

IDENTIFYING THE INHERENT FACTORS CAUSING DELAYS IN THE UAE
CONSTRUCTION INDUSTRY

by

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Dedication

I dedicate this thesis to my family who I hopefully will make proud. To everyone who is doubtful in pursuing a master's degree, the journey will take you to a destination where you will be proud of yourselves for the years to come. The UAE for being the land of opportunities and blessings, may it always be safe.

Abstract

The construction industry is one of the most important industries that impact the economy of a country as it contributes significantly to the GDP, employment, and wealth. The UAE construction industry contributes to 8.7% of the overall GDP which makes it a key industry for the country's economy. The industry is challenged with several risks that plague the performance of the projects where most projects experience significant delays. Some of the consequences of the delays include loss of revenues for the owners, loss of future opportunities for the contractors, and litigation. The UAE has one of the most dynamic economies in the world, but it has also been suffering from delays in the execution of its construction projects. There is lack of recent research that identifies the most frequent, severe, and important causes and effects of delays in the UAE construction industry. This thesis aims to scrutinize the construction industry in the UAE and determine the most important causes of delays, the most frequent factors, the most severe factors, and the most important effects of delays. A total of 40 delay causes and 10 effects were identified through the literature review. A questionnaire was prepared and distributed to professionals in the UAE construction industry. A total of 128 responses were received and analyzed from owners, consultants, contractors, and the overall perspectives. Overall, the most important causes of delays were "Award the project to the lowest bidder", "Delay in progress payment by the owner", and "Change orders by the owner". A high level of agreement was found between the consultants and contractors according to Spearman's rank correlation results. The most frequent cause of delay was found to be "Award the project to the lowest bidder" while the most severe cause was found to be "Financial crisis". The most likely effects were "Time overrun/extension of time" and "Poor quality of work due to hurrying the project". Using Factor Analysis, 6 components are extracted explaining 83.87% of the total variance. Several recommendations are provided to mitigate the delays and to reduce the frequency and impact of the key causes.

Keywords: Construction industry, frequency, severity, importance, causes and effects of delays, United Arab Emirates (UAE).

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Chapter 1. Introduction

1.1 Overview

1.1.1 Significance of the construction industry to the global economy. The construction industry is one of the most significant industries that contribute to the overall growth of a country [1]. It plays a major role in improving the economy of a country and generating employment opportunities [2]. In 2018, the contribution of the construction industry to the Germany's GDP was 10.3%, whereas it contributed by 5.9% for Spain's GDP in the same year [3]. In 2019, it was reported that the industry contributed by 6.8% of Canada's overall GDP making it a significant industry for the country's economy [3]. The demand for construction projects in Singapore has dramatically increased from \$8 billion in 2003 to \$28.4 billion in 2011, meaning that there is a constant increase in the demand for construction projects [4]. In recent years, Vietnam has been receiving an increase in the number of highway construction projects due to the shortage of highways. Some of the projects were reported to be valued at \$48 billion dollars [5]. In Ghana, the contribution of the construction industry to the total GDP reached 12.6% in 2013 [6]. The construction industry's contribution to industrial development also experienced a constant increase. It was reported to be 37.4% in 2011 [6]. In India, reports suggest that the construction industry is the second largest industry after agriculture where it contributes to approximately 9% of the total Indian GDP with an annual increase reaching to 10%. The investments in the construction industry made in India are reported to be \$50 billion [7], [8]. Kumar [9] revealed that the Indian government has forecasted to invest approximately \$350 billion for road infrastructure in the North-East region between 2020-2025. The construction industry contributes to approximately 7.8% of the national GDP of Bangladesh where approximately 5.9 million people work in the industry [2]. Moreover, China has completed works worth up to \$2.914 billion in 2016 [10]. In Cambodia, the construction industry contributes to approximately 30% of the country's GDP [11]. In Malaysia, Sambasivan and Soon [12] stated that the contribution of the construction industry to the GDP is 3.3%. This statement was agreed by Shehu et al. [13], who declared that it is estimated that the construction industry has contributed to around 3-5% of the overall GDP in the past decades. It was reported that public works by the government is the largest consumer

of the construction industry in Malaysia [13]. Oyegoke and Kiyumi [14] reported that the construction industry contributed to 5% of Oman's overall GDP in 2013, and is expected to increase to 11% in 2030. The construction industry in Afghanistan represents the backbone of social and economic development where it contributes to 10% of the overall GDP [15]. In Zimbabwe, Nyoni and Bonga [16] reported that the construction industry contributed to 3% of the overall GDP and was projected to increase to 15% in future years. The Palestinian construction industry contributes significantly at 33% of the overall GDP; this significant portion affects several sectors including the economic, social, educational, and the vocational sectors [17]. Other studies reported the contribution of the construction industry to the overall GDP in Palestine is 26% [18]. In 2013, the construction industry contributed to 3.4% of the GDP in Johannesburg, South Africa [19]. According to Soliman [20], the construction industry contributes to approximately 7% of Kuwait's GDP. Some of the megaprojects in Kuwait is the Kuwait new university which is estimated to cost 1.5 billion Kuwaiti Dinar (approximately \$4.9 billion) and is planned to finish in 2022. The New Kuwait airport had an estimated cost of 1.4 billion Kuwaiti dinars (\$4.5 billion) and is expected to be completed in 2021 [20]. Al-Kharashi and Skitmore [21] revealed a statistic by the Saudi Ministry of Planning stating firmly that the construction industry contributed to 30-40% of non-oil productive sectors in the country. Elawi et al. [22] stated the \$574.8 billion were spent on construction projects between 2008 and 2013 in Saudi Arabia. The cost of expansion of the Holy Mosque in Mecca was estimated to be \$146.6 billion and took 6 years to complete.

There is an increase in the demand for housing in Bangladesh considering the population growth where it is estimated that 4 million new houses and apartments are required annually to satisfy the population demand for the upcoming 20 years [2]. That, in turn, will increase the employment opportunities to satisfy the increase in demand for the new houses and apartments as well as reduce the unemployment rates [2]. The industry also contributes significantly in providing employment opportunities in India where it has been reported that 31.46 million jobs were provided. The demand for construction manpower also increased by 8-9%, thus resulting in providing 2.5 million new jobs annually with 125,000 new engineering jobs [8]. In Germany, 5.6% of the total employment is from the construction industry solely [3]. The construction industry

in Oman employs more than 210,000 workers [14]. According to Wang et al. [10], the construction industry in China employs approximately 45 million workers. Ghana is experiencing an increase in the population where it was reported the urban residents in 2000 and 2010 were 43.8% and 50% of the overall populace, respectively. This increase resulted in an estimated additional demand of approximately 2 million housing units by 2020 [6]. In Kuwait, the construction industry employs more than 177,000 workers [20].

1.1.2 Risks and challenges of the construction industry. The construction industry is a major contributor to the growth of a country's economy [13]. One of the construction projects' most important success attributes is to be completed on time. However, most of the projects end up being delayed and finish after the scheduled date [1]. For example, Vu et al. [5] reported that almost all highway projects in Vietnam experience time overruns. Islam and Suhariadi [2] identified the negative consequences of project delays: Drastic losses in revenues as well as degrading in the reputation for all involved parties, delays in providing the services for the community and beneficiary parties. In severe cases, delays in projects also may lead to legal issues such as litigation, arbitration, dispute and abandonment of the entire project. Al-Khalil and Al-Ghafly [23] stated that delays cost the owners of potential revenues and an increase in the overhead costs for contract and administration. The contractor loses opportunities to work on new projects for diminished financial and resource capabilities. Mydin et al. [24] mentioned that delays will cause time-associated cost effects where the projects will require more time and resource consumption to complete.

All projects have some degree of risks. Due to the vast number of possible risks and factors that may cause delays, it is not practical to account for all of them [25]. According to Alaghbari [26], the magnitude of the delay varies from a project to another. Some projects may be delayed only a few days, whereas other projects may be delayed for more than a year.

Construction projects have inherent risks and challenges due to the contribution of different parties such as the architects, consultants, owners, contractors, and subcontractors. However, with the increase in project size and complexity, other external factors can influence the overall performance of the project [25]. The industry is challenged with different issues such as lack of professionally qualified employees

and low productivity that hinder the overall quality of the projects. Those issues eventually result in time overruns of the projects [7].

El-Sayegh [25] divided risks into 2 categories: internal risks; and external risks. Similarly, El-Sayegh and Mansour [27] developed a Risk Breakdown Structure (RBS) that was divided into two categories: internal and external. The internal risks are the risks that are directly related to the project and are under the control of the project team. The external risks are the risks that are outside of the control of the project team. Vu et al. [5] identified 2 main sources of schedule delay risks: risks are from stakeholders and the macro-environment. The stakeholder category is comprised of factors from the owner, contractor, supervisor, and survey and design. The macro-environment category is comprised of factors from politics, economics, society, and nature.

1.1.3 Construction project problems worldwide. Delays in construction projects is a common phenomenon that usually results in adverse consequences as such time overrun. Doloi et al. [7] reported that over 40% of the construction projects are performing poorly in India. The authors reported a statistic by the Statistics and Programme Implementation who mentioned that from 951 monitored projects, 309 projects exceeded the budget and 474 were behind schedule. The total cost overrun reported was \$12.4 billion where \$8.4 billion came from the 474 projects. The main reasons stated were disputes regarding land acquisition and poor coordination. Aibinu and Jabbaro [28] stated that the two most frequent issues on the Nigerian construction industry are cost and time overrun. They observed 61 construction projects in Nigeria and reported that the mean average time overrun for projects costing between 0 to 10 million Nigerian Naira to be 92.64% whereas the average time overrun for projects exceeding 10 million Nigerian Naira is 59.23%. The authors also reported that the average cost overruns of the projects are 17.34% of the project cost estimate. Delay is also a common issue for the megaprojects in Oman. For example, Muscat wastewater project has been delayed for more than 6 years whereas Muscat International Airport has been delayed for more than 2 years [14]. Alnuaimi and Mohsin [29] reported that 42% of the projects in Oman are delayed between 2007-2008 and 59% between 2009-2010.

Ahsan and Gunawan [30] studied the completed projects in China, India, Bangladesh, and Thailand. The population of these countries represents 50% of the

world's population. India had the largest average time overrun with 55%. Bangladesh, Thailand, and China had average delays of 34%, 33%, and 14%, respectively. Only 25% of groundwater construction projects in Ghana were completed on time and within budget meaning that 75% of the projects failed to achieve the planned project cost and schedule [31]. In Malaysia, Othman et al. [32] revealed the that road projects had an average delay of 37%. Al-Hazim et al. [33] reported that the average delay in infrastructure projects in Jordan is 226%. Amoatey and Ankrah [34] reported that 70% of the road projects in Ghana experience delay with an average delay of 17 months. The construction industry in the Kingdom of Saudi Arabia has also been suffering from project delays. The Ministry of Municipal and Rural Affairs (MOMRA) of Saudi Arabia reported that up to 75% of public construction projects were delayed [35]. Al-Kharashi and Skitmore [21] reported a statistic by the Water and Sewage Authority in the Eastern Province of Saudi Arabia stating that 59% of the projects completed in the past decades experienced delays. Elawi et al. [22] reported that the average delay for the infrastructure projects in Mecca, Saudi Arabia was 39%.

Infrastructure projects are increasing at an unprecedented rate around the world including the developing countries. These projects are also increasing in complexity mainly because the increase in project scope as some projects exceed \$1 billion in investments, and because of the increasing number of stakeholders being involved in the projects. Because these projects can take several years to complete, the project team is challenged with the ability to address and adapt to the risks such as changes of interests and demands of the stakeholders [36].

1.1.4 Background on UAE. Ever since it was founded on the 2nd of December in 1971, the United Arab Emirates (UAE) has been experiencing continuous and rapid development in several aspects such as the economy, social activities, and tourism. The UAE is a unity of seven emirates: Abu Dhabi, Dubai, Sharjah, Ajman, Umm Al-Quwain, Ras Al Khaimah, and Fujairah [36]. It is located below the Arabian Gulf and is bordered by three nations. The topography of the UAE is mainly desert (sand), and the majority of the urban cities are of level terrain with the exception of few Emirates in the north and east sections such as Ras Al Khaimah and Fujairah where these cities are mountainous [27]. There are several factors that contributed to the booming of the economy in the UAE. The discovery of oil in the late 60's had a major impact on

causing significant changes to the lifestyles and dependencies of the general public [37]. Traditionally, the UAE's economy was dominated by sea activities such as fishing and pearl diving. The unity of the Emirates, along with the facilitation of transportation and communication has also contributed to the increase in productivity and boosting the economy. The UAE's population has increased by 13,941% between 1950 and 2019, doubled since 2005, and tripled since 2000 [38].

The Gross Domestic Product (GDP) has also experienced a significant increase in the past decades. In 2010, the GPD was 1.093 trillion AED making it 100 times the GDP in 1973 which was 11 billion AED. The increase in GDP was a result of the constant growth of the different sectors of the economy such as production, investments, and construction [39].

The number of tourists has also been experiencing tremendous increase in the past decades. The increase is attributed to the constant new projects that UAE inaugurated such as The Ferrari World and Burj Khalifa. The number of tourists in 2017 is approximately 9 times the number in 1995, and is constantly increasing [40].

The contribution for the economy is highly influenced by the construction industry not just in the UAE, but also across several countries in the world. Some countries realize that the construction industry is the most influential industry in determining the growth and the GDP rates.

1.1.5 Construction industry in UAE. The construction industry has contributed significantly to the economy of UAE. It contributes to approximately 8.7% of the overall GDP of the country [41]. The construction industry had an annual growth rate of 4.38% between 2012 to 2016 [42]. The results of a KPMG survey in 2019 predicted that the UAE construction sector will grow between 6-10% in 2020. A minor fraction of the participants (13%) predicted that the growth will be between 11-15% whereas 7% of the participants predicted the growth to exceed 15% [43].

The construction industry in the UAE experienced a great boom in the past decades starting from 1996 and peaking at 2007. There were several megaprojects during that period including the highest tower in the world and the largest mall in the world [27]. The number of housing units in Abu Dhabi increased by 300% from 60,643 units in 1975 to 242,324 units in 2005. The number of housing units in Dubai increased

by 355% from 45,102 units in 1975 to 205,518 units in 2005. The number of buildings in Abu Dhabi between 1975 and 2005 increased by 309% from 28,756 to 117,469 buildings, respectively. During the same period, the number of buildings in Dubai increased by 195% from 26,381 to 77,886, respectively [39].

In 2019, the ruler of Dubai has approved a three-year budget of \$53 billion for the years 2020 to 2022 as part of the government's strategy to boost the economy [44]. The UAE government announced that they will invest in over \$8.7 billion on infrastructure for the EXPO 2020 where the site area is 4.3 million m² [42]. A total of \$19.9 billion will be invested by the developers on the Jumeirah Central project. In that project, 278 buildings will be constructed and they will be distributed between housing units, retail, offices, and hotels [42]. Other megaprojects in Dubai include Dubai Media City, Jumeirah Village, and Palm Islands.

To accommodate all the megaprojects in UAE, the road network should also be simultaneously developed. Several highway projects were inaugurated to improve the traffic flow, the level of service, and travel convenience. The projects include roads projects, bridges, ramps, tunnels, and freeways [27]. Moreover, there has been a noticeable activity in terms of other transportation infrastructure projects including seaports, airports, and rails. An example of a transportation megaproject in the UAE is the Dubai-Fujairah highway. This project linked the emirates of Dubai and Sharjah to Fujairah in the east coast to mitigate the traffic congestions on the other highways. The estimated budget for this project is AED 1.43 billion (390 million) [36]. However, some projects were reported to be significantly delayed. The Dubai Metro project was delayed by 5 years and the total cost exceeded the planned cost by approximately 85% [45]. Faridi and El-Sayegh [37] reported that half of UAE's construction projects are delayed. The literature of Al Nahyan et al. [36] identified that delays were common in the UAE construction projects. Some of the main delay factors include lack of coordination, lack of coherence between the stakeholders, design errors, slow decision-making, and utility relocation.

1.2 Problem Statement

The construction industry is associated with several risks and challenges arising from different sources. These risks, if not properly managed, will adversely impact the

outcomes of the projects. Some of the outcomes of delays are cost overruns, customer dissatisfaction, and losing possible opportunities for the involved parties [4]. Sambasivan and Soon [12] reported that some effects of delays include arbitration and total abandonment of the project. In the UAE, billions of dollars are being spent on infrastructure and construction projects, especially in the past decades. The Government has been investing significantly on up-coming projects such as EXPO 2020. Faridi and El-Sayegh [37] reported that half of all the construction projects in the UAE are being delayed. Despite the efforts taken in order to reduce the delays, they still occur frequently with significant impact. One of the main reasons that the delays still occur is because there has been lack of research to identify the root causes of these delays. Without fully comprehending the surrounding environment or identifying the potential threats from the risks of the construction industry, it will be troublesome to significantly reduce the delays in the projects while maintaining the planned budget, quality, time and resources. Moreover, the frequency and severity of the causal factors are also critical to be determined in order to incorporate the suitable measures into the process. For example, if “lack of skilled labors” is one of the most frequent and severe causes of delays, then companies should ensure proper training and preparation of the labors as part of the schedule before commencing the work. That will improve the competence levels of the labors as well as finishing the projects on the initially planned date. Therefore, it is imperative to investigate the root causes of the delays in order to improve the overall project performance.

As mentioned, there is shortage of recent research on the status of delays in the UAE construction industry. Most of the papers that were previously published cannot be assumed to accurately represent the construction industry today as the conditions in UAE have changed including significant improvement in the construction and infrastructure from the date of the previous publications. The UAE has one of the most dynamic economies and is one of the fastest growing countries in the world. The previous studies did not take in consideration the frequency and the severity of the delay factors. Therefore, new studies should be conducted to determine the updated status of the industry as well as the causes of the delays using new methods for evaluation. Also, the previous studies did not consider the impact of delays in the UAE construction industry.

1.3 Significance of this Research

The contributions of the construction industry to the well-being of the economy in the UAE is significant. As mentioned, the construction industry contributes to 8.7% of UAE's overall GDP in 2018 [41]. Future predictions depict that the construction industry is expected to grow further [43]. However, delays in the construction industry have reported to occur frequently. Faridi and El-Sayegh [37] found that "preparation and approval of drawings" and "inadequate early planning of the project" are the most significant factors of delays in the UAE construction industry. There is lack of research to determine the frequency of factors occurring, as well as the impact of the factors on the outcomes of the projects.

This research is significant in terms of identifying the most important, frequent, and severe causes of delays to allow for better planning and mitigations considering the factors for future projects. Identifying the potential threats of the projects will enable stakeholders to take control measures from the early stages of the project to secure the success of the project and the continuity of the economy. Completing projects on time reflects positively on the reputation of the contractors and consultants where they will receive more opportunities for projects in the future. For the owners, completing the projects on time will enable them to begin operating the development and start earning the return from their investment. On a strategic level, finishing projects on time will contribute to the continuous growth and flow of the economy. Determining the root causes of the delays will aid in completing the projects on time, achieving customer satisfaction, improve the reputation and business relationships, and diminish disputes. Therefore, it is crucial to identify the main factors that cause delays in order to enable the involved parties to minimize, mitigate, or avoid the delays [1].

1.4 Objectives and Goals of this Research

This research aims to scrutinize the status of the delays in construction projects in the UAE by identifying and evaluating the delay factors and determine the inherent causes. This will aid in mitigating and avoiding issues in future projects. The detailed objectives of this research are as follows:

- 1- To determine the most frequent, severe, and important factors that are causing delays in the UAE construction industry based on the perception of clients, consultants, and contractors.
- 2- To compare the findings of the delay factors with the previous findings in UAE and other countries.
- 3- To determine the most important effects of delays in the UAE construction industry.
- 4- To reduce the number of factors to determine the inherent causes of delays using Factor Analysis.

1.5 Methodology

1.5.1 Questionnaire preparation and demographics. A questionnaire was distributed to construction experts with varying experiences to obtain their perspectives of the most frequent and severe factors that cause delays in the UAE construction industry, as well as the effects of the delays. A total of 128 responses were received and analyzed where 22% of the participants were owners, 24% were contractors and 54% were consultants. Moreover, 37% of the participants had 0-5 years of experience in the UAE construction industry, 28% had 6-10 years, 25% had 11-20 years, and 10% had more than 20 years of experience. The majority of the participants worked in roads and infrastructure projects with 57%, 34% worked in building projects, 2% worked in rail projects, and 6% worked in other projects. The distributions of the participant demographics are shown in Figures 1, 2, 3 below. The questionnaire consisted of 3 main sections. The first section identified the demographic information about the. In the second part, the participants were asked to rate the frequency and the severity for all the factors individually. The factors were then ranked in terms of Frequency Index (FI), Severity Index (SI), and Importance Index (II) from the owners, consultants, contractors, and the overall point of views. In the third section, the participants were asked to rate the likelihood of the effects to the UAE construction industry. The rating used in parts 2 and 3 were “Very low”, “Low”, “Moderate”, “High”, and “Very high”. For the analysis the rating were converted to numeral scores as follows:

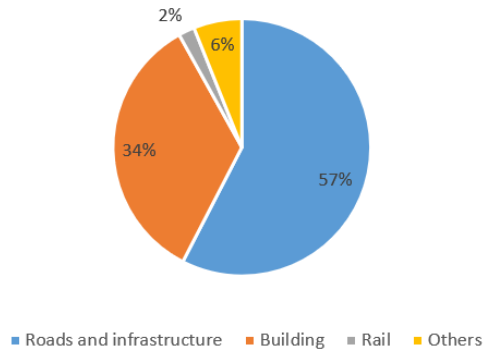


Figure 1: Participants' Roles

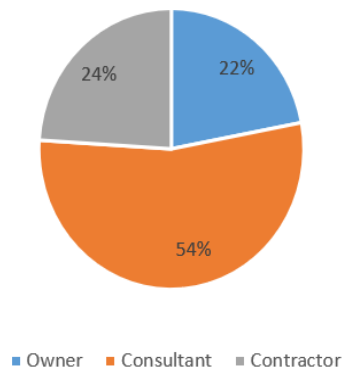


Figure 2: Participants' Roles

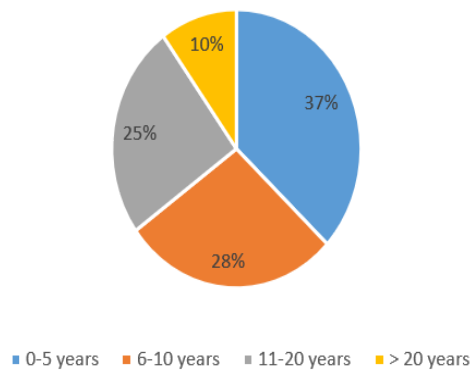


Figure 3: Participants' Years of Experience

- For the frequency and severity:
 - 1= Very low
 - 2= Low
 - 3= Moderate
 - 4= High
 - 5= Very high

- For the effects:
 - 1= Extremely unlikely
 - 2= Unlikely
 - 3= Neutral
 - 4= Likely
 - 5= Extremely likely

1.5.2 Data analysis. After completing the surveys, the data was analyzed through the following techniques:

- Frequency index (FI): This value of this index shows the frequency of occurrence of the delay factors regardless of the impact they have. The following equation was used:

$$FI = \frac{\sum an_x}{5N} \quad (1)$$

where

N the total number of responses in the survey depending on the perspective of analysis;

a the scoring from 1-5;

n_x the number of participants who scored from 1 – 5 for a particular factor.

The range of the indices will be between 0.2 – 1 where 0.2 generally indicates very low frequency and 1 indicates very high frequency.

- Severity index (SI): The value represents the level of impact the factor has on project duration if it occurs. The following equation was used:

$$SI = \frac{\sum an_x}{5N} \quad (2)$$

where

N the total number of responses in the survey depending on the perspective of analysis;

a the scoring from 1-5;

n_x the number of participants who scored from 1 – 5 for a particular factor.

The range of the indices will be between 0.2 – 1 where 0.2 generally indicates very low severity and 1 indicates very high severity.

- Importance index (II): The overall importance of each factor in causing delays in the UAE construction industry is determined by multiplying the FI and the SI [46] as follows:

$$II = FI * SI \quad (3)$$

where

FI Frequency Index

SI Severity Index

The range of the indices will be between 0.2 – 1 where 0.2 generally indicates very low importance and 1 indicates very high importance.

- Relative Importance Index (RII) of effects: This value represents the occurrence of the effects of the delays. The following equation was used:

$$RII = \frac{\sum an_x}{5N} \quad (4)$$

where

N the total number of responses in the survey depending on the perspective of analysis;

a the scoring from 1-5;

n_x the number of participants who scored from 1 – 5 for a particular factor.

The range of the indices will be between 0.2 – 1 where 0.2 generally indicates very low likelihood and 1 indicates very high likelihood.

1.5.3 Comparative analysis. Spearman's rank correlation was used to assess the level of agreement among the different parties (owners and consultants; owners and contractors; consultants and contractors). The correlation shows the strength and direction of the relationship between the ranks of the factors by the parties. The

Spearman's rank correlation coefficient r_s ranges between -1 and +1, where -1 indicates a perfectly negative relationship (inversely proportional) whereas +1 indicated a perfectly positive relationship (proportional). If r_s is found to be -1 then that also indicates a disagreement between the parties, and an agreement if the value is +1. If the value approaches 0, then that indicates that there is no or little correlation between the involved parties. The Spearman rank correlation r_s is used to determine the level of agreement between 2 involved parties while disregarding the third. Equation was used as follows [37]:

$$r_s = 1 - \frac{6\sum d^2}{(N^3 - N)} \quad (5)$$

where N is the number of factors, and d is the difference in ranking between the parties.

1.5.4 Comparisons with other studies worldwide. After the determining the Importance Index (II) of the factors and ranking them, the top 5 causes of delays found in this study were compared with the top 5 factors of other countries. This will be useful in determining the relationship and similarities in the nature of the construction industry between different countries. It will also aid in understanding the behaviors and problems on a regional scale. Akogbe et al. [47] compared the top 5 delay factors from their study in Benin with the findings of papers from Vietnam, Malaysia, South Korea, Jordan, Kuwait, Hong Kong, Ghana, and Nigeria.

1.5.5 Comparisons with other studies in UAE. Another comparison will be conducted for the causes of delays from other studies in the UAE. The selected papers will be from different time periods and the difference in ranks with findings of this study will be reported. This will aid in determining the changes in the overall behavior of the construction industry as UAE is one of the fastest growing countries in the world along with having a dynamic economy. Motaleb and Kishk [48] compared the ranking of importance of their findings with the ranking of the factors of Faridi and El-Sayegh [37], they have also determined the difference in rank changes of the factors. For example, "change orders" was ranked as the top cause of delay by Motaleb and Kishk [48] whereas it was ranked 27 by Faridi and El-Sayegh [37].

1.5.6 Factor Analysis. Factor Analysis is a significant technique that correlates seemingly unrelated factors and combines them into fewer unobserved variables [49]. The analysis will be conducted using principal component factor analysis with varimax rotation. Varimax rotation is used because it simplifies the columns of the factor matrix, and it provides the loading value. Loading values near 1 indicate that there is high association between the variable and the unobserved factor whereas a value of 0 indicates lack of association [50]. Furthermore, varimax rotation ensures that identifiable variables are tapped into their specified latent variable. Additionally, the analysis will be done on SAS where the final output will be sorted according to a minimum loading cut off equals to 0.5 [7].

Chapter 2. Literature Review

2.1 Causes and Effects of Delays

Akogbe et al. [47] identified the most important construction delay factors in Benin. They determined the frequency, severity, and the importance for 35 delay factors. The authors conducted a survey and obtained 175 valid responses. “Financial capability” from the contractor-related group had the highest Frequency Index (FI) and the highest Severity Index (SI). It was found that the most important delay factors were found to be financial capability by contractors, financial difficulties by owners, poor subcontractor performance, material procurement of contractor, and changes in drawings of architects.

Amoatey et al. [6] assessed the main delay causes and effects for the public housing projects in Ghana. They have identified 37 delay causes and 10 effects. The effects of delays include cost overrun, time overrun, litigation, lack of continuity by client, arbitration, termination of contract, increased portfolio of “non-performing” projects, contractor in financial crisis, total abandonment of project, and difficulties with payment. A questionnaire was sent and 31 valid responses were used in this study. They determined the frequency of occurrence and degree of impact by calculating the Relative Importance Index (RII) of each. The results indicate that the most frequent and severe causes are “delay in payment to contractor/supplier”, “inflation/price fluctuation”, “price increases in materials”, and “funding from sponsor/client”. The most important effects are “cost overrun” and “time overrun”.

Lo et al. [51] conducted a study to identify the most important delay factors in Hong Kong. They determined the overall mean scores of 30 delays factors by analyzing 151 valid questionnaires. Overall, the most significant causes of delays were found to be “inadequate resource due to contractor/lack of capital”, “unforeseen ground conditions”, “exceptionally low bid”, “inexperienced contractors”, and “works in conflict with existing utilities”. From the clients’ perspective, the most significant factor was found to be “exceptionally low bid” whereas the consultants and contractors agreed that “unforeseen ground conditions” is the most significant factor.

Aziz [52] carried out an extensive study to determine the most critical factors causing delays in the Egyptian construction industry after the revolution. They have

identified 99 factors distributed among 9 major categories. They collected the data from 2500 participants through a survey. The results dictated that the most important factors contributing to delays are: “Delay in progress payment (funding problems)”, “different tactics patterns for bribes”, “shortage of equipment”, “ineffective project planning and scheduling”, “poor site management and supervision”. The most important categories contributing to the delays were “contractor-related” and “equipment-related” factors.

Yang and Wei [53] conducted a study to identify the most important, frequent, and severe delay causes for construction projects in Taiwan. The study focused mainly on the planning and design phases of the project. They have identified 15 planning factors and 20 design factors with some common factors from both phases such as “weather”. The authors analyzed the data obtained from 95 valid questionnaire responses based on Relative Importance Index (RII) and Severity Index (SI) equations. The findings show that “Changes in client’s requirement”, which was a common factor in both phases, had the highest importance, frequency, and severity index. The second most severe factors were for planning and design stages were “complicated administration process of client” and “inadequate integration on project interfaces”, respectively.

Sambasivan et al. [54] studied and reported the most important causes and effects of delays in construction projects in Tanzania. They collected the data by distributing questionnaires and analyzed the results of 308 valid responses by the Relative Importance Index (RII). The authors identified 32 delay factors and grouped them into 7 categories. The most important causes of delays are “finance and payment of completed works” from the client, “improper planning” by the contractor, and “on time delivery” from the material-related causes. The most important effects were “cost overrun” and “dispute”.

Elawi et al. [22] conducted a real time quantitative analysis on 49 road and bridge projects in Mecca, Saudi Arabia. They identified the most frequent and severe factors based on the perspective of the owners. The most frequent causes were reported to be “land acquisition”, “contractor’s lack of expertise”, “re-designing”, and “line services (utilities and underground services)”. The most severe factor was reported to be “land acquisition”. Factors from owners were responsible for 53% of the delays for the observed projects.

Al Nahyan et al. [36] conducted interviews with 20 experts to determine the most important factors behind unsuccessful completion of transportation infrastructure projects in UAE. The experts were sponsors/clients, governmental agencies, management firms, consultants, and contractors. The majority of the participants defined a successful project to be “minimum time overrun”. Overall, the most common interview responses for unsuccessful project completion are “unqualified or bad contractors”, “bad design”, and “bad increments”.

Mahamid [17] developed a risk matrix to identify the most frequent and severe causes of delays for road construction projects in Palestine. The author studied the factors from the owners’ perspectives and analyzed 18 completed questionnaire responses where 43 factors were identified and divided into 5 groups: Logic and environment, managerial, consultant, financial, and external. The risk matrix consisted of 3 zones: Green, yellow, and red. The red zone identifies the most critical factors and should be given priority. The results indicate that there were 8 factors in the red zone: Poor communication between construction parties, poor resource management, delay in commencement, insufficient inspectors, rework from poor material quality, rework from poor workmanship, payments delay, and segmentation of the West Bank.

Yong and Mustaffa [55] carried out a survey to identify the most critical factors that contribute to the success in Malaysia’s construction projects. They have selected 37 factors and distributed questionnaires to developers, contractors, and consultants. Based on the results of the 14 returned questionnaires, there are 15 critical factors that impact the success of construction projects. The five most critical factors are the financial capabilities, control of subcontractor works, competence of consultant, cooperation in solving problem skillful workers, and competence of the team leader.

Zidane and Andersen [1] conducted an extensive study to identify the most significant factors that affect the construction projects in Norway. The authors identified 44 delay factors, distributed questionnaires, and analyzed the findings of 202 responses based on the frequency of occurrence. The findings suggest that the categories with the highest delay significance are ordered as follows: “Poor planning and scheduling”, “slow or poor decision-making process”, “internal administrative procedures and bureaucracy”, “resources shortage”, “poor communication and

coordination between parties”, “slow quality inspection process of the completed work”.

In the same paper, Zidane and Andersen [1] also identified the most important universal delay factors by reviewing 103 papers from 46 countries. They identified 33 factors and analyzed the results based on the Overall Ranking Index (ORI). The most important universal factors were “Design changes during construction/change orders”, “delays in payment of contractors”, “poor planning and scheduling”, and “poor site management and supervision”.

Gewanlal and Bekker [56] carried out a study to determine the most important attributes that contribute to the project success for the construction projects in South Africa. The authors identified six categories where each category consisted of six factors. They analyzed the data from 163 questionnaire responses received by mean value of ranks equation. The results dictated that the most important categories are “Interpersonal factors” and “Application of theory”. The least important categories were determined to be “Personal contribution” and “Personal character”. The most important factors were found to be “Communication skills”, “Leadership styles”, and “Planning (integrative)”.

Sweis et al. [57] assessed the causes of delays for the Jordanian residential construction projects. They identified 40 causes and grouped them into 3 main categories: Input Factors, Internal Environment, and Exogenous Factors. The authors analyzed 91 questionnaire responses from consultants, clients, and contractors based on the frequency. Overall, the most important factors were found to be related to the contractor’s financial difficulties and the change orders from the owners.

Obodoh and Obodoh [58] carried out a study to determine the major causes of delays in the Nigerian construction projects. They have identified 57 factors that were classified into 8 groups. The authors distributed questionnaires and analyzed the data from 91 valid responses by the Relative Importance Index (RII). According to their findings, the main factors of delays were: Insufficient number of equipment, poor time estimation, payment difficulties, frequent change orders, poor cost estimation, poor site management, inadequate modern equipment, scarcity in construction material,

incompetent team members, improper planning and scheduling, and contractors' financial difficulties.

Motaleb and Kishk [48] investigated the causes and effects of delays in the UAE construction industry. They have identified 42 factors that were grouped by: Contractors, consultants, project managers, clients, financial, and unforeseen factors. The authors distributed questionnaires and analyzed the results of 35 responses based on the Relative Importance Index (RII). Overall, the most important causes of delays are “change orders”, “lack of capability of client representative”, and “slow decision making by client. The most important effects were reported to be “time overrun”, “cost overrun”, and “dispute”.

Alfakhri et al. [59] studied the factors causing delays in the Libyan road construction projects. They identified 39 factors and analyzed the data of 256 valid questionnaire responses. The results revealed the most important factor is “delays in conversion and transfer of utility services by competent authorities”.

Kaming et al. [60] evaluated and ranked 10 delay factors for high-rise construction projects in Indonesia. They have obtained the data by surveying and interviewing 31 project managers that worked on high-rise construction projects. They have analyzed the importance, frequency, and severity of the factors. The severity index in this paper represented the overall results and was calculated by multiplying the importance and frequency scores of the factors. Overall, the most severe factors were found to be “design changes”, “poor labor productivity”, “inadequate planning”, “materials shortage”, and “inaccuracy of materials estimate”.

Doloi et al. [7] distributed a questionnaire to determine the most important factors causing delays in the Indian construction industry. They have analyzed 45 factors based on the relative importance index. The results dictated that the most important delay causes are “delay in material delivery by vendors”, “non-availability of drawing/design on time”, and “financial constraints of contractor”.

Mukuka et al. [61] studied the effects of schedule overruns on the construction industry in South Africa. They have identified 20 effects and analyzed the results of 146 valid questionnaire responses using the Mean Item Score (MIS). The results

revealed that the most important effects are “extension of time”, “cost overruns”, “loss of profit”, “disputes”, and “poor quality of work due to hurrying the project”.

Santoso and Soeng [62] analyzed the causes of delays for road construction projects in Cambodia. They identified 64 delays factors and analyzed the results based on 153 valid questionnaire responses by determining the Frequency Index (FI), Severity Index (SI), and the Importance Index (II). Overall, the most frequent causes of delays were “working during rainy season” and “award the project to the lowest bidder”. The most severe and important factors were “working during rainy season” and “flooding”.

Durdyev et al. [11] conducted a survey to determine the most important causes of delay in the Cambodian residential projects. They identified 31 factors and analyzed the results of 48 usable responses based on the Relative Importance Index (RII). The most important factors causing delays were found to be “shortage of materials on site”, “unrealistic project scheduling”, and “late delivery of material”.

Mezher and Tawil [63] distributed surveys to owners, contractors, and architectural/engineering (A/E) firms to identify the main causes of delays in the Lebanese construction industry. The survey included 64 delay factors and the authors analyzed 35 survey responses using the Importance Index equation. According to the owners, the most important factors were “cash problems during construction” and “schedule of subcontractors”. According to the contractors, the most important factors are “owner’s slow decisions” and “design change by owner”. Finally, the most important factors according to the A/E firms were “shop drawings”, “preparation of scheduling work”, and “lack of personnel training and management support”.

Tariq and Marey-Pérez [64] analyzed the results of 35 surveys using the Statistical Package for Social Scientist (SPSS) to identify the most important causes of delays in the Omani construction industry. The results show that the most important client-related causes are “change of scope” and “delays in decision making by the client”. On the other hand, the most important causes from the contractor-related causes are “lack of experienced workers” and “poor contract management” whereas “delayed approval of drawings” was found to be the most important consultant-related factor.

Latif et al. [65] identified 48 factors to study the causes of delays in the Omani construction industry. The factors were distributed into 5 groups. They analyzed the

results of 105 questionnaire response using the Average Index method. The most important delay factors from each group were “changes in scope of project”, “lack of communication between parties”, “shortage of skilled labor”, “mistakes during construction”, and “insufficient data collection and survey before designing”.

Al-Hazim et al. [33] collected data of 40 infrastructure projects in Jordan that were constructed between 2000-2008 from the Ministry of Public Works and Housing (MPWH). The results show that the delays and cost overrun were caused by 20 factors. The most important factors were reported to be “Terrain” and “Weather conditions”.

Oyegoke and Kiyumi [14] carried out a study to identify the most important causes, effects, and mitigations for the megaprojects in the Sultanate of Oman. They identified 44 causes, 17 effects, and 14 mitigation methods and analyzed the results of 53 questionnaire responses. Overall, the most important causes of delays were reported to be “selecting the lowest not the best bidder by the client”, “main contractor poor financial condition”, and “delay in decision-making by the client”. The most important effect was found to be “extra cost” whereas the most important mitigation was reported to be “use/engage experienced contractors and consultant”.

Al-Emad et al. [66] determined the most significant factors causing delays in Makkah, Saudi Arabia. The authors identified 37 factors and analyzed the results of 100 valid questionnaire responses using the Average Index method. It was found that “Difficulties in financing project by contractor”, “poor coordination between parties”, and “shortage of manpower” are the most significant factors.

Nyoni and Bonga [16] identified 46 delay factors for the construction industry in Zimbabwe. They have grouped the factors into 12 groups and analyzed the results of 120 questionnaire responses. It was found that 27 factors are significant for causing delays in the construction industry of Zimbabwe where the top factors were found to be “delay in progress payment by owner” and “delay in revising & approving design documents by owner”.

Mpofu et al. [67] conducted a study to identify the most important causes of delays in the UAE construction industry. They grouped the factors into 11 groups and analyzed the responses of 208 surveys. Results show that the most important factors are

“unrealistic contract duration imposed by client”, “incomplete design at the time of tender”, and “too many scope changes and change orders”.

Bekr [68] studied the most important causes and effects for the public construction projects in Iraq. The author identified 65 causes and analyzed the responses of 134 survey responses and determined the Frequency Index (FI), Severity Index (SI), and Important Index (II). Results show that the most important factors causing delays are “security measures”, “government change of regulations and bureaucracy”, and “official and non-official holidays”. The most frequent effects were found to be “time overrun” and “cost overrun”.

Koushki et al. [69] conducted 450 interviews with private residential project owners in Kuwait to identify the most important delay causes. Based on the results of the interviews, the authors reported that the most important delay factors are “change orders”, “owners’ financial constraints”, and “owners’ lack of experience in the construction business”.

Wuala and Rarasati [70] reviewed 19 previous studies and identified 36 delay factors for the developing countries in South East Asia. The countries include Indonesia, Malaysia, Thailand, and Vietnam. The most identified factors were found to be contractor-related factors such as “material shortages on site/late of delivery” and “improper/ineffective planning and scheduling”.

Aziz and Abdel-Hakam [71] studied the most important delay factors for the road construction projects in Egypt. The authors identified 293 causes from the literature and classified them into 15 groups. Data results obtained from 186 valid questionnaire responses were analyzed using the Overall Relative Importance Index (ORII). Results show that the most important factors are “owner financial problems/client finance/economic ability for the project” and “shortage in equipment/insufficient numbers”.

Tafazzoli and Shrestha [72] conducted a survey to analyze the most important factors causing delays in the US construction industry. They identified 30 factors and analyzed the results of 219 survey responses. It was found that excessive change orders and delay in decision making process contributed significantly to the delays.

Oshungade and Kruger [19] studied the causes and effects of delays in the construction industry for Johannesburg, South Africa. They identified 48 causes and 13 effects. The authors analyzed the responses of 75 questionnaires and determined the frequency, severity, and importance indices using SPSS. Overall, the most important factors causing delays were found to be “strikes”, “rework due to errors in construction”, and “shortage of materials in market”. The most important effects were found to be “create stress on contractors” and “cost overrun”.

Thapanont et al. [73] conducted a study to identify the most important causes of delay of the Thai road construction projects. They have identified 26 factors that were reduced to 8 factors and ranked based on the Mean Square (MS) from the results obtained from 10 questionnaire responses. The top five factors were found to be “incomplete drawings”, “lack of equipment efficiency or financial status of contractors”, “delay in relocating existing infrastructure structures”, “less of project engineer experiences”, and “delay in relieving environmental impact”.

Sweis [74] analyzed the most important, frequent, and severe (product of importance and frequency) factors that affect the public construction projects in Jordan. The author analyzed the results of 30 questionnaire responses. It was found that “too many change orders from owner” and “poor planning and scheduling of the project by the contractor” were the top factors for the frequency and severity. On the other hand, the most important factors were found to be “shortage of equipment” and “too many change orders from owner”.

Mahamid [18] conducted a study to identify the most frequent causes of delays in the road construction projects in the West Bank of Palestine from the contractors’ viewpoint. The author identified the 52 factors and analyzed the results of 34 questionnaire responses from the contractors. It was found that the most frequent causes of delays are “segmentation of the West Bank and limited movement between area”, “political situation”, and “progress payment delays by owner”.

Hasan et al. [75] determined the causes and effects of delays for road projects in Bahrain. They identified 47 delay causes and 12 effects and analyzed the frequency and severity results using SPSS. The data was collected from a questionnaire consisting of 36 contractors, 24 consultants, and 84 engineers working the Ministry of Work

(owners). Results show that “long response from utilities agencies” is the most frequent and severe factor. The most frequent responses for effects with the highest means are “time overrun”, “cost overrun”, and “disruption of traffic movement”.

Alnuaimi and Mohsin [29] analyzed the most important causes of delays in the construction industry in Oman between 2007-2008 and 2009-2010. For the period 2007-2008, the most important delay reasons are “weather”, “variations and claims”, and “change in initial design”. For the period 2009-2010, it was found that the most important delay factors were “planning and programming construction work”, “poor construction experience”, and “shortage in material”.

Amoatey and Ankrah [34] explored the critical factors that contributed to the delays for road projects in Ghana. The authors identified 23 factors and analyzed the results of 123 questionnaire responses. The results show that the most important factors were “delay in finance and payment of completed work by owner”, “inadequate contractor experience”, “change in scope by the owner during construction”.

Gündüz et al. [76] determined the causes of delays in the Turkish construction industry. The authors identified 83 factors that were grouped into 9 groups. They analyzed the results of 64 questionnaire from highly experienced construction professional using the Relative Importance Index (RII). The most important factors causing delays were found to be “inadequate contractor experience”, “ineffective project planning and scheduling”, and “poor site management and supervision”.

Khahro and Memon [77] the determined the most important causes in the Pakistani construction industry. The authors identified 42 factors that affect the contractors’ performance. Results show that “slow material mobilization”, “subcontractor unreliability” and “shortage of labor and material” are the most important causes of NED.

Mahamid et al. [78] studied the most severe factors for the road construction projects in West Bank of Palestine. The authors analyzed the results of 64 questionnaire responses from consultants and contractors. They identified 52 factors that were categorized into 8 groups. Results show that the most severe factors were found to be: “Political situation”, “segmentation of the West Bank and limited movement between area”, and “award the project to the lowest bid price”.

Wang et al. [10] conducted a study to identify the frequency, impact, and overall and important causes of delays for Chinese building projects. The authors identified 37 potential causes and analyzed the data of 115 valid questionnaire responses. Overall, it was found that the most important causes are “delay in progress payments”, “variation/change orders”, “exceptionally low bids”.

Ahmad and Kansal [79] identified the most important causes of delays for the road construction projects. Data of 33 questionnaire responses were analyzed for 63 delay factors. Results show that “Delivery in site delivery to contractor (land acquisition)”, “delay in obtaining clearance (permits/NOC) from concern authority (Railway, municipal, environmental, & forest etc.)”, and “ineffective project planning and scheduling by contractor”.

Ludwig et al. [80] determined the most frequent and high impact factors causing delays in road construction projects by reviewing 25 studies from 25 different countries. They identified 84 delay factors and analyzed the impact of the factors by quasi-meta-analysis. The most frequent causes that were repeated in the studies are “frequent changes in design” and “lack of experience construction manager”. However, frequency does not necessarily imply the importance of impact of the factors. Based on the results of the quasi-meta-analysis, the most important causes were “lack of experienced construction manager” and “inadequate planning/scheduling”.

Kumar [9] identified 92 factors to determine the most important causes of delay in the Indian highway and expressway projects. The author collected data through surveys and interviews. The most severe causes reported are “political situation” and “award project to lowest bid price”.

Abd El-Razek et al. [81] conducted a study to determine the main causes of delay in the Egyptian building projects. The authors analyzed the results 74 questionnaire results from owners, consultants, and contractors based on the Importance Index. The results that the most important causes among the identified 32 factors are “financing by contractor during construction”, “delays in contractor’s payment by owner”, “design changes by owner or his agent during construction”. The most important groups were found to be “financing” and “materials”. Spearman rank

correlation between the consultants with the owners and contractors were 0.65 and 0.69, respectively.

Marzouk and El-Rasas [82] studied the Egyptian construction industry where they determined the most frequent, severe, and important causes of delays. They identified 43 factors that were grouped into 7 groups and analyzed the results of 33 questionnaires based on the views of the experts. Overall, the most important factors were found to be related to the owners' financing the project, the change orders by the owners, and the subsurface conditions such as high-water table.

Assaf and Al-Hejji [46] conducted a survey to identify the most frequent, severe, and important causes of delays for large construction projects in Saudi Arabia. The authors identified 73 causes and analyzed the survey responses of owners, contractors, and consultants. According to the owners, the most important delay factors was "shortage of labor". According to the contractors and consultants, the most important causes were found to be "delay in progress payments by owner" and "type of project bidding and award", respectively.

Almutairi [83] identified the causes of delays in the construction industry in Kuwait. Data of 22 survey responses were collected analyzing and ranking 40 identified delay factors. Results show that the most important causes of delays are "using a lowest price bidding and tendering system", "poor performance of the main contractors", and "inadequate experience or qualifications of main contractor's staff".

Soliman [84] conducted interviews with 30 experts to determine the most important causes of delays for the Kuwaiti construction projects. The author identified 29 causes that were group into 6 categories and analyzed the results by the Importance Index. According to the consultants, the most important cause of delay is "owner financial problems" whereas "submittal delay of design documents from consultant" was found to be the most important factor according to the contractors.

Shebob et al. [85] studied the main causes of the delay in the Libyan construction industry. The authors identified 75 factors and analyzed the results of 116 questionnaire responses. The authors determine the Frequency Index (FI), Severity Index (SI), and Importance Weight (IW). Overall, the most critical delay factors were found to be "low skills of manpower" and "changes of scope of the project".

Table 1 below summarizes the key findings of the delay causes from previous researches from different countries. There is no consensus on the main factors as they are different between the countries. Some of the reasons include difference in economic and political situations, soft and technical competencies, and the site conditions. Another reason is the difference in perspectives the studies were conducted.

Table 1: Top Causes of Delays by Country

Country	Authors	Top delay causes
Benin	Akogbe et al. [47]	Financial capability by contractors Financial difficulties by owners Poor subcontractor performance
Ghana	Amoatey et al. [6]	Delay in payment to contractor/supplier Inflation/price fluctuation Price increases in materials
Cambodia	Santoso and Soeng [62]	Working during rainy season Flooding Impact on people's land along the road construction project
Egypt	Aziz [52]	Delay in progress payment (funding problems) Different tactics patterns for bribes Shortage of equipment
Zimbabwe	Nyoni and Bonga [16]	Delay in progress payment by owner Delay in revising & approving design documents by owner Delay in approving shop drawings & sample materials
Tanzania	Sambasivan et al. [54]	Finance and payment of completed works Improper planning On time delivery of material
Saudi Arabia	Elawi et al. [22]	Land Acquisition Contractor's lack of expertise Line services (utilities and underground services)

Palestine	Mahamid [17]	Poor communication between construction parties Poor resource management Delay in commencement
South Africa	Gewanlal and Bekker [56]	Communication skills Leadership styles Planning (integrative)
Iraq	Bekr [68]	Security measures Government change of regulations and bureaucracy Official and non-official holidays
Nigeria	Obodoh and Obodoh [58]	Insufficient number of equipment Inaccurate time estimation Payment difficulties
Libya	Alfakhri et al. [59]	Delays in the conversion and transfer of utility services Difficulty in budget availability for the project Original contract duration is too short
Egypt	Aziz and Abdel-Hakam [71]	Owner financial problems/client finance/economic ability for the project Shortage in equipment/insufficient numbers Inadequate contractor experience (work) causing error
India	Doloi et al. [7]	Delay in material delivery by vendors Non-availability of drawing/design on time Financial constraints of contractor
China	Wang et al. [10]	Delay in progress payments Variation/change orders Exceptionally low bids
Egypt	Marzouk and El-Rasas [82]	Finance and payment of completed works by owner Variation orders/changes of scope by owner during construction Effects of subsurface conditions (e.g., soil, high water table, etc.)

Kuwait	Almutairi [83]	Using a lowest price bidding and tendering system Poor performance of the main contractors Inadequate experience or qualifications of main contractor's staff
Cambodia	Durdyev et al. [11]	Shortage of materials on site Unrealistic project scheduling Late delivery of material
Ghana	Amoatey and Ankrah [34]	Delay in finance and payment of completed work by owner Inadequate contractor experience Change in scope by the owner during construction

2.2 Factor Analysis

Factor Analysis is an analysis method that reduces the number of seemingly unrelated variables by combining some of these variables into latent (unobserved) variables [7]. The latent variables give a general reflection of the observed variables they represent for better interpretation. The method is used when the data set is large and most of them are correlated [49]. Several methods are used to conduct factor analysis such as principal axis factor and maximum likelihood. The relationships between the variables are tested in order to determine the feasibility to proceed with factor analysis to determine the latent variables [49].

Alfakhri et al. [59] conducted factor analysis to determine the underlying factors from 50 delays variables (factors) in Libya. Initial tests showed that 11 factors were discarded from factor analysis. The results of the factor analysis showed that the 39 factors were reduced to 8 factors based on eigenvalues greater than 1. The 8 factors accounted for 79.324% of the total variance.

Kaming et al. [60] reduced 11 factors of delay (variables) for the Indonesian high-rise projects using factor analysis. A total of 4 factors were extracted for the delay factors (variables) based on the eigenvalues. The new variables were named by the authors: Equipment usage, resource estimates', buildability, and human resource shortage. The cumulative variance of the 4 factors contributed to 66.1% of the total variance.

Doloi et al. [7] conducted factor analysis to reduce the identified 45 delay factors (variables) in India. Out of the 45 factors, 18 were discarded because they had no significant correlation with one another. A total of 7 latent variables were extracted: Lack of commitment, inefficient site management, poor site coordination, improper planning, lack of clarity in project scope, lack of communication, and sub-standard contract. The cumulative variance of the 7 factors contributes to 70.64% of the total variance. “Lack of commitment” had the highest variance explained with 11.61% followed by “inefficient site management” with 10.97%.

Arantes and Ferreira [86] utilized statistical package for social sciences (SPSS) to conduct factor analysis to reduce the number of factors that cause delays in the Portuguese construction industry. They originally identified 46 causes of delays. The results revealed that 70% of the total variance are represented by 8 factors: Inefficient site management, lack of productivity, poor control, lack of commitment, lack of communication, related to developer, financial constraints, and excess of and changes in Bureaucracy.

Rahman et al. [87] categorized 37 delay factors in the Saudi construction industry by conducting factor analysis. Initially, the results revealed that the data could be represented in 9 groups. However, after modifications done by the authors to reflect the theoretic suitability of the factors to assigned groups, the final distribution of factors were categorized in 7 groups: Material and machinery related factors (MMF), contractor’s site management related factors (CSMF), design and documentation related factor (DDF), information and communication technology related factors (ICTF), labor management related factors (LAB), client and consultant related factors (CCF), project management and contract administration related factors (PMCAF). “Client and consultant related factors (CCF)” consisted 9 factors which was the highest number of factors in comparison to the other groups.

Tafazzoli and Shrestha [72] conducted factor analysis to reduce the number of delay factors in the US construction industry. Results show that the initial 30 causes were reduced to 14 and were grouped into four categories related to decision making, communication, designer’s efficiency, and contractor’s inefficiency.

Sweis [74] conducted factor analysis for the top ten factors according to the rankings. Based on the results of the analysis, three factors were extracted: “Poor qualification of consultant, engineers and staff assigned to the project”, “poor planning and scheduling of the project by the contractor”, and “severe weather conditions on the job site”.

Chapter 3. Identification of the Factors of Delays

An extensive literature review has been conducted to identify the main factors to determine the most important causes of delays in the UAE construction industry. The literature mainly consisted of journal articles previously published. Some of the journal that were referred to were “KSCE Journal of Civil Engineering” and “Engineering, Construction and Architectural Management”.

3.1 Causes of Delays

During the process of extracting the factors from the literature, repetitions were avoided as the interpretation of the factors was considered and matched with the factors used in this study. For example, “Lack of skilled workers” was used by Akogbe et al. [47] whereas Sweis et al. [57] called the factor “presence of unskilled labor”. Despite the naming of the factors is different, the interpretation is the same. Therefore, both factors were considered as “lack of skilled workers” in this study. “Frequent equipment breakdown” was used by Durdyev et al. [11] whereas it was used as “construction equipment failure” by Islam and Suhariadi [2]. For consistency, the factor is used as “Frequent equipment breakdown” in this study. Zidane and Andersen [1] avoided repetitions of factors from their literature such as “complex project seen from the contractor perspective”, “poor building methods”, and “inexperienced contractor” and referred them as “inadequate contractor experience/building methods and approaches”.

The grouping of the factors was also studied based on the interpretation of the factors. For example, “Lack of skilled workers” was considered a contractor related factor for Akogbe et al. [47] whereas “lack of skilled labor/technical personnel” was considered a resource related factor for Lo et al. [51]. Doloi et al. [7] classified “extreme weather conditions” as a site related factor whereas Akogbe et al. [47] classified “weather conditions on the job site” as an external factor. For consistency, “adverse weather conditions” will be classified as “other factors” in this study. Islam and Suhariadi [2] identified “shortage of equipment” as a manpower and resource factor whereas Oyegoke and Kiyumi [14] considered “shortage of equipment on site” as a contractor-related cause. Some papers did not group the factors into categories. For example, Zidane and Andersen [1] did not group the factors obtained from the literature

review when they identified the most important universal factors. Moreover, Kaming et al. [60] did not group the factors when analyzing the most important factors for high-rise construction projects in Indonesia.

After conducting the review of the literature, 40 delay factors were identified and divided into 5 categories: owner-related, consultant-related, contractor-related, resource-related and other factors. Sambasivan et al. [54] identified 32 delay factors and grouped them into 7 categories. Akogbe et al. [47] identified 35 factors and grouped them into 5 groups. Bekr [68] identified 65 causes that were grouped into 4 categories. Oshungade and Kruger [19] identified 48 factors and distributed them among 10 groups. Oyegoke and Kiyumi [14] identified 44 causes of delays and grouped them into 4 categories.

The owner-related group consists of 9 causes, the consultant-related group consists of 8 factors, the contractor-related factors consist of 9 factors, resource-related group consists of 7 factors, and the other factor group consists of 7 factors. Table 2 summarizes the factors used showing the identification and the references from previous studies. The definitions of the factors are as follows:

3.1.1 Owner-related factors. A total of 9 owner-related factors were used in this study. “Owner's financial difficulties” is the financial difficulties from the owner to provide the required budget on time. That will lead setting the project on hold and preventing it from proceeding to the next phase [54]. “Land acquisition” is the delay in handing over the land from the client to proceed with the construction phases (including expropriation from occupants) [59]. “Slow decision making by owner” is when the owner cannot make rapid decisions regarding what he/she wants such as type of material to be used. That will cause the consultants and contractors to wait without further productivity. “Delay in progress payment by the owner” is when the owner may not be capable of paying the consultants and contractors after the completion of a phase or a task which will force the project to be on hold before starting the next phase [86]. “Unrealistic requirements by the owner” is defined as the unrealistic desires from the owner such as contract duration to complete the project. “Work suspension by the owner” is defined as the owner's decision to temporarily hold or postpone the project. “Award the project for the lowest bidder” is selecting the contractor based on the lowest offered price. That will hinder the project mainly due to an expected reduction in quality

due to limitations such as resources [2]. “Change orders by the owner” is the requested changes during design and construction that will significantly delay the project. The consultants and contractors will have to go back to the previous stages which will cause the delays from the initially planned completion date. “Lack of experience by the owner and the representatives” is the lack of knowledge and experience of the owner/representative which results in slower suitable decision making [76].

3.1.2 Consultant-related factors. A total of 8 consultant-related factors were used in this study. “Lack of experience/competence of the consultant” is defined as the insufficient experience and knowledge by the consultant [2]. “Slow inspection of completed works by the consultant” is the delay in performing inspection by consultant of completed work. That will delay the approval and proceeding to the next stage [1]. “Delay in preparation, review, and approval of drawing by consultant” is the delay in preparation, review, and approval of the drawing which will not enable the contractor to commence the construction with proper approved drawings [14]. “Inaccurate site investigation by the consultant” is inadequate site assessment for proper design. The poor site reflection such as leveling will impact the construction phase for the contractor. “Consultant’s reluctance for change” is defined as the delay caused from resisting the change orders [76]. “Consultant's misunderstanding of owner's requirements” is when the consultant misinterprets of the owner's desires and leads to false design. That means that the consultant should re-design. “Inaccurate, incomplete, and unclear details in design” is when the drawings are incomplete and are missing data which will not allow the drawings to be approved by the concerned parties (government...). This will force contractors to review the drawings during construction and re-obtain the approvals [1]. “Mistakes in design by the consultant” is the presence of defective design and discrepancies made by designers which will lead to re-designing [52].

3.1.3 Contractor-related factors. A total of 9 contractor-related factors were used in this study. “Financial Capability by the contractor” is the difficulties of the contractors to finance the projects such as budget allocation and payment for subcontractors [82]. “Inadequate planning and scheduling by the contractor” is defined as the poor planning and scheduling by the contractor which will delay the projects beyond the planned time [19]. “Poor subcontractor performance” is defined as the delay

in subcontractor work, unreliable and incompetent sub-contractor [52]. “Rework due to errors in construction/bad quality” is defined as repeating the work due to errors in construction or obtaining undesirable quality of product [54]. “Changes of subcontractors” is the frequent turnover of the subcontractors which will cause delay in handing over to the new subcontractor and delay until the new subcontractor understands the project and the requirements. “Poor site management” is defined as poor site arrangement, management, and supervision during construction [62]. “Improper construction methods” is defined as utilizing obsolete construction techniques and unacceptable methods [7]. “Accidents/injuries during construction” is defined as the site accidents that occur especially to the labors due to lack of safety measures. The time needed to treat the labor will be lost as well as loss of manpower [7]. “Poor qualification and experience of contractor” is the inadequate experience and qualification of the contractor. The lack of experience and knowledge will impede the project and lead to more mistakes.

3.1.4 Resource-related factors. A total of 7 resource-related factors were used in this study. “Late delivery of material” is the late delivery and procurement of material by vendors [10]. “Shortage of manpower” is defined as insufficient and lack of availability of labor [62]. “Shortage of material” is defined as lack of available material in the market. “Shortage of equipment” is the lack of availability and insufficient equipment when needed as sometimes the equipment is being used for a different project. The contractors will have to wait until the equipment is available. “Frequent equipment breakdown” is defined as the regular failure of equipment and lower productivity than estimated [1]. “Poor and obsolete technology used” is the use of obsolete technology and inadequate modern equipment. Using advanced equipment saves time and improves productivity [47]. “Lack of skilled workers” is defined as low productivity and ineffective use of equipment due to unqualified work force since most of the labor are from developing countries and are not educated [11].

3.1.5 Other factors. A total of 8 other factors were used in this study. “Political situation such as war” is the effects of the political situation, and the security conditions that affect the project such as war, strikes, revolutions, and public protests [75]. “Adverse weather conditions” is mainly high temperatures that can affect the performance of the labor as well as cause design changes such as concrete mix design.

The effects of rain during winter are also effective [75]. “Changes in government regulations” is changes in government regulation and law, and restrictions in working hours for labors [75]. “Unforeseen site conditions” is defined as unexpected surface and sub-surface conditions (geology and soil, terrain, water table, pipelines...) [71]. “Financial Crisis” is defined as the impact of the local and international economic problems on the progress of the project. This may lead to changes in prices, financial difficulties by the owner, and increase in unemployment rates. “Lack of communication between the involved parties” means the communication channels between the parties are poor and not well developed. The poor communication may lead to misunderstanding and conflict which will delay the project. “Inflation/price fluctuation” is the inflation, high interest rates, and increase of material. The prices may not be sufficient to satisfy the allocated budget [2].

3.2 Effects of delays

Similar to the causes of delays, the effects were also identified from the literature. Logic and interpretation were used to combine factors with similar meaning. For example, Mukuka et al. [61] identified the factor “loss of profit” as an effect whereas Oshungade and Kruger [19] identified “delays in getting profit”. For consistency, the effect that will be used in this study is “Loss of profit/opportunity cost for the involved parties”. A total of 10 effects were identified and are summarized in Table 3 with the main references. The effect factors are defined below.

“Cost overrun” is the additional costs that are required for the projects from the allocated budget initially planned, where more resources and time were consumed to complete the project. “Time overrun/extension of time” is the extended time from the initial planned date because of the accumulated delays from the factors [61]. “Litigation” is defined as the issues that arise and are settled at court such as lawsuits. “Arbitration” is defined as the issues that arise but are settled outside a court. “Termination of contracts” is when the owner decides to terminate the contract with the involved parties because of the excessive delays. The reasons can be due to financial difficulties or poor performance of the contractors or consultants [6]. “Increased portfolio of "non-performing" projects/ bad reputation of involved parties” is when the involved parties (owner, consultant, and contractor) develop a negative reputation for

Table 2: References of the Factors

Delay Groups	No.	Causes of Delay	References
Owner	1	Owner's financial difficulties	Zidane and Andersen [1]; Oyegoke and Kiyumi [14]; Mahamid [17]; Santoso and Soeng [62]; Sambasivan et al. [54]; Alnuaimi and Mohsin [29]; Yong and Mustaffa [55]; Ahmad and Kansal [79]; Vu et al. [5]; Soliman [84]; Islam and Suhariadi [2]; Ludwig et al. [80]
	2	Land acquisition	Kumar [9]; Mahamid [18]; Jawad [35]; Elawi et al. [22]; Marzouk and El-Rasas [82]; Santoso and Soeng [62]; Alfakhri et al. [59]; Mpofu et al. [67]

	3	Slow decision making by owner	Tafazzoli and Shrestha [72]; Motaleb and Kishk [48]; Mahamid [18]; Wang et al. [10]; Sambasivan et al. [54]; Mpofu et al. [67]; Sweis [74]; Zidane and Andersen [1]; Shehu et al. [13]; Tariq and Marey-Pérez [64]; Obodoh and Obodoh [58]; Ludwig et al. [80]; Oyegoke and Kiyumi [14]; Hasan et al. [75]; Kumar [9]; Ahmad and Kansal [79]; Marzouk and El-Rasas [82]; Amoatey and Ankrah [34]; Almutairi [83]
Owner	4	Delay in progress payment by the owner	Sweis [74]; Mahamid [18]; Hasan et al. [75]; Gündüz et al. [76]; Islam and Suhariadi [2]; Amoatey et al. [6]; Mahamid et al. [78]; Alfakhri et al. [59]; Vu et al. [5]; Santoso and Soeng [62]; Soliman [84]; Almutairi [83]; Shehu et al. [13]; Nyoni and Bonga [16]; Tafazzoli and Shrestha [72]; Amoatey and Ankrah [34]; Wang et al. [10]; Kumar [9]; Tariq and Marey-Pérez [64]
	5	Unrealistic requirements by the owner	Mahamid [18]; Amoatey and Ankrah [34]; Sambasivan et al. [54]; Tafazzoli and Shrestha [72]; Nyoni and Bonga [16]; Mpofu et al. [67]; Oyegoke and Kiyumi [14]

6	Work suspension by the owner	Hasan et al. [75]; Marzouk and El-Rasas [82]; Mahamid [18]; Gündüz et al. [76]; Amoatey and Ankrah [34]; Shehu et al. [13]; Alfakhri et al. [59]; Mpofu et al. [67]; Sweis [74]; Oshungade and Kruger [19]
7	Award the project for the lowest bidder	Nyoni and Bonga [16]; Bekr [68]; Jawad [35]; Alfakhri et al. [59]; Santoso and Soeng [62]; Wang et al. [10]; Oyegoke and Kiyumi [14]; Vu et al. [5]; Ludwig et al. [80]; Mahamid [18]; Mpofu et al. [67]; Islam and Suhariadi [2]; Elawi et al. [22]
Owner		
8	Change orders by the owner	Tafazzoli and Shrestha [72]; Marzouk and El-Rasas [82]; Vu et al. [5]; Mpofu et al. [67]; Obodoh and Obodoh [58]; Mahamid et al. [78]; Santoso and Soeng [62]; Mezher and Tawil [63]; Bekr [68]; Amoatey et al. [6]; Aziz [52]; Latif et al. [65]; Mahamid [18]; Ahmad and Kansal [79]; Amoatey and Ankrah [34]; Oyegoke and Kiyumi [14]; Islam and Suhariadi [2]; Shehu et al. [13]; Sweis [74]; Hasan et al. [75]; Zidane and Andersen [1]; Wang et al. [10]
9	Lack of experience by the owner and the representatives	Bekr [68]; Obodoh and Obodoh [58]; Aziz [52]; Islam and Suhariadi [2]; Oyegoke and Kiyumi [14]; Ludwig et al. [80]

			Oshungade and Kruger [19]; Tafazzoli and Shrestha [72]; Nyoni and Bonga [16]; Aziz [52]; Obodoh and Obodoh [58]; Santoso and Soeng [62]; Hasan et al. [75]; Alfakhri et al. [59]; Amoatey and Ankrah [34]; Kumar [9]; Alnuaimi and Mohsin [29]; Oyegoke and Kiyumi [14]; Bekr [68]; Almutairi [83]; Ahmad and Kansal [79]; Islam and Suhariadi [2]; Mpofu et al. [67]
Consultant	10	Lack of experience/competence of the consultant	
	11	Slow inspection of completed works by the consultant	Aziz [52]; Mahamid [17]; Obodoh and Obodoh [58]; Mahamid [18]; Shehu et al. [13]; Zidane and Andersen [1]; Almutairi [83]; Santoso and Soeng [62]; Mpofu et al. [67]; Oshungade and Kruger [19]; Ahmad and Kansal [79]
	12	Delay in preparation, review, and approval of drawing by consultant	Ahmad and Kansal [79]; Tafazzoli and Shrestha [72]; Nyoni and Bonga [16]; Tariq and Marey-Pérez [64]; Oyegoke and Kiyumi [14]; Alfakhri et al. [59]; Sambasivan et al. [54]; Aziz [52]; Latif et al. [65]; Kumar [9]
	13	Inaccurate site investigation by the consultant	Obodoh and Obodoh [58]; Aziz [52]; Ahmad and Kansal [79]; Oyegoke and Kiyumi [14]; Gündüz et al. [76]; Tafazzoli and Shrestha [72]

Consultant	14	Consultant's reluctance for change	Hasan et al. [75]; Santoso and Soeng [62]; Aziz [52]; Alfakhri et al. [59]; Oshungade and Kruger [19]
	15	Consultant's misunderstanding of owner's requirements	Aziz [52]; Oyegoke and Kiyumi [14]; Aziz and Abdel-Hakam [71]; Tafazzoli and Shrestha [72]; Nyoni and Bonga [16]; Ahmad and Kansal [79]
	16	Inaccurate, incomplete, and unclear details in design	Aziz [52]; Marzouk and El-Rasas [82]; Gündüz et al. [76]; Santoso and Soeng [62]; Oshungade and Kruger [19]; Amoatey and Ankrah [34]; Islam and Suhariadi [2]; Ludwig et al. [80]; Zidane and Andersen [1]
	17	Mistakes in design by the consultant	Amoatey and Ankrah [34]; Bekr [68]; Mahamid [17]; Islam and Suhariadi [2]; Obodoh and Obodoh [58]; Sweis [74]; Santoso and Soeng [62]; Mpofo et al. [67]; Latif et al. [65]; Aziz [52]; Mahamid [18]; Tafazzoli and Shrestha [72]; Wang et al. [10]; Ahmad and Kansal [79]; Islam and Suhariadi [2]
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	18	Financial Capability by the contractor	Mahamid et al. [78]; Mahamid [18]; Shehu et al. [13]; Marzouk and El-Rasas [82]; Hasan et al. [75]; Zidane and Andersen [1]; Sweis [74]; Alfakhri et al. [59]; Doloi et al. [7]; Vu et al. [5]; Oyegoke and Kiyumi [14]; Amoatey and Ankrah [34]; Tafazzoli and Shrestha [72]; Tariq and Marey-Pérez [64]; Kumar [9]; Ludwig et al. [80]

Contractor	19	Inadequate planning and scheduling by the contractor	Obodoh and Obodoh [58]; Aziz [52]; Oshungade and Kruger [19]; Latif et al. [65]; Kumar [9]; Yong and Mustaffa [55]; Bekr [68]; Wang et al. [10]; Hasan et al. [75]; Sambasivan et al. [54]; Oyegoke and Kiyumi [14]; Vu et al. [5]; Amoatey and Ankrah [34]
	20	Poor subcontractor performance	Amoatey and Ankrah [34]; Santoso and Soeng [62]; Kumar [9]; Alfakhri et al. [59]; Aziz [52]; Wang et al. [10]; Islam and Suhariadi [2]; Yong and Mustaffa [55]; Almutairi [83]; Obodoh and Obodoh [58]; Mpofu et al. [67]
	21	Rework due to errors in construction/bad quality	Oshungade and Kruger [19]; Nyoni and Bonga [16]; Mpofu et al. [67]; Aziz [52]; Kumar [9]; Wang et al. [10]; Sambasivan et al. [54]; Alfakhri et al. [59]; Bekr [68]; Soliman [84]; Mezher and Tawil [63]; Marzouk and El-Rasas [82]; Santoso and Soeng [62]; Hasan et al. [75]; Amoatey and Ankrah [34]; Ludwig et al. [80]; Almutairi [83]; Vu et al. [5]; Ahmad and Kansal [79]
	22	Changes of subcontractors	Almutairi [83]; Aziz [52]; Doloi et al. [7]; Ahmad and Kansal [79]; Santoso and Soeng [62]
	23	Poor site management	Amoatey and Ankrah [34]; Mahamid [18]; Obodoh and Obodoh [58]; Santoso and Soeng [62] Elawi et al. [22]; Oshungade and Kruger [19]; Hasan et al. [75]; Bekr [68]; Aziz [52]; Ahmad and Kansal [79]; Nyoni and Bonga [16]; Tafazzoli and Shrestha [72]

	24	Improper construction methods	Ahmad and Kansal [79]; Mahamid [18]; Tafazzoli and Shrestha [72]; Oyegoke and Kiyumi [14]; Shehu et al. [13]; Sweis et al. [57]; Mpofu et al. [67]; Mahamid et al. [78]; Doloi et al. [7]; Obodoh and Obodoh [58]; Bekr [68]; Oshungade and Kruger [19]; Vu et al. [5]; Oyegoke and Kiyumi [14]; Almutairi [83]
Contractor	25	Accidents/injuries during construction	Marzouk and El-Rasas [82]; Santoso and Soeng [62]; Alfakhri et al. [59]; Hasan et al. [75]; Islam and Suhariadi [2]; Aziz [52]; Ludwig et al. [80]; Aziz and Abdel-Hakam [71]; Lo et al. [51]; Kumar [9]; Doloi et al. [7]; Mpofu et al. [67]; Amoatey et al. [6]; Ahmad and Kansal [79]; Vu et al. [5]
	26	Poor qualification and experience of contractor	Ahmad and Kansal [79]; Sambasivan et al. [54]; Gündüz et al. [76]; Aziz and Abdel-Hakam [71]; Faridi and El-Sayegh [37]; Wang et al. [10]; Tafazzoli and Shrestha [72]; Marzouk and El-Rasas [82]; Aziz [52]; Elawi et al. [22]; Obodoh and Obodoh [58]; Oshungade and Kruger [19]; Santoso and Soeng [62]; Oyegoke and Kiyumi [14]; Mpofu et al. [67]; Islam and Suhariadi [2]

	27	Late delivery of material	Aziz [52]; Oyegoke and Kiyumi [14]; Oshungade and Kruger [19]; Nyoni and Bonga [16]; Mpofu et al. [67]; Nyoni and Bonga [16]; Zidane and Andersen [1]; Wang et al. [10]; Mezher and Tawil [63]; Tariq and Marey-Pérez [64]
Resources	28	Shortage of manpower	Ludwig et al. [80]; Alfakhri et al. [59]; Mahamid [18]; Obodoh and Obodoh [58]; Aziz [52]; Marzouk and El-Rasas [82]; Santoso and Soeng [62]; Hasan et al. [75]; Mezher and Tawil [63]; Khahro and Memon [77]; Soliman [84]; Almutairi [83]; Ahmad and Kansal [79]; Alnuaimi and Mohsin [29]; Oyegoke and Kiyumi [14]; Nyoni and Bonga [16]; Wang et al. [10]
	29	Shortage of material	Mpofu et al. [67]; Alnuaimi and Mohsin [29]; Mezher and Tawil [63]; Sweis et al. [57]; Mahamid [18]; Islam and Suhariadi [2]; Ahmad and Kansal [79]; Marzouk and El-Rasas [82]; Gündüz et al. [76]; Kaming et al. [60]; Nyoni and Bonga [16]; Khahro and Memon [77]; Hasan et al. [75]; Sambasivan et al. [54]; Aziz [52]; Alfakhri et al. [59]; Soliman [84]; Santoso and Soeng [62]; Ludwig et al. [80]; Obodoh and Obodoh [58]; Bekr [68]; Zidane and Andersen [1]

Resources	30	Shortage of equipment	Obodoh and Obodoh [58]; Santoso and Soeng [62]; Aziz [52]; Sweis [74]; Soliman [84]; Mezher and Tawil [63]; Oyegoke and Kiyumi [14]; Sambasivan et al. [54]; Mahamid [18]; Bekr [68]; Mpofu et al. [67]; Almutairi [83]; Alfakhri et al. [59]; Islam and Suhariadi [2]
	31	Frequent equipment breakdown	Mpofu et al. [67]; Aziz [52]; Sweis [74]; Shehu et al. [13]; Alnuaimi and Mohsin [29]; Oshungade and Kruger [19]; Santoso and Soeng [62]; Almutairi [83]; Islam and Suhariadi [2]; Obodoh and Obodoh [58]; Bekr [68]; Soliman [84]; Zidane and Andersen [1]; Kumar [9]
	32	Poor and obsolete technology used	Santoso and Soeng [62]; Obodoh and Obodoh [58]; Nyoni and Bonga [16]; Aziz [52]; Islam and Suhariadi [2]; Gündüz et al. [76]
	33	Lack of skilled workers	Islam and Suhariadi [2]; Soliman [84]; Yong and Mustaffa [55]; Mpofu et al. [67]; Alfakhri et al. [59]; Latif et al. [65]; Wang et al. [10]; Mezher and Tawil [63]; Sweis [74]; Mahamid [18]; Aziz [52]; Obodoh and Obodoh [58]; Ahmad and Kansal [79]

34	Political situation such as war	Hasan et al. [75]; Mahamid [17]; Obodoh and Obodoh [58]; Mahamid [18]; Santoso and Soeng [62]; Alfakhri et al. [59]; Aziz and Abdel-Hakam [71]; Ludwig et al. [80]
35	Adverse weather conditions	Ahmad and Kansal [79]; Mahamid [18]; Santoso and Soeng [62]; Mahamid [17]; Sambasivan et al. [54]; Marzouk and El-Rasas [82]; Kumar [9]; Islam and Suhariadi [2]; Yong and Mustaffa [55]; Alnuaimi and Mohsin [29]; Almutairi [83]; Sweis [74]; Aziz [52]; Vu et al. [5]; Hasan et al. [75]; Alfakhri et al. [59]; Oyegoke and Kiyumi [14]; Nyoni and Bonga [16]
36	Changes in government regulations	Aziz [52]; Alfakhri et al. [59]; Ludwig et al. [80]; Sweis et al. [57]; Santoso and Soeng [62]; Marzouk and El-Rasas [82]; Oyegoke and Kiyumi [14]; Kumar [9]; Bekr [68]; Almutairi [83]; Ahmad and Kansal [79]; Hasan et al. [75]
Others		
37	Unforeseen site conditions	Sambasivan et al. [54]; Ludwig et al. [80]; Obodoh and Obodoh [58]; Kumar [9]; Almutairi [83]; Mezher and Tawil [63]; Ahmad and Kansal [79]; Mahamid [18]; Bekr [68]; Nyoni and Bonga [16]; Oshungade and Kruger [19]
38	Financial Crisis	Ludwig et al. [80]; Mpofu et al. [67]; Aziz [52]; Bekr [68]; Alfakhri et al. [59]; Ahmad and Kansal [79]; Kumar [9]
39	Lack of communication between the involved parties	Kumar [9]; Mpofu et al. [67]; Alfakhri et al. [59]; Alnuaimi and Mohsin [29]; Tafazzoli and Shrestha [72]; Marzouk and El-Rasas [82]; Aziz [52]; Obodoh and Obodoh [58]; Bekr [68]; Santoso and Soeng [62]; Alfakhri et al. [59]

40	Inflatin/price fluctuation	Obodoh and Obodoh [58]; Oyegoke and Kiyumi [14]; Amoatey et al. [6]; Aziz [52]; Mahamid [17]; Mpofu et al. [67]
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themselves in the market. That will hinder them from acquiring tenants or clients in the future [14]. “Total abandonment of project” is when the excessive delays force the client to completely abandon the project. This may occur due to the frequent disputes and losses. “Loss of profit/opportunities for the involved parties” is when the delays during the construction phases cause the development to start operating late. That, in turn, will cause a delay for the owners to start earning returns for their investments. For the consultants and contractors, delays in a project will deprive them the opportunities of working for future projects [14]. “Acceleration losses” is when the delays cause the project to be accelerated which will require more resources to complete. “Poor quality of work due to hurrying the project” is when the acceleration of the project will make it more prone to mistakes. As a result, the final product may not be produced with the targeted quality.

Table 3: Effect Factors and the References

No.	Effect	References
1	Cost Overrun	Amoatey et al. [6]; Sambasivan et al. [54]; Obodoh and Obodoh [58]; Mukuka et al. [61]; Bekr [68]; Oshungade and Kruger [19]; Hasan et al. [75]
2	Time overrun/extension of time	Bekr [68]; Sambasivan et al. [54]; Hasan et al. [75]; Amoatey et al. [6]; Mukuka et al. [61]; Obodoh and Obodoh [58]; Oshungade and Kruger [19]; Oyegoke and Kiyumi [14]
3	Litigation	Bekr [68]; Amoatey et al. [6]; Mukuka et al. [61]; Obodoh and Obodoh [58]; Oyegoke and Kiyumi [14]; Hasan et al. [75]
4	Arbitration	Oshungade and Kruger [19]; Sambasivan et al. [54]; Motaleb and Kishk [48]; Amoatey et al. [6]; Mukuka et al. [61]; Bekr [68]; Hasan et al. [75]; Oyegoke and Kiyumi [14]
5	Termination of contracts	Amoatey et al. [6]; Mukuka et al. [61]; Oyegoke and Kiyumi [14]

6	Increased portfolio of "non-performing" projects/ bad reputation of involved parties	Mukuka et al. [61]; Amoatey et al. [6]; Oyegoke and Kiyumi [14]
7	Total abandonment of project	Hasan et al. [75]; Amoatey et al. [6]; Obodoh and Obodoh [58]; Sambasivan et al. [54]; Mukuka et al. [61]; Bekr [68]; Oshungade and Kruger [19]
8	Loss of profit/opportunities for the involved parties	Mukuka et al. [61]; Oyegoke and Kiyumi [14]; Oshungade and Kruger [19]
9	Acceleration losses	Mukuka et al. [61]
10	Poor quality of work due to hurrying the project	Mukuka et al. [61]; Oshungade and Kruger [19]

Chapter 4. Results

4.1 Frequency, Severity, and Importance of Factors

4.1.1 Overall perspectives. The results of the overall perspectives of the owners, consultants, and contractors are shown in Table 4. Overall, the most important cause of delay was found to be “award the project for the lowest bidder”, followed by “delay in progress payment by the owner”, “change orders by the owner”, “poor subcontractor performance”, and “inadequate planning and scheduling by the contractor”. The results show that the top 3 delay factors are all attributed to the owners. Owners tend to select the lowest bidder to execute the projects mainly due to the relatively lower prices. However, selecting the lowest bidder means that the contractors have lower qualifications such as resource and capability constraints where the quality of the construction process and product will be jeopardized. The contractors with lower qualifications will also have poor planning and scheduling at which the project completion will not meet the initially agreed terms. Undecisive owners will also request for constant changes especially when market condition changes as UAE has a highly dynamic economy. Moreover, UAE has several major developers with employees who lack experience in megaprojects. Therefore, the upper management and specialists should be provided sufficient guidance and training to the employees. The finding is consistent with the results of Almutairi [83] in Kuwait and Oyegoke and Kiyumi [14] in Oman. The results and comparisons also dictate that selection of the lowest bidder is a recurring issue in the MENA region and not just in the UAE. Moreover, owners in the UAE construction industry tend to delay the progress payments for the contractors where the contractors will be unable to fulfill their expenses. As a result, the work will be delayed due to inadequate cash flow to support the required expenses. Other studies such as Abd El-Razek et al. [81] and Aziz [52] reported that the delays payments by the owner are among the most important causes of delays. Due to dynamic economy in the UAE, owners tend to request for change orders during construction, that will cause for more delays for the projects. Tafazzoli and Shrestha [72], Zidane and Andersen [1], and Sweis et al. [57] have reported that the change orders by owners are among the most important causes of delays in the US, universal, and Jordan, respectively.

The least important factors were found to be “political situation such as war”, “adverse weather conditions”, “changes in government regulations”. Politically, the UAE is a stable country and is one of the most multi-national countries in the world. The weather is typically hot and dry almost throughout the year, so the impact of rain and hurricanes are minimal. Government regulations do not frequently change, they usually are adjusted every few years.

The top 4 most frequent factors causing delays in the UAE construction industry are consistent with the top 4 most important causes. Out of the top 10 most frequent causes of delays, 6 factors are owner-related and 4 factors are contractor-related factors. Consultant-related factors, resource-related factors, and other factors were not found to be significantly frequent. “Award the project for the lowest bidder” was the most frequent cause of delay with a Frequency Index (FI) of 0.659, followed by 0.625 for “Delay in progress payment by the owner”, 0.620 for “Change orders by the owner”, 0.588 for “Poor subcontractor performance”, and 0.584 for “Owner's financial difficulties”. Delay in payments by the owners to the contractor and change orders were reported to be among the most frequent causes of delays by Amoatey et al. [6]. Award the project to the lowest bidder and late progress payments were reported to be among the most frequent causes of delays by Santoso and Soeng [62].

The results show that 3 out of the top 5 most severe factors based on the overall perspectives are owner-related factors. “Financial crisis” was found to be the most severe factor in causing delays in the UAE construction industry with a Severity Index (SI) of 0.706. The reason is mainly attributed to the 2008 financial crisis which had a significant impact in delaying several megaprojects at the time. The COVID19 pandemic has also contributed to causing financial issues in the economy where several projects have been delayed. Stock prices in the UAE dropped drastically, some companies went bankrupt, and citizens lost their jobs. This, in turn, was also reflected on the construction projects where the owners were facing difficulties especially in financing the projects. The second, third, and fourth most severe factors are contractor-related factors. “Inadequate planning and scheduling by the contractor”, “Poor subcontractor performance”, and “Financial Capability by the contractor” have scored SI values of 0.675, 0.670, and 0.664, respectively. “Change orders by the owners”, which was ranked as the third most important and frequent factor, was ranked as the

fifth most severe factor with a SI value 0.655. “Delay in progress payment by the owner” and “Award the project for the lowest bidder”, which are ranked the top 2 most important and frequent causes of delays, are ranked as the sixth and seventh most severe causes, respectively. “Award the project to the lowest bidder” was ranked among the top 10 most severe factors by Santoso and Soeng [62]. Islam and Suhariadi [2] ranked the lowest bidder selection and improper planning and scheduling among the most severe factors causing delays for construction projects in Bangladesh. Lowest bidder, change orders, delay in progress payment, contractor’s lack of capital, and unforeseen ground conditions were reported to be among the most severe factors of delay by Wang et al. [10] in China. Moreover, “Poor planning and scheduling by contractor” was reported to be among the top 15 most severe causes of delays by Wang et al. [10].

Similar to the importance index, “political situation such as war”, “adverse weather conditions”, and “changes in government regulations” were among the least frequent and severe factors of delays.

4.1.2 Owners’ perspectives. The results of the most frequent, severe, and importance factors from the perspective of the owners are depicted in Table 5. Only 2 factors from the top 10 most important factors were owner-related. Overall, the most important factor was found to be “Inadequate planning and scheduling by the contractor” with an Importance Index (II) value of 0.395. The second most important factor was found to be “Unforeseen site conditions” with an II value of 0.392. The third, fourth, and fifth most important factors were “Consultant’s reluctance for change”, “Financial Capability by the contractor”, and “Delay in preparation, review, and approval of drawing by consultant” with II values of 0.382, 0.370, and 0.369, respectively. The next three factors had similar II to 3 decimal places, but change at the fourth. Therefore, the sixth, seventh, and eighth most important factors were “Award the project for the lowest bidder”, “Change orders by the owner”, and “Poor subcontractor performance”, respectively. The ninth and tenth most important factors according to the owners were “Financial crisis” and “Shortage of manpower”, respectively. According to the owners’ point of view reported by Akogbe et al. [47], financial capabilities by contractors, poor subcontractor performance, inadequate planning and scheduling, and preparation and approval of drawing were among inadequate planning and scheduling, and preparation and approval of drawing were

Table 4: Results of the Overall Perspectives

Factors	Frequency Index (FI)	Rank (FI)	Severity Index (SI)	Rank (SI)	Importance Index (II)	Rank (II)
Award the project for the lowest bidder	0.659	1	0.644	7	0.424	1
Delay in progress payment by the owner	0.625	2	0.650	6	0.406	2
Change orders by the owner	0.620	3	0.655	5	0.406	3
Poor subcontractor performance	0.588	4	0.670	3	0.394	4
Inadequate planning and scheduling by the contractor	0.580	7	0.675	2	0.391	5
Financial Capability by the contractor	0.572	8	0.664	4	0.380	6
Financial Crisis	0.525	15	0.706	1	0.371	7
Slow decision making by owner	0.583	6	0.617	10	0.360	8
Owner's financial difficulties	0.584	5	0.611	18	0.357	9
Rework due to errors in construction/bad quality	0.523	16	0.641	8	0.335	10
Poor site management	0.541	11	0.617	11	0.334	11
Delay in preparation, review, and approval of drawing by consultant	0.548	10	0.608	20	0.333	12

Lack of experience by the owner and the representatives	0.556	9	0.598	23	0.333	13
Shortage of manpower	0.538	12	0.614	15	0.330	14
Lack of skilled workers	0.519	18	0.628	9	0.326	15
Lack of communication between the involved parties	0.530	13	0.614	16	0.325	16
Late delivery of material	0.522	17	0.611	19	0.319	17
Unrealistic requirements by the owner	0.528	14	0.592	25	0.313	18
Unforeseen site conditions	0.502	20	0.617	12	0.310	19
Poor qualification and experience of contractor	0.495	22	0.616	14	0.305	20
Changes of subcontractors	0.498	21	0.603	21	0.301	21
Shortage of material	0.489	24	0.597	24	0.292	22
Inflation/price fluctuation	0.494	23	0.586	27	0.289	23
Work suspension by the owner	0.470	31	0.613	17	0.288	24
Lack of experience/competence of the consultant	0.478	28	0.600	22	0.287	25
Shortage of equipment	0.484	25	0.591	26	0.286	26
Inaccurate, incomplete, and unclear details in design	0.480	27	0.583	28	0.280	27
Mistakes in design by the consultant	0.448	35	0.617	13	0.277	28

Improper construction methods	0.477	29	0.578	29	0.276	29
Consultant's reluctance for change	0.505	19	0.536	36	0.270	30
Slow inspection of completed works by the consultant	0.473	30	0.558	32	0.264	31
Inaccurate site investigation by the consultant	0.455	33	0.575	30	0.261	32
Land acquisition	0.481	26	0.533	37	0.256	33
Poor and obsolete technology used	0.470	32	0.544	35	0.256	34
Frequent equipment breakdown	0.450	34	0.555	33	0.250	35
Consultant's misunderstanding of owner's requirements	0.439	36	0.566	31	0.248	36
Accidents/injuries during construction	0.394	39	0.545	34	0.215	37
Changes in government regulations	0.409	37	0.520	39	0.213	38
Adverse weather conditions	0.398	38	0.509	40	0.203	39
Political situation such as war	0.319	40	0.522	38	0.166	40

among the top 10 most importance causes of delays. According to Islam and Suhariadi [2], “Lowest bidder selection” and “Improper planning and scheduling” were among the most important causes of delays according to the owners. The least important factors according to the owners were found to be “Frequent equipment breakdown”, “Changes in government regulations”, “Adverse weather conditions”, “Accidents/injuries during construction”, and “Political situation such as war”.

The most frequent cause of delays according to owners was found to be “Consultant’s reluctance for change” with a FI value of 0.614. The next three factors were all owner-related factors which are “Award the project for the lowest bidder”, “Change orders by the owner”, and “Owner's financial difficulties”. “Inadequate planning and scheduling by the contractor”, which was the most important cause according to the owners, was the fifth most frequent factor with a FI of 0.564. “Land acquisition”, “Delay in preparation, review, and approval of drawing by consultant”, “Unforeseen site conditions”, “Poor subcontractor performance”, and “Financial Capability by the contractor” were found to be the sixth, seventh, eighth, ninth, and tenth most frequent causes of delays according to the owners, respectively. Wang et al. [10] reported that “Variations/changes of scope”, “Delay caused by nominated subcontractor”, “Delay caused by domestic subcontractor”, and “Poor planning and scheduling by Contractor” are among the top 10 most frequent causes of delays in China from the clients’ point of view.

According to the owners, none of the top 10 most severe causes are owner-related factors. The top 2 most severe factors were found to be “Unforeseen site conditions” and “Financial Crisis” which are categorized as other factors. The following 2 most severe factors are “Inadequate planning and scheduling by the contractor” and “Financial Capability by the contractor” with the same SI value of 0.700. The next 2 most severe factors are “Poor subcontractor performance” and “Mistakes in design by the consultant” with similar SI value of 0.679. The following 2 most severe factors are “Delay in preparation, review, and approval of drawing by consultant” and “Lack of experience/competence of the consultant” with similar SI value of 0.671. The ninth and tenth most severe factors according to the owners were “Inaccurate site investigation by the consultant” and “Late delivery of material”, respectively. The results are consistent with the findings of Akogbe et al. [47] where

the authors reported that “Financial capability” by the contractors, “Inadequate planning and scheduling”, “Poor subcontractor performance”, “Preparation and approval of drawing”, “Accepting inadequate design drawings”, and “Material procurement” were among the top severe factors according to the owners. “Improper planning and scheduling” was reported by Islam and Suhariadi [2] to be one of the most severe factors causing delays according to the owners.

4.1.3 Consultants’ perspectives. The analysis results of the most frequent, severe, and important causes of delays from the consultants’ perspectives are displayed in Table 6. It can be seen that none of the top 10 most important causes are consultant-related factors. The factors of the top 10 most important causes of delays from the consultants’ perspectives are similar to the factors of the overall top 10 most important factors with modified rankings. According to the consultants, 3 of the top 5 most important causes are owner-related factors whereas the 2 other factors are contractor-related factors. The most important cause of delay from the consultants’ perspective was found to be “Delay in progress payment by the owner” with an II value of 0.416 followed by “Award the project for the lowest bidder” with an II value of 0.408. At the fourth decimal place, it was found that the third and fourth most important factors were “Inadequate planning and scheduling by the contractor” and “Change orders by the owner”, respectively. “Financial Crisis” was the only non-owner/contractor related factor among the top 10 most important causes ranked eighth. Aziz and Abdel-Hakam [71] reported “Owner financial problems/client finance/economic ability for the project” and “Poor subcontractor performance/delays” to be among the top 10 causes of delays from the consultants’ point of view. Assaf and Al-Hejji [46] reported “Type of project bidding and award” and “Delay in progress payment by owner” among the most important delay causes according to the consultants. Almutairi [83] reported “Using a lowest price bidding and tendering system”, “Rework due to errors during construction”, and “Poor performance of subcontractors” among the most important causes of delays from the perspectives of the consultants.

The top 6 most important causes from the consultants’ point of view are the same top 6 most frequent causes according to them. “Award the project for the lowest bidder”, which was the second most important cause, is ranked as the most frequent causes according to the consultants with an FI value of 0.655. “Delay in progress

Table 5: Results from the Owners' Perspectives

Factors	Frequency Index (FI)	Rank (FI)	Severity Index (SI)	Rank (SI)	Importance Index (II)	Rank (II)
Inadequate planning and scheduling by the contractor	0.564	5	0.700	3	0.395	1
Unforeseen site conditions	0.543	8	0.721	1	0.392	2
Consultant's reluctance for change	0.614	1	0.621	16	0.382	3
Financial Capability by the contractor	0.529	10	0.700	4	0.370	4
Delay in preparation, review, and approval of drawing by consultant	0.550	7	0.671	7	0.369	5
Award the project for the lowest bidder	0.607	2	0.600	26	0.364	6
Change orders by the owner	0.579	3	0.629	15	0.364	7
Poor subcontractor performance	0.536	9	0.679	5	0.364	8
Financial Crisis	0.471	22	0.707	2	0.333	9
Shortage of manpower	0.514	13	0.643	12	0.331	10
Owner's financial difficulties	0.564	4	0.579	29	0.326	11
Lack of experience/competence of the consultant	0.486	19	0.671	8	0.326	12
Poor site management	0.507	16	0.643	13	0.326	13

Land acquisition	0.557	6	0.579	30	0.322	14
Inaccurate, incomplete, and unclear details in design	0.514	14	0.621	17	0.320	15
Late delivery of material	0.486	20	0.657	10	0.319	16
Inflation/price fluctuation	0.486	21	0.650	11	0.316	17
Mistakes in design by the consultant	0.457	29	0.679	6	0.310	18
Inaccurate site investigation by the consultant	0.464	25	0.664	9	0.308	19
Slow inspection of completed works by the consultant	0.493	18	0.621	18	0.306	20
Lack of experience by the owner and the representatives	0.514	15	0.593	27	0.305	21
Rework due to errors in construction/bad quality	0.471	23	0.636	14	0.300	22
Delay in progress payment by the owner	0.529	11	0.564	33	0.298	23
Lack of skilled workers	0.471	24	0.621	19	0.293	24
Consultant's misunderstanding of owner's requirements	0.464	26	0.621	20	0.289	25
Changes of subcontractors	0.464	27	0.614	21	0.285	26
Slow decision making by owner	0.521	12	0.543	40	0.283	27
Shortage of equipment	0.464	28	0.607	24	0.282	28
Poor qualification and experience of contractor	0.457	30	0.614	22	0.281	29
Unrealistic requirements by the owner	0.500	17	0.557	34	0.279	30
Shortage of material	0.457	31	0.607	25	0.278	31
Lack of communication between the involved parties	0.443	32	0.614	23	0.272	32

Improper construction methods	0.407	36	0.593	28	0.241	33
Poor and obsolete technology used	0.436	33	0.550	39	0.240	34
Work suspension by the owner	0.429	34	0.557	35	0.239	35
Frequent equipment breakdown	0.407	37	0.571	31	0.233	36
Changes in government regulations	0.414	35	0.557	36	0.231	37
Adverse weather conditions	0.400	38	0.557	37	0.223	38
Accidents/injuries during construction	0.371	39	0.557	38	0.207	39
Political situation such as war	0.307	40	0.571	32	0.176	40

payment by the owner”, which was the most important cause of delay according to the consultants, is ranked as the second most frequent factor with an FI of 0.635. “Change orders by the owner”, “Poor subcontractor performance”, “Inadequate planning and scheduling by the contractor”, and “Slow decision making by owner” are ranked third, fourth, fifth, and sixth most frequent causes according to the consultants, respectively. According to Santoso and Soeng [62], “Award the project to the lowest bidder” was found to be the second most frequent cause of delays from the consultants’ perspective. Akogbe et al. [47] reported that inadequate planning and scheduling, poor performance of subcontractors, and the financial difficulties by both the owners and contractors are among the most frequent causes of delays according to the consultants.

“Financial Crisis”, which was found to be the most severe cause of delay from the overall perspectives, is also the most severe cause according to the consultants. The second and third most severe factors are contractor-related causes which are “Inadequate planning and scheduling by the contractor” and “Poor subcontractor performance”, respectively. The fourth and fifth most severe factors are owner-related factors which are “Delay in progress payment by the owner” and “Change orders by the owner”, respectively. The sixth and seventh most severe factors are contractor-related which are “Financial Capability by the contractor” and “Rework due to errors in construction/bad quality”, respectively. The eighth, ninth, and tenth most severe factors are owner-related which are “Slow decision making by owner”, “Work suspension by the owner”, and “Award the project for the lowest bidder”, respectively. Similar to the most frequent factors, Akogbe et al. [47] reported that the financial difficulties by the contractors, poor performance of subcontractors, and inadequate planning and scheduling by the contractor are also the most severe according to the consultants.

4.1.4 Contractors’ perspectives. The rankings of the most frequent, severe, and important factors causing delays in the UAE construction industry from the contractors’ opinions are shown in Table 7. It can be seen that 3 out of the top 5 most important factors are owner-related. The rankings of the 2 most important factors according to the contractors are consistent with the 2 most important causes based on the overall perspectives. “Award the project for the lowest bidder” was found to be the most important cause of delay according to the contractors with an II value of 0.552

Table 6: Consultants' Perspectives

Factor	Frequency index (FI)	Rank (FI)	Severity index (SI)	Rank (SI)	Importance index (II)	Rank (II)
Delay in progress payment by the owner	0.635	2	0.655	4	0.416	1
Award the project for the lowest bidder	0.655	1	0.623	10	0.408	2
Inadequate planning and scheduling by the contractor	0.588	5	0.678	2	0.399	3
Change orders by the owner	0.614	3	0.649	5	0.399	4
Poor subcontractor performance	0.591	4	0.667	3	0.394	5
Slow decision making by owner	0.586	6	0.632	8	0.370	6
Financial Capability by the contractor	0.565	8	0.643	6	0.364	7
Financial Crisis	0.519	14	0.699	1	0.362	8
Owner's financial difficulties	0.583	7	0.603	12	0.351	9
Rework due to errors in construction/bad quality	0.528	10	0.638	7	0.336	10
Lack of experience by the owner and the representatives	0.542	9	0.597	14	0.324	11
Lack of communication between the involved parties	0.528	11	0.603	13	0.318	12
Unrealistic requirements by the owner	0.525	12	0.588	16	0.309	13
Poor site management	0.525	13	0.588	17	0.309	14

Lack of skilled workers	0.490	16	0.614	11	0.301	15
Work suspension by the owner	0.475	19	0.626	9	0.298	16
Late delivery of material	0.490	17	0.574	20	0.281	17
Poor qualification and experience of contractor	0.470	20	0.597	15	0.280	18
Shortage of manpower	0.490	18	0.559	23	0.274	19
Delay in preparation, review, and approval of drawing by consultant	0.496	15	0.545	26	0.270	20
Unforeseen site conditions	0.464	22	0.580	19	0.269	21
Changes of subcontractors	0.467	21	0.574	21	0.268	22
Shortage of equipment	0.455	24	0.565	22	0.257	23
Shortage of material	0.449	26	0.559	24	0.251	24
Inflation/price fluctuation	0.458	23	0.539	29	0.247	25
Improper construction methods	0.455	25	0.536	31	0.244	26
Lack of experience/competence of the consultant	0.441	28	0.554	25	0.244	27
Mistakes in design by the consultant	0.406	35	0.583	18	0.236	28
Poor and obsolete technology used	0.443	27	0.530	34	0.235	29
Frequent equipment breakdown	0.429	31	0.542	27	0.233	30
Inaccurate, incomplete, and unclear details in design	0.432	30	0.533	32	0.230	31

Inaccurate site investigation by the consultant	0.417	34	0.539	30	0.225	32
Land acquisition	0.435	29	0.510	37	0.222	33
Consultant's misunderstanding of owner's requirements	0.403	36	0.542	28	0.218	34
Slow inspection of completed works by the consultant	0.423	33	0.516	36	0.218	35
Consultant's reluctance for change	0.429	32	0.481	40	0.206	36
Accidents/injuries during construction	0.368	38	0.533	33	0.196	37
Adverse weather conditions	0.374	37	0.487	38	0.182	38
Changes in government regulations	0.362	39	0.487	39	0.176	39
Political situation such as war	0.290	40	0.519	35	0.150	40

followed by “Delay in progress payment by the owner” with an II value of 0.494. “Shortage of manpower”, which is considered a resource-related factor, was ranked as the third most important factor according to the contractors. “Change orders by the owner” and “Delay in preparation, review, and approval of drawing by consultant” were ranked fourth and fifth, respectively. Despite “Financial Crisis” being the seventeenth most frequent cause, it was ranked as the sixth most important cause with an II value of 0.424 followed by “Financial Capability by the contractor” by difference in the fourth decimal place. “Poor subcontractor performance”, “Lack of skilled workers”, and “Slow decision making by owner” were ranked as the eighth, ninth, and tenth most important factors, respectively. The results are consistent with the findings of Assaf and Al-Hejji [46] where the authors reported “Delay in progress payments by owner”, “Change orders by owner during construction”, “Late in reviewing and approving design documents by consultant”, “Difficulties in financing project by contractor”, and “Slowness in decision making process by owner” to be among the top 10 most important causes of delays according to the contractors in Saudi Arabia. “Poor subcontractor performance/delays” was ranked as the seventh most important factor from the contractors’ point of view according to Aziz and Abdel-Hakam [71].

Similar to the important ranking, “Award the project for the lowest bidder” and “Delay in progress payment by the owner” were ranked as the first and second most frequent factors according to the contractors. “Change orders by the owner”, which was ranked as the third most frequent cause according to the overall perspectives, is also ranked the third most frequent cause according to the contractors. “Shortage of manpower” and “Delay in preparation, review, and approval of drawing by consultant” were ranked the fourth and fifth with similar FI values of 0.665. “Slow decision making by owner”, which was ranked the sixth most frequent cause based on the overall perspectives, is also the sixth according to the contractors. “Financial Capability by the contractor”, “Poor subcontractor performance”, “Lack of skilled workers”, “Late delivery of material”, and “Lack of experience by the owner and the representatives” were ranked as the seventh, eighth, ninth, tenth, and eleventh most frequent factors with a similar FI value of 0.626. Akogbe et al. [47] reported financial capability by the contractors, the poor performance of the subcontractors, material procurement, and preparation and approval of drawing by the consultant to be among the most frequent

factors causing delays according to the contractors. Santoso and Soeng [62] reported “Award project to the lowest bid price” and “Late progress payments” to be among the most frequent causes based on the contractors’ point of view.

Similar to the most important and frequent causes according to the contractors, “Award the project for the lowest bidder” was ranked as the most severe cause with an SI value of 0.729. “Financial Crisis”, which was ranked as the most severe causes from the overall perspectives, was found to be the second most severe cause according to the contractors. “Delay in progress payment by the owner” and “Shortage of manpower” are ranked as the third and fourth most severe factors with SI values of 0.716 and 0.710, respectively. “Change orders by the owner” and “Delay in preparation, review, and approval of drawing by consultant” are ranked fifth and sixth with similar SI values, followed by “Financial Capability by the contractor”. “Poor subcontractor performance” and “Shortage of material” are ranked eighth and ninth with similar SI values. “Lack of skilled workers” is ranked as the tenth most severe cause according to the contractors with an SI value of 0.665. Wang et al. [10] reported “Exceptionally low bid”, “Labor shortage”, “Variations/changes of scope”, and “Delay in progress payments” to be among the severe (high impact size) factors according to the contractors. Islam and Suhariadi [2] reported “Contractor’s cash flow problem” and “Lowest bidder selection” among the most severe factors causing delays according to the contractors.

4.1.5 Participants with 5 or less years of experience. The results of the most frequent, severe, and important factors causing delays in the UAE construction industry according to the participants with 5 or less years of experience are shown in Table 8. It was found that the top 2 most important causes are contractor-related causes which are “Inadequate planning and scheduling by the contractor” and “Poor subcontractor performance”. The third most important factor, “Change orders by the owner”, is consistent with the finding based on the overall perspectives. The top 2 most important factors based on the overall perspectives, “Award the project for the lowest bidder” and “Delay in progress payment by the owner”, are ranked fourth and seventh according to the participants with 5 or less years of experience, respectively. Among the top 10 most important causes according to the participants with 5 or less years of experience, 4 of

Table 7: Contractors' Perspectives

Factors	Frequency Index	Rank (FI)	Severity Index	Rank (SI)	Importance Index (II)	Rank (II)
Award the project for the lowest bidder	0.716	1	0.729	1	0.522	1
Delay in progress payment by the owner	0.690	2	0.716	3	0.494	2
Shortage of manpower	0.665	4	0.710	4	0.472	3
Change orders by the owner	0.671	3	0.690	5	0.463	4
Delay in preparation, review, and approval of drawing by consultant	0.665	5	0.690	6	0.459	5
Financial Crisis	0.587	17	0.723	2	0.424	6
Financial Capability by the contractor	0.626	7	0.677	7	0.424	7
Poor subcontractor performance	0.626	8	0.671	8	0.420	8
Lack of skilled workers	0.626	9	0.665	10	0.416	9
Slow decision making by owner	0.632	6	0.652	17	0.412	10
Late delivery of material	0.626	10	0.652	18	0.408	11
Shortage of material	0.606	13	0.671	9	0.407	12
Owner's financial difficulties	0.606	14	0.658	11	0.399	13
Poor site management	0.606	15	0.658	12	0.399	14

Changes of subcontractors	0.600	16	0.658	13	0.395	15
Lack of communication between the involved parties	0.613	12	0.639	21	0.391	16
Improper construction methods	0.587	18	0.658	14	0.386	17
Poor qualification and experience of contractor	0.587	19	0.658	15	0.386	18
Lack of experience by the owner and the representatives	0.626	11	0.606	28	0.380	19
Inadequate planning and scheduling by the contractor	0.574	21	0.645	20	0.370	20
Inflation/price fluctuation	0.581	20	0.632	24	0.367	21
Rework due to errors in construction/bad quality	0.561	25	0.652	19	0.366	22
Inaccurate, incomplete, and unclear details in design	0.555	28	0.658	16	0.365	23
Shortage of equipment	0.568	23	0.632	25	0.359	24
Unrealistic requirements by the owner	0.561	26	0.632	26	0.355	25
Lack of experience/competence of the consultant	0.555	29	0.639	22	0.354	26
Mistakes in design by the consultant	0.535	31	0.639	23	0.342	27
Slow inspection of completed works by the consultant	0.568	24	0.594	30	0.337	28
Consultant's reluctance for change	0.574	22	0.581	31	0.333	29
Unforeseen site conditions	0.548	30	0.606	29	0.333	30
Poor and obsolete technology used	0.561	27	0.568	33	0.319	31
Work suspension by the owner	0.497	36	0.632	27	0.314	32

Frequent equipment breakdown	0.535	32	0.568	34	0.304	33
Inaccurate site investigation by the consultant	0.529	33	0.574	32	0.304	34
Changes in government regulations	0.510	35	0.561	36	0.286	35
Consultant's misunderstanding of owner's requirements	0.497	37	0.568	35	0.282	36
Land acquisition	0.516	34	0.542	38	0.280	37
Accidents/injuries during construction	0.471	38	0.561	37	0.264	38
Adverse weather conditions	0.452	39	0.516	39	0.233	39
Political situation such as war	0.394	40	0.484	40	0.190	40

the factors were owner-related. These factors are also found among the top 10 most important causes according to the overall perspectives. This shows that the participants with 5 or less years of experience have been able to comprehend the situation of the construction industry in the UAE. The top 4 most frequent causes of delays according to them are the same top 4 most frequent factors according to the overall perspectives. “Award the project for the lowest bidder” was found to be the most frequent factor according to the participants with 5 or less years of experience with a FI value of 0.630, followed by “Change orders by the owner” with a FI value of 0.621. “Inadequate planning and scheduling by the contractor”, which was the seventh most frequent cause according to the overall perspectives, was found to be the fifth most frequent factor according to the participants with 5 or less years of experience. The top 3 most severe causes according to them are the same top 3 causes based on the overall perspectives. “Financial crisis” was the most severe cause with a SI value of 0.745. This can be attributed to the COVID19 pandemic which occurred during the 5 or less years of experience of the participants. The second and third most severe factors are “Inadequate planning and scheduling by the contractor” and “Poor subcontractor performance” with SI values of 0.698 and 0.681, respectively. The fourth most severe cause according to the participants with 5 or less years of experience, “Rework due to errors in construction/bad quality”, was the eighth most severe cause based on the overall perspectives.

4.1.6 Participants with more than 5 years of experience. The results of the most frequent, severe, and important causes according to the participants who had more than 5 years of experience in the UAE construction industry are found in Table 9 below. The top 3 most important causes according to the participants with more than 5 years of experience are the same top 3 based on the overall perspectives. “Award the project for the lowest bidder” was found to be the most important factor according to participants with more than 5 years of experience followed by “Delay in progress payment by the owner” and “Change orders by the owner”. A total of 5 out of the top 10 most important factors according to them were owner-related factors. “Owner’s financial difficulties” and “Slow decision making by owner” were found to be the sixth and ninth most important factors according to them, respectively. This shows that the most significant party causing delays in the UAE construction industry is the owner.

Table 8: Results of participants with 5 years or less experience

Factors	Frequency index (FI)	Rank (FI)	Severity index (SI)	Rank (SI)	Importance index (II)	Rank (II)
Inadequate planning and scheduling by the contractor	0.596	5	0.698	2	0.416	1
Poor subcontractor performance	0.600	4	0.681	3	0.409	2
Change orders by the owner	0.621	2	0.634	7	0.394	3
Award the project for the lowest bidder	0.630	1	0.621	11	0.391	4
Financial Crisis	0.515	16	0.745	1	0.383	5
Rework due to errors in construction/bad quality	0.553	8	0.681	4	0.377	6
Delay in progress payment by the owner	0.600	3	0.596	20	0.357	7
Financial Capability by the contractor	0.549	9	0.651	6	0.357	8
Slow decision making by owner	0.583	6	0.613	14	0.357	9
Lack of communication between the involved parties	0.532	12	0.630	9	0.335	10
Delay in preparation, review, and approval of drawing by consultant	0.553	7	0.604	18	0.334	11
Unforeseen site conditions	0.494	21	0.655	5	0.323	12
Owner's financial difficulties	0.532	11	0.604	17	0.321	13
Shortage of manpower	0.515	15	0.617	13	0.318	14
Lack of experience by the owner and the representatives	0.536	10	0.591	22	0.317	15
Poor site management	0.519	13	0.609	16	0.316	16

Lack of skilled workers	0.494	20	0.634	8	0.313	17
Late delivery of material	0.506	17	0.613	15	0.310	18
Shortage of equipment	0.494	19	0.600	19	0.296	19
Unrealistic requirements by the owner	0.515	14	0.574	26	0.296	20
Work suspension by the owner	0.472	26	0.621	10	0.293	21
Changes of subcontractors	0.481	22	0.579	25	0.278	22
Inaccurate site investigation by the consultant	0.472	27	0.587	23	0.277	23
Poor qualification and experience of contractor	0.464	29	0.596	21	0.276	24
Inflation/price fluctuation	0.481	23	0.570	30	0.274	25
Shortage of material	0.477	25	0.574	27	0.274	26
Consultant's reluctance for change	0.502	18	0.540	38	0.271	27
Lack of experience/competence of the consultant	0.447	33	0.583	24	0.260	28
Mistakes in design by the consultant	0.417	36	0.617	12	0.257	29
Land acquisition	0.464	28	0.553	34	0.257	30
Improper construction methods	0.460	30	0.549	36	0.252	31
Frequent equipment breakdown	0.455	32	0.553	35	0.252	32
Slow inspection of completed works by the consultant	0.477	24	0.528	39	0.251	33
Consultant's misunderstanding of owner's requirements	0.434	34	0.566	31	0.246	34
Inaccurate, incomplete, and unclear details in design	0.430	35	0.570	28	0.245	35

Poor and obsolete technology used	0.460	31	0.523	40	0.241	36
Adverse weather conditions	0.387	37	0.562	32	0.218	37
Accidents/injuries during construction	0.374	39	0.570	29	0.214	38
Changes in government regulations	0.379	38	0.549	37	0.208	39
Political situation such as war	0.289	40	0.557	33	0.161	40

Moreover, 4 among the top 10 most important causes were contractor-related factors. Similarly, the top 3 most frequent causes according to the participants with more than 5 years of experience are consistent with the top 3 most frequent factors based on the overall perspectives, and is consistent with the top 3 most important causes. “Award the project for the lowest bidder” was found to be the most frequent cause according to the participants with more than 5 years of experience with a FI value of 0.677, followed by “Delay in progress payment by the owner” and “Change orders by the owner” with FI values of 0.640 and 0.620, respectively. The fourth most frequent cause was also found to be an owner-related factor which was “Owner's financial difficulties” with a FI value of 0.615. It was found that 6 out the top 10 most frequent factors are owner-related and 4 are contractor-related according to the participants with more than 5 years of experience. “Financial crisis”, which was the most severe cause based on the overall perspectives and based on the participants with 5 years or less experience, was also the most severe causes according to the participants with more than 5 years. “Delay in progress payment by the owner”, which was the sixth most severe factor based on the overall perspectives, was found to be the second most severe factor with a SI value of 0.681. “Award the project for the lowest bidder”, which was the seventh most severe factor based on the overall perspectives, was also the seventh most severe factor for the participants with more than 5 years of experience, followed by “Poor qualification and experience of contractor”.

4.2 Spearman’s Correlation

Spearman’s rank correlation was used to measure the level of agreement for the importance of each factor between each two parties excluding the third party. It was noticed that the top 10 most important factors according to the owners consisted of factors from all 5 groups. On the other hand, the consultants mainly blamed the owners for the delays where it was noticed that 3 among the most important 5 and 5 out of the most important 10 causes are owner-related factors. It was also noticed that the same 3 owner-related related factors among the top 5 for the consultant are the same among the top 5 most important causes according to the contractors. Moreover, the fourth owner-related factor among the top 10 according to the contractors is also found in the top 10 according to the consultants. “Financial Crisis”, “Financial Capability by the

Table 9: Results for participants with more than 5 years of experience

Factor	Frequency Index (FI)	Rank (FI)	Severity index (SI)	Rank (SI)	Importance index (II)	Rank (II)
Award the project for the lowest bidder	0.677	1	0.657	7	0.444	1
Delay in progress payment by the owner	0.640	2	0.681	2	0.436	2
Change orders by the owner	0.620	3	0.667	4	0.413	3
Financial Capability by the contractor	0.585	5	0.672	3	0.393	4
Poor subcontractor performance	0.580	7	0.664	5	0.385	5
Owner's financial difficulties	0.615	4	0.615	15	0.378	6
Inadequate planning and scheduling by the contractor	0.570	8	0.662	6	0.377	7
Financial Crisis	0.531	16	0.684	1	0.363	8
Slow decision making by owner	0.583	6	0.620	11	0.361	9
Poor site management	0.553	10	0.622	10	0.344	10
Lack of experience by the owner and the representatives	0.568	9	0.602	24	0.342	11
Shortage of manpower	0.551	11	0.612	16	0.337	12
Lack of skilled workers	0.533	14	0.625	9	0.333	13
Delay in preparation, review, and approval of drawing by consultant	0.546	12	0.610	18	0.333	14

Late delivery of material	0.531	15	0.610	19	0.324	15
Unrealistic requirements by the owner	0.536	13	0.602	23	0.323	16
Poor qualification and experience of contractor	0.514	18	0.627	8	0.322	17
Lack of communication between the involved parties	0.528	17	0.605	22	0.320	18
Changes of subcontractors	0.509	20	0.617	14	0.314	19
Rework due to errors in construction/bad quality	0.506	22	0.617	13	0.312	20
Lack of experience/competence of the consultant	0.496	25	0.610	17	0.303	21
Shortage of material	0.496	26	0.610	20	0.303	21
Unforeseen site conditions	0.506	23	0.595	26	0.301	23
Inaccurate, incomplete, and unclear details in design	0.509	19	0.590	28	0.300	24
Inflation/price fluctuation	0.501	24	0.595	27	0.298	25
Improper construction methods	0.486	28	0.595	25	0.289	26
Mistakes in design by the consultant	0.467	33	0.617	12	0.288	27
Work suspension by the owner	0.469	32	0.607	21	0.285	28
Shortage of equipment	0.479	29	0.585	29	0.280	29

Slow inspection of completed works by the consultant	0.472	31	0.575	30	0.271	30
Consultant's reluctance for change	0.506	21	0.533	35	0.270	31
Poor and obsolete technology used	0.477	30	0.556	34	0.265	32
Land acquisition	0.491	27	0.521	37	0.256	33
Inaccurate site investigation by the consultant	0.444	35	0.568	31	0.252	34
Consultant's misunderstanding of owner's requirements	0.442	36	0.565	32	0.250	35
Frequent equipment breakdown	0.447	34	0.556	33	0.248	36
Changes in government regulations	0.427	37	0.504	38	0.215	37
Accidents/injuries during construction	0.405	38	0.531	36	0.215	38
Adverse weather conditions	0.405	39	0.479	40	0.194	39
Political situation such as war	0.336	40	0.501	39	0.168	40

contractor”, and “Poor subcontractor performance” were also common among the top 10 most important causes according to the consultants and contractors. Therefore, Spearman’s rank correlation between the consultants and contractors was found to be 0.804 which indicates a high level of agreement between the two parties. On the other hand, the owners’ rank correlation with the consultants and contractors were found to be 0.446 and 0.494, respectively. The owners had moderate level of agreement for the importance of the causes with both parties.

4.3 Effects of Delays

The most likely effects that will occur as consequences of the delays from the overall perspectives are illustrated in Table 10. Overall, it was found that “Time overrun/extension of time” has the highest likelihood of occurrence with a value of 0.677. Obodoh and Obodoh [58] and Hasan et al. [75] found that “Time overrun” is the top effect of delays. The second most important effect found in this study is “Poor quality of work due to hurrying the project” with a value of 0.636. It is commonly noticed that the quality of projects in UAE are adversely impacted when the projects are accelerated. “Cost overrun” was ranked third with a value of 0.603. Oshungade and Kruger [19] reported “Cost overrun” to be among the most important effects of delays. “Loss of profit/opportunities for the involved parties”, “Acceleration losses”, and “Increased portfolio of "non-performing" projects/ bad reputation of involved parties” were ranked fourth, fifth, and sixth most likely effects in the UAE construction industry, respectively. “Litigation” and “Arbitration” are ranked the seventh and eighth, respectively. Disputes often occur in the UAE due to the accusations of each party to another regarding the delays. However, the escalations do not happen at all times and thus are not ranked among the top effects. Bekr [68] reported “Litigation” and “Arbitration” as frequently occurring effects but are not among the top 3. The last 2 least likely effects found are “Termination of contracts between the parties” and “Total abandonment of project”. Amoatey et al. [6] reported “Total abandonment of project” to be the least important effect. Regardless of the delay status of the construction projects in UAE, the projects do not typically get abandoned. Owners might decide to change the consultants and contractors, they may suspend the project temporarily, and frequently change the scope, but the projects will eventually complete.

Table 10: Results of the Effects

Factor	Likelihood	Rank
Time overrun/extension of time	0.677	1
Poor quality of work due to hurrying the project	0.636	2
Cost Overrun	0.603	3
Loss of profit/opportunities for the involved parties	0.552	4
Acceleration losses	0.547	5
Increased portfolio of "non-performing" projects/ bad reputation of involved parties	0.511	6
Litigation	0.506	7
Arbitration	0.505	8
Termination of contracts between the parties	0.488	9
Total abandonment of project	0.430	10

4.4 Comparison with Other Studies Worldwide

The comparison between the most important cause of delays in the UAE construction industry and selected studies from other countries is shown in Table 11. The studies were conducted in Oman, Iraq, Cambodia, Benin, and Tanzania. Overall, it was found that the selection of the lowest bidders is common among the top 5 most important delay causes in the other studies. This shows that the selection of the lowest bidder is an international phenomenon that has adverse impact on the performance of the construction projects. It can be seen that 3 of the top 5 overall causes of delay by Oyegoke and Kiyumi [14] in Oman are similar to the findings of this study which are the lowest bidder selection, changes by the owners, and poor planning by the contractor. Moreover, all 5 most important causes in this study and the study of Oyegoke and Kiyumi [14] are either owner or contractor related which means that these causes are also in the regional level. The 3 most important causes by Bekr [68] in Iraq are unique

when compared to the other studies in this comparison where they were all classified as the external group. This is due the political issues that Iraq is facing. However, the remaining factors are similar to the findings of this study. Cambodia is considered a tropical Asian country with frequent raining. Therefore, Santoso and Soeng [62] reported that causes related to the weather are the 2 most important causes, the third is related to the impact of people's private land. All 3 most important causes are unique when compared to the other studies in this comparison. The 2 most important causes by Akogbe et al. [47] in Benin were found to be financial related issues for the contractors and owners. The financial issues by the owners and poor performance of the subcontractor were similar to this study. Similar to Akogbe et al. [47] in Benin, the other study conducted in the African country by Sambasivan et al. [54] also shows financial issues by the owners as well as material delivery. Planning issues by the contractor, financial issued by the owner were similar to the most important causes found in this study.

4.5 Comparison with Other Studies in UAE

A comparison between the most important causes of delays found in this study and previous studies in the UAE is shown in Table 12 below. The top 2 most important factors found in this study "Award the project for the lowest bidder" and "Delay in progress payment by the owner" are not among the top 10 most important causes of delays in any of the previous studies. However, the third most important cause, "Change orders by the owner", is found among the results of Mpofu et al. [67] and is the most important cause by Motaleb and Kishk [48]. Inadequate and improper planning by the contractor is found among the top 10 in all of the studies. "Financial crisis", which was found to be seventh most important cause in this study, is not found in any of the previous studies. This can be attributed to the economy issues caused by the COVID19 pandemic since this is the only study to be conducted after the pandemic. The pandemic caused a significant impact on the frequency of financial crisis, and the participants are might be living with the effects of the pandemic in the society. Overall, a minimum of 3 owner-related factors were among the top 10 most important causes in this study and the studies by Mpofu et al. [67] in 2017 and Motaleb and Kishk [48] in 2010. On the other hand, the findings of Faridi and El-Sayegh [37] in 2006 contains only 1 owner-related factor in the top 10 whereas 6 factors were contractor-related. Moreover, the

Table 11: Comparison with Other Studies Worldwide

	This study	Oyegoke and Kiyumi [14] (Oman)	Bekr [68] (Iraq)	Santoso and Soeng [62] (Cambodia)	Akogbe et al. [47] (Benin)	Sambasivan et al. [54] (Tanzania)
1	Award the project for the lowest bidder	Selecting the lowest not the best bidder by the client	Security measures	Working during rainy season	Financial capability of contractor	Finance and payment of completed works
2	Delay in progress payment by the owner	Main contractor poor financial condition	Government change of regulations and bureaucracy	Flooding	Financial capability of owner	Improper planning by contactor
3	Change orders by the owner	Delay in decision-making by the client	Official and non-official holidays	Impact on people's land along the road construction project	Poor subcontractor performance	On time delivery of material
4	Poor subcontractor performance	Poor construction planning of the project by the main contractor	Low performance of the lowest bidder contractors in the government tendering system	Award the project to the lowest bidder	Materials procurement	Unforeseen site condition
5	Inadequate planning and scheduling by the contractor	Changes in design by the client	Design changes by the owner	Frequent equipment breakdowns	Changes in drawings	Site management by contractor

tenth most important factor “Financing by contractor during construction” in their study was considered a financial-related factor despite it being directly related to contractors. This shows that the delays in the UAE construction industry have shifted from contractor-related to owner-related causes in the past decade. Additionally, the study by Faridi and El-Sayegh [37] was conducted during the UAE boom where several megaprojects were under construction at the time. This showed that contractors were highly active in the industry where the most important causes of delays were attributed to them. The shift also introduced “Award the project for the lowest bidder” and “Delay in progress payment by the owner” as the top 2 factors in this study which means that the owner-related factors are changing throughout the years. This indicates that there is poor control of the owners on their projects. It was also found that financial challenges became significant where 4 out of the 10 most important causes in this study were financial related. The financial related factors are “Delay in progress payment by the owner”, “Financial Capability by the contractor”, “Financial Crisis”, and “Owner's financial difficulties”. Financial related causes were not significant in any of the previous studies as only “Financing by contractor during construction” was reported in the top 10 by Faridi and El-Sayegh [37].

4.6 Factor Analysis

As mentioned, Factor Analysis is used to reduce a large number of seemingly unrelated variables to a smaller number capable of representing the initial variables [7]. The reduction of the variables will be used for better interpretation and facilitate in proposing mitigations to reduce the delays. Overall, 6 components from the analysis were extracted based on the eigenvalues. These components represent 29 factors and explain 83.87% of the total variance. The eigenvalues of the extracted components were 15.33, 3.25, 2.88, 1.71, 1.17, and 1.11 and the scree plot showing all eigenvalues is depicted in Figure 4. The detailed results showing all the relevant factors are shown in Table 13. The results of the loading were multiplied by 100 in SAS. Using interpretation, the factors were named as “Resource management by the contractor”, “Owners' capabilities”, “Consultants' competence”, “External impact”, “Technical capability of the contractors”, and “Site supervision by the contractor”.

Table 12: Comparison with Other Studies in UAE

	This study	Mpofu et al. [67]	Motaleb and Kishk [48]	Faridi and El-Sayegh [37]
1	Award the project for the lowest bidder	Unrealistic contract duration imposed by client	Change orders	Preparation and approval of drawings
2	Delay in progress payment by the owner	Incomplete design at the time of tender	Lack of capability of client representative	Inadequate early planning of the project
3	Change orders by the owner	Too many scope changes and change orders	Slow decision making by client	Slowness of the owner's decision-making process
4	Poor subcontractor performance	Inadequate planning and scheduling	Lack of experience of client in construction	Shortage of manpower
5	Inadequate planning and scheduling by the contractor	Poor project planning and control	Poor site management and supervision	Poor supervision and poor site management
6	Financial Capability by the contractor	Delay in obtaining permit/approval from municipality/different gov. authorities	Incompetent project team	Productivity of manpower
7	Financial Crisis	Poor labor productivity problems	Inflation/prices fluctuation	Skill of manpower
8	Slow decision making by owner	Slowness in decision-making process by owner	Inaccurate time estimating	Non-availability of materials on time
9	Owner's financial difficulties	Design changes	Late delivery of materials	Obtaining permit/approval from the municipality/different government authorities
10	Rework due to errors in construction/bad quality	Inadequate site management, monitoring and control	Improper project planning / scheduling	Financing by contractor during construction

4.6.1 Factor 1: Resource management by the contractor. The first extracted component is “Resource management by the contractor”. This component represents factors and solely explains 50.76% of the total variance. The 7 factors are shortage of material, shortage of manpower, shortage of equipment, late delivery of material, lack of skilled workers, poor and obsolete technology used, and frequent equipment breakdown. Since contractors have poor resource management, then it is likely that all resource related issues will arise including the availability and utilization of the resources. That will eventually reflect on the performance and expertise of the contractors. Contractors should be more skilled in handling and acquiring the resources in order to complete the work with minimal obstructions.

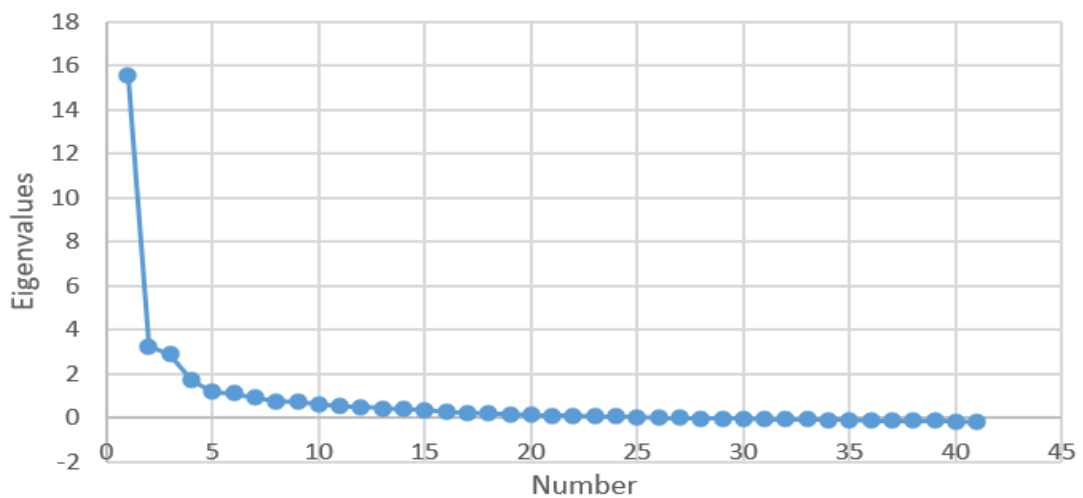


Figure 4: Scree Plot

4.6.2 Factor 2: Owners' capabilities. The second extracted factor is “Owners' capabilities”. This component represents 6 factors and explains 10.63% of the total variance. The factors this component represents are slow decision making by owner, owner's financial difficulties, delay in progress payment by the owner, change orders by the owner, work suspension by the owner, and award the project for the lowest. Most of the factors are related to the owners and can be mitigated if the owners had the necessary capabilities and experience. If the owners had the capabilities, they could have planned the project better at which they could have eliminated the frequent change orders, slow decision making, and the payment issues. Moreover, selecting the project parties based on the lowest bidder also reflects on the overall performance of the project throughout the project lifecycle.

4.6.3 Factor 3: Consultants' competence. The third extracted component is “Consultants' competence”. This component represents 7 factors and explains 9.44% of the total variance. The 7 factors this component represents are slow inspection of completed works by the consultant; lack of experience/competence of the consultant; delay in preparation, review, and approval of drawing by consultant; inaccurate site investigation by the consultant; inaccurate, incomplete, and unclear details in design; consultant’s reluctance for change; and mistakes in design by the consultant. Some of the consultants’ main tasks are to design properly according to the site conditions and ensure proper inspection. Therefore, delaying in the preparation of the documents because of missing details, mistakes, or improper reflection of the site conditions will have a profound impact on the timeline of the project. Some of the flaws will be identified in the later stages such as execution, where it will force the project to go back to the previous stages so that the consultants could amend the layouts and obtain the approvals. Therefore, proper site investigation should be conducted and advanced software should be used by the consultants to ensure satisfactory quality of the documents.

4.6.4 Factor 4: External impact. The fourth extracted component is “External impact”. This component consists of 4 factors and explains 5.59% of the total variance. The factors of this component are adverse weather conditions, changes in government regulations, political situation such as war, and unforeseen site conditions. Despite that the other components represent controlled factors; this component represents the factors that are beyond the control of the project team. This includes governmental regulations, nature, politics and economy. Generally, the project team cannot be blamed for the delays from these factors but should consider them properly when planning the project.

4.6.5 Factor 5: Technical capability of the contractors. The fifth extracted component is “Technical capability of the contractors”. This component consists of 3 factors and explains 3.83% of the total variance. The factors this component represents are poor subcontractor performance, rework due to errors in construction/bad quality, and inadequate planning and scheduling by the contractor. Contractors play a decisive role on the performance of the projects especially because they are responsible for the execution. They need to ensure that reliable subcontractors should be selected from the beginning to avoid further hurdling the project which leads to changing the

subcontractors. Poor contractors and subcontractors will have more mistakes that will lead to reworking, which may significantly impact the project duration as it involves consumption of time and resources. Therefore, planning and scheduling should be conducted properly from the beginning to consider all the anticipated obstacles. Contractors will be able to make amendments as the project progresses, but they need to make sure that these amendments will not adversely impact the initial completion date.

4.6.6 Factor 6: Site supervision by the contractor. The sixth and final extracted component is “Site supervision by the contractor”. It consists of 2 factors and explains 3.63% of the total variance. The 2 factors this component represents are poor site management and improper construction methods. Contractors should ensure that the construction methods they utilize are compatible with the site conditions. Moreover, they must ensure proper supervision for all site activities to ensure proper coordination and transition between the activities. Contractors will be held responsible for any flaws caused in site which may lead to delays in the project. Unsatisfied owners may escalate the issues to the court if needed.

Table 13: Factor Analysis Results

Factor Number	Description	Factor pattern (loading)	% Variance explained
Factor 1: Resource management by the contractor			
29	Shortage of material	85	50.76%
28	Shortage of manpower	81	
30	Shortage of equipment	78	
27	Late delivery of material	75	
33	Lack of skilled workers	71	
32	Poor and obsolete technology used	59	
31	Frequent equipment breakdown	52	
Factor 2: Owners' capabilities			
3	Slow decision making by owner	84	10.63%
1	Owner's financial difficulties	81	
4	Delay in progress payment by the owner	72	
8	Change orders by the owner	70	
6	Work suspension by the owner	58	
7	Award the project for the lowest bidder	55	
Factor 3: Consultants' competence			

11	Slow inspection of completed works by the consultant	76	
10	Lack of experience/competence of the consultant	68	
12	Delay in preparation, review, and approval of drawing by consultant	68	9.44%
13	Inaccurate site investigation by the consultant	65	
16	Inaccurate, incomplete, and unclear details in design	65	
14	Consultant's reluctance for change	64	
17	Mistakes in design by the consultant	51	
Factor 4: External impact			
35	Adverse weather conditions	80	
36	Changes in government regulations	78	5.59%
34	Political situation such as war	71	
37	Unforeseen site conditions	64	
Factor 5: Technical capability of the contractors			
20	Poor subcontractor performance	74	
21	Rework due to errors in construction/bad quality	72	3.83%
19	Inadequate planning and scheduling by the contractor	55	
Factor 6: Site supervision by the contractor			
24	Improper construction methods	71	3.63%
23	Poor site management	53	

Chapter 5. Conclusions and Recommendations

This study assessed the most frequent, severe, and important factors causing delays in the UAE construction industry. Moreover, the effects of the delays and the inherent causal factors were also identified. A survey was distributed to construction experts with varying experiences from different fields, and the responses of 128 participants were analyzed. After conducting the analysis and comparing the results, the following conclusions are made:

- The construction industry is a significant industry to the economy and growth of several countries. Despite the previous studies, delays in the construction projects are still recurring worldwide and in the UAE.
- The most frequent and important factors causing delays in the UAE construction industry were owner-related factors which are “Award the project for the lowest bidder”, “Delay in progress payment by the owner”, and “Change orders by the owner”. The most severe factors were “Financial crisis” and “Inadequate planning and scheduling by the contractor”.
- Owners did not blame any specific group. The 10 most frequent, severe, and important causes consisted of factors from all the groups.
- Consultants and contractors mostly accused the owners for the delays where the most important factors according to each party are “Delay in progress payment by the owner” and “Award the project for the lowest bidder”.
- A high level of agreement between the consultants and contractors was observed with a Spearman’s rank correlation of 0.804 as both parties mainly blamed the owners.
- The results show that the most likely effects of the delays in the UAE construction industry are “Time overrun/extension of time” and “Poor quality of work due to hurrying the project”.
- Lowest bidder selection was found to be a common important cause of delay across several countries worldwide. The most important causes determined in this study are consistent with the findings of other studies in the MENA region. However, the findings of this study are different from other studies in other regions. Therefore, the location of the country of study is an important feature to consider when comparing the results.

- There has been a shift of responsibilities of the most important delay causes from the contractors to owners in the past decade. Financial related aspects have also increased in importance in causing the delays.
- Based on the results of the Factor Analysis, 6 components were extracted explaining 83.87% of the total variance.

Based on the findings of this study, the following recommendations are provided in order to control and minimize the delays:

- Owners should review the resources and capabilities of the contractors before selecting based on the lowest bidding price.
- Owners should ensure progress payment in timely fashion to enable the contractors to proceed with the following stages.
- The contractors should properly utilize the progress payments by the owners to control and minimize the cash flow problems. This will eliminate all financial issues and will enable them to work efficiently.
- The owners have the right to impose design changes. However, they must not request for changes that will adversely impact the project.
- Contractors should focus on the accuracy of the planning and scheduling. Revising the plans are allowed as the project proceeds but without significantly impacting the project performance.
- Due to the involvement of several parties, proper communication channels should be established during each phase. Avoiding any misunderstandings and misinterpretations will reduce the delays.
- Preparation, review and approval of drawings is a crucial role of the consultants. Frequent revisions of the drawings and detecting mistakes in later stages will result in significant delays. Therefore, the consultants should focus on the quality and time dedicated to prepare, review, and approve the drawings.
- Site management and supervision should be conducted properly. Reliable administrative and technical staff should be assigned to the projects.
- More training should be given to the workforce to ensure satisfactory competence levels including resource management. This will aid in completing the tasks faster and reducing error while achieving desirable quality.

- Contractors should ensure ample number of labors are allocated for the projects. Shortage of labors will result in slower work completion and more pressure on the available labor force.

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Vita

Haitham Alajmani was born in 1996 in Dubai, UAE. He was educated in Al Mawakeb School in Dubai and graduated in 2013 with a Presidents Shield award as he received multiple distinction awards during his years in the school. He received a scholarship from Roads and Transport Authority (RTA) for his bachelor's degree in Civil Engineering at the American University of Sharjah. He graduated in 2017 and has earned multiple Dean's List awards during his years at the American University of Sharjah. He has numerous publications mainly in the fields of materials and structures.

Mr. Alajmani is currently working as an engineer at RTA from his graduation in 2017 to date. He has also earned multiple professional certificates of appreciation for his efforts at RTA. In 2019, Mr. Alajmani began a Master's program in Engineering Systems Management at the American University of Sharjah.

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