Delays in major construction projects: identifying the potential problems in the Context of Kazakhstan

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Submitted in fulfillment of the requirements for the degree of Master of Science in Civil & Environmental Engineering

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April 2024

Declaration

I hereby declare that this manuscript, entitled “Delays in major construction projects: identifying the potential problems in the Context of Kazakhstan”, is the result of my own work except for quotations and citations which have been duly acknowledged.

I also declare that, to the best of my knowledge and belief, it has not been previously or concurrently submitted, in whole or in part, for any other degree or diploma at Nazarbayev University or any other national or international institution.

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Abstract

This study investigates one of the most common problems in the construction sector in Kazakhstan which is the delay of projects. The construction industry is strategically significant in Kazakhstan since it provides servicing and supporting roles to other sectors. Annual growth in the construction industry makes it a critical component of the modern economy of the country. Numerous conditions have been established by the state at the republic and local executive levels to encourage the growth of this sector. However, real-world construction projects frequently face extensive time delays during their life cycle and take longer to complete than scheduled, even with detailed planning, advanced management techniques, and critical path networks. This is because these projects are more complex and have a wider scope at different activity levels, and there are numerous practical constraints concerning labor, materials, equipment, management, environment, and effectiveness. In Kazakhstan, construction projects suffer and are affected by this problem too.

The methodology of the work consists of quantitative and qualitative research methods to obtain more reliable and valuable results. Based on the literature review the survey method using a questionnaire was conducted among building professionals. The main goal is to identify the most frequent and important delay causes according to respondents' experience and opinions. The results according to responses the scope, initial duration, and budget of the projects are important and initially these factors should be discussed. Most respondents agreed that owners' financial situations, lack of planning, coordination, and management skills, and unclear scope of the owner led to delays. Also, issues that are out of control such as force majeure, construction material supply chain problems, and increased prices affect the duration of the project.

Conducting the case study method through a primarily descriptive exploration of real-life cases of delayed projects in Kazakhstan, the concepts that are beneficial in the clarification of the whole phenomenon of delays in natural settings, are presented. According to the analyzed and collected data, further understanding of the causes of delay issues has been provided, namely financial problems, poor scope definition, project complexity, etc. Mostly their impact on the country is tremendous. In addition, modern techniques that are currently and often used for delay analysis in projects and effectively calculate and predict the time extensions in Kazakhstan are discussed in the work. Nowadays, the implementation of BIM is contemporary and it transforms into a new approach as TIMCO.

Results of secondary data collection methods and primary data collection methods were compared and discussed, and the main 14 causes that are widespread in the country were detected. The main goal and result of the study are to pay attention to the specialists from the country to the importance of the delays and try to prevent its causes. This study, among the most extensively discussed, introduces the primary subject in the country and gives more insights into the construction industry.

Acknowledgments

I want to take this opportunity to thank Dr. Abid Nadeem for every help and encouragement he provided during my thesis research. He was always willing to contribute his knowledge, suggestions, and constructive criticism and feedback that served as a guide for me, starting from the time I discussed the idea and concept for my work and ending with the moment I received the results and conclusion. I would also like to thank Dr. Shazim Ali Memon for serving as co-supervisor of my thesis and for his insights in improving my study.

I would also like to express appreciation to the Nazarbayev University faculty and staff for providing me with a supportive learning environment and potential for both professional and personal development. Receiving my degree along with being able to write my thesis with the inspiration and support of university members is an honor to me.

A sincere thanks to my friends, group members, and like-minded individuals for the discussion sessions and moral support. Finally, I would like to acknowledge my family for their unwavering support and influence, which was highly valuable throughout challenging periods. All of the aforementioned people's beliefs kept me motivated and empowered me to accomplish my goals. I desire to thank everyone for helping me succeed.

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List of Abbreviations

OKED - General Classifier of types of Economic Activities

SP RK - Code of Rules of the Republic of Kazakhstan

CPM - Critical Path Method

CM - Construction manager

LRT - LightRailTransport

BRT - Bus Rapid Transit

EPC - Engineering-Procurement-Construction

LLP - Limited Liability Partnership

ADP - Abu Dhabi Plaza

CIT - Corporate Income Tax

VAT - Value Added Tax

JSC - Joint Stock Company

PPPs - public-private partnership projects

ST-KZ - Certificate of origin of goods for domestic circulation (a document certifying that the country of origin of goods is the Republic of Kazakhstan)

ETD - Executive-Technical Documentation

UGID - Unified Geoportal of Infrastructure Data

GGK - State town-planning cadastre

RSE - Republican State Enterprise

GASK - State Architecture and Construction Control

IoT - the Internet of Things

BIM - Building Information Modeling

CIS - Commonwealth of Independent States

KazNIISA - Kazakh Research and Design Institute of Construction and Architecture

TIMCO - Technology of Information Modeling of Construction Objects

ISO - International Organization for Standardization

PIM - Project Information Model

AIM - Asset Information Model

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Chapter 1 - Introduction

This chapter provides a brief overview of the thesis, the motivation and history, established goals and objectives, and a summary of the thesis' further organization. The Introduction chapter contains 5 sections: Section 1.1 presents a description of the study, Section 1.2 lists the aims and objectives, Section 1.3 explains the used methodology, Section 1.4 gives information about the literature review and Section 1.5 consists of an outline with a description of each chapter.

1.1 Overview

In real-world construction projects because of the complexity and great scope of work even with comprehensive preparation and planning, the construction process may take longer than it was scheduled. Due to the widespread interest in the problem of construction project delays in project management, several studies from different angles have been undertaken, including statistical approaches that present a comprehensive examination of global issues, determine their significance, and quantify the impact of studies on a specific research issue. Over the last thirty years, not much research has been done to assess and quantify the causes and consequences of construction project delays in Kazakhstan. The research is anticipated to promote more studies on this topic and enhance attention to the solution of the problem. The thesis includes investigations into common delays and their causes that occur on construction sites, monitoring procedures for analyzing delays, and the process of implementing mitigation strategies in Kazakhstan.

When a project's schedule is violated, it can result in negative consequences and for example, the following outcomes may occur. Having to spend more time rescheduling the project. The following could be the cause of this: errors performed by significant project participants when defining the scope of work, which resulted in their failing to consider some of the project's objectives; incomplete initial data; incorrect scheduling of the required resources; etc. Defective work may also be one of the outcomes of irregularities in the project schedule. This is because project participants are attempting to complete more work in the shortest amount of time. Delays in time may lead to quality and reputation risks, and financial and technical risks.

1.2 Aims and Objectives

By studying the findings of earlier research on this subject, this study seeks to improve understanding of Kazakhstan's construction project delays issue. This work is an innovative attempt to use the findings of earlier studies to assess the importance and variations in delay causes in Kazakhstan's construction projects and to highlight techniques in the country. The following are the research objectives:

1. To investigate and advance the theme of delays in the major construction projects in Kazakhstan;
2. To evaluate the current situation with delays in Kazakhstan;
3. To determine and characterize analysis and mitigation methods used specifically in Kazakhstan;
4. To establish a foundation that allows for further work and finding solutions

1.3 Methodologies and Techniques

The investigation began with a search of earlier studies on construction projects delayed worldwide and in Kazakhstan. To conduct it, the literature review was considered. The research's output studies were subsequently sorted to concentrate on determining the reasons behind the delay. Previous research has identified the primary factors of delays using a variety of techniques and demonstrated that they are typically categorized into 112 causes of delays. Data collection methods, mostly secondary data collection methods, were used to collect, analyze, compare, and process data from the literature review. Furthermore, the survey was conducted to gather a database about the causes of delays from specialists from the construction sphere. A case study analysis was conducted to investigate the problem specifically in Kazakhstan, examine the situation from all aspects in-depth, and propose possible solutions. Cases include background information on the project, focus on the main causes and factors of delays, their effects, and recommended solutions. More information about the used techniques will be provided in the following chapters.

1.4 Literature Review

The total number of used literature is 64 papers from different sources, mostly from ScienceDirect, GoogleScholar, and websites and papers from researchers and authors from Kazakhstan.

1.5 Thesis Structure

This thesis work contains 8 chapters:

Chapter 1. The issue statement about the current investigation and the background information that is used to identify. The study goals are introduced.

Chapter 2. This chapter gives a fundamental understanding of delays, delay analysis, and mitigation techniques based on the previous studies. Also, background information about the construction industry in Kazakhstan, what kind of delays happen, and methods to analyze, and mitigate are discussed here.

Chapter 3. The research methodology section outlines the approach and techniques employed in the thesis step by step and covers the process for collecting and analyzing the necessary information.

Chapter 4. In this section results of survey are presented and analysed.

Chapter 5. Cases about delay scenarios in Kazakhstan are described and details about the causes of delay and mitigation procedures are provided.

Chapter 6. Some new approaches dealing with delays in construction projects that are implemented and can be used in Kazakhstan are described.

Chapter 7. This chapter outlines the final results and key findings of the research. Numerical and objective results, and also more subjective discussions are provided.

Chapter 8. This chapter is the summary of the whole thesis work explaining key findings and with some suggestions for further investigation.

Appendix A. These appendices are related to the questionnaire and it consists of the survey questions.

Chapter 2 - Literature Review

2.1 Introduction

One of the most significant industrial sectors of Kazakhstan's industrial production is the construction sector. The construction sector is unique in that it specializes in building immovable fixed assets and residential real estate. Capital- and material-intensive, complex, requiring specialized equipment and technologies, and requiring an exceptional management structure are all characteristics of the construction activity process [1].

The biggest issue facing construction companies when it comes to carrying out investment activities is either a lack of financial resources or the incapacity to use them efficiently during the construction process, as well as an absence of efficient techniques for the assessment and analysis of investment projects in the sector. Also, there is a problem known as the "tender problem" that arises when the lowest-bidding companies win the tender without providing any assurance about the quality of the work they are going to perform. Bribery, collusion, and other forms of corruption are caused by tenders. Another problem affecting the construction sector is the limited capacity of the regional construction firms to completely satisfy the demands of the country's internal market. A small amount of products with high added value are produced in the construction materials industry, with small firms making up about 80% of all enterprises involved in the production of construction materials. The lack of cooperation and interaction between designers and Kazakhstani manufacturers, the severe lack of skilled laborers and engineers, and the absence of domestic technologies, machinery, and equipment used in the production of construction materials are problems hard to resolve too. All of these harm the construction projects' completion time and quality [1].

2.1.1 Kazakhstan Construction Industry Statistics

In the Republic of Kazakhstan, construction is a strategically significant and rapidly growing sector. The nation's socio-economic growth as well as that of its distinct regions are greatly influenced by the construction industry, which also serves as the framework for sustaining the nation's internal political stability. The state of the nation's democratic system and overall economy are both significantly impacted by the building industry. The indicators of construction statistics, which enable evaluation of the overall status and development patterns of the construction market, are among the measures of the republic's socioeconomic development. It is necessary to provide an analysis of the construction statistics indicators to evaluate the current status and future directions of Kazakhstan's building industry.

According to the Bureau of National Statistics Agency for Strategic Planning and Performs of the Republic of Kazakhstan the construction industry of the country experienced growth of over 5.9 trillion or 5918.9 billion tenge in the first eleven months (January-November) of 2023 which is a 12.6 % increase over the same period in 2022. Private construction companies completed 87.3 % of the country’s total construction activity, followed by foreign contractors (12.5 %) and state contractors (0.2 %). The total area of constructed facilities that were commissioned was 17296.8 thousand square meters through 2023 of which 15067.2 thousand square meters is the residential buildings. Overall 70 general education schools, 44 preschools, 2 hospitals, and 31 clinics were all put into operation during 2023 [2]. These statistics from 2023 demonstrate that the rate of construction is enhanced every year and continuously affects the contemporary economy of the republic. Both domestic and foreign investors are attracted to the building sector.

Also, the National Statistics Bureau provides dynamic statistics that in 1990 the volume of completed construction works was nearly 11 million tenge. In 2022 this volume peaked at 6.3 billion tenge [2]. Table 2.1 shows the budget of the construction sphere in Kazakhstan over the last 32 years.

Table 2.1: Volume of completed construction works through years

Year	In total	By type of construction work		
	thousand tenge	OKED 41	OKED 42	OKED 43
1990	10 460	403	4 407	5 650
1995	77 624 009	2 707 101	31 536 167	43 380 741
2000	15 1427 002	22 135 099	37 465 658	91 826 245
2005	1 069 504 543	314 398 519	347 235 668	407 870 356
2010	1 943 960 016	572 855 460	852 396 670	518 707 886
2015	2 896 877 008	907 310 462	1 372 907 129	616 659 417

2020	4 934 069 181	1 672 717 945	1 972 834 089	1 288 517 147
2022	6 304 274 070	2 454 415 995	2 226 019 130	1 623 838 945

In the General Classifier of Types of Economic Activities (OKED) there is a section that covers general construction and specialized construction works for the construction of buildings and civil engineering projects [3]. Along with the construction of temporary buildings, it also involves the construction of new buildings as well as repairs, reconstruction (modernization), restoration, and the erection of finished buildings from the completed structures. OKED 41 (Building Construction) section includes general construction work for the construction of all kinds of buildings. Entire residential complexes, retail establishments, office buildings, and other public, governmental, and agricultural structures are all included in this section. Construction of both residential and nonresidential buildings by combining technical, financial, and human resources to realize a project to sell it. OKED 42 (civil engineering) section involves the construction of heavy structures, including roads, streets, bridges, tunnels, railroads, runways, ports, and other water structures, as well as industrial buildings, pipelines and power lines, irrigation systems, sewage systems, and outdoor sports facilities. These projects are completed on a contractual basis, at the contractor's expense, or for compensation. Subcontractors can handle all or a portion of the work. OKED 43 (specialized construction works) covers specialized construction works for the assembly or completion of building components and civil engineering projects. These works, which require specialized knowledge or tools like pile driving, foundation work, framing work, concrete and reinforced concrete work, masonry work, scaffolding, roofing, etc., are concentrated in a single area that is shared by many building and structure types. Mostly specialized construction work is done by subcontractors; however, in the case of building renovations, the owner is in charge of these tasks [3].

In 2023 the Bureau of National Statistics presented some statistics that show the current situation of the construction industry and the huge impact on the country’s economy. The value of construction works in 2023 was equal to nearly 7494.6 billion tenge [2]. It is approximately $16.75 billion and is 0.18% of the global construction industry in 2023 according to the reports [4]. The number of facilities put into operation was equal to 38816 units [2] (Table 2.2).

Table 2.2: Statistics on completed construction works and facilities in 2023

Types of construction projects	Number of projects put into operation, in units	Forms of ownership of developers		
		State	Private	International (foreign)
Residential buildings	34 972	346	34 610	16
Industrial facilities	307	27	213	67
Cultural and entertainment facilities	161	85	67	9
Hotel, restaurant, and similar facilities	311	1	310	-
Educational facilities	181	45	129	7
Buildings of medical organizations	154	105	49	-
Offices	377	28	339	10
Transportation and communications facilities	198	7	191	-
Civil engineering facilities: highways (except elevated highways), streets, roads; railroads; airfield facilities; bridges, elevated highways, tunnels, and underground roads	67	23	37	7
Tanks and warehouses	179	-	175	4
Agricultural buildings	271	1	269	1
Veterinary buildings	4	2	2	-
Religious facilities	17	-	17	-
Trunk and local pipelines, communication lines, power cable lines, auxiliary facilities	613	386	172	55
Harbors, waterways, dams, irrigation systems, and other water management facilities	11	3	7	1
Other facilities	76	49	20	7

2.2 Introduction to Delays: Definition and Types.

Delay can be defined in several ways, such as causing something to occur later than anticipated, causing some actions to be performed later than scheduled, or failing to act promptly.

It is typical for delays to happen on construction projects as well as other projects where work is planned using a specific timeline [5]. There are four fundamental categories for delays:

1. Critical or noncritical delays. Activity delays that have a significant impact on the project's development and are expected to postpone the project's completion date are referred to as critical delays. Delays that have an impact on the time the project is completed are referred to as critical delays, and delays that have no big impact on the completion date are called non-critical delays [5].

2. Excusable or inexcusable delays. The delay that can be excusable is the one that results from unforeseen circumstances outside of the control of the contractor. If a delay is considered excused, it must be determined in the context of a particular contract. The conditions that could warrant being granted a grace period until the contract's completion date should be identified in detail in the contract [5].

3. Compensable or non-compensable delays. A delay that qualifies as compensable gives the contractor the right to an extension of the deadline along with additional compensation for the delay. In the event of a non-compensable delay, the contractor will not be eligible for any further delay-related compensation. Certain excusable delays can be compensable, and there is no compensation for any inexcusable delay [5].

4. Concurrent or nonconcurrent delays. Concurrent delays are distinct delays to the critical path that happen simultaneously. Concurrency is important for both identifying critical delays and allocating fault for expenses associated with delays. However, only very few contract specifications define what constitutes a "concurrent delay" or explain how one might be entitled to extra payments for time extension or be held accountable for liquidated damages in the event of a delay [5].

2.3 Main Causes of Delays in Construction

After searching for over 50 articles the list of the most common delay causes was created (Table 2.3) [6-43].

Table 2.3: Common delay causes from the literature review

No.	Type of factor	Factors	Causes of delays
1	Internal	Project-related factors	Unrealistic or unreasonable project/contract duration [27,29,32,34,43]
2	Internal	Project-related factors	Problems due to usage of contract clauses and procedures (Non-compliance with contract-award rules) [13,18,25,37]
3	Internal	Project-related factors	Contract termination and change of contractor [18]
4	Internal	Project-related factors	Non-compliance with subcontractors selection rules [18]
5	Internal	Project-related factors	Conflict between the main parties to the contract [9,10,13,18,24,43]
6	Internal	Project-related factors	Poor scope definition (Ambiguity in specifications and conflicting interpretation by parties) [14,17,18,19,22]
7	Internal	Project-related factors	Conflicts due to incomplete understanding of client's requirements [18,29]
8	Internal	Project-related factors	Slowness in making a decision [7,11,16,18,19,22,24,35]
9	Internal	Project-related factors	Variation orders/change of scope during construction [7,12,13,14,18,19,20,21,24,28,33,40]
10	Internal	Project-related factors	Difficulty of coordination and communication between various parties contractor, subcontractor, owner, consultant working on the project [7,9,10,11,13,14,16,18,20,22,24,25,28,32,34,40]
11	Internal	Project-related factors	Improper consultation between parties [11,32]
12	Internal	Project-related factors	Problems due to construction resources management [14]
13	Internal	Project-related factors	Slow variation orders in extra quantities [10,18,43]
14	Internal	Project-related factors	Work starts before design completion [18,38]
15	Internal	Project-related factors	Unreasonable or unpractical initial plan [17,19]
16	Internal	Project-related factors	Project complexity [17,28,36]
17	Internal	Project-related factors	Focus on financial analysis and awarding the lowest bidder [12,14,32,36.37]
18	Internal	Project-related factors	Awarding contractors projects beyond their financial and technical potential [12,35]
19	Internal	Project-related factors	Selection of contractors who have other faltering projects [12]
20	Internal	Project-related factors	Inadequate integration of project interfaces [17]
21	Internal	Project-related factors	Lack of accuracy in the studying of quantities, specifications, and drawings [16,19,35,40]
22	Internal	Project-related factors	Limited construction area [14]
23	Internal	Project-related factors	Inconvenient site access [14]
24	Internal	Project-related factors	Poor budget and cost control [20,40]
25	Internal	Owner-related factors	Changes in owner's requirement [17,35,36,37,43]
26	Internal	Owner-related factors	Lack of commitment and/or clear requirements of the owner [14,16,18,24,35]
27	Internal	Owner-related factors	Owner financial problems and delayed payments [6,7,9,13,14,17,18,19,20,22,25,28,33,35,36,37,40]
28	Internal	Owner-related factors	Slowness or delay in the owner's decision-making process [6,9,13,14,18,22,25,29,32,35,36,37,43]
29	Internal	Owner-related factors	Changes during construction issued by the owner [9,11,17,18,22,25,33,36,37,43]
30	Internal	Owner-related factors	Delay in reviewing and approving the design documents, sample material, etc. by the owner

			[7,9,11,13,14,18,25,35,36,37,40,43]
31	Internal	Owner-related factors	Inappropriate owner-representative management style (Lack of owner's management skills) [18,20,40]
32	Internal	Owner-related factors	The weakness of coordination between service providers is related to project sites and project works [12,35]
33	Internal	Owner-related factors	The weakness of experience of some engineers in studies and supervision [12,36,40]
34	Internal	Owner-related factors	Non-payment or default in obtaining payment finished work [9,10,11,14,19,21,27,28,29,32,33,34,35,36,37,38]
35	Internal	Owner-related factors	Limited negotiations with the consultant/owner [14,18,25,32,40]
36	Internal	Owner-related factors	Delay in the provision of the construction site by the owner [14,18,22,32,40,43]
37	Internal	Owner-related factors	Delay in the provision of on-site public services [18,25]
38	Internal	Owner-related factors	Poor information exchanges between the owner's departments [18]
39	Internal	Owner-related factors	Owner's indication of suspension or delay [14,17,18,25]
40	Internal	Owner-related factors	Slow or low-quality inspection process of the completed work [10,13,16,25,32,35,36]
41	Internal	Owner-related factors	Complicated administration process of client [9,17,32,36]
42	Internal	Owner-related factors	Improper selection of subsequent consultants [12,14,17,22,25,34,36]
43	Internal	Owner-related factors	Owner interference [13,19,25]
44	Internal	Owner-related factors	Ineffective delay penalties [19,25]
45	Internal	Contractor-related factors	Contractor financial problems [11,14,20,22,25,43]
46	Internal	Contractor-related factors	Weakness of the financial and technical capabilities of some contractors [12,19,29,35]
47	Internal	Contractor-related factors	Poor planning/scheduling and control procedures [6,7,10,11,13,14,16,17,18,19,20,21,22,25,35,40]
48	Internal	Contractor-related factors	Poor organization, site management, and supervision [7,9,10,13,14,18,19,21,22,24,25,27,33,35,37]
49	Internal	Contractor-related factors	Conflicts during work execution [14,18,24,25]
50	Internal	Contractor-related factors	Subcontractor problems (coordination, selection, competence,.) [7,9,11,12,13,18,19,22,24,25.27,29,32,34,35,37,40]
51	Internal	Contractor-related factors	Difficulties in financing projects by contractors during construction [7,9,11,18]
52	Internal	Contractor-related factors	Construction errors, mistakes, and substandard works [7,9,10,11,13,14,18,20,21,25,27,38,40,43]
53	Internal	Contractor-related factors	Inadequate contractor qualification and experience [9,13,14,18,19,20,21,22,25,29,32,35,37]
54	Internal	Contractor-related factors	Inadequate techniques, methods, and tools used in project planning [9,13,14,18,20,22,25,32]
55	Internal	Contractor-related factors	Lack of risk response plan [18,24]
56	Internal	Contractor-related factors	Inappropriate schedules with labor regulations [18,25]
57	Internal	Contractor-related factors	Delay in producing design guide drawings [18]
58	Internal	Contractor-related factors	Internal administrative procedures and bureaucracy within project organizations [16]
59	Internal	Contractor-related	Poor information exchanges between the contractor's

		factors	departments [18]
60	Internal	Contractor-related factors	Limited negotiations with the contractor [18,32]
61	Internal	Contractor-related factors	Delay in commencement [14,32,40,43]
62	Internal	Designer-related factors	Design changes [9,37]
63	Internal	Designer-related factors	The design team experienced a deficiency [17,18,25]
64	Internal	Designer-related factors	Defective in design quality such as mistakes, errors, incomplete [7,9,11,14,16,17,20,25,29,35,40,43]
65	Internal	Designer-related factors	Delay in preparing and authorization of drawings [6,7,9,11,21,40]
66	Internal	Designer-related factors	Late arrival of design plans on-site [18,19,32]
67	Internal	Designer-related factors	Delays related to shop drawings and material samples [7,9]
68	Internal	Designer-related factors	Lack of database in estimating activity duration and resources [9,17,21,25]
69	Internal	Designer-related factors	Change orders by deficiency design [16,17,32]
70	Internal	Designer-related factors	Unrealistic design duration imposed [17]
71	Internal	Designer-related factors	Improper or wrong cost estimation [17,20,25,34,40,43]
72	Internal	Designer-related factors	Disagreement on design specifications [17,32]
73	Internal	Designer-related factors	Unclear authority among designers [17]
74	Internal	Designer-related factors	Poor communication between designers [17,25]
75	Internal	Designer-related factors	Slow decision-making by designers [17]
76	Internal	Designer-related factors	Slow information delivery between designers [17,32]
77	Internal	Designer-related factors	Late design works (Delay in preparation of design documents) [14,20,21,22,25,40]
78	Internal	Designer-related factors	Changes in material types and specifications during construction [14]
79	External	Construction materials and equipment-related factors	Construction material supply chain problems [18,25,33,38]
80	External	Construction materials and equipment-related factors	Delay in materials delivery [6,7,9,18,19,20,25,35,37,38]
81	External	Construction materials and equipment-related factors	Shortage in locally required quality construction materials (Application of quality control based on foreign specification) [9,13,18,25]
82	External	Construction materials and equipment-related factors	Shortage in material and high-technology equipment [6,9,10,11,13,14,16,18,19,20,21,22,25,28,29,34,35]
83	External	Construction materials and equipment-related factors	Increased prices [9,11,19,28]
84	External	Construction materials and equipment-related factors	Damages of materials and equipment [11,19,25,28]
85	External	Construction materials and equipment-related factors	Poor equipment productivity (Lack of equipment efficiency) [7,9,10,13,14,21,25,28]
86	External	Construction materials and equipment-related factors	Poor quality of materials [6,25]
87	External	Labour-related factors	Poor productivity level of labors [6,9,11,12,13,14,19,20,25,35,38,43]
88	External	Labour-related factors	Labor availability supply chain problems (shortage)

			[9,10,13,16,18,19,20,21,22,25,28,32,33,34,35,37,40,43]
89	External	Labour-related factors	Insufficient skilled labor to manage construction projects [9,11,14,18,19,21,22,25,27,28,32,35,38,43]
90	External	External-related factors	Unforeseen site conditions [7,9,11,13,14,19,25,34]
91	External	External-related factors	Accidents during construction due to lack of safety measures [9,11,18,25,28]
92	External	External-related factors	Force majeure [7,19,24,25,32]
93	External	External-related factors	Weather/climate conditions [9,11,13,14,17,18,19,20,24,28,32,33,35,38]
94	External	External-related factors	Infectious disease (e.g. Covid-19) [8,17]
95	External	External-related factors	Lack of knowledge about the socio-economic and technological environment [18]
96	External	External-related factors	Uncertainties about regulatory and political issues [18]
97	External	External-related factors	Lack of knowledge about the project's closest environment [18]
98	External	External-related factors	Long customs clearance procedures for imported products [18]
99	External	Government-related factors	Delay/ difficulty of governmental permit and approval procedures [24,25,27,28,32,40,43]
100	External	Government-related factors	Social effects [13,14,17,24,25,32,43]
101	External	Government-related factors	Change in governmental laws and regulations [11,13,14,20,25,28,32]
102	External	Government-related factors	Interference by political leaders [11]
103	External	Government-related factors	Ministries are not interested in the development of the engineering sector [12]
104	External	Government-related factors	Government entities are late in giving financial rights to contractors [12]
105	External	Government-related factors	Government entities do not withdraw the delayed projects from the faltering contractor [12,25]
106	External	Government-related factors	Weak technical analysis of the competitors [12]
107	External	Government-related factors	Lack of interest in timetables and updating them constantly [12]
108	External	Government-related factors	The weakness of training and development of engineers and engineering departments [12]
109	External	Government-related factors	Weak efficiency and experience of the Technical Supervision Department of the government entity [12]
110	External	Government-related factors	Weak information bases at ministries and companies on infrastructure [12]
111	External	Government-related factors	Lack of planning by government entities [12]
112	External	Government-related factors	Corruption [25]

According to the Code of Rules of the Republic of Kazakhstan (SP RK), namely SP RK 1.02-112-2018 LIFE CYCLE OF CONSTRUCTION PROJECTS. Part 1. General concepts, regarding the stage of the construction project there are some possible causes of delays (Table 2.4) [44].

Table 2.4:.Causes of delays through the life cycle of a construction project

Stage	Objectives	Possible delays
Pre-Design	Determination of commercial, economic, and social efficiency, technical feasibility, and performance of the created construction object as an asset with a certain value, considering its environmental and operational safety; deciding on further implementation of the project and the most appropriate way to create the construction object.	- Delays in the selection of a land plot; - Delays in the development and comparison of architectural and urban planning concepts; - Delays in determining technical and economic indicators of volume-planning solutions to develop substantiation of investments in construction; - Delays in conducting design and survey works to study local environmental and technogenic conditions of the site; - Delays in registration of the right to a land plot for construction; - Delays in preparation of the package of initial permit documentation; - Delays in the visualization of conceptual solutions using CAD.
Design (Pre-Construction)	Development of design documentation for construction that meets the requirements of the client and technical regulations on safety, and applicable regulatory documents.	- Delays in producing drawings and specifications; - Late verification and evaluation of design solutions; - Unsuccessful provision of spatial interdisciplinary coordination and collision checking; - Delays regarding the calculation of the scope of work and determination of the estimated cost; - Delays regarding the engineering calculations; - Delays in the development of construction management design, and integrated network schedule; - Delays in the development of construction plans; - Delays in visualization of design solutions; - Delays in passing the expert examination of design and estimate documentation; - Delays regarding other actions and tasks of the current legislation.
Construction and monitoring	Implementation of design solutions to create a construction project under technical safety regulations, and testing.	- Delays due to incorrect or inadequate construction planning and management; - Delays in construction site preparation; - Delays due to improper monitoring of construction and installation works; - Delays due to monitoring of labor protection and industrial safety at the construction site; - Delays in production of building structural elements and products; - Delays in the procurement of resources, materials, and services; - Delays regarding other actions and tasks of the current legislation.
Commissioning (post-construction)	Ensuring that the construction project is commissioned upon completion following existing regulations and requirements.	- Delays due to late signing of the acceptance certificate of the construction project; - Delays regarding other actions and tasks of the current legislation.

Liquidation	Guarantees the safe completion of a construction site with respect to environmental regulations and the safety of human life.	- Delays in calculating the scope of work and estimating the estimated cost; - Delays in visualizing the dismantling process; - Delays regarding other actions and tasks of the current legislation.

2.4 Construction Duration and Delay Regulations in Kazakhstan

The "Duration of construction and backlog in the construction of enterprises, buildings, and structures" sections of SP RK 1.03-101-2013, SN RK 1.03-01-2013, part I, and SP RK 1.03-102-2014, SN RK 1.03-102-2014, part II determine the normative duration of construction. Construction duration, according to the regulations, is the amount of time from the commencement of work at the construction site to the commissioning of business facilities, including their phases, start-up complexes, and individual objects at the project's full completion [44].

“Time Frame rates for construction and pre-construction work in the construction of enterprises, buildings and structures” are construction standards that govern the timing and length of construction for both new and established businesses, as well as the order in which they should be built and expanded, start-up complexes, buildings, and structures. They also govern the distribution of capital investment during the construction phase and for building and installation work, as well as the planning of the construction process, the creation of technical and economic feasibility studies, and the projects of construction organizations. In order to determine the duration of construction and the construction of enterprises, buildings, and structures, the regulatory requirements aim to establish mandatory regulations that are common to the entire territory of the Republic of Kazakhstan or to several regions within it that have specific climatic, geological, and other natural conditions. According to the regulation it gives information about the normative duration for each type of building [5]:

- Industrial construction (electric power industry, petroleum industry, petroleum refining industry, gas industry, coal industry, ferrous metallurgy, non-ferrous metallurgy, chemical and petrochemical industry, mechanical engineering, building materials industry, food industry, hydraulic engineering, aviation industry, etc.);
- Transportation construction (railway, river and road transportation, bridges and tunnels, transportation of oil and petroleum products, etc.);

- Construction of communication enterprises;
- Construction of geological facilities;
- Construction of trade and public catering facilities;
- Non-production construction (residential buildings, communal services, domestic service of the population, education and culture, health care, physical training and social security, scientific institutions, urban engineering facilities, etc.).

According to the Law of the Republic of Kazakhstan on Architectural, Urban Planning, and Construction Activities in the Republic of Kazakhstan, the main activities in the field of architecture, town planning, and construction shall ensure state, public, and private interests. In order to ensure state, public, and private interests in constructing buildings on time architectural and construction control and supervision must be carried out [45]:

1. Design supervision is the designers' authority to exercise control over the development of the construction project (construction documents), which is carried out by the designers (authors) of the architectural and town-planning work, and the construction project implementation, which is carried out by developers, including designers. Design supervision is mandatory for the duration of the construction (restoration, expansion, technical re-equipment, modernization, capital repair) of the facility or maintenance of incomplete facilities during construction at the cost of funds allocated in the design documentation for the construction of facilities compliant with current regulations. The following responsibilities are assigned to those who perform designer supervision [45]:

- to ensure that design solutions specified in approved projects are accurately fulfilled during construction;
- to maintain the supervision log on a regular basis and properly;
- to take part in the execution and signing of certificates of witnessing concealed works and intermediate acceptance of critical structures;
- to make timely decisions regarding any kind of modifications to approved design (design and estimate) documentation in compliance with Republic of Kazakhstan legislation;
- to notify the owner and the relevant division of the state architectural and construction control and supervision body in the case that the contractor fails to fulfill or improperly fulfills instructions;
- to complete the annexures to the act of acceptance of the object into operation with the actual measurements.

2. Technical supervision is the supervision of construction at every stage of the project's execution, encompassing terms, quality, and cost as well as acceptance of finished work and

facility commissioning. In the fields of architecture, urban planning, and construction, technical supervision is performed by the owner either independently or in conjunction with consultants who possess the necessary certification to offer engineering services. Technical supervisors are required to manage the following [45]:

- to control the contractor's compliance with organizational and technological documents outlining the technological process of construction and installation works;
- to ensure that construction and installation work is completed to a high standard;
- to monitor compliance with site regulations concerning the contractor;
- to maintain the technical supervision log on a regular and appropriate basis;
- to take part in the completion and signature of the certifications attesting to all works and the provisional approval of key structures;
- to submit a report on a monthly basis to the body state architectural and construction control and supervision regarding the status and progress of the facility's construction;
- to report to the owner and the relevant division of the state architectural and construction control and supervision authority in the event that the contractor fails to fulfill or improperly fulfills instructions;
- to track the contractor's execution of instructions recorded in the technical supervision log.

3. A customer or owner is a person or organization that carries out the architectural, urban planning, and construction-related operations in compliance with Republic of Kazakhstan regulations. The customer may be the developer, owner, customer-investor of the project, or the permitted individuals, depending on the activity's objectives. The customer of the construction project accomplishes the following [45]:

- to provide the contractor with the required project (design and estimate) documentation before construction and installation operations begin;
- to provide the facility with all permission documents required by Republic of Kazakhstan legislation;
- to guarantee that the object is constructed under technical and designer supervision;
- to take action against the contractor for failing to comply with technical and author's supervision instructions in a reasonable time frame;
- to guarantee the technical and designer's supervision's working conditions;
- to guarantee that governmental architectural and construction control and supervision organizations' requests are followed;

- to guarantee entry to the site for representatives of the state architectural and construction control and supervision body to supervise technical supervision operations;
- to carry out additional duties outlined in the Republic of Kazakhstan's legislation.

4. The contractor (main contractor) has the right to request the following from the customer [45]:

- the establishment of requirements needed for the completion of the work outlined in the signed contract;
- the appropriate authorization documents required by the Republic of Kazakhstan's legislation.

The contractor is obligated:

- to complete construction and installation work in compliance with the customer's approved design (design and estimate) documentation, Republic of Kazakhstan regulations, and normative and technical documents;
- to conduct all kinds of work and changes of independent production control for the quality of construction (including geodetic, inbound, operational, intermediate, and acceptance);
- to guarantee the timely and appropriate maintenance of executive technical documentation;
- to timely eliminate issues (defects and mistakes) that occur throughout the building process;
- to conduct laboratory quality inspection of applied construction materials, services, and structures as well as perform (executed) construction and installation works upon request from the state architectural and construction control and supervision body;
- to comply with directives from the state architectural and construction control and supervision body, along with directives from individuals handling technical and designer supervision;
- not to permit impediments or interference with the state architectural and construction control and supervision body;
- to carry out additional duties outlined in the Republic of Kazakhstan's legislation.

Failure to fulfill the obligations of at least one of the above-mentioned parties, connected by contracts, leads to delays in the construction process. Therefore, it was important to divide and clarify by groups in the list with common causes of delays.

The parties whose action or inactivity causes a delay in the building include officials and state administrative entities that carry out regulation as well as control and supervisory tasks in the fields of architecture, town planning, and construction [45]:

1. The President of the Republic of Kazakhstan;

2. The Government of the Republic of Kazakhstan. This body makes decisions on the design and construction of facilities of national and interstate importance. This makes a direct impact on the schedule and other parameters of the project;

3. The authorized body on architecture, town planning, and construction. The responsibilities include control and supervision over the activities of local executive bodies for architecture, town planning, construction, and state architectural and construction control in terms of appropriate performance of function;

4. Other central executive bodies within the limits of their special powers on issues related to architectural, town-planning, and construction activities;

5. Local representative and executive bodies of regions, cities of republican significance, and the capital, districts, and cities of regional significance. Their duties include coordination of project implementation activities (deadlines for design, construction, and commissioning), monitoring of facilities and complexes under construction (or planned for construction) under the procedure established by the authorized body for architecture, town planning, and construction, and keeping records of acts of acceptance of facilities into operation.

2.5 Delayed Construction Projects in Kazakhstan

In practically every big city in Kazakhstan, different buildings have been left halfway through. Furthermore, these are state-sponsored complex mega projects. The majority of these facilities were part of a large plan for the region and even the nation's development.

According to the reports of the Department of Urban Planning control after unscheduled inspections starting from November 2023 a number of unfinished or delayed construction projects have been identified in Almaty [46]. During the course of unannounced inspections, it was found 1,140 violations and issued 634 orders to remove them. 8 technical supervision organizations and 25 technical supervision experts suspended their certificates for six months due to improper control, while 68 organizations were found accountable for inadequate design and organization of construction and installation works [47]. All projects from Table 2.5 are well-known among citizens and they still have not been finished due to the current time [48-49].

Table 2.5: Examples of delayed projects in Almaty

No.	Name	Started - suspended date	Delay causes
1	Construction of a hotel with public service facilities in, the Almalinsk district	2016 - 2018	Delay in financing by investors
2	Reconstruction of buildings, Almalinsk district	2015 - 2015	Delay in financing by investors
3	Construction of an 8-story administrative building, in the Almalinsk district	2000 - 2000	Conflicts between various parties.
4	Annex of laboratory and clinical building, Almalinsk district	1983 - 1988	Financial problems Indifferent attitude from the government
5	Facility with service facilities and underground parking, Bostandyk district	2014 - 2016	Delay in financing by investors Changes of owners during construction
6	Construction of a building for public services	2015 - 2016	Financial problems
7	Construction of a residential complex, in the Medeu district	2005 - 2007	Delay in financing by owners Corrections in project
8	Construction of residential complex Gornyi Giant SPK, Medeu district	2015 - 2016	Financial problems of the owner
9	Construction of a five-story parking lot, in the Medeu district	2007 - 2009	Financial problems of the owner
10	Construction of restaurant complex "Samal" with a summer park, Medeu district	2012 - 2013	Financial problems of the owner
11	Construction of a world-class college 1st stage, Medeu district	2014 - 2015	Delay in financing by investors
12	Construction of scientific research center, Medeu district	2014 - 2014	Problems with housing and social infrastructure Financial problems
13	Annex to the existing building for 125 places, Medeu district	2006 - 2008	According to the results of expertise, the object is not suitable for construction completion
14	Capital construction of 2 residential buildings for 120 apartments in the military garrison, Turksib district	2012 - 2014	Financial problems of the owner

The technical opening of the metro stations Saryarka and Dostyk was also delayed in Almaty. The Saryarka station construction started in July 2015, and the Dostyk station followed two years later. It was intended for the 3.1-kilometer route to be finished in 2021. However, May 30, 2022, was the day of the grand opening. Dostyk station is 17 meters below ground, whereas Saryarka station is 35 meters below. The Research and Design Institute of Transport and Communications has projected that the inauguration of the additional stations has resulted in a daily increase in passenger traffic of up to 86 thousand. The two stations' construction cost 68.1 billion tenge, of which 10.3 billion was spent in 2019 [50]. In order to finish building the extra stations on the first metro line, the government approved the project and gave an additional 20 billion tenge for 2020. Geological circumstances, the amount of financing allotted, the density and kind of above-ground structures, and several other factors influenced while scheduling of the project. Employees claim that since private buildings inside the construction zone were bought out, commissioning was delayed. The proposed compensation tended to be met with protest from plot owners. Residents of that area, for instance, complained that the Akimat's (administration of the city) price was one-third less than what the market price was. Additional factors affecting construction time were unaccounted-for engineering networks from the Soviet era [51].

Criminal proceedings are frequently filed in tandem with the subway's development. The former director of "Almaty Metro Kurylys" and "Metropolitan" state enterprises, Murat Ukshebayev, received a nine-year jail sentence in 2015. Yerbol Kaldybaev, his deputy, was sentenced to eight years in jail. They were found guilty of misappropriating other people's property and of widely legalizing money obtained via illegal ways. According to Article 190, Part 4 of the Criminal Code of the Republic of Kazakhstan, a criminal prosecution concerning corruption was filed in 2019 against Kairat Reimov, the chairman of the board of directors of "Almaty Metro Kurylys". A strike attempt was made at the Saryarka station by subway builders on November 29, 2019. Employees expressed fear that they might not get paid before the New Year due to Reimov's imprisonment, as he authorized the financial agreements and wage distribution. Until Almaty's Akim (mayor of the city), Bakytzhan Sagintayev guaranteed that, despite the detention of the "Almaty Metro Kurylys" head, there is no cause for alarm and that construction will not be suspended. According to the mayor, when the company's head was detained, employees of "Almaty Metro Kurylys" were misinformed about potential financial difficulties [52].

In Kazakhstan, there are often occurrences related to building. At first, the big launch was announced and all of a sudden, the money vanished and everything was frozen. This is a picture that is seen every year. The concert hall in Atyrau was originally allocated 2.4 billion tenge. In 2010, the digging for excavation pits began. However, when the site's corruption cases were being investigated, work on the project was suspended. The object was no longer under observation after the region's head resigned. Further investigation by the state expert group discovered that 5 billion tenge more were required to finish the construction. It is not profitable to complete this project due to the high expense of repair work. Furthermore, the Interregional Center for Training of Personnel of Machine-Building Industry in Ust-Kamenogorsk was put on hold due to the corruption scandal. For this center, 4 billion tenge were set aside in 2011. It was intended that qualification would take place here for the specialists in demand at that moment across the country. The construction of a glass plant in Kyzylorda was completed in 2022. Though the project's concept was first proposed in 2005, actual work on it did not start until ten years later. Disagreements between authorities, investors, and corruption were the main causes of the delay. The country's glass industry developed much more slowly as a result of the factory6's funds being misappropriated. All such excessively ambitious ideas inevitably end up with financial difficulties. A broiler poultry farm was to be built in Karaganda Oblast in 2020 with funding allotted of 2 billion tenge. Even the KazArgo Industrialization Map, a comprehensive plan for the growth of the entire area, featured this project. However, it was declined to carry out the construction after financial issues surfaced. Both finishing the construction and demolishing it would have been too costly. The West Kazakhstan region also has extensive construction projects. In the Taksaala district, a cement plant was scheduled to open in 2006. However, when the crisis impacted a year later, there was not enough funding and it was unable to find sponsors [53].

2.6 Delay Analysis Techniques

Schedule delay analysis is frequently used in construction contracts to show the causal relationships between time-related deputies. The literature frequently mentions four methods that are considered professional. These consist of four different analysis methods: as-planned vs as-built schedule analysis method, impacted as-planned schedule analysis method, collapsed as-built schedule analysis method, and window Analysis schedule analysis method [54].

1) As-Planned vs As-Built schedule analysis method. A straightforward method for comparing the baseline or as-planned schedule to the as-built schedule or a schedule update that reflects progress is the as-planned vs. as-built analysis. Using this strategy, activities on the as-scheduled critical and near-critical pathways are compared to their planned start and finish dates. This indicates long starts, long durations, and late completions. Simple projects with limited timelines and a single, distinct critical path that is followed consistently throughout the project are the best candidates for this methodology. As the actual critical path diverges from the projected timeline, its accuracy decreases [54].

2) Impacted As-Planned schedule analysis method. To ascertain the potential impact of such events, delay events are inserted into a baseline or as-planned schedule in the impacted as-planned analysis. Using this approach, the baseline or as-planned schedule is modified to add new tasks and logic to account for delays. The delay is measured by the difference between the original as-planned schedule and the impacted as-planned schedule for the project completion date. There is no need for an as-built timeline with this straightforward methodology. Nevertheless, because it doesn't rely on as-built data, it is regarded as a hypothetical model [54].

3) Collapsed as-built schedule analysis method An impacted as-planned analysis is practically the reverse of a collapsed as-built analysis. With this approach, the as-built timeline is stripped of delay events to ascertain the project's completion date "but for" the delay events. This approach is simple to comprehend and does not call for real-time schedule adjustments or an as-planned timetable. On the other hand, it is manipulable by inserting delay events and logic linkages after the fact [54].

4) Window Analysis schedule analysis method. The windows analysis is a retrospective technique that measures the as-built critical path delays for each of the smaller periods (sometimes referred to as "windows") that make up the entire project duration. The as-built schedule, which reflects the as-built conditions for each chosen period, is compared to the baseline or as-planned schedule's anticipated critical path in this type of study. The schedules must normally be used in their contemporaneous state of submission ("as-is") in order to use this strategy. Completing and comprehending the Windows analysis is simple. It takes into account the actual state of construction as well as current conditions to identify delays and acceleration

quantities. As-built performance data and a dependable baseline or as-planned timetable are prerequisites for Windows analysis, which is labor-intensive and time-consuming [54].

To precisely measure delays, it is crucial to choose the right delay analysis approach. In order to choose the best approach for the given situation, analysts need to be aware of the advantages and disadvantages of each strategy. When choosing a delay analysis methodology, contractual constraints, source data availability, budget, study time allotted, and dispute size are just a few of the elements that need to be taken into account [54].

The kind and caliber of the documentation that is available for examination will typically determine the approach taken to measure or quantify delays on a construction project. Nonetheless, every analysis of delays should be guided by these five fundamental principles, irrespective of the approach selected [5]:

- The first principle of delay analysis: only deviations from the project's critical path can cause a delay in the project. It is the fundamental idea that underpins the study of delays. Accurately identifying the critical path is necessary for the proper application of this principle. This is one of those things that is simple to do wrong as well as right. Float and the Critical Path: The project's critical path predicts when it will be completed because it is the longest work path within the schedule network [5].
- The second principle of delay analysis: Not every delay to the critical path will cause the project to be delayed. Not every delay on the critical path will cause the project to be delayed, even though only delays on the critical path have the potential to do so. Float and the Critical Path: Critical activities with positive total float values can be included in the critical path. These critical route tasks can be postponed without causing the project to go behind schedule if this situation holds true. The total number of float days will determine how many days of delay can be absorbed. Construction projects that are subject to work restrictions due to seasonality or environmental factors are more likely to encounter this situation [5].
- The third principle of delay analysis states that the longest path is the critical path. The use of multiple calendars, activity constraints, and float and the Critical Path will all affect the total float values of the scheduled activities. This means that relying entirely on total float values to identify the project's critical path in each schedule is not feasible [5].

- The fourth principle of delay analysis: The critical path can and will change. The critical path is dynamic, so as the project develops, it may move or change. Changes to the schedule logic, the project's planning, and the rate of progress—or lack thereof—in the work are all factors that affect when a project moves onto the critical path. Delay analysts should recognize and take into consideration shifts in the critical path when identifying and measuring project delays because these changes can occur during the project's progress or in response to schedule modifications [5].
- The fifth principle of delay analysis: activity delay and project delay are not the same. It's critical to recognize the distinction between project and activity delays. Although there could be repercussions if an activity is delayed beyond its originally scheduled duration, each day that an activity is delayed will either cause the float to be consumed or cause the project to be delayed, but not both. Determining when an activity's delay has caused the project to be delayed requires an understanding of the activity's location within the network and its total float value in relation to the critical path. Naturally, this connects to the first Delay Analysis Principle [5].

2.7 Techniques to Mitigate Delays

There are a lot of risks involved in the construction process. Time and the associated costs of delay are among the most hazardous areas. Effective risk management of time is essential for a project to succeed. These potentially expensive risks can be reduced and managed by acknowledging the risks that are present and adequately modeling them in the project schedule. Good project documentation goes hand in hand with well-thought-out planning and scheduling. Without adequate documentation, it is impossible to carry out the analytical procedures, which will allow project managers to recognize risks early and make effective adjustments for them. Daily reports are the most important ones, and they are supplemented with images and videos that are taken at different points during the project. Additionally, thorough cost documentation needs to be kept up to date in a way that, whenever possible, permits segregation to specific issues [5].

Throughout the feasibility studies and early project planning phases, owners should start assessing the possible risks related to the project's length. The owner's first thought is usually directed toward the outside time constraints. The owner has to take into account the fact that the project will not be completed in the allotted time. A project may not actually be finished by a given date just because external factors demand it be finished by that date. A reasonable project duration should be determined by the owner in consultation with knowledgeable advisors and included in the contract documents. Although bidders should independently research the time constraints in detail, it is usually preferable for the owner to make any unique considerations clear from the start. For instance, the requirement for these elements should be mentioned in the contract or at the very least addressed during the pre-bid meeting if the required duration can only be met by an accelerated effort, such as multiple shifts and 7-day work weeks. It would be far more advantageous for the owner to inform bidders of the expected urgency with which the project must be completed [5].

The contractor needs to share a trustworthy schedule with the owner in order to oversee and manage the project's duration. The contract should outline the requirements for both a dependable schedule and regular updates to guarantee that the intended schedule is followed. The contract may specify different scheduling requirements based on the owner's level of participation. It is advisable to incorporate in scheduling clauses the necessity of submitting a baseline schedule prior to the start of work. There should be a deadline for the baseline schedule's completion as well as a designated window of time for the owner's review. Contracts frequently contain these clauses, but how they are enforced varies widely. The scheduling clause may or may not call for cost loading, personnel, and equipment. Both the owner and the contractor may find this kind of information helpful, but the owner should carefully weigh whether the advantages outweigh the costs. It is undeniable that including resource and cost loading in a schedule makes it possible to track progress more precisely and to evaluate payment requests objectively, but these improvements also make the schedule more complex and may cause confusion or other issues. The owner may find it equally advantageous to provide a basic Critical Path Method (CPM) schedule without resource loading but with the option to demand that the contractor provide this data for particular tasks upon request [5].

When writing the contract, the owner should also think about whether to include a liquidated damages clause. The owner should carefully consider the potential losses in the event that the project is delayed when doing this. It is important to take into account any potential losses the owner might sustain in the event that the project is delayed [5]. The owner should include in the contract any time frames within which the contractor is required to submit claims. The contract should clearly state that claims for additional compensation must be submitted to the owner within a specific number of days after the incident giving rise to the claim. It is recommended that the clause explicitly indicate that the contractor will lose any further compensation rights if the necessary claim information is not submitted within the designated time frame [5]. The owner is responsible for closely monitoring and overseeing change orders during the project. Each change order consists of two components: money and time, and it should indicate whether or not more time is necessary. Maintaining an up-to-date CPM schedule throughout the project will make this task much easier and enable you to determine the delay for each change order with confidence [5]. The owner also runs the risk of being held liable for delay damages. In an effort to transfer the risk of delays to the contractor, the owner may include a no-damage-for-delay clause in the agreement. An alternate strategy would be to set restrictions on the kinds of damages that can be sustained in the event of a delay. This is how some government organizations operate [5].

In certain projects, a construction manager is involved, who is commonly referred to as "CM." If the owner chooses to hire the CM as its construction representative, the CM will be in charge of defending the owner's best interests and serving as their representative. Typically, this arrangement is referred to as "agency CM." In other situations, the CM might be working on the project at a predetermined maximum cost, also known as a "guaranteed maximum price," or GMP, and might have a financial stake in it. It's possible that the CM is operating under a GMP agreement but sharing some of the savings below the GMP. These kinds of agreements are frequently referred to as "CMAR" or "CM at risk." [5]. The construction manager (CM) is responsible for making sure that the overall project schedule allows sufficient time for all parties to complete their work, including the owner and designer's exchange of project performance information during the design phase; the meticulous preparation of contract documents, including time and schedule clauses; the fostering of contractor or subcontractor interest in the project; the preparation of responsive bids; the owner's evaluation of bids; and, above all, the project's construction under normal conditions. To ensure that the project continues on schedule, the CM is responsible for overseeing all project parties. The CM is accountable for the means and methods to oversee and manage the performance of all parties, including the assessment of delays, in the same way, that the contractor is normally in charge of the means and methods of construction.

The CM may not be familiar with some project parties' rigorous time management practices. The CM is responsible for making sure that time management policies and procedures are included in the contract language for each party [5].

Even with the best of intentions, delays are possible. The CM must be able to foresee delays and take proactive measures to minimize or completely avoid them. Project completion is frequently delayed as a result of the performance—or lack thereof—of project participants. The CM must keep accurate and comprehensive records of every party's performance. Again, the project manager (CM) is meant to be the point of contact throughout the project and manage any setbacks for the good of all parties, including the owner [5]. CMs are responsible for managing contracts with contractors and subcontractors and supervising the construction process when they are involved in an "at-risk" arrangement. Again, in this case, it is believed that the construction management specialist (CM) is the most qualified individual to supervise the activities of the project parties. It is the CM's responsibility to create and maintain clear and comprehensive performance records, clear contract clauses, and dispute resolution procedures. A "at-risk" CM, on the other hand, functions more like a general contractor. As a result, the owner must ensure that the CM's contract is appropriately drafted in order to control the owner's risks [5].

In addition to time and schedule management, the CM is in charge of managing modifications and the change order procedure. Change orders must account for the additional cost of the modified work as well as the time required to finish it. A current and accurate CPM schedule, comprehensive performance records, and adequate information from the contractors and subcontractors should enable the CM to evaluate time extensions and additional costs. All too often, requests for extra time or time extensions are omitted from the change order, which only covers additional costs resulting from the changes. It is not a good idea to "postpone" or "delay" time management and assessment because this makes conflicts unnecessary. The CM needs to take the initiative to stop this frequent issue [5].

A few of the many variables that go into construction projects are the needs of the project, the participant motivations, and the necessity of building the project under occasionally erratic conditions. Consequently, it is common for a range of variables, such as adjustments, unanticipated events, and the deeds or inaction of several project stakeholders, to add to project delays. For this reason, identifying and evaluating the reason for delays may prove difficult even with the best of records. It is plausible that certain CMs possess superior proficiency in delay analysis and evaluation compared to others. To supplement the CM's services and help the owner assess the delays on a project, it could be required to hire a scheduling and delay analysis specialist. In this scenario, hiring a schedule/delay consultant as soon as a problem is noticed is advised [5].

To guarantee high-quality project work, project safety, and/or compliance with environmental regulations, the CM may also be appointed as the owner's representative. Once more, the choice of CM should only be made after giving considerable thought to prior experience in these areas, as the CM is expected to be the owner's representative and the construction expert. The CM firm's experience as well as the qualifications of the people the CM promises to assign to the project should be taken into account [5].

2.8 Summary of Research Gap

A review of existing research and literature has identified some issues regarding this thesis work's topic. First of all, there is no comprehensive study on construction delays, their causes, and reasons in the context of Kazakhstan. Complex projects with limited timeframes are very widespread in the country but research has not expanded this topic yet. That is why there is a lack of proper information which is necessary to prevent risks of delays further. Also, secondly, there is a limited database on the analysis methods and activities to prevent delays in the construction sector in Kazakhstan. There is no research that considers all types and methods of analysis and mitigation of delays in construction in the current period of time. In the following chapters, there will be a focus on these gaps.

Chapter 3 - Research Methodology

3.1 Introduction

This chapter covers the research methodology and procedures used to achieve the study's aim and objectives, based on the literature review conducted in Chapter 2. Suitable research approaches of primary data collection such as survey methods using quantitative questionnaires and case study methods were chosen as the most appropriate for this work. It is necessary to test the main hypothesis about causes of delays within a population and take into account certain aspects of Kazakhstan. Both quantitive and qualitative approaches were used to get a more complete understanding of the topic

3.2 Survey

Due to that, the goal of this research is to obtain information about the causes of delays, particularly in the context of Kazakhstan it is significant to consider different factors of the construction sphere in the country. The descriptive research methodology, specifically the survey method is an effective method of gathering information and examining professionals' views, attitudes, and opinions. The structured questionnaire collects quantitative and very specific data. A questionnaire was created with closed-ended questions to ensure accurate data gathering and analysis. The survey questions were based on a preliminary list of common delay factors identified in the literature review part (Table 2.3).

The online survey was conducted using the platform Qualtrics XM. The base language of the survey is English and it was translated to Russian to be understandable for respondents. By selecting the sampling method it was purposive to define whether respondents were professionals from the construction sphere. The purpose is to consider building professionals as samples to highlight their experiences and get quality results over quantity or randomity. Respondents were informed about the study's goal and their participation rights. Before participating in the study, respondents supplied informed consent.

There are 15 questions in total and it was divided into 3 parts (Appendix A). The first part consists of 6 questions to get information about the background of the respondents. The second and third parts are about delay causes. In general, 90 potential delay causes were distributed into several factors as in Table 2.3. The second part consists of 4 questions and is related to the responsible parties (client, consultant, designer, and contractor). The third part consists of other 5 questions related to external factors (material and equipment, labor, project and contract, external and government-related). The respondents were asked to rate the importance of each cause of delay on a five-degree Likert scale, where 5 for extremely important, 4 for very important, 3 for important, 2 for not very important, and 1 for not important at all. There was a question with an empty slot for additional suggestions and recommendations regarding delay causes. Delay causes from Literature review (Table 2.3) into groups to make the analysis of the data more convenient and comprehensible (Table 3.1). Each delay cause is divided into factors are represented in Appendix A. The statistical analysis of results from the survey was done in the Jamovi program which is an alternative to the SPSS program, and Microsoft Excel.

Table 3.1: Division of the questions

No. of Question	Questions	Abbreviation	Number of Factors
Q7	Client-related delay causes	CL	16 questions
Q8	Consultant-related delay causes	C	6 questions
Q9	Designer-related delay causes	D	12 questions
Q10	Contractor-related delay causes	CT	15 questions
Q11	Material and equipment related delay causes	M	7 questions
Q12	Labor-related delay causes	L	3 questions
Q13	Project and contract related delay causes	P	16 questions
Q14	External and governmental elated delay causes	E	15 questions

3.2.1 Demographic Statistics

Before analysis of the basic data analysis demographic statistics for general information will be provided. The data shows the frequency and percentage of classification questions related to respondents' employed companies, professions, working experience, and experience in delayed projects.

3.2.2 Descriptive Statistics

This section displays frequency distributions for each delay factor used to build dependent variables. The general tendency is mean value and standard deviation. The average score of the data or mean score comes up with the following formula:

$$B_i = \frac{\sum_{j=1}^{n} a_{ij}}{n}, \quad (3.1)$$

where N - number of rates, a_{ij} - the importance of the factor i rated by the respondents j, B_i - the importance of factor i.

When two or more factors have the same mean value, the factor with the lowest Standard Deviation value is chosen to be higher. A lower Standard Deviation indicates that the difference between raters is not statistically significant, making the average more accurate for the majority. Standard Deviation calculated with:

$$\sigma = \frac{\sqrt{\sum_{i=1}^{n} a_i - B_i}}{n}, \quad (3.2)$$

Using the Sharipo-Wilk test, the data's normal distribution was examined. To determine whether a set of data has a standard normal distribution, one statistical method called the Shapiro-Wilk test can be employed. P-value calculations and test statistics are made. If the p-value is less than 0.05, it is concluded that the data do not follow a normal distribution. The Shapiro-Wllk test is calculated by:

$$W = \frac{\left(\sum_{i=1}^{n} a_i y_i\right)^2}{\sum_{i=1}^{n} (y_i - y)^2}, \quad (3.3)$$

3.2.3 Reliability Test

Cronbach's alpha evaluates the internal consistency and reliability of survey items or questions. It demonstrates how data are reliable. Higher alpha coefficients suggest greater internal consistency or reliability. It ranges from 0 to 1. In research, an alpha coefficient of 0.7 or above is considered adequate, while 0.8 or higher is considered acceptable. The formula of Cronbach's alpha:

$$\alpha = \frac{\frac{kcov}{var}}{1+(k-1)cov/var}, \tag{3.4}$$

where α - Cronbach's alpha coefficient value, k - is the number of items, cov - the average covariance among the items, var - is the average variance in the items

3.2.4 Factor Analysis

Factor Analysis (FA) is a statistical technique that identifies correlations between several variables. Factor analysis involves three major steps: a) determining the suitability of the data, b) factor extraction, and c) factor rotation and interpretation. Before performing FA, the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity were calculated. KMO values range from 0 to 1, with closer values indicating more reliable and unambiguous factor analysis. Bartlett's test confirms the correlation's existence. Factor analysis uses statistics to analyze the relationship between sub-factors and variables, identify components, and assess reliability. The tool also generates coefficient scores for deductive analysis, including regression between results aspects as independent variables and competitive advantage as a dependent variable. In factor analysis, variables are assessed using correlation matrices and alpha coefficients, without considering their dependencies or independence. This study uses Principal Component Analysis to load factors.

Factor extraction and factor rotation are the primary FA procedures. Factor rotation evaluates extracted factors, while factor extraction identifies the underlying factors that contribute to a set of variables. Factor matrix rotation simplifies and improves factor patterns by moving variation from early to later factors. Factor rotation employs both oblique and orthogonal techniques. Varimax, Equamax, and Quartimax assume factor independence; Promax, Oblimin, and Quartimin tolerate factor correlation. Factors were retrieved using principal component analysis and varimax rotation. Eigenvalues greater than 1 were used to compute a factor's variance explanation. The components were classified based on common themes across the variables in the study.

Eigenvalues indicate the common features of data and its components. The number of initial Eigenvalues corresponds to the number of indicators and questions. This could be accomplished using a scree plot and the accepted rules for extracting Eigenvalues. According to Kaiser Criteria, eigenvalues should have a variance of at least 1. However, due to that the components number was 90 it was decided to use parallel analysis for factor loading. Parallel analysis generates random data in parallel with the actual data set to identify factors and compare eigenvalues between the two sets.

3.3 Case Study

One of the methods of descriptive research methodology is the case study method. Case studies entail considerable research and analysis of several projects that experienced delays. Case studies generate hypotheses and broaden the scope of investigation for a phenomenon. Even while case studies are used to establish the source and effect of delays, they cannot make exact projections. However, this method was taken into account to compare and discuss the responses from the survey and real-life cases to more accurate results.

Case studies in this study are mostly a qualitative method of analyzing data. It also focuses on the analysis of individual projects and their experience. To make the case study anonymous and clear the names of people, companies, and organizations were described in the following way:

- Project A - the name of the Project;
- Owner A - the owner or client company of the related Project A;
- Contractor A - the contractor company of the related Project A;
- Consultant A - the consultant company of the related Project A;
- Designer A - the designer company of the related Project A.

A similar distribution is for Project B and Project C. Also, when there are several roles in the project it is written as A.1, A.2, etc (for example, Owner A.1, Owner A.2.)

Chapter 4 - Survey results

4.1 Introduction

In this chapter, the responses from the survey are presented. The results from the survey are divided into two parts: the demographic aspect of respondents and the analysis of the main part of the survey.

4.2 The Survey Results: Demographic Part

In total number of respondents was 48. The first 6 questions give information about the respondents and their backgrounds. Table 4.1 shows the distribution of the company type in which the respondents are employed and their specialties. It demonstrates that most respondents are from contractor companies. According to the frequency mostly they are specialized in all types of construction projects.

Table 4.1: Frequency of companies

Company_of_respondents	Counts	% of Total	Cumulative %
Client company	11	22.9 %	22.9 %
Consultant company	4	8.3 %	31.3 %
Contractor company	24	50.0 %	81.3 %
Designer company	9	18.8 %	100.0 %

Table 4.2 shows the distribution of roles (positions) of the respondents. As can be seen, most of the respondents are engineers. Table 4.3 demonstrates the working experiences of respondents in years, and mostly they have 1-5 years of working experience. Tables 4.4 and 4.5 present if any of the respondents worked on delayed projects for how much projects were delayed. The number of delayed projects among our respondents was almost equal to the not delayed projects. That is proof that in the country construction projects face delays more often. According to the responses, the duration of delays quit low (1-3 months).

Table 4.2: Frequency of positions

Profession_of_respondents	Counts	% of Total	Cumulative %
Architect	13	27.1 %	27.1 %
Construction estimator	3	6.3 %	33.3 %

Consultant	1	2.1 %	35.4 %
Engineer	21	43.8 %	79.2 %
Other (please specify)	4	8.3 %	87.5 %
Project Manager	6	12.5 %	100.0 %

Table 4.3: Frequency of years of experience

Experience_of_respondents	Counts	% of Total	Cumulative %
1 - 5 years	25	52.1 %	52.1 %
11 - 15 years	1	2.1 %	54.2 %
16 - 20 years	1	2.1 %	56.3 %
6 - 10 years	8	16.7 %	72.9 %
Less than 1 year	13	27.1 %	100.0 %

Table 4.4: Frequency of delayed projects

Delayed_projects	Counts	% of Total	Cumulative %
No	25	52.1 %	52.1 %
Yes	23	47.9 %	100.0 %

Table 4.5: Frequency of duration of delayed projects

The_duration_of_delays	Counts	% of Total	Cumulative %
1 - 3 months	14	60.9 %	60.9 %
4 - 6 months	4	17.4 %	78.3 %
6 - 12 months	3	13.0 %	91.3 %
More than 1 year	2	8.7 %	100.0 %

4.3 The Survey Results: Statistical Analysis

4.3.1 The Mean Score Ranking and Normality

The total mean score of each group and results from the normality test are represented in Tables 4.6 - 4.12. When calculating the Shapiro-Wilk test the P-value is less than 0.05 and it is less than 0.001 in all results which means that responses are not normally distributed. The most frequent and common delay causes are chosen if the mean value is more than 4 which means that causes are very important. If the mean score is less than 3 it means that these causes are not very unimportant according to the respondents. Since there is no value among results less than 3 the least important factor from each category will be also presented.

Table 4.6: Client-related delay causes

			Shapiro-Wilk	
	Mean	SD	W	p
CL1	3.98	1.021	0.813	< .001
CL2	4.00	0.968	0.842	< .001
CL3	3.96	0.922	0.852	< .001
CL4	4.04	0.874	0.823	< .001
CL5	4.08	0.895	0.829	< .001
CL6	3.85	0.922	0.865	< .001
CL7	3.81	1.065	0.835	< .001
CL8	3.71	1.071	0.878	< .001
CL9	3.94	1.019	0.825	< .001
CL10	4.23	0.951	0.758	< .001
CL11	4.06	0.998	0.824	< .001
CL12	4.04	0.849	0.817	< .001
CL13	3.75	1.158	0.833	< .001
CL14	3.71	0.967	0.859	< .001
CL15	3.83	0.996	0.867	< .001
CL16	3.88	0.914	0.856	< .001

Table 4.7: Consultant-related delay causes

			Shapiro-Wilk	
	Mean	SD	W	p
C1	3.90	0.994	0.843	< .001
C2	3.79	1.071	0.861	< .001
C3	4.04	0.898	0.827	< .001
C4	3.94	1.040	0.833	< .001
C5	4.04	0.967	0.828	< .001
C6	3.77	1.036	0.879	< .001

Table 4.8: Designer-related delay causes

			Shapiro-Wilk	
	Mean	SD	W	p
D1	3.73	0.818	0.857	< .001

D2	3.90	0.951	0.860	< .001
D3	3.98	0.887	0.836	< .001
D4	4.21	0.824	0.807	< .001
D5	4.00	0.899	0.847	< .001
D6	3.96	1.010	0.849	< .001
D7	3.81	0.938	0.865	< .001
D8	3.90	0.905	0.856	< .001
D9	4.17	0.781	0.794	< .001
D10	3.85	1.130	0.837	< .001
D11	3.85	1.010	0.868	< .001
D12	4.25	0.887	0.774	< .001

Table 4.9: Contractor-related delay causes

			Shapiro-Wilk	
	Mean	SD	W	p
CT1	3.98	0.887	0.831	< .001
CT2	3.83	0.930	0.866	< .001
CT3	3.85	0.967	0.865	< .001
CT4	3.96	0.874	0.833	< .001
CT5	3.29	1.031	0.912	0.002
CT6	4.21	0.988	0.752	< .001
CT7	4.04	0.922	0.831	< .001
CT8	4.08	0.986	0.809	< .001
CT9	3.98	1.041	0.826	< .001
CT10	3.88	1.064	0.860	< .001
CT11	3.73	1.233	0.846	< .001
CT12	3.79	0.967	0.876	< .001
CT13	3.75	1.000	0.856	< .001
CT14	3.94	0.885	0.843	< .001
CT15	3.77	0.951	0.876	< .001

Table 4.10: Material and equipment, and labor-related delay causes

			Shapiro-Wilk	
	Mean	SD	W	p
M1	4.02	0.812	0.841	< .001
M2	3.79	0.874	0.852	< .001
M3	3.73	0.939	0.879	< .001
M4	3.56	1.070	0.898	< .001

M5	4.06	0.932	0.823	< .001
M6	3.38	1.084	0.896	< .001
M7	3.83	0.953	0.836	< .001
L1	3.81	0.842	0.864	< .001
L2	3.90	0.905	0.861	< .001
L3	3.73	1.026	0.864	< .001

Table 4.11: Project and contract-related delay causes

			Shapiro-Wilk	
	Mean	SD	W	p
P1	4.25	0.887	0.770	< .001
P2	4.06	0.909	0.833	< .001
P3	4.06	0.810	0.837	< .001
P4	3.75	1.021	0.883	< .001
P5	3.85	1.052	0.847	< .001
P6	3.60	1.106	0.881	< .001
P7	3.90	1.036	0.845	< .001
P8	3.81	1.142	0.859	< .001
P9	3.81	0.982	0.860	< .001
P10	3.85	1.072	0.863	< .001
P11	3.54	1.237	0.866	< .001
P12	3.58	1.145	0.885	< .001
P13	3.92	0.895	0.820	< .001
P14	4.23	0.751	0.789	< .001
P15	4.06	0.861	0.839	< .001
P16	3.63	1.160	0.887	< .001

Table 4.12: External and governmental related delay causes

			Shapiro-Wilk	
	Mean	SD	W	p
E1	3.98	0.978	0.813	< .001
E2	3.85	1.052	0.854	< .001
E3	4.08	1.028	0.796	< .001
E4	3.79	0.967	0.861	< .001
E5	3.69	1.095	0.883	< .001
E6	3.73	0.893	0.874	< .001
E7	3.81	1.024	0.875	< .001
E8	3.81	1.142	0.848	< .001

E9	4.13	0.761	0.803	< .001
E10	3.92	1.069	0.833	< .001
E11	3.77	1.115	0.815	< .001
E12	3.92	0.895	0.859	< .001
E13	3.81	0.867	0.856	< .001
E14	3.77	0.905	0.859	< .001
E15	4.02	0.785	0.841	< .001

According to the results, there can be identified most frequent and important causes of delays and it is demonstrated in Table 4.13.

Table 4.13: Importance of delay causes

No	Most important	No	Least important
CL2	Lack of commitment and/or clear requirements of client	CL8	The weakness of experience of some engineers in studies and supervision
CL5	Delay in reviewing and approving the design documents, sample material and etc. by the clien	CL14	Delay in the provision of on-site public services
CL 4	Changes during construction issued by client		
CL10	Financial problems of client		
CL11	Non-payment or a default in obtaining payment finished work		
CL12	Complicated administration process of client		
C3	Delay in reviewing and approving the design documents, sample material etc. by the consultant	C2	Limited negotiations with the contractor
C5	Poor planning/scheduling and control procedures	C6	Financial problems of consultant
D4	Delay in preparing and authorization of drawings	D1	Changes in material types, specifications, and projects during construction
D5	Late arrival of design plans on-site	D7	Lack of database in estimating activity duration and resources
D9	Improper or wrong cost estimation		
D12	Delay in preparation of design documents		
CT6	Subcontractor problems (coordination,	CT5	Conflicts during work execution

	selection, competence,.)		
CT7	Difficulties in financing project by contractor during construction	CT11	Inappropriate schedules with labour regulations
CT8	Construction errors, mistakes and substandard works		
M1	Construction material supply chain problems	M6	Damages of materials and equipment
M5	Increased prices		
L2	Labor availability supply chain problems (shortage)		
P1	Unrealistic or unreasonable project/contract duration	P11	Work start before design completion
P2	Poor scope definition	P12	Project complexity
P3	Difficulty in coordination and communication between various parties contractors, subcontractors, client, consultants working on the project		
P14	Lack of accuracy in the studying of quantities, specifications, and drawings		
P15	Poor budget and cost control		
E3	Force majeure	E6	Uncertainties about regulatory and political issues
E9	Delay/ difficult of governmental permit and approval procedures	E11	Interference by political leaders
E15	Corruption	E14	The weakness of training and development of engineers and engineering departments

4.3.2 Reliability

To evaluate the reliability of the responses Cronbach's Alpha value was calculated. Table 4.14 shows the Scale Reliability Statistics of the total questions indicating an adequate level of internal consistency in this investigation. The total value is more than 0.9 which is acceptable. For every question, the rate is also more than 0.7 (adequate rate) except for material and equipment-related delay causes and labor-related delay causes which are close to 0.7.

Table 4.14: Cronbach's Alpha value

	Cronbach's α
total	0.967
client-related delay causes	0.881
consultant-related delay causes	0.725
designer-related delay causes	0.815
contractor-related delay causes	0.911
material and equipment-related delay causes	0.642
labor-related delay causes	0.657
project and contract-related delay causes	0.883
external and governmental related delay causes	0.898

4.4 The Survey Results: Factor Analysis

Principal component analysis was conducted for the Factor Analysis test. Firstly assumption checks such as Barlett's test of Sphericity and KMO measure of sampling adequacy are presented in Tables 4.15 and 4.16.

Table 4.15: Bartlett's Test

χ^2	df	p
Inf	4005	< .001

Table 4.16: KMO

	MSA
Overall	0.500

For Principal Component Analysis as the method of rotation, the Varimax factoring method was used and given in Table 4.17. A number of factors were chosen based on eigenvalue greater than 1. The scree plot of eigenvalue is presented in Figure 4.1.

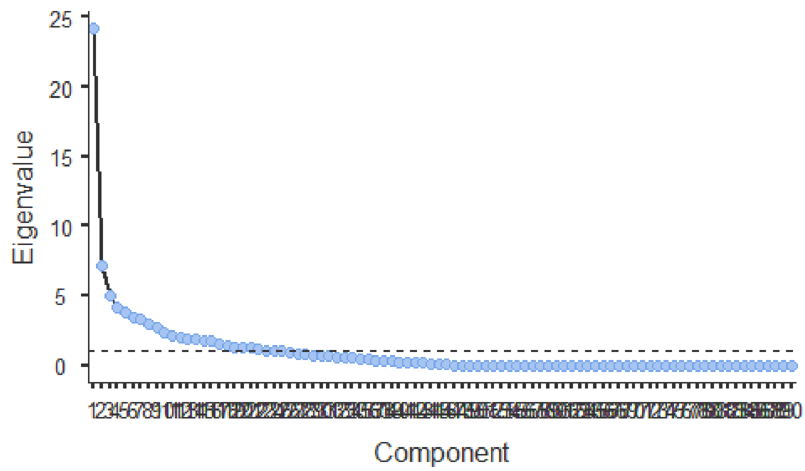

Figure 4.1: Scree plot

Table 4.17: Component loadings

	1	2	3	4	5	6	7	8	9	10	11	12
CL1					0,46		0,45					
CL2								0,82				
CL3	0,32											
CL4	0,54											
CL5								-0,4		0,32		
CL6									-0,4			
CL7	0,36					0,31						
CL8												
CL9	0,4											
CL10				0,43			0,39	0,53				
CL11					0,67			0,37				
CL12					0,54							
CL13	0,79											
CL14	0,81											
CL15	0,68											
CL16	0,38											0,64
C1	0,64					0,43						
C2	0,53											
C3		0,35					0,35					
C4	0,5							0,32		0,43		
C5			0,32									0,3
C6	0,45								0,31			

D1	0,36				0,43							
D2												
D3												
D4												
D5		0,48										
D6				0,36								
D7			0,32		0,33							
D8			0,65				0,39					
D9							0,7					
D10	0,34	0,3			0,52	0,3						
D11		0,36			0,72							
D12		0,34		0,46	0,31							
CT1				0,49		0,54						
CT2			0,3			0,47						0,34
CT3			0,44			0,72						
CT4						0,74						
CT5			0,44									
CT6			0,49									
CT7								0,3				
CT8			0,83									
CT9			0,54	0,36				0,31		0,35		
CT10			0,5						0,49			
CT11									0,8			
CT12		0,49		0,32				0,41				
CT13			0,32	0,73								
CT14				0,44					0,33			0,34
CT15				0,61								
M1												
M2												
M3												
M4		-0,3		0,33								
M5			0,85									
M6	0,37	0,45										
M7	0,76											
L1												0,84
L2	0,34									0,41	0,36	
L3										0,82		
P1			0,36		0,39							
P2							0,88					
P3					0,43						0,47	

P4											0,79	
P5										0,4		
P6		0,3										
P7	0,48		0,35									
P8	0,49	0,34		0,4								
P9	0,48	0,33	0,3					0,36				
P10	0,62	0,35							0,3			
P11	0,57	0,5							0,44			
P12		0,36										
P13							0,38					
P14				0,48								
P15				0,46								
P16	0,62	0,3										
E1		0,75										
E2	0,56	0,37										
E3		0,69										
E4		0,7										
E5	0,31	0,48										
E6		0,5										
E7	0,4	0,67										
E8	0,34	0,54										
E9												
E10		0,54										
E11	0,33	0,71										
E12		0,48									0,61	
E13		0,55		0,53			0,31					
E14	0,32	0,56									0,34	
E15												

Table 4.17: Component loadings (continuation)

	13	14	15	16	17	18	19	20	21	22	23	24
CL1								0,4				
CL2												
CL3			0,66									
CL4				0,42								0,35
CL5			0,51	0,34								
CL6									0,32			
CL7												0,52

CL8							0,75					
CL9												0,69
CL10												
CL11												
CL12									-0,4			
CL13												
CL14												
CL15												
CL16							0,34					
C1												
C2			0,47									
C3							0,4			0,35		
C4												
C5					-0,3				0,38			
C6												
D1												
D2					0,81							
D3		0,83										
D4								0,86				
D5					0,66							
D6		0,31	0,38				0,3	0,32				
D7	0,38				0,3							
D8												
D9						0,31						
D10												
D11												
D12								0,48				
CT1												
CT2												
CT3												
CT4												
CT5	0,5		0,32									
CT6			0,47									
CT7	0,5											
CT8												
CT9							0,31					
CT10												
CT11												
CT12		0,31										
CT13												

CT14												
CT15										0,34		
M1											0,81	
M2				0,83								
M3						0,8						
M4				0,36								
M5												
M6												
M7												
L1												
L2												
L3												
P1											0,38	
P2												
P3										0,38		
P4												
P5						0,38						
P6				0,49								
P7	0,5											
P8												
P9		0,32										
P10												
P11												
P12							0,31				0,33	
P13					0,42				0,36			
P14							0,45					
P15		-0,4										
P16	0,32					0,32						
E1												
E2												
E3		-0,3										0,33
E4						0,31						
E5	0,38				0,32							
E6						0,36						
E7												
E8									0,52			
E9									0,72			
E10	0,51											
E11												
E12												

E13	0,3	
E14		
E15		0,82

In this study, we have 24 factors or components. In Table 4.18 they are assorted by size. Component 1 explains the most variances and is equal to 10.3% and Component 24 explains only 2.1% of the variance. In general, by using only 24 components it is possible to get 89.1% of the whole response.

Table 4.18: Component statistics

Component	SS Loadings	% of Variance	Cumulative %
1	9.27	10.30	10.3
2	7.90	8.78	19.1
3	5.12	5.69	24.8
4	4.35	4.83	29.6
5	4.02	4.46	34.1
6	3.73	4.14	38.2
7	3.47	3.85	42.1
8	2.84	3.16	45.2
9	2.83	3.14	48.4
10	2.78	3.09	51.5
11	2.77	3.07	54.5
12	2.68	2.97	57.5
13	2.58	2.87	60.4
14	2.56	2.84	63.2
15	2.56	2.84	66.1
16	2.52	2.80	68.9
17	2.52	2.80	71.6
18	2.50	2.78	74.4
19	2.46	2.74	77.2
20	2.40	2.66	79.8
21	2.39	2.65	82.5
22	2.12	2.35	84.8
23	1.95	2.17	87.0
24	1.89	2.10	89.1

Following there will be presented results component loadings on the Components 1-24 which are the most related and influenced on each variable for each factor separately.

Component 1 was the most correlated to the client-related delay causes and there are Delay in the provision of construction site by client (CL13), and Delay in the provision of on-site public services (CL14) have the largest positive value which is nearly 0.8. Slowness or delay of the decision making process (CL3), Changes during construction issued by client (CL4), The weakness of coordination between service providers that are related to project sites and project works (CL7), Owner's indication of suspension or delay (CL9), Limited negotiations with the consultant (CL15), and Slow or low quality inspection process of the completed work (CL16) have positive loadings with values 0.32-0.64. The highest positive loading of consultant-related delays is for Improper selection of subsequent consultants (C1) with 0.64 also on Component 1. Other positive values were influenced by Limited negotiations with the contractor (C2), Slow or low quality inspection process of the completed work (C4), and Financial problems of consultant (C6) with approximately 0.5 value. Highest loading values on this component were for the project and contract-related delay causes, specifically Conflict between the main parties to the contract (P7), Variation orders/change of scope during construction (P8), Problems due to construction resources management (P9), Slow variation orders in extra quantities (P10), and Work start before design completion (P11) had values between 0.48 and 0.62. That means Component 1 describes delay causes related to client-consultant-contract. And it weight the most percent of variance equal to 10.3%.

Contractor-related delay causes had most positive values on Component 3. The highest value 0.83 was for Construction errors, mistakes and substandard works (CT8). Weakness of the technical capabilities of some contractors (CT2), Poor planning/scheduling and control procedures (CT3), Conflicts during work execution (CT5), Subcontractor problems (coordination, selection, competence,.) (CT6), Inadequate contractor qualification and experience (CT9), Inadequate techniques, methods and tools used in project planning (CT10), and Delay in commencement (CT13) had positive loading values from 0.3 to 0.54. Component 3 describes contractor-material-related factors. Material and equipment-related delay, specifically Increased prices (M5) causes also had the highest positive loading value of 0.85.

The variables for designer-related delay causes showed the most of positive values on Component 5. Slow decision making by designers (D11) showed value 0.72, Changes in material types, specifications, and projects during construction (D1), Lack of database in estimating activity duration and resources (D7), Disagreement on design specifications (D10), Delay in preparation of design documents (D12) have positive loading from 0.33 to 0.52. Component 5 describes design documentation and influences to 4.46% of variances. Component 10 describes labor-related factors due to high positive loading values of Labor availability supply chain problems (shortage) (L2) and Insufficient skilled labour to manage construction projects (L3) with 0.41 and 0.82, respectively. Lastly, Component 2 explains external-governmental-related causes. For Unforeseen site conditions (E1), Force majeure (E3), Weather/climate conditions (E4), Lack of knowledge about the project's closest environment (E7), and Interference by political leaders (E11) the loading is equal to nearly 0.7 and for Lack of knowledge about the socio-economic and technological environment (E5), Uncertainties about regulatory and political issues (E6), Long customs clearance procedures of imported products (E8), Change in governmental laws and regulations (E10), Government entities are late in giving financial rights to contractors (E12), Lack of planning by government entities (E13), The weakness of training and development of engineers and engineering departments (E14) the loading is equal to approximately 0.5.

Chapter 5 - Case Studies

In this chapter to accomplish the objectives of this study case study approach was chosen. To provide more reliable data three specific examples, namely Project A, Project B, and Project C. Each of them has certain reasons why their construction was delayed for several years or at risk of delay.

5.1 Project A

Project A is about the higher-level subway network and it has gained significant international recognition due to the many controversies that have accompanied its implementation [55].

5.1.1 Project Description

Project A is an elevated subway system that can be used as a transit route between medium-sized cities (200–600 thousand people), but it may additionally serve as an intermediate line for larger agglomerations' metros or to carry commuters between their suburban places of employment [55]. Project A is implemented in Astana and it is a cutting-edge, fully elevated passenger rail system with rolling stock intended for use both off-street and on the city's network of streets and roads. It is a completely above-ground system which is a less expensive alternative to a metro or railroad designed for urban use. With 18 stations, 1 depot, and 19 rolling stock, the 22.4 km system is expected to carry 83,000 passengers daily [56]. The rolling stock will be the "TRITON" model from the People's Republic of China (PRC). The maximum capacity will be 652, the maximum speed will be 80 km/h, and the power will be 115 KW. The trains are operated remotely by an operator and are completely automated. Stations will be established in place in compliance with all accessibility and safety regulations. Provide automated ticketing areas, waiting rooms with retail spaces, hygienic and sanitation facilities, and technologies that keep people out of hazardous areas. Some elevators accommodate the needs of individuals with limited mobility and escalators to enter the station. Furthermore, 10 subterranean crosswalks and 7 elevated crosswalks are planned to provide all-around access to the stations [57].

Project A will cost $1,888 million in total. The project is divided into two start-up complexes to speed up the launch. The first complex costs $1,152.5 million (8 stations and 5 units of rolling stock), while the second costs $735.5 million (10 stations and 14 units of rolling stock). Finally, the Chinese firm carried out the building as an investor and contractor [57].

The project was intended to improve Astana's urban environment and promote sustainable economic growth. The creation of an integrated, competitive, and efficient light rail system in Astana that is integrated with the city's public transportation network was the anticipated project outcome. The project produced two outputs: (i) an integrated urban transport strategy for Astana is established, and (ii) a modern public transport system is in place and functional in the Main North-South corridor of Astana [58]. Construction of Project A began in 2011 and was scheduled to be finished before 2017, however, the completion date was repeatedly delayed. There will be an analysis of the main causes of this project’s delay.

5.1.2 Timeline

The mayor's office of Astana, first suggested the necessity for a new form of urban transit in 2005 to address the city's transportation infrastructure issues. This marked the beginning of the implementation of Project A. A feasibility study for the project was presented in 2006 by the mayor of the city at the time. That same year, a new mayor was appointed, and it was suggested in 2008 that Project A be canceled to facilitate the implementation of another project. The concept of Project A was reintroduced by the new mayor, who established Owner A.1, a company that financed the construction of Project A. A grant of 570 thousand euros was granted by the French government (investor) to carry out the project [55]. The system's construction was originally intended to begin in 2008, but it was delayed. In the last 4th quarter of 2009, the project was approved to start implementation.

In 2011, there was a capsule laying ceremony in recognition of the beginning of Project A. With a total route length of 41.81 kilometers, the project was divided into three phases. 200 thousand passengers were expected to travel by train every day across all stages. For the first line, the first Contractor A.1 was selected. The development and delivery of the main train were valued by the French party at 2.3 billion euros [59]. Through the year 2013, additional funding sources were under consideration. Kazakhstan was considered as a possible source of funding by the banks but it was concluded that the project was too costly and declined to support it [55]. According to the technical assistance completion report of consultants from the bank, giving the

Government of Kazakhstan sufficient advisory support encouraged in 2008 another project [58]. Then there was an order to postpone the costly project and in 2014 another alternative project was recalled. Nevertheless, again authorities of the city were changed and it was intended to start again with Project A it was approved and resurrected by the Astana government. In 2015 signed an agreement to collaborate on the construction of Project A with a group of Chinese enterprises (Contractor A.2 [59]). Following prolonged discussions, it was signed a financing deal to finance the project in addition to the first phase of the EPC (Engineering-Procurement-Construction) contract in 2015. The design, procurement, and construction of the project by a contractor are all outlined in the EPC contract. 80 percent of the project's cost, or 1.6 billion dollars, was to be completed by a group of Chinese enterprises. According to the terms of the loan arrangement, the Chinese bank (investor) loaned this sum for 20 years at a rate of 2.5% annually. More than 200 million US dollars, or the remaining 20 percent, should be paid by the Kazakh side. A strategy for the 2015–2019 improvement of the city's transportation complex was presented in 2016. This program stated that Project A would be "an ideal solution for the capital city" after evaluating the global experience [55]. The establishment of a new company Owner A.2 to supervise construction, was announced in 2017 as the capital's new mayor. Contractor A.2 was confused due to changes of owners and made the decision to change the contract's primary terms—including the project's cost, the rail gauge's expansion, and the depot's reduced territory—was made public by the newly formed sub-department several months prior to the commencement of work. The new contract terms were deemed unacceptable by Contractor A.2, who complained Owner A.2's actions were impeding the commencement of construction [59].

A new deadline of 2017 was assigned for Project A. At that time the length was decreased to 22.4 kilometers once more (it had originally been 61.1 kilometers and then 41.8 kilometers) [55]. The authorities did not have enough time to finish the project till the scheduled time. In response to questions concerning the construction hold-up, it was stated that the administrative paperwork had been ready the entire time [55]. During 2018-2019 the construction again was stopped after new authorities were elected [59]. A revised deadline of December 31, 2019, was set, and the launch was scheduled for the summer of 2020 [60].

Project A was chastised in the summer of 2019. According to the report, it is not feasible to abandon the project despite the expenses incurred. Because of this, the authorities made the decision to build only 11 stations (the construction of 7 stations was put off until later) and started looking for other funding sources. The project's price tag was lowered to $1.55 billion. The Anti-Corruption Service audited the legitimacy of costs incurred during the building of Project A at the same time [60]. As of that moment, completion was scheduled for the end of 2022. Additionally, the line was expected to open to customers in 2023. For the time being, the authorities are searching for financiers willing to contribute to the controversial project. In 2023 the construction of Project A was restarted and it is expected that the project will be finished in two stages by 2026, dependent upon monthly funding. The first startup complex will be completed by 2025, while the second is expected to open by 2026 [61].

5.1.3 Causes

First of all the main causes are the financial problems of the owner, also distribution of the finances, and planning ineffectively cost estimation. Initially, the project was estimated to be expensive cost, and financial analysis was not done properly. Then by the owner, there was poor budget and cost control. Because finances were inactive or were used to other goals.

Concerning the financing of the construction of Project A, Owner A.1 received a state guarantee for the first time. Furthermore, the finances were transferred from the Chinese bank (investor) to the accounts of Owner A.1 [55]. In 2011, the state granted Owner A.1 its first payments of 10.3 billion tenges. However, the money remained inactive. Over this entire period, all finances were placed in a lower-level bank and stayed there until 2015 [62]. Financial irregularities totaling 9 billion tenges were discovered just a year later [55]. Out of 10 billion tenges, 4.5 billion tenges were set aside for engineering, design, and documentation work in the spring of 2013. The remaining 5.8 billion tenges was deposited by Owner A.1. However, an additional 38 billion tenge was transferred from the state budget to the company's funds throughout 2014 for implementing another less costly project. Following all payments, Owner A.2''s budget account held 3.6 billion tenge. In 2015, Project A was provided with the 5.5 billion tenges remaining from 2010 [62]. Only in 2018, 16.2 billion tenges were allocated from Kazakhstan's state budget for the building of Project A. Furthermore, it was discovered that $258 million in budgetary funds—funds obtained from the Chinese loan—were still deposited in lower-level banks, whose license was terminated because of financial difficulties. In 2019 Chinese bank (investor) had provided $343 million. At that period of time, only 15% of the installation and building work was finished. Contractor A.2 charged 313 million dollars for their services, of which only 86 million have been paid. 203 million dollars was the total sum owed to contractors.

Since 2011 (on a regular basis), funds from the state budget have been deposited into Owner A.1's funds to carry out the implementation of Project A. Kazakhstan's anti-corruption agency investigated the legitimacy of project expenditures and it turned up evidence of a billion-dollar theft conspiracy. The prosecutor's office currently discovered the misappropriation of 5.8 billion tenges from Project A through price manipulation and illegally enlisting the help of international engineering and consulting firms that specialize in infrastructure, energy, environmental, and urban solutions [62].

Secondly, there were too many changes among authorities during the entire period. Interference and interest of politicals in Project A delayed the process of construction. However, on the other hand, it was challenging for authorities to achieve their goal due to constant construction suspensions, orders, financial problems beyond their control, and an already-established pattern of misappropriation of the budget. Due to international obligations, authorities have been unable to suspend the project due to sanctions that carry significant financial losses if the requirements are not fulfilled.

Thirdly, even though the scope of the project was inspiring, many factors and calculations were unprocessed. Regarding the needs of the public in the city, everything that is done should be useful. In other words, it ought to align with the needs and advancements of the city during a specific stage of its growth. From this point of view, Project A is not timely. There are not enough people to follow the project's route subway system. In addition, the city has made significant changes to the detailed design plan and increased the number of high-rise and apartment buildings along the project. However, only after the project was completed, it was decided that accommodation was necessary. Consequently, the cause-and-effect link is incorrect. To meet the demands of the population, a wider range of public transportation options had to be developed in the city. A variety of instruments have been created for this objective, and the initiatives should address the existing obstacles and possibilities alongside the city's growth possibilities instead of the idea of realizing expensive Project A [63].

5.1.4 Impact and Results

The most important impact of Project A’s delay was the economic effect on the country. According to the general opinion of experts, this project is unprofitable and related to the global economic crisis and conditions, and from the point of view of the budget deficit in the country, it was inappropriate to get a loan from international companies. Also, after the transfer of the project to the balance of the city, it will be an excessive burden on the budget for many years, as this type of transportation needs quite a lot of expenses on maintenance and service [59].

Project A’s delay caused a huge backlash and negative public reaction. Residents and taxpayers were confused as to why, after so many years, the construction project was still uncompleted and not yet getting taxes from the citizens, since the budgeting was funded by the state. Many in the community were and still are opposed to funding this questionable project because of expensiveness and real necessity [59]. The reliability of the feasibility study's cost, the design and estimate documentation, the quantity of construction work completed, the provision of consulting services, and the technical supervision are all checked for accuracy.

These above-mentioned consequences of the delay of Project A affected the reputation of Kazakhstan worldwide and became an example of improper scope definition and poor management and control over the process.

5.2 Project B

Sometimes grandiose plans to develop the capital result in controversies. There is another extensive construction project in Astana in addition to the railroad tracks. The United Arab Emirates and Kazakhstan collaborated on the concept of Project B. The project is a distinctive skyscraper that will stand as one of the highest structures in the nation or possibly all of Central Asia [65].

5.2.1 Project Description

Project B is a multipurpose complex made up of several buildings with varying floors that is currently under construction in Kazakhstan's capital, Astana. It is Kazakhstan's highest point. At approximately 382 meters, the 75th floor will be the tower's highest point. Project B will occupy an area of over 510 thousand square meters overall. The project will have a total expense of $1.6 billion [66]. In addition to being the tallest point in Kazakhstan's capital, Project B is a true "city within a city," encompassing a hotel, a shopping center with apparel stores, a pharmacy, a supermarket, cafes, and a children's entertainment center, in addition to office space and business apartments [67]. Project B consists of two hotels, 111 thousand square meters of retail space, 500 apartments spread across a 75-story tower, and four high-rise buildings totaling 90 thousand square meters of office space. The complex's parking lot will have 5,300 spots available for parking [68]. November 2010 defined the start of construction, which was scheduled to end at the end of 2016. The project has not been fully commissioned yet, though.

An extensive period of engineering and geological research preceded the construction of such a large-scale project for Kazakhstan. Numerous experts from multiple fields investigated the site's geodetic, geological, and environmental characteristics. Therefore, when constructing the skyscraper, consideration was given to the high standards of quality as well as the unique climate, natural features, and other details of Astana. Stiffening belts, also known as outrigger belts, are installed on the skyscraper. Due to additional reinforcement, such systems give the building exceptional strength. Stiffening disks, such as spatial trusses several stories high, carry the weight of the building itself as well as the strong impact of steppe winds. A system of sensors built into the building structure is used within the building to monitor its stability and detect any deviations. The building process was considerably simplified by the establishment of a factory on the construction site to produce facade panels. The owner of the project made provisions for the treatment of metal and concrete structures with a special coating that enables them to withstand extremely low or high temperatures and maintain a comfortable microclimate of the entire building, taking into account the peculiarities of Astana's climate, particularly the capital's frosts. Fire-resistant materials are used to coat and treat the steel load-bearing components of the building frame and secondary floor beams. It's also interesting to note that the building's construction required the highest cranes in Central Asia [67].

Modern business centers and mixed-use complexes, or mixed-use developments, are in greater demand since they place all the facilities required for work as well as pleasure, including contemporary offices and fitness centers. The popularity of the mixed-use complex concept is a reflection of both the desire to save time—the most valuable resource—and the trend toward efficient space utilization. This gives the developer the chance to combine various types of space intended for a wide target audience on one territory, while the customer benefits from a comfortable place to work and activity. The most noteworthy example of this concept in Kazakhstan's real estate market is the multifunctional complex in Astana. Particularly in the office real estate market, Project B is considered the most enhanced business district in the capital. The presence of natural light and attractive views outside the office window may considerably increase employee efficiency. They experience less weariness and stress, as well as increased motivation and focus [69].

5.2.2 Timeline

In 2009 a development and investment company (Owner B) with the UAE government as a major shareholder was awarded a significant Kazakh project. Regarding the building of the complex, Kazakhstan and the UAE signed an intergovernmental agreement [70-71]. The agreement offered significant tax benefits for 25 years; Owner B will not be required to pay corporate income tax (CIT), value-added tax (VAT), land tax, property tax, or vehicle tax until 2034. Furthermore, Owner B and its contractors were granted an exemption from customs duties on imported building materials and components. Additionally, the document approved the employment of 6.6 thousand foreign laborers for the skyscraper's construction. Owner B, the exclusive owner of the future facility, agreed to invest roughly $1.6 billion in the building in exchange for favorable conditions [70]. The company also insisted on other requirements, such as not adhering to limitations on the proportion of foreign to local employees, professional training requirements for local staff, and publication requirements for job postings.

A capsule at the site of the future high-rise complex was placed in August 2009 [70]. According to the initial plans, the construction is supposed to start in 2009 and be finished in 2014. However, the 2010 excavation project was put on hold due to the crisis. By the end of the next year, the work started again, and by 2013, the construction site consisted of just piles for installation. Owner B's contract ended in the spring of 2013, while the company continued to be an investor in the project, as the general contractor at the construction site was replaced. The project's completion date was shifted to the end of 2016 when was appointed as the new general contractor (Contractor B). The idea was supposed to be presented the night before 2017. Even though the outside cladding of all buildings—aside from the high-rise tower—had been completed by the summer of 2017 and the construction of load-bearing components was complete, the deadline was again delayed. It was intended to finish in 2018, followed by 2019. It began discussing the completion of Project B in 2020, but these plans were never going to be fulfilled. This time, the COVID-19 pandemic was the reason [70].

On the other hand, some of the complex's facilities were still able to open: the 26-thousand-square-meter shopping center opened for business in December 2019, while the Hotel received its first visitors in March 2020 [70]. It was announced in the fall of 2020 that Contractor B would be dissolved due to adverse market conditions. The decision was taken during the annual general meeting following the discovery of multimillion-dollar losses through an audit. Even though the owner became bankrupt, the authorities of the city later reported on the construction being completed. Owner B stated that Project B's construction will not be impacted by the financial status of Contractor B. And that time, the deadline was moved to 2021. However, there, repair works are still being done [72].

5.2.3 Causes

The first factor of delay of Project B is crisis. Although the first construction began in November 2010, it was already put on hold in December. The cause was the world financial crisis, which also had an impact on Kazakhstan. The value of the national currency collapsed, and construction projects all over were put on hold [72]. In the beginning, it should be noted that global financial markets rapidly deteriorated in 2008 and within the first months of 2009, and demand for vital supplies declined. This affected Kazakhstan, which was further hit by a decrease in industrial production and financial sector liquidity issues. Recognizing the detrimental effects of the financial crisis on the nation's foreign exchange reserves and declining economic competitiveness, Kazakhstan devalued the tenge (to 150 tenges per dollar). Devaluation also resulted in a decline in the population's economic conditions and a worsening of Kazakhstani citizens' social conditions. The construction industry, which before the crisis more or less focused on a relatively high number of employed people in the nation's economy, made a significant "contribution" to the ranks of the unemployed. Official data for that period shows that Kazakhstan continued to lead the post-Soviet nations in bringing foreign direct investment, even in the face of the crisis [81]. Contrary to Western investors who are going through difficult times as a result of the credit and financial markets crisis, investments from the Persian Gulf countries, based on oil profits, are least susceptible to situational devaluation. Consequently, during those years, foreign private investment in Kazakhstan primarily came from Arab companies. This was the beginning of the construction of Project B [82]. The years 2008 and 2009 can be characterized as crisis years, and the years 2010 and 2011 as periods of economic recovery and crisis alleviation. The issue was only partly overcome in 2011.

The global economy decreased by 4.3% in 2020, which is nearly three times larger than what happened during the financial crisis of 2008. Due to the COVID-19 pandemic, there was a global financial crisis that resulted in devaluation, border closures, a temporary suspension of all industries, and a collapse in oil prices to negative levels. During this time, the primary contractor for Project B announced its liquidation. Its downfall was caused by deteriorating economic conditions, an overabundance of real estate, and dim growth prospects in addition to poor management. Owner B's representatives promised that the project would be completed in 2021, which is later than expected, because of the COVID-19 quarantine restrictions [83].

Secondly, during the construction external related factors have occurred. Between 2016 and 2018, the building burned at least five times. The fire in February 2016 spread from the 11th to the 25th floor using tarps and wooden shuttering. The mineral wool (insulation) at the second-floor level below caught fire on the evening of April 1 of that year. The fire occurred that month, consuming floors 38–40. Then the Hotel's dining room caught fire in November 2017, igniting items of furniture, appliances, and kitchenware. Before the state firefighting service arrived, the tower's own forces set out a fire that had fragmented in April 2018 due to the exterior cladding on the upper floors [70]. The complex is experiencing an important spike in fires. A structural collapse and a fire in a ventilation chamber were among the multiple fires that happened at various times. Both worker safety and the development of construction were negatively impacted by these incidents.

The third cause of the delay was social conflicts. With permission to employ over 6,000 foreign workers, the foreign partners, Owner B, preferred to hire mostly foreign specialists at the construction site because they had no social obligations to the local population. Additionally, they drew employees from countries with low salaries for low-skilled jobs. As a result, the Kazakhstani workers who started working at the construction site received inadequate salaries. As a result, there were several conflicts between workers, to exact 2012, 2014, and 2017 were years full of incidents[70], [72], [73]. It was due to the lack of knowledge about the socio-economic and technological environment of Owner B.

5.2.4 Impact and Results

Over the years of building, Project B has evolved into both a significant component of Astana's business district and a legendary figure in the community [70]. Also, Project A and Project B are connected. Project A's path is expected to run along the new administrative center and has to be finished at the same time as Project B [71]. Also following the commencement of Project B through private investment, private Arab investors have committed to executing several significant projects in the areas of education, healthcare, and tourism within the nation. In addition to bringing in more foreign capital, this will boost employment in the city.

5.3 Project C

Project C is about the national project of constructing schools which has certain risks of being out of schedule. The main causes of these risks are discussed below.

5.3.1 Project Description

Project C was launched and approved in 2022. Realization period is 2023–2025 years. The republican budget has allocated 2.385 trillion tenge (2023 - 499.999 billion tenge, 2024 - 976.394 billion tenge, 2025 - 909.439 billion tenge) for the realization of the national project during the 2023–2025 period [74]. Project C is currently classified as a pilot project. This could imply that it will continue with the potential to expand its scope further if it is implemented successfully. Kazakhstan's school-age population remains growing, and the country has many general education facilities that require modernization to become fully pleasant and modern [75].

Project C aims to deal with three-shift education, emergency facilities, and the lack of student spots in secondary education organizations [74]. As part of the initiative, 401 contemporary schools for 842 thousand students nationwide will be built. By constructing 369 schools in major cities and rural communities that can educate 300–2,500 students, it is intended to create a record number of additional student places in 2024–2025—738 thousand. By the end of 2024, 217 new, contemporary schools will be operational as part of the project's first phase.

Among these, 98 schools are scheduled to open on September 1st, and the remaining 119 by the end of the school year [76].

Task 1: by 2026, at least 740,000 extra student spots (with double-shift education) must be implemented in place in cities and rural areas to cover up for the present and anticipated student place shortfall. The following mechanisms are applied to accomplish this task:

- Client company C was assigned as the directorate responsible for the targeted building of secondary education organizations' objects within the national project's framework. The decision states that the coordinator-directorate for the implementation of the pilot national project in the field of education Consultant C will design objects of secondary education organizations under the national project in accordance with assignments for the design of secondary schools for 300, 600, 900, 1,200, 1,500, 2,000, and 2,500 students.
- Purchasing as products from their owners by local executive bodies, secondary education organizations' created items are ordered following the rules for the procurement of goods. This mechanism applies to secondary education organizations' facilities in oblast centers, republican significance cities, and the capital that meet the project's requirements and whose technical state is rated as "serviceable" or "operable" based on the findings of independent technical expertise carried out by local executive bodies designated expert organizations.
- Constructing secondary school buildings with a minimum design capacity of 1,200 student spots as part of public-private partnership projects (henceforth referred to as PPPs). The nationwide pilot project is structured around this mechanism, which is executed in compliance with the Basic Parameters of Public-Private Partnership Projects. If required, the PPP's Basic Parameters may be modified to represent more effective and/or clarified qualities as well as the amount of money expected to be spent within the parameters of the project.

Task 2: Establishing a safe and pleasant atmosphere for learning in secondary education establishments funded by the National Project.

Another expected outcome is to indicate that fixed capital investment in the secondary school sector will reach 109% (real increase percentage to 2021 levels) by 2025. Additionally, the establishment by 2026—at the latest—of secondary education facilities: 41.7 thousand permanent and 53.5 thousand temporary job places [74].

With a positive conclusion of the comprehensive non-departmental expertise of the state expert organization for reapplication and georeferencing of reapplication projects, the costs of developing 37 design and construction plans (6 types of schools for five climatic/seismic zones, 1 type of school for 2,500 pupils for one climatic/seismic zone, 6 individual projects) under the unified standard of the national project are carried out at the expense of funds allocated for the implementation of the national project. An information system for tracking construction progress, an interactive map with video streaming, and photo reports of construction sites for a variety of users will be available during the facility's construction. Local executive bodies will designate a person from among qualified education specialists as soon as construction starts. This person will oversee the building of the facility, furnish it with furnishings and technology, and begin the process of selecting teaching personnel by the date the facility is finished [74].

5.3.2 Timeline

It was announced the beginning of the program back in 2007, gave the government three years to construct one hundred new educational and medical facilities nationwide. However, there were delays in the project's 2016 final delivery. The state sustained damages totaling 1.5 billion tenge as a result of the program [84]. Later, in 2022 Project C was launched. It is noticed that in the previous program, there was not a permanent supervising operator. The scenario is very different concerning Project C. Consultant C has been designated by the government as the exclusive operator in charge of designing, building, and equipping educational institutions with all new equipment. In all, 369 new format schools are to be constructed as part of the 2023–2025 pilot project, with consideration given to all relevant requirements. Slightly less than half of the 369 schools that are planned will be built in villages, and 56% will be in cities [84]. The construction is now funded by budgetary resources, and it is expected to be completed by 2026.

5.3.3 Causes

First of all, the main risk of delay is low rates of project documentation development. At the beginning of the realization of the national project, there were a lot of concerns regarding the project documentation. Ensuring the completion of the design and estimated paperwork by the deadline specified in the tender, which is March 2023, was unrealistic. In contrast, the building regulations (SP RK 1.02-110-2013) provide that schools with 300–1200 students have nine months to produce the building and design documents. There is very little design competition for the project. The requirements stipulated for competition participants are implausible, and experts believe that they were purposefully designed and prescribed for particular participants who are either in the process of generating or already had ready-made paperwork [85]. Hundreds of projects struggle to meet the state's expertise during the whole year because every aspect of the design and estimate documentation of comfortable schools is evaluated in detail. The design and construction documentation, created by 50 design organizations, is actively discussed every day by the design group, under the direction of Consultant C. It is actually time-consuming. The main problem was that there was not ready the 37 common designs and estimated documentation, as was planned, for all identical schools all over the country.

Secondly, there were issues with site allocation. Formalism and the self-disengagement of the many regional authorities lead to delays regarding the registration of land plots and provision of engineering and communication infrastructure [77]. Bureaucracy within the government during the planning process has also interfered with the start dates of many construction projects [78]. A week after signing the contract, contractors were predicted to mobilize on the sites, however, several businesses were unable to meet this deadline. Construction company executives cite a variety of issues as the cause of this, including the site's lush landscaping and trees, challenging topography, garbage, and a lack of utilities. Consultant C highlighted that local administrative bodies have the authority to assign land properties. Project implementation is impacted when authorized bodies take longer than expected to complete tasks.

Thirdly, lack of sufficient control over the activities of contracting organizations [77]. Even though Consultant C, who is responsible for the project, adopted EPC contracts as a practice, there is still a risk of delay. This approach to construction management is foreign when it comes to complete turnkey facility delivery. It means, a group of construction and design firms will plan, create, and furnish educational facilities, and the client—represented by a single operator—will be given a fully functional school. This strategy will raise the bar for Kazakhstan's construction industry while also guaranteeing exceptional educational facilities. Project C's contractors are required to closely adhere to deadlines for the development of design and estimate documentation as well as construction work. The construction will be transferred to another, more responsible organization and the company will instantly cancel the contract unilaterally if they violate them for more than seven days or twice. These actions are performed to guarantee that all schools are operational within a reasonable timeframe. Additionally, cross-platform reporting by contractors in an electronic format on the status of work every week will guarantee transparency. This will make various levels of control possible. The system will notify you if the contractor is running late or is behind schedule on any particular type of work. Therefore, the system also has all payment records and completion certificates, so you can see exactly what the contractor has performed and how much money he has been paid. It even follows if the provider manages its subcontractors with integrity. Additionally, this should remove the possibility of corruption, which the public suspects might return [84]. Concerning technical supervision throughout the building and installation stages, entrepreneurs also have a lot of concerns [85].

Fourth, delay in the procurement of construction materials, equipment, and furniture. Due to the concept of supporting domestic manufacturers and industry, there are some procurement issues with certain types and amounts of products. The most important point of this suggestion was that since the project is funded by the Republican budget, the funds need to benefit the nation's economy. The government order on the project's implementation states that only local manufacturers with "ST-KZ" certificates may be used to acquire furniture for schools. The contractor has to provide a monthly report on the utilization of products and materials made in Kazakhstan is required from contractors [79].

5.3.4 Impact and Results

The opportunities for entrepreneurship in education are growing in appeal given the current shortage of student spots and the rising enrollment of schools. There is a stable market as one benefit of investing in education in Kazakhstan. A constant flow of students into educational institutions is made possible by a steady increase in the birth rate. An important factor in the education sector's appeal to investors is state support. A spike in demand for an unprepared supply, according to experts, will have dire repercussions. There are only so many building companies, suppliers, contractors, and laborers in the world. There is a significant chance that their prices and service costs will rise. Additionally, Project A's construction scale is bound to have an impact on inflationary processes. It is important to realize that the simultaneous construction of so many different locations and structures will eventually drive up the cost of building supplies. Macroeconomically speaking, there is a chance that inflation will pick up speed. The Center for Workforce Development of the Ministry of Labor and Social Protection of Population of the Republic of Kazakhstan projects that by 2027, there will be 5 million more people in the school-age population (6–18 years old). Experts' earlier predictions are starting to come true. The number of students attending secondary schools rose by 658,867 in five years, from 3,050,770 in the 2017–2018 academic year to 3,709,637 in 2022–2023. Concurrently, the number of schools in the network expanded by 410 during the course of the five years, rising from 7,414 in the 2017–2018 academic year to 7,824 in 2022–2023. The data clearly shows that, with all the associated ramifications, the rate of new school starts is falling behind the growth in need [86].

5.4 General Trend

Based on three cases, the causes of most delays of the complex projects can be summarized in Table 5.1 according to Table 2.3.

Table 5.1: Summary of case study analysis

No	Project	Causes of delays
1	Project A	Owner financial problems and delayed payment
2		Interference by political leaders
3		Change in governmental laws and regulations
4		Inappropriate owner-representative management style (Lack of owner's management skills)
5		Poor budget and cost control
6		Poor scope definition (Ambiguity in specifications and conflicting interpretation by parties)
7		Project complexity
8		Slowness in making a decision

9		Subcontractor problems (coordination, selection, competence)
10		Lack of risk response plan
11		Lack of knowledge about the socio-economic and technological environment
12		Uncertainties about regulatory and political issues
13		Lack of planning by government entities.
14		Non-payment or default in obtaining payment finished work
15	Project B	Lack of knowledge about the socio-economic and technological environment
16		Owner financial problems and delayed payment
17		Lack of planning by government entities.
18		Social effects
19		Force majeure
20		Inappropriate owner-representative management style (Lack of owner's management skills)
21		Uncertainties about regulatory and political issues
22		Lack of knowledge about the socio-economic and technological environment
23		Poor planning/scheduling and control procedures
24		Lack of risk response plan
25		Project complexity
26		Poor budget and cost control
27	Project C	Changes in owner's requirement
28		Slowness in making a decision
29		Lack of commitment and/or clear requirements of the owner
30		Delay in commencement
31		Unrealistic or unreasonable project/contract duration
32		Delay in reviewing and approving the design documents, sample material, etc. by the owner
33		Work starts before design completion
34		Poor scope definition (Ambiguity in specifications and conflicting interpretation by parties)
35		Construction material supply chain problems
36		Delay/ difficulty of governmental permit and approval procedures

Chapter 6 - New Approaches for Dealing Construction Delays

6.1 Delay Analysis Techniques in Kazakhstan

One of the digital instruments for enhancing the nation's construction industry's quality control and transparency is the E-Qurylys system, a unified information system. They are attempting to implement state architectural and construction control in the Republic of Kazakhstan with its assistance. It documents the stages of object acceptance and commissioning and includes all reports related to each construction object. It is a good idea for state control to use the "E-Qurylys" system to monitor the construction site with cameras, correct all stages of construction, control design, and estimate documentation, and provide justification for project and work costs. But more importantly, "E-Qurylys" is merely a fixation and control system; it is not a handy digital assistant for handling urgent construction tasks on the job site or in project management [80]. The "E-Qurylys" system collects and processes the following information:

- Reports on technical and design supervision;
- Recordings of the construction process;
- Documents of execution of planned and finished work;
- Reports of the acceptance of the project at all stages;
- Centralized information accessibility for every project;
- Centralization of testing of construction workers.

The planned and actual construction schedule, along with the percentage of work completed at each stage - from excavation to commissioning - will be shown by the system. There is online broadcasting, and photo and video fixation available. It will be feasible to keep track of the amount of domestically produced materials used in the building of the facility with the aid of the input control log[80].

Expert-customer interaction is facilitated by the E-PSD system. It keeps track of all project data, including estimates, standard projects, and technical and economic project indicators. The "single window" design of the E-PSD system facilitates communication between expert organizations and customers. It first includes information on technical and economic indicators, standard projects, expert organization conclusions, and aggregated estimates. The system's benefits include time savings and online information accessibility [80]. The following information can be taken from the E-PSD system:

- Conclusions from experts and consultants;
- Project feasibility studies;
- Bills of materials for the projects;
- Final project design and estimate documents;
- Approvals from experts.

A unified geoportal of infrastructure data (UGID) is also available in Kazakhstan. Its purpose is to control the planning and development of urban areas; it includes analytics on urban development along with data on all general plans, layouts, engineering nodes, and infrastructure. UGID GGK is currently updating its data continuously and will eventually become a digital twin of the nation's built environment, displaying visual information in a clear and understandable manner. It will be feasible to maintain engineering network statistics, raise tax revenues, save infrastructure costs, and lower the accident rate on engineering networks by 20% with an integrated approach to the creation of the town-planning cadastre. Links to engineering infrastructure facilities are publicly available through the town planning cadastre system. The process of giving each facility a unique number is also in progress. This will make it possible to guarantee the Architectural and planning task's issuance, the coordination of the system's preliminary design in accordance with master plans and detailed planning projects without taking human factors into account, the end-to-end verification of documents for compliance with the intended purpose, and the monitoring and tracking of all phases, beginning with the project's development. Everything will be evident in the little things that we take for granted every day. For instance, homeowners will be able to identify construction flaws and comprehend the parts of a home [80].

Expertise cycle provided by "Kazreestr". This is a single, integrated information system for sharing involvement in the housing construction industry. Automating data collection, processing, storing, and analysis in the state registration domain for the registration of shared housing construction is the aim. It includes electronic share participation agreements, data on-premises, notifications, and unique project numbers. One benefit of the system is that it removes the possibility of double selling of apartments and illegal real estate sales. First and foremost, the electronic system expedites the process for developers to submit applications, cutting down on the number of working days it takes to verify and register share participation agreements from three to two hours [80].

The housing and utility industries' needs are the e-SHANYRAQ system's primary focus. In order to guarantee the productivity and transparency of utility services, it is used to track and evaluate their performance. It consists of the water and heat metering system, the accounting system, the elevator control system, and so forth. Making timely decisions requires being able to quickly assess the state of the utility infrastructure, which is made possible by the system [80].

An online resource for building supplies material.kz. This platform connects Kazakhstani building material producers with construction firms, other market players, and prospective clients. Kazakhstan Housing Company developed the portal to assist Kazakhstani manufacturers of building supplies. The platform enables national manufacturers of building supplies to design a price-based showcase for themselves. Building materials from Kazakhstan can be directly accessed by construction companies, saving them the expense of having to find manufacturers. By using this method, one of the issues facing the housing construction market can be resolved: the information asymmetry and lack of knowledge in the housing sector can be eliminated [80].

Blockchain and tokenization in the real estate market. The parameters of tokenization for real estate are being discussed. This will transform the sector, boost real estate objects' liquidity, and facilitate the administration, taxation, and ownership transfer of real estate. Verifying the legitimacy of sales and purchases, offering risk insurance, and luring capital into rental property are all made possible by tokenization. Digitizing the rental housing market will be possible with an integrated approach, but institutional reform and oversight are still necessary. This will enable the establishment of contemporary real estate funds, draw in investments, and boost administrative effectiveness [80].

In terms of technology, the Internet of Things (IoT) is growing, and big data, cloud services, and various types of sensors are being actively utilized. Computer vision is one of the instruments utilized. It was feasible to visually assess the level of completion of various objects in Almaty with the use of a camera on an already finished project, including the number of installed window openings, finished balconies, and facade works. This makes it possible to comprehend the object's overall level of completion. Additionally, computer vision is utilized for entrance control, labor force movement scheduling, visitor count, identification of individual visitors, and machinery movement scheduling [80].

6.2 Techniques to Mitigate Delays in Kazakhstan

Digital technologies are transforming our lives in amazing ways; an idea that was novel a few years ago may quickly become the new norm, setting the stage for subsequent innovation in the same field. In Kazakhstan, a genuine digital revolution has started that will permanently alter the construction industry, which is one of the most traditional in the country's economy. The Republic of Kazakhstan 1.02-04-2018 "Information modeling in construction. Basic provisions" is a guideline document for construction that was authorized in 2018. It is based on BIM technology. The design of technologically complex objects in Kazakhstan is required to use BIM as of 2023, and the public construction services sector is actively making the shift to "digital" construction services [80].

The digitalization of construction in Kazakhstan is unique in that it is implemented at the state level and covering every stage of the life cycle of real estate objects, from design to online monitoring of building progress and operation (Table 5.1) [80]. Kazakhstan's construction sector has launched geo-information systems with notable success. Still, there are a lot of issues with digitalization in the Republic of Kazakhstan's construction sector. There will be an attempt to examine the Republic of Kazakhstan's construction sector in terms of digitalization in 2023 [80].

Table 6.1: Stages of development of BIM in Kazakhstan

Year	Actions
2015	KazNIISA initiative on industry transition to BIM Pilot project in ADSK Revit
2016	Research work of analyzing global BIM experience
2017	The concept of transitioning the construction industry from the Republic of Kazakhstan to TIMCO was developed, and the Action Plan for the introduction of information modeling technology in project design was approved by the Minister of Investment and Development along with two technical and regulatory documents.
2018	Acts about regulation "Information modeling in construction" Initiation of the ISO 81346 classifier adaptation project
2019	Pilot project implementation from conception to commissioning Adapting the legal framework following pilot project experience
2023	Establishing the necessity of the required application Requirement for the implementation of executive information models

The technology of information modeling of construction objects, or TIMCO (analog of building information modeling (BIM)), is a collection of methods, procedures, and laws that enable the sharing and organizing of data about a construction object throughout its entire life cycle [57]. In Kazakhstan, information modeling—also known as the technology of information modeling of building objects, or TIMCO—became widely used in the year 2023, marking a significant turning point in the field. Before that, seven years of planning and legislation adaptation were put into the introduction of building information modeling. The construction industry in Kazakhstan started implementing BIM in 2015. In 2016, Kazakhstan started implementing BIM in an inventive method. The Kazakh Research and Design Institute of Construction and Architecture was involved in general issues of BIM implementation, and this activity began proactively, without orders from above, and only after some time for the purposes of BIM implementation began to be allocated budget funding. The Committee for Construction Affairs directed and coordinated all activities, while RSE "Gosexpertiza" prepared for the transition to the information modeling sphere of project expertise. Important to remember is that the "Concept of introduction of information modeling technology in industrial and civil construction of the Republic of Kazakhstan" was the first project in Kazakhstan to use BIM, and KazNIISA was given the responsibility of developing it. Following the approval of a plan of measures for 2016–2019, the process of adapting the law to the new standards got underway. A set of guidelines and standards for the application of BIM technologies with due consideration to international standards, as well as a roadmap and unified system of information classification and coding, were developed [80].

A contemporary method for creating, organizing, managing, and using asset information across the asset life cycle is called TIMCO. Participants in the construction asset information modeling process make changes to the information model in a timely and coordinated way. Information modeling is carried out in compliance with exchange information requirements (EIR), which are requirements for clients’ requirements. Through collecting relevant and validated data through the information model, TIMCO makes it possible to cover every phase of a construction project's life cycle, from design through operation and liquidation. At every step of a construction project's life cycle, the information model's goal is to establish and maintain efficient information management of the asset and its constituent parts. The information model, which is updated over the course of the construction project, includes both engineering and financial data. Both structured and unstructured data can be included in the project information model (PIM) and asset information model (AIM). Databases, timetables, and graphical models are a few examples of organized information. Documentation, audio and video records and documentation are a few examples of unstructured information. All phases of the construction project life cycle are supported by the Project Information Model (PIM) and the Asset Information Model (AIM) [57].

Table 6.2: Life cycle of a construction project

Stages of the life cycle of a construction project	Steps of the life cycle of a construction project	Goals at stages	TIMCO's goals
Development of construction projects. It includes its design, building, and commissioning.	Preparing the construction site for predesign (includes engineering surveys)	Evaluating the construction project's sustainability, return on investment, and efficiency as an asset	1) Creating and comparing architectural and urban planning concept variations; 2) Identifying technical and financial indicators of volumetric and planning solutions to establish the rationale for construction investments; 3) Examine the prospective building object's location, engineering-geological conditions, and environmental conditions; 4) Carrying out engineering surveys for building; 5) Creating conceptual solution visualization
	Preparing construction design	Creating design and estimate documentation that complies with technical safety norms and client specifications	1) Developing specifications and drawings; 2) Getting technical solution verification and assessment; 3) Organizing spatial multidisciplinary cooperation and collision checking; 4) Estimating the scope of work processes and cost estimations; 5) Calculating engineering estimations; 6) Creating an all-inclusive, unified network timetable; 7) Providing the information model's display of design solutions
	Producing construction and installation works	In compliance with the project documentation, constructing a facility	1) Information modeling of building structures and products; 2) Developing of construction master plan; 3) Geodetic partitioning works; 4) Geodetic controlling in construction;

			5) Construction planning and management (determination of volumes, technological sequence, and terms of construction and installation works)
	Putting into operation	Distributing information in time to all stakeholders is guaranteed throughout the construction project's execution and operation, as needed, and in compliance with the requirements of confidentiality, reliability, and completeness of the content	
Operation of a construction project while it is under construction. It is when the facility is utilized, operated, and maintained.	Servicing	Constant operational effectiveness and functionality are guaranteed, and operating expenses are decreased	1) Planning for maintenance and repairs, including scheduling and quality control; 2) Managing data from performance monitoring; 3) Asset management; 4) Using an automated monitoring system to keep an eye on the state of the construction project; 5) Modeling emergency scenarios and creating efficient emergency response plans (such as choosing safe evacuation routes, etc.
	Current Repair		
	Substantial repair		
	Reconstruction		
Finalization of the existence of the construction project. The stage when the project ends with liquidation or post-utilization.	Liquidation	Ensuring the safe closure of a building site from the perspective of environmental regulations and the safety of human life activity	1) Determining the extent of the labor and estimating the cost, taking into account the steps and actions made in order to disassemble the building object; 2) Modeling and visualizing the disassembly procedure; 3) Labor protection and industrial safety monitoring at the location of the demolished structure

The subject of BIM application being required is being worked on by the Ministry of Infrastructure Development. Transitioning to BIM will be required for technically complex objects starting in 2025. By then, the data gathered from pilot projects will be used to update the legislation [80].

The creation of a "State Bank of Information Models" has as its primary goal the collection and archiving of information about TIMCO objects, which aids in decision-making during the execution of investment projects. Customers are currently able to submit BIM models as part of the project documentation for expert review. The developers must review the model for conflicts before submitting it for expert review. The expertise of the project created with the use of TIMCO is executed while keeping in mind Kazakhstan's building regulations [80].

However, generally speaking, Kazakhstan's BIM technology maturity is still categorized as 0 level, even with the state's actions. Many sizable building firms, developers, and architectural bureaus have already made the transition to information modeling. When asked if they were prepared to switch to the information system from TIMCO, half of Kazakhstan's top businesses said they were, and 70% of them reported having the right tools to work with 3D models. According to the survey, 48% of businesses use 3D modeling, 12% intend to use it, but 40% of businesses have not yet adopted the information model. The most popular software programs in Kazakhstan for creating 3D models are ABC, KOMPAS-3D, AutoCAD, Autodesk Revit, Autodesk 3ds Max, and ArchiCAD [80].

However, there have been several issues with TIMCO's implementation [80]:

- Not every business is prepared to transition to information modeling. Many businesses oppose TIMCO because it requires large investments in software, hardware, and staff training. Forty percent of respondents said they are not prepared to move into modeling. Big market players are actively involved in digital processes, producing their digital products in the construction industry. One example of this is BI Group, which has created a platform of BIM tools for all parties involved in the development of design and estimate documentation.
- Absence of TIMCO-related government orders. Businesses that have shifted to producing 3D models, committed large sums of money and helped the sector become more digitally literate talk about how much state assistance is required. The Republic of Kazakhstan has been creating rules, an action plan, and a state information system for some years. TIMCO projects are not subject to government orders, though; businesses anticipate that this will change in 2023.

- Lack of personnel. Only 46% of companies, according to the survey, have received TIMCO training. However, the same number do not consider it a priority and have not received any training in the new methodology. Specialists are not qualified to handle information models correctly. In general, Kazakhstan and other post-Soviet nations are experiencing a shortage of BIM managers and specialists who can work with information models.
- Many participants are unaware of the advantages of BIM, particularly customers. Working the traditional way is simpler, especially when considering Kazakhstan's unique construction needs: the country's low population density eliminates the need for intricate, high-rise structures.
- Need for application of project management practices.

Chapter 7 - Results and Discussions

7.1 Introduction

In this chapter, the responses from the survey are presented with discussions. Firstly, the results from the survey are divided into two parts: the demographic aspect of respondents and the analysis of the main part of the survey. Then, the analyzed data is discussed and compared with the results from case studies and literature review.

7.2 Discussions

The survey results were obtained and the statistical analysis provided a reliable database to extend the understanding of what are common causes of delays in the country within the construction industry. In this section insights from the literature review, the case studies, and the survey analysis are compared to get the final information. Table 7.1 demonstrates the investigated causes of delays in case study projects and the most frequent causes of delays from the opinions of respondents (mean value more than 4). With green color common points were highlighted.

Table 7.1: Summary of results

No.	Factors	Causes of delays from the Case study method	Causes of delays from the Survey method
1	Project-related factors	Unrealistic or unreasonable project/contract duration	Unrealistic or unreasonable project/contract duration
2		Poor scope definition (Ambiguity in specifications and conflicting interpretation by parties)	Poor scope definition
3		Poor budget and cost control	Poor budget and cost control
4			Difficulty in coordination and communication between various parties contractors, subcontractors, clients, consultants working on the project
5			Lack of accuracy in the studying of quantities, specifications, and

			drawings
6		Project complexity	
7		Slowness in making a decision	
8		Work starts before design completion	
9	Owner-related factors (or Consultant-related factors)	Changes in owner's requirement	Changes during construction issued by client
10		Delay in reviewing and approving the design documents, sample material, etc. by the owner	Delay in reviewing and approving the design documents, sample material and etc. by the client
11		Owner financial problems and delayed payment	Financial problems of client
12		Non-payment or default in obtaining payment finished work	Non-payment or a default in obtaining payment finished work
13		Inappropriate owner-representative management style (Lack of owner's management skills)	Poor planning/scheduling and control procedures
14		Lack of commitment and/or clear requirements of the owner	Lack of commitment and/or clear requirements of client
15			Complicated administration process of client
16			Delay in reviewing and approving the design documents, sample material etc. by the consultant
17	Contractor-related factors	Subcontractor problems (coordination, selection, competence)	Subcontractor problems (coordination, selection, competence,.)
18			Difficulties in financing project by contractor during construction
19			Construction errors, mistakes and substandard works
20		Lack of risk response plan	

21		Poor planning/scheduling and control procedures	
22		Delay in commencement	
23	Designer-related factors		Delay in preparing and authorization of drawings
24			Late arrival of design plans on-site
25			Improper or wrong cost estimation
26			Delay in preparation of design documents
27	Construction materials and equipment-related factors	Construction material supply chain problems	Construction material supply chain problems
28			Increased prices
29	Labour-related factors	-	Labor availability supply chain problems (shortage)
30	External-related factors and Government-related factors	Force majeure	Force majeure
31		Delay/ difficulty of governmental permit and approval procedures	Delay/ difficult of governmental permit and approval procedures
32		Corruption	Corruption
33		Interference by political leaders	
34		Change in governmental laws and regulations	
35		Lack of knowledge about the socio-economic and technological environment	
36		Uncertainties about regulatory and political issues	
37		Lack of planning by government entities.	
38		Social effects	

Chapter 8 - Conclusions

8.1 Conclusions

In conclusion, in today's world full of high technology and new innovations, it is becoming more difficult to realize complex and non-standard projects in terms of timely implementation. Kazakhstan as well as all other developing countries faces such problems every year. However, the causes and factors of project delays have not been fully investigated in Kazakhstan until this study.

By researching and analyzing the laws, and regulations of the country, with many examples and consequences, it was found that there are a number of projects that are not delivered on time in Kazakhstan. Since a lot of control, regulation, management, and supervision of the whole life project process is conservative and comprehensible. If all responsible parties, executives, and authorities perform their duties according to all requirements from pre-design to commissioning, there should be no delays.

Generalized and common causes of delays were derived from the works of other researchers around the world and were compared with the situation in Kazakhstan. Thus it was found that:

- Financial problems from the investors and clients/owners side is a very critical factor. Also unfortunately corruption is a more global and still fully unresolved issue for the country;

- The lack of disclosure of ideas and scope, and insufficiently competently done work before the project realization entails a lot of problems with timing and budgeting;

- Improper cost estimation and budget control;

- Bureaucracy and frequent changes made by the authorities are also a peculiar reason for Kazakhstan. Due to numerous changes in project design, documentation, and concept, many large projects may not be commissioned for years;

- Problems with subcontractors, their coordination, and planning of their work;

- Irresponsibility and negligence of all involved parties are important factor that affects not only the timing and budgeting but also the quality and significance of the project;

- Lastly, there might be unforeseen citations and force-majors that are out of control during the implementation of the projects.

8.2 Recommendations and Future Directions

Based on the collected information and findings, I would like to give some recommendations regarding delays in construction projects, especially major ones. First of all, it is necessary to think about all risks in advance in the pre-design stage and to work with different applications and software which is still new to Kazakhstan. TIMCO is a great idea that has become mandatory nowadays, but it needs to be improved and optimized. It is necessary to integrate foreign methods of analysis in Kazakhstan. Secondly, I think it is necessary to mention, discuss, and reveal all the examples where mistakes were made and because of which there were delays in the project. It is necessary to make reports, an evaluation sheet, or research on such cases in order to avoid these risks again in the future and to understand the importance of this problem. And lastly, it could be continued the topic of time delays by linking and relying on other aspects such as quality of work, financing, impact on society, and on the final result.

Also, the research analyzing all previous delayed projects in the country since independence would present the historiography of delays in Kazakhstan. It would be helpful to evaluate the level of the delays and how they were analyzed and mitigated through the years. On the basis of such a database, it could be predicted possible progress. Also through such work, it would be possible to investigate the whole impact on all spheres of the country nowadays.

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Appendices

Appendix A

The survey consent form and survey results are shown in the figures below.

Q1. In which company are you employed?

- ◯ Client company
- ◯ Consultant company
- ◯ Designer company
- ◯ Contractor company
- ◯ Other (please specify) [ ]

*Q2. What is your working experience in years?

- ◯ Less than 1 year
- ◯ 1 - 5 years
- ◯ 6 - 10 years
- ◯ 11 - 15 years
- ◯ 16 - 20 years
- ◯ More than 20 years

Figure A.1: Questions 1 and 2

*Q3. What is your profession?

○ Architect

○ Engineer

○ Project Manager

○ Consultant

○ Construction estimator

○ Other (please specify) [ ]

*Q4. What type of building projects does your organization specialize in? (multiple answers are acceptable)

☐ Residential Building Project

☐ Private Project

☐ Commercial Project

☐ State Construction Project

☐ Industrial Project

☐ Infrastructure and Heavy Construction Project

☐ Highway Construction Project

Figure A.2: Questions 3 and 4

Q5. Has any project you have worked experienced delay?

- ◯ Yes
- ◯ No

Q6. If yes, for how long?

- ◯ 1 - 3 months
- ◯ 4 - 6 months
- ◯ 6 - 12 months
- ◯ More than 1 year
- ◯ More than 5 years

Figure A.3: Questions 5 and 6

Client related delay causes: Please, assess the importance of the following delay causes. (1 - not at all important, 5 - extremely important)

	1	2	3	4	5
CL1. Changes in client's requirements	○	○	○	○	○
CL2. Lack of commitment and/or clear requirements of client	○	○	○	○	○
CL3. Slowness or delay of the decision making process	○	○	○	○	○
CL4. Changes during construction issued by client	○	○	○	○	○
CL5. Delay in reviewing and approving the design documents, sample material and etc. by the client	○	○	○	○	○
CL6. Lack of client's management skills	○	○	○	○	○
CL7. The weakness of coordination between service providers that is related to project sites and project works	○	○	○	○	○
CL8. The weakness of experience of some engineers in studies and supervision	○	○	○	○	○
CL9. Owner's indication of suspension or delay	○	○	○	○	○
CL10. Financial problems of client	○	○	○	○	○
CL11. Non-payment or a default in obtaining payment finished work	○	○	○	○	○
CL12. Complicated administration process of client	○	○	○	○	○
CL13. Delay in the provision of construction site by client	○	○	○	○	○
CL14. Delay in the provision of on-site public services	○	○	○	○	○
CL15. Limited negotiations with the consultant	○	○	○	○	○
CL16. Slow or low quality inspection process of the completed work	○	○	○	○	○

Figure A.4: Question 7

Consultant related delay causes: Please, assess the importance of the following delay causes. (1 - not at all important, 5 - extremely important)

	1	2	3	4	5
C1. Improper selection of subsequent consultants	○	○	○	○	○
C2. Limited negotiations with the contractor	○	○	○	○	○
C3. Delay in reviewing and approving the design documents, sample material etc. by the consultant	○	○	○	○	○
C4. Slow or low quality inspection process of the completed work	○	○	○	○	○
C5. Poor planning/scheduling and control procedures	○	○	○	○	○
C6. Financial problems of consultant	○	○	○	○	○

Figure A.5: Question 8

Designer related delay causes: Please, assess the importance of the following delay causes. (1 - not at all important, 5 - extremely important)

	1	2	3	4	5
D1. Changes in material types, specifications, and projects during construction	○	○	○	○	○
D2. Design team experience deficiency	○	○	○	○	○
D3. Defective in design quality such as mistakes, errors, incomplete	○	○	○	○	○
D4. Delay in preparing and authorization of drawings	○	○	○	○	○
D5. Late arrival of design plans on-site	○	○	○	○	○
D6. Delay related to shop drawings and material samples	○	○	○	○	○
D7. Lack of database in estimating activity duration and resources	○	○	○	○	○
D8. Unrealistic design duration imposed	○	○	○	○	○
D9. Improper or wrong cost estimation	○	○	○	○	○
D10. Disagreement on design specifications	○	○	○	○	○
D11. Slow decision making by designers	○	○	○	○	○
D12. Delay in preparation of design documents	○	○	○	○	○

Figure A.6: Question 9

Contractor related delay causes: Please, assess the importance of the following delay causes. (1 - not at all important, 5 - extremely important)

	1	2	3	4	5
CT1. Financial problems of contractor	○	○	○	○	○
CT2. Weakness of the technical capabilities of some contractors	○	○	○	○	○
CT3. Poor planning/scheduling and control procedures	○	○	○	○	○
CT4. Poor organization, site management and supervision	○	○	○	○	○
CT5. Conflicts during work execution	○	○	○	○	○
CT6. Subcontractor problems (coordination, selection, competence,.)	○	○	○	○	○
CT7. Difficulties in financing project by contractor during construction	○	○	○	○	○
CT8. Construction errors, mistakes and substandard works	○	○	○	○	○
CT9. Inadequate contractor qualification and experience	○	○	○	○	○
CT10. Inadequate techniques, methods and tools used in project planning	○	○	○	○	○
CT11. Inappropriate schedules with labour regulations	○	○	○	○	○
CT12. Difficulties in internal administrative procedures	○	○	○	○	○
CT13. Delay in commencement	○	○	○	○	○
CT14. Lack of quality control / mistakes during construction	○	○	○	○	○
CT15. Poor information exchanges	○	○	○	○	○

Figure A.7: Question 10

Material and equipment related delay causes: Please, assess the importance of the following delay causes. (1 - not at all important, 5 - extremely important)

	1	2	3	4	5
M1. Construction material supply chain problems	○	○	○	○	○
M2. Delay in materials delivery	○	○	○	○	○
M3. Shortage in local required quality construction materials	○	○	○	○	○
M4. Shortage in material and high technology equipments	○	○	○	○	○
M5. Increased prices	○	○	○	○	○
M6. Damages of materials and equipment	○	○	○	○	○
M7. Lack of equipment efficiency	○	○	○	○	○

Figure A.8: Question 11

Labor related delay causes: Please, assess the importance of the following delay causes. (1 - not at all important, 5 - extremely important)

	1	2	3	4	5
L1. Poor productivity level of labors	○	○	○	○	○
L2. Labor availability supply chain problems (shortage)	○	○	○	○	○
L3. Insufficient skilled labour to manage construction projects	○	○	○	○	○

Figure A.9: Question 12

Project and contract related delay causes: Please, assess the importance of the following delay causes. (1 - not at all important, 5 - extremely important)

	1	2	3	4	5
P1. Unrealistic or unreasonable project/contract duration	○	○	○	○	○
P2. Poor scope definition	○	○	○	○	○
P3. Difficulty in coordination and communication between various parties contractors, subcontractors, client, consultants working on the project	○	○	○	○	○
P4. Improper consultation between parties	○	○	○	○	○
P5. Problems due to usage of contract clauses and procedures (Non-compliance with contract-award rules)	○	○	○	○	○
P6. Contract termination and change of contractor	○	○	○	○	○
P7. Conflict between the main parties to the contract	○	○	○	○	○
P8. Variation orders/change of scope during construction	○	○	○	○	○
P9. Problems due to construction resources management	○	○	○	○	○
P10. Slow variation orders in extra quantities	○	○	○	○	○
P11. Work start before design completion	○	○	○	○	○
P12. Project complexity	○	○	○	○	○
P13. Improper focus on financial analysis and awarding the lowest bidder	○	○	○	○	○
P14. Lack of accuracy in the studying of quantities, specifications, and drawings	○	○	○	○	○
P15. Poor budget and cost control	○	○	○	○	○
P16. Ineffective delay penalties	○	○	○	○	○

Figure A.10: Question 13

External and govermental related delay causes: Please, assess the importance of the following delay causes. (1 - not at all important, 5 - extremely important)

	1	2	3	4	5
E1. Unforeseen site conditions	○	○	○	○	○
E2. Accidents during construction due to lack of safety measures	○	○	○	○	○
E3. Force majeure	○	○	○	○	○
E4. Weather/climate conditions	○	○	○	○	○
E5. Lack of knowledge about the socio-economic and technological environment	○	○	○	○	○
E6. Uncertainties about regulatory and political issues	○	○	○	○	○
E7. Lack of knowledge about the project's closest environment	○	○	○	○	○
E8. Long customs clearance procedures of imported products	○	○	○	○	○
E9. Delay/ difficult of governmental permit and approval procedures	○	○	○	○	○
E10. Change in governmental laws and regulations	○	○	○	○	○
E11. Interference by political leaders	○	○	○	○	○
E12. Government entities are late in giving financial rights to contractors	○	○	○	○	○
E13. Lack of planning by government entities	○	○	○	○	○
E14. The weakness of training and development of engineers and engineering departments	○	○	○	○	○
E15. Corruption	○	○	○	○	○

Figure A.11: Question 14

Please feel free to include any additional suggestions and comments about delay caues that have significant influence.

Figure A.12: Question 15

This is the last page of the survey.

Once you click the "Submit" button below, you will not be able to participate in this survey again and your answers will be recorded. You can go back to questions if you think you have something to change.

Figure A.13: Submission page of the survey