among factors, whereas (Ri – Ci) reflects the relations among factors. Positive values are categorised as cause factors, whereas the negative values are effect factors (Abdullah et al., 2019).

The (Ri + Ci) and (Ri – Ci) values in Table 4.8 are plotted in the cause-and-effect diagram (see Figure 4.2). It demonstrates that the Occupation and political hurdles (F7) component is the most influencing element, while the Problems with neighbour's (F23) factor is the least affecting factor. F23, F18, F13, F20, F10, F1, and F6 factors are categorised as the cause group as their (Ri – Ci) values are positive. In contrast, F7, F4, F3, and F11 factors are classed into the effect group as their (Ri – Ci) values are negative (see Table 4.10).

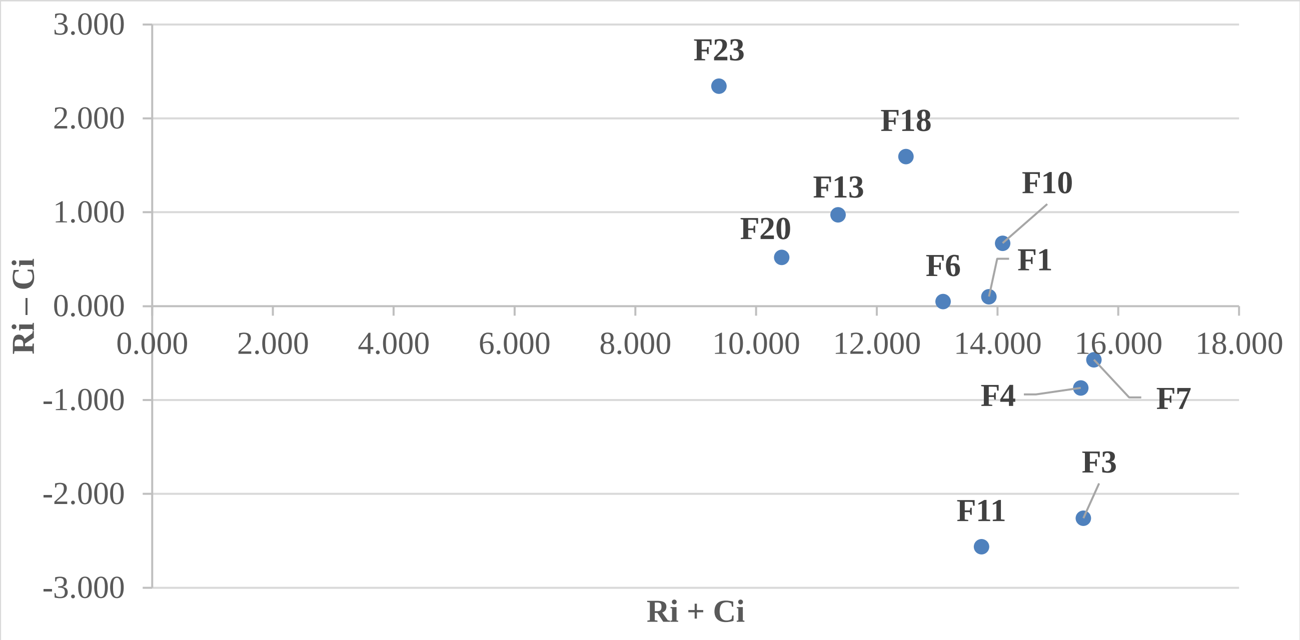

Figure 4: Cause and effect diagram of construction delay

Table 4.10 Order of influence of construction delay factors

Factors	Prominence (Ri + Ci)	Rank of factors	Relation (Ri - Ci)	Cause/Effect Group
Occupation and political obstacles (F7)	15,597	1	Negative	Effect
Lack of sufficient financing for the project (F3)	15,422	2	Negative	Effect
Delay in payments (F4)	15,379	3	Negative	Effect
variation orders (F10)	14,084	4	Positive	Cause
Problem/ Mistakes during implementation (F1)	13,859	5	Positive	Cause
Referral of bids to the lowest price (F11)	13,732	6	Negative	Effect
Slow decision-making (F6)	13,099	7	Positive	Cause
Contractor Lack of sufficient experience (F18)	12,482	8	Positive	Cause
Problems in the contract documents (F13)	11,36	9	Positive	Cause

Mistakes in design (F20)	10,423	10	Positive	Cause
Problems with neighbour's (F23)	9,387	11	Positive	Cause

The overall extent to which one factor is influenced by another (i.e., the influence weight) is determined by dividing each prominence value (see Table 4.10) by the sum of all prominence values, which is 144.824 (calculated as 15.597 + 15.422 + 15.379 + 14.084 + 13.858 + 13.732 + 13.099 + 12.482 + 11.36 + 10.423 + 9.387).

The importance weight of the F7 factor is, for example $\frac{15.597}{144.824}$ X 100 = 10.770% (see Table 4.11).

Table 4.11 Total degree to which a factor is influenced by the other factors

Rank	Factor	Value (%)
1	Occupation and political obstacles (F7)	10.770
2	Lack of sufficient financing for the project (F3)	10.649
3	Delay in payments (F4)	10.619
4	variation orders (F10)	9.725
5	Problem/ Mistakes during implementation (F1)	9.570
6	Referral of bids to the lowest price (F11)	9.482
7	Slow decision-making (F6)	9.045
8	Contractor Lack of sufficient experience (F18)	8.619
9	Problems in the contract documents (F13)	7.844
10	Mistakes in design (F20)	7.197
11	Problems with neighbour's (F23)	6.482

The results indicate that the "occupation and political obstacles (F7)" factor is the most influential in causing construction project delays. This is followed by "Lack of sufficient financing for the project (F3)," "Delay in payments (F4)," "Variation orders (F10)," "Problems/Mistakes during implementation (F1)," "Referral of bids to the lowest price (F11)," "Slow decision-making (F6)," "Contractor lack of sufficient experience (F18)," "Problems in the contract documents (F13)," "Mistakes in design (F20)," and "Problems with neighbours (F23)," respectively. A summary of the DEMATEL analysis results is shown in Figure 5.

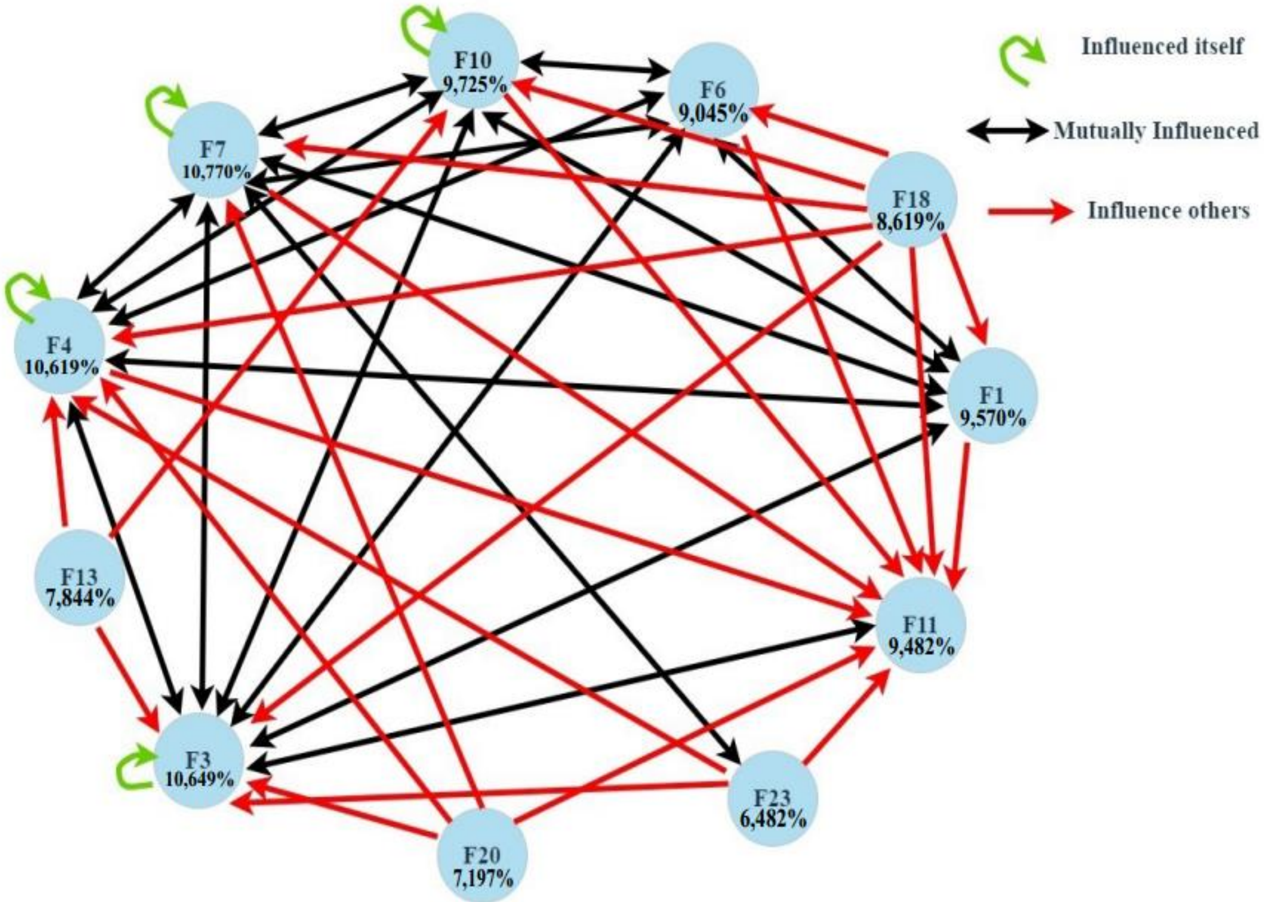

Figure 5: Cause and effect diagram of construction delay factors with their influence

6. Discussion

The interrelationships among the risk factors in construction projects depicted in Cause and effect diagram of construction delay factors with their influence in Figure 5 illustrates that the Occupation and political obstacles (F7), Lack of sufficient financing for the project (F3), Delay in payments (F4), variation orders (F10), and Problem/ Mistakes during implementation (F1) have more influence over the other six risk factors. This finding shows that decision-makers should first consider these five factors during the assessing key delay factors in construction projects in Palestine.

The analysis has identified "Occupation and Political Obstacles" (F7) as the most critical delay factor in construction projects, with an "R+C" value of 15.597 and a staggering value of 10,770%. This high prominence value signifies that F7 not only exerts a significant influence on other factors but is also heavily influenced by them, indicating its central role in the assessing key delay factors in construction projects in Palestine. These obstacles can include regulatory hurdles, changes in government policies, and political instability, which can severely impede project progress. This aligns with findings from other research, particularly in politically unstable regions like the Middle East, where political issues are primary causes of delays. For instance, Jarkas and Haupt (2015) highlight political instability as a major barrier in the construction industry of developing countries. Mitigating this factor could involve engaging in more robust stakeholder management, securing political risk insurance, and fostering strong relationships with local authorities to navigate bureaucratic challenges more effectively.

The second most impactful factor is the "lack of sufficient financing for the project " (F3), valued at 10,649%. Financial constraints can halt project activities, delay procurement of materials, and disrupt cash flow. This issue is similarly prominent in other studies. For example, Sambasivan and Soon (2007) in Malaysia found that financial problems were among the top causes of delays in construction projects. Addressing this requires comprehensive financial planning, securing multiple funding sources, and maintaining contingency reserves to manage unforeseen financial difficulties.

Delays in payments (F4), scoring 10,619%, are a significant cause of project slowdowns. Late payments can lead to work stoppages, demotivation among contractors, and strained relationships between stakeholders. Similar findings are prevalent in global studies, where delayed payments are a common hindrance. Aibinu and Odeyinka (2006) highlighted payment delays as a critical issue in the Nigerian construction industry. To mitigate this, implementing clear contractual payment terms, establishing a streamlined payment process, and using technology for real-time payment tracking can be effective measures.

Variation orders (F10), with a value of 9,725%, reflect changes in project scope or specifications, often leading to delays. This factor is commonly highlighted in literature as a source of disruption due to the need for additional approvals and adjustments. For example, Assaf and Al-Hejji (2006) in Saudi Arabia found that change orders are one of the top causes of delays. Establishing a comprehensive initial scope and employing a rigorous change management process can help minimize the impact of variation orders.

Problems or mistakes during implementation (F1), rated at 9,570%, can arise from technical errors, miscommunication, or inadequate planning. This aligns with findings from various studies that identify problems during implementation as critical delay factors. Chan and Kumaraswamy (1997) in Hong Kong identified on-site problems as significant delay factors. Effective strategies to address this include investing in skilled labour, continuous training, regular site inspections, and adopting advanced project management tools to enhance coordination and execution accuracy.

Referring bids to the lowest price (F11), scoring 9,482%, often leads to selecting contractors who may lack the necessary experience or resources. This practice is widely criticized in the literature for compromising quality and causing delays. Studies such as those by Kaming et al. (1997) in Indonesia emphasize that this approach often leads to selecting less qualified contractors, resulting in delays. A shift towards quality-based selection criteria is suggested to improve project outcomes and reduce delays caused by inexperienced contractors.

Slow decision-making (F6), valued at 9,045%, can cause significant project slowdowns. Delays in approvals and responses can halt progress and increase costs. This issue is frequently noted in various studies as a bottleneck in project timelines. Olawale and Sun (2010). in the UK highlighted that delays in approvals and decision-making processes significantly impact project timelines. Establishing clear decision-making protocols, setting deadlines for approvals, and utilizing collaborative decision-making tools can accelerate the process and reduce delays.

A contractor’s lack of sufficient experience (F18), with a value of 8,619%, often leads to inefficiencies and mistakes. Studies corroborate that inexperienced contractors tend to face more difficulties, resulting in project delays. For instance, Faridi and El-Sayegh (2006) in the UAE found that inexperienced contractors contribute significantly to project delays. Addressing this requires thorough vetting during the contractor selection process, emphasizing experience and past performance, and providing necessary training and support during the project.

Problems in contract documents (F13), scoring 7,844%, can lead to misunderstandings, disputes, and delays. In line with other studies, unclear or incomplete contract documents are frequently cited as significant delay factors. Al-Momani (2000) in Jordan indicates that unclear or incomplete contract documents lead to misunderstandings and disputes. Ensuring meticulous preparation and review of contract documents, with input from all stakeholders, can help prevent these issues and facilitate smoother project execution.

Mistakes in design (F20), valued at 7,197%, often necessitate redesigns and corrections, causing delays. This issue is consistent with findings in other studies where design errors are significant contributors to project delays. For example, Memon et al. (2011) in Malaysia found that design changes and mistakes significantly contribute to project delays. Implementing rigorous design review processes, using advanced design software, and involving experienced designers can minimize these mistakes and enhance project timelines.

Problems with neighbours (F23), at 6,482%, can include disputes over land, noise, or other disruptions caused by the project. These issues are commonly highlighted in the literature as sources of delays due to conflicts and legal challenges. A study by Doloi et al. (2012) in India identified neighbour-related issues as contributing factors to construction delays. Effective stakeholder engagement, maintaining open communication with neighbouring communities, and addressing their concerns proactively can help mitigate these delays.

7. Conclusion

The performance of construction projects is crucial for their success; however, many projects suffer from significant delays, failing to meet their scheduled targets. These delays can have severe economic and operational impacts, making it essential to identify and understand the underlying causes. The primary goal of this research is to comprehend the causal relationships among the key factors causing delays, using insights from construction experts, to ensure projects are completed as scheduled.

An extensive literature review on cases of delays in construction projects in Palestine and other developing countries with similar conditions was conducted. From this review, 26 cases of delays were identified to prioritize the key factors influencing delays in construction projects in Palestine.

To prioritize the key delay factors, a process was employed that included distributing questionnaires to 13 experts. These questionnaires were then examined using the content validity index to ensure their ability to fulfil the intended objective, which is to identify the items or key delay factors that would be used in the DEMATEL analysis. The result of the content validity index led to the identification of 11 key delay factors:

- Occupation and political obstacles (F7)
- Lack of sufficient financing for the project (F3)
- Delay in payments (F4)
- Variation orders (F10)
- Problems or mistakes during implementation (F1)
- Referral of bids to the lowest price (F11)
- Slow decision-making (F6)
- Contractor’s lack of sufficient experience (F18)
- Problems in the contract documents (F13)
- Mistakes in design (F20)
- Problems with neighbours (F23)

A DEMATEL analysis was conducted to study the cause-and-effect relationships among the 11 key delay factors. This analysis relied on expert opinions, with 15 experts in the construction project field participating in the study to evaluate the key delay factors. The DEMATEL analysis results confirm that all key delay factors are prominent and influence each other and construction delays to varying degrees. The influence weights of the factors are as follows:

- Occupation and political obstacles (F7): 10.770%
- Lack of sufficient financing for the project (F3): 10.649%
- Delay in payments (F4): 10.619%
- Variation orders (F10): 9.725%
- Problems or mistakes during implementation (F1): 9.570%
- Referral of bids to the lowest price (F11): 9.482%
- Slow decision-making (F6): 9.045%
- Contractor’s lack of sufficient experience (F18): 8.619%
- Problems in the contract documents (F13): 7.844%
- Mistakes in design (F20): 7.197%
- Problems with neighbours (F23): 6.482%

The findings underscore that political and occupation-related obstacles, insufficient project financing, delays in payments, and variation orders are the primary contributors to these delays. These insights align with global studies, underscoring that political instability and financial challenges are pervasive issues in the construction industry. The DEMATEL analysis reveals that occupation and political obstacles (F7) are the most significant factors, emphasizing the unique challenges faced in regions with political unrest.

Additionally, the study highlights the critical impact of financial management, with factors such as lack of sufficient financing for the project (F3) and delay in payments (F4) being paramount. This indicates a need for better financial planning and management to mitigate delays. Moreover, the analysis identifies internal project management issues, such as variation orders (F10) and slow decision-making (F6), as significant delay factors. This suggests that improving internal processes and decision-making efficiency can substantially reduce project delays.

The study's comprehensive approach, incorporating perspectives from contractors, consultants, and owners, provides a holistic view of the delay factors. It is evident that addressing these issues requires a collaborative effort among all stakeholders, emphasizing the need for enhanced communication, proper planning, and robust financial strategies. This research offers valuable insights into the delay factors specific to the Gaza Strip, with broader implications for construction projects in politically unstable and financially constrained environments. Future research should focus on developing targeted strategies to mitigate these delays, potentially incorporating advanced project management techniques and policy interventions to foster a more conducive construction environment.

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