Cost Overrun Factors During the Lifecycle Phases of Buildings Construction Projects in the United Arab Emirates

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Abstract

Cost overruns are quite common in the construction industry. The phrase refers to extra project costs relative to what was initially estimated. Examples of causal factors that can lead to cost overrun include mistakes in design, inaccurate estimations, engineering variations, and reworks. Due to the unique nature of construction projects that is characterized by different time-phased stages and quality, cost overrun factors will have varied impacts during different phases of the project lifecycle. Although significant research has been done on the topic of cost overruns, the presence of this issue requires more investigation into the root causes in order to develop workable tools and mitigation measures. It is argued here that cost overruns can be more noticeable in countries with rapid growth, such as the United Arab Emirates (UAE). The main goal of this research is to identify the major factors causing cost overruns in UAE construction sector projects with the focus on four project lifecycle phases, namely, the design, bidding, construction and Defect Liability Period (DLP). The number of factors that could lead to cost overruns during different phases have been identified in the literature review. A survey was carried out on UAE-based projects with consideration for numerous stakeholders, including clients, contractors, and consultants. The study identifies a number of significant factors shaping cost overruns based on a practical evaluation of projects. This research will support future steps towards developing extensive tools to monitor and mitigate cost overruns in construction projects during different phases.

Keywords

Cost Overrun, Project Lifecycle Phases, Estimation, Stakeholders, Construction

1. Introduction

Around the world, the construction industry is widely viewed as a leading investment sector, reflecting the quality of a country's economy. Since the construction industry has been attracting investors, and employees and their families, governments should work on providing services needed for enhancing the functionality of their countries'

infrastructure. This relationship between infrastructure development and community welfare will always encourage both investors and governments to collaboratively work hard to launch new construction projects.

The UAE has experienced a steady growth in the construction industry over the past decade. This resulted in a diversification of investments, paving the way for the country's construction industry to flourish and completely re-define the world's perceptions of this sector. The UAE's construction industry's contribution to the country's Gross Domestic Product (GDP) has been steadily increasing over the past few years. Back in 2007, it was found out that the construction industry was the fourth amongst the country's largest economic sectors. In 2018, the construction industry contributed to 6.4% of Dubai's total GDP ($108.4bn), rising to a 6.7% during the first half of 2019 (Dubai Statistics Center, 2019). In addition, the construction industry has been identified as the UAE's largest employer, contributing to around 34% of the UAE's workforce, estimated at 1.5 million laborers (Sequeira, 2015), underscoring the importance of this sector for economic stability. But the construction industry comes with some drawbacks and limitations, foremost of which is the cost overrun. As the cost represents the most critical factor in any feasibility study, investor can decide whether to go ahead with the project or look for alternatives. Though an "Order of Magnitude Estimate" is advisable at the earliest in the feasibility stage, it was found out that the accuracy of such estimates could vary between -40% to +40%, according to a report by AACE International, (2020). This wide range means that decision makers will have to spend more money and time for advancing analysis and finalizing the design during the other phases. The traditional approach has been to wait until the full design package is completed to provide investors with a better estimate. However, the accuracy of the final estimate will still vary between the -5% and +10% as suggested by the US Department of Energy Cost Estimating Guide (2018). The exact figure will only be determined after completing the project which might cause a huge loss to investors.

On the other hand, the contractor goal is to win the bid on the project by submitting the lowest applicable price, keeping in mind that the fundamental concept of any business is to make profit. Some contractors could submit a very low price, even lower than the actual cost. Reasons for this include errors in quantity takeoff or estimating calculations, financial issues, or current situation of market. If the project was awarded based on the lowest-bid concept and the submitted price was lower than the project cost, then in most cases, the contractor will try to compensate that loss by lowering the quality of the work. Cost overrun factors and the reasons for their occurrence should be clearly identified to mitigate their impact during the different phases of the project lifecycle. Researchers around the world studied the cost overrun concept, analyzed its reasons and its impact on the project, but gaps in this research area remain massive, as the detailed impact of factors with comparison to estimations was not previously investigated with respect to different lifecycle phases or in the UAE. In addition to that, limited research has considered the impact of currently executed projects in predicting cost overruns, while preparing estimates for new projects.

Construction projects go through different phases in their lifecycles. For the purpose of this research, the different phases of a project's lifecycle that will be studied have been limited to four: The design phase, the bidding phase, the construction phase and the Defect Liability Period (DLP). Accordingly, each phase of the project is subject to cost overruns, which is due to reasons that vary from one phase to another. These factors will be identified in this research along with their frequent effects on projects costs. Gathering and analyzing such information continuously will cost more time and money than does the existing procedure. But if all this information is to be gathered and analyzed realistically, then it will generate indices to implement while preparing future estimates.

Larger projects information will lead to more accurate results. Thus, the research will follow a pragmatic research philosophy from data to theory, where the research approach and strategy would be quantitatively supporting a stronger inductive approach. The methodology will commence after conducting the literature review and highlighting previous research methodologies, gaps, and suggested future research priorities. The first step in the methodology focuses on understanding cost overrun factors and their frequent impact on the four lifecycle phases where data will be collected from previous research, interviews and questionnaires. The second step includes filtering the previous collected data and analyzing it. The research contribution will be essential to the field of construction management as the issue of cost overrun is remarkably complex. The research is expected to support the theoretical studies in the area of projects cost. In addition, this research is expected to provide building construction stakeholders in the UAE with a practical indicative map that highlights cost overrun factors during four phases of the project lifecycle to improve future cost estimates. The research will be focused on building construction projects in the UAE and will be limited to four phases of projects lifecycle. The research will follow a standard layout starting with the research literature review. Next, would be the methodology where steps of collecting and analyzing the data will be discussed.

2. Literature Review

This section reviews published research carried out on topics such as project lifecycle phases, cost estimation and cost overrun. Understanding the building projects lifecycle phases and investigating cost overrun factors in each phase of the project lifecycle and in UAE will be the starting point of this research to help understand the different variables bearing on the project's cost as construction projects pass through different phases throughout their lifecycles. The phases have been described and classified in numerous ways. For example, Zhao et al. (2010) as quoted in Renuka et al. (2014), divided the construction lifecycle into six stages that include pre-bidding, planning, design, execution, implementation and handing over. Likewise, Alshubbak et al. (2009) framed the construction cycle in five phases that consist of feasibility, design, construction & inspection, exploitation (operation & maintenance) and dismantling. Moreover, Saad (2011) described the five phases of the total project's lifecycle as major project activities which include conceptual & planning, engineering & functional design, preparing drawings & specifications in addition to tendering and awarding, construction & completion, and operation & utilization. In this study, the economic feasibility study phase will not be discussed as research works in that area not directly related to construction costs. In addition, the study will not cover the operational and dismantling phases where the main contractor is not involved. To support the coherence of this research, the construction project lifecycle has been divided into four phases: the designing phase, the budgeting phase, the construction phase, and the Defect Liability Period (DLP) as shown in Figure 1 below.

Figure 1. Construction Projects Lifecycle

According to Hatush et al. (2005), the design phase needs qualified technical experts as it involves the preparation of engineering maps. Respectively, Bennett (2003) suggested that the design phase can be divided into three distinctive stages. The first stage occurs when the projects' objectives are defined by comparing alternatives to achieve optimum objectives and financial feasibility. During the second stage, architectural drawings are developed to demonstrate relationships among project elements, followed by detailed designs relating to the structural, MEP and finishing aspects. In the third stage, the contract documents are produced for use in contractor selection. The outcome of the design phase will include a full set of bidding documents for the contractor selection stage, including initial plans of the construction process, drawings, and specifications. Furthermore, The bidding phase provides a controlling benchmark of project cost to ensure the construction falls within the clients' budget (Ali & Kamaruzzaman, 2010). Multiple techniques and strategies can be adopted to shortlist the competitors and select the best comprehensive offer submitted from the most reliable contractors. Moreover, the construction phase covers the designs and plans to be executed (Roslan et al. 2014). The execution process consists of two aspects (Breesam, 2017): The first aspect is executing the work to complete the product of the project, while the second aspect is implementing a definite project plan. During the construction or execution phases, the project team implements all works that had been defined during the previous phases. The last phase is the Defect Liability Period, which begins upon the completion of the project and goes on for a specified period of time that normally runs for one year. The defects liability obligation acknowledges defects which can occur in cases of damage during the construction phase or during incorrect implementation. McNair (2016) stated that contractors are obliged to rectify those defects and meet the agreed standard specifications in the contract. During this period, the building operator will raise all concerns and identify defects to the main contractor. It will be the responsibility of the main contractor to do the necessary maintenance or coordinate with subcontractors responsible for that task. In summary, this research will focus on four phases which are design, bidding, construction and the DLP. The characteristics of the four construction lifecycle phases in this research are summarized in Table 1 below. The role of the primary construction project stakeholders namely, the client, consultant, and contractor, are also highlighted on the table. The concept of estimation is very critical to the construction industry as it motivates clients to participate in profitable investments. As project elements get more and more defined throughout the project lifecycle, estimated prices keep fluctuating. Different factors may affect the project's final cost compared to the estimated price. Thus, the accuracy of the estimation varies between different phases; yet it cannot be predicted till the finalization of the project. This fluctuation results in losses for both investors and contractors since the excessive cost was not accounted for earlier. Table 2 has been generated and developed based on the cost estimate classification matrix for process industries by AACE International (2020) which lists different types of estimates and their related phases, in addition to the amount of information available during the listed phases. Furthermore, the table

indicates the use of such estimates and the levels of accuracy (Table 1). As the terminologies and definitions vary from one background to another, a second aim of this proposed table is to standardize definitions of general concepts, which will support other parts of the research.

Table 1. Characteristics of Construction Projects Lifecycle Phases

	Design Phase	Bidding Phase	Construction Phase	Defect Liability Period
What	Determine plans/ specifications	Award the execution of project to a bidder	Execution the project	Maintaining the project
Why	Identify a solution / Design the product	To select qualify bidders	Build the product	Check construction defects
Who	Technical specialist	Contracts professional	Specialist Labors	User
Where	Office	Office	Site and office	Site
When	Start of project	After designing and before execution	Start form commencement	Operation Phase, after construction
How	Contracts - Analysis - Design	Best bidding offer	Implementing the plan and design	Using the project
How Much	Medium Expenses	Minimum Expenses	Maximum expense	Income
Client	Approvals of plans and budget	Approve consultant choice and cost	Commissioning	Operation
Consultant	Main tasks during this phase	Review submitted biddings	Planning / supervising	Communication
Contractor	Minimum involvement	Study documents and submit bid	Implementation / Installation	Maintenance team

In order to explain the issue of cost overruns, it is important to provide a clear understanding of the definition of "a project" and its characteristics. Based on the Cambridge dictionary "a project is a piece of planned work or an activity that is completed over a period of time and is intended to achieve a particular purpose". The Project Management Institute (PMI) identified uniqueness as the main characteristic of a project. No matter how similar two projects are, at different points of their lifecycle, each will have its own challenges. Thus, project plans and execution strategies will change accordingly. This uncertainty will have an inverse correlation with available information along the project lifecycle. During each phase of the lifecycle, different estimate types of project costs will be generated and will be referred to for different purposes. Accuracy of cost estimation will increase along the project progression until the exact final cost is achieved at the conclusion of the project. When comparing the final cost to each estimate type, a variance amount will be noticed. If this change in amount exceeds the estimate, it will be described as Cost Overrun. According to Al-hazim et al. (2017), cost overrun is defined as an unexpected additional cost to projects that is greater than what was initially estimated. Cost overrun is a common problem within the construction industry that occurs due to several factors such as inaccurate cost estimation, delay of project, poor implementation of works, and many more (Subramani et al., 2014). Typically, cost overruns can be analyzed by comparing the final actual cost at the end of each phase with the estimation submitted at the beginning of that particular phase. According to Alkhatib & Altarazi (2019), the typical cost overrun for construction projects varies between 12% to 70% of the contract value.

On the other hand, the UAE utilizes the construction sector to its maximum capabilities to support its developing plans and vision. Starting with an inclusive infrastructure network and reaching to the tallest building in the world, the urban development in the UAE through different and distinct construction projects is just unique. The construction industry is considered as a leading sector in the UAE economy, but like other construction sectors around the world, it is unlikely to find a project that is committed to its budget and time. Faridi & El-Sayegh (2006) stated that about 50% of the UAE projects were analyzed with delay and cost overrun. Different factors affect the cost allocation and flow in construction projects, such as the COVID-19 pandemic whose impact will undoubtedly continue to be felt in the coming years. Similarly, researchers have looked into cost overruns and their impact on construction projects in the

UAE. Ramabhadran (2018) identified the main causes of cost overruns in UAE construction projects. Around 200 professionals were classified based on their occupation into five categories: architects, cost consultants, project management consultants, main contractors, and subcontractors. A survey of specialists concluded that the main five causes of cost overruns in UAE construction projects are poor productivity, insufficient early planning, delays in projects completion, unskilled resources, and lack of motivation. This study can be improved as results analysis has not taken into consideration the weight of responses representing each discipline in assessing the overall order of causes and mitigation measures. Somehow respondents will refer to the variables which can be caused by others as more critical. Moreover, if the number of responses received from each stakeholder category is asymmetrical, then the overall ranking can be considered as biased. For example, in the study, insufficient early planning was ranked third overall based on the frequency index results, but it was ranked as the thirteenth reason for cost overruns by the architect respondents following the same analysis. Additionally, Johnson & Babu (2020) claimed that the five main causes of cost overruns in UAE construction projects are: Design variations by client and consultant, poor cost estimation, clients approval delays, client financial constraints, and inadequate procurement methods. The results were based on a survey received from around fifty professionals representing five categories: Clients 25%, design consultants 25%, main contractors 25%, cost management consultants 13%, and project management consultants 12%. The experts' years of experience were analyzed with reference to overall years of experience in the construction industry and in the UAE only. Though the number of representatives from each occupation is relatively the same, the low number of respondents might weaken the reliability of the results.

Table 2. Cost Estimate Classification Matrix for Construction Industry (AACE International, 2020)

The phase in which the estimate is submitted	Estimate Type	Definition	Estimating Method		Purpose	Information Level of Project Definition	Expected Accuracy Range (variation)
Initiating Phase	Order of Magnitude	Developing a rough estimate by depending on historical information. Can be improved by using cost factors indices	Analogous	Top to down estimate. Expert Judgment based on historical data	Conceptual Estimate Project Selection and initiation	0%to 2%	L:-20%to -50% H:+30%to +100%
			Capacity factor	Identifying cost of proposed project by comparing its capacity or production rate to previous projects			
			Parametric Models	Scalable measurement, by using of mathematical relationship between variables from old data			
Feasibility Phase	Feasibility	Highlighting the project suggested plan of work and related cost.	Equipment Factor	Identifying cost of proposed project by comparing the number of Main Items with previous projects	Feasibility economic Study Presented to decision makers for Go/No-Go decision	1%to 15%	L:-15%to -30% H:+20%to +50%
			Parametric Models	Scalable measurement, by using of mathematical relationship between variables from old data			
Design Phase	Preliminary	forecast the project budget by selecting the best alternative from different options	Semi-Detailed Unit Cost	Assembly level Line items	Allocate Budget Procced with selected option	10%to 40%	L:-10%to -20% H:+10%to +30%
Bidding Phase	Substantive	Preparing Project Bill of Quantity based on design and assign cost to specified items with addition to overhead and profit amount of the estimating entity	Detailed Unit Cost	Forced Detailed Take-off	Award project based on Bidding analysis Approve project cost	30%to 70%	L:-5%to -15% H:+5%to +20%
Execution Phase & DLP	Definitive	During project execution and according to project scenario, contractors will request for quotations of different items where for cost can vary.	Detailed Unit Cost	Detailed Take-off	Project controlling Contracts and purchasing	50%to 100%	L:-3%to -10% H:+3%to +15%

AL Mousli & El-Sayegh (2016) studied the causes of cost overruns in UAE construction projects, but from a different perspective. The focus of their study was on the interfacing issues that could arise between project design and construction phases. The study suggested twenty-two interface problems falling under three categories: design phase, construction phase, and design-construction phase. The results suggested that the top five design-construction interface factors are: weak coordination inside the design firm, unexperienced construction manager, poorly written contract, project management professional participation, and time constrains in the design phase. A relatively newer study was conducted by Al Hosani et al. (2020) on factors causing cost overruns in UAE infrastructure projects. The findings of the questionnaire survey were also based on an assessment of the severity, frequency, and importance indices. The factors identified by this study fall under nine categories which are: material, labor and equipment, financing, design and documentation, management and organization, schedule, contractual issues, scope of work, and external issues. The study suggested five major reasons leading to cost overruns in UAE road projects including delays by authorities, continuous changes by clients, inappropriate cost estimate, weak site management, and frequency of variation orders and additional works. Therefore, cost overrun is one of the biggest challenges which the UAE

construction industry is facing. As per the annual Global Construction Survey – UAE findings conducted by KPMG International (2019) show that 44% of respondents identified cost overruns as the biggest challenge that faces the UAE construction industry. (Table 2)

3. Research Methodology

The research methodology aims to close the gaps of previous analysis models and methods noted in the literature review. The importance of developing a clear and systematic methodology derives from highlighting the significance of the research subject and providing the user with a practical tool to highlight the factors of cost overruns in each of the four phases of the UAE construction projects in order to control their impact. The research follows an inductive approach to conclude the outcomes of the methodology under the umbrella of a pragmatist research philosophy. The research methodology will be divided into three Stages:

Stage 1: Data Collection. Identify cost overrun factors with respect to four phases of the UAE construction projects lifecycle. After conducting an intensive review of existing literature, interviews and questionnaires have been developed and shared with stakeholders representing clients, consultants, and contractors. Data have been collected and classified under specified categories.

Stage 2: Data pre-processing. Data will go through different stages of filtering, analysis, and normalization. This is important to rank cost overrun factors based on their relative importance.

Stage 3: Validation. in which data and results have been tested to check the reliability of the proposed model to conclude the inductive approach followed in this research project.

4. Data Collection

The main objective of this step is to collect primary data required to fulfill the research objectives. A survey has been conducted after concluding the following Steps:

Step 1: Collection of data from previous research.

Step 2: Interviews with professionals.

Step 3: Survey Questionnaire.

Historical data was gathered from previous studies and research as a preparation for expert interviews to highlight the most common cost overrun factors in UAE construction projects. Interviews with selected expertise representing different stakeholders was conducted to identify their perceptions of the main cost overrun factors in UAE construction projects. Next, the interviews results were used to design a survey which was shared with a sample of the industry employees representing different stakeholders in the construction industry. The survey used a 5-point Likert scale survey to encourage respondents to participate, and to support data analysis. Collected data have been analyzed under two categories representing lifecycle phases and stakeholders. To fulfil the first step, cost overrun factors were collected from previous research, listed, cross-checked and categorized with respect to the different project lifecycle phases. The next step was to set up interviews with selected professionals from the construction industry in the UAE to receive their input about the collected overrun factors in addition to provide additional factors impacting UAE building construction project costs. The Interview results suggested sixty-seven cost overrun factors during the different four phases of construction projects lifecycle in UAE as Table 3 show below. Each cost overrun factor was assigned an ID for convenient referencing and analysis during next steps. Design phase-related cost overrun factors were assigned the ID code (DPF) and the interviews results suggested fifteen cost overrun factors under this phase. Similarly, bidding phase related cost overrun factors were assigned the code (BPF) and the interviews suggested fifteen factors that could results in cost overrun during this phase. For the construction phase, the interviews proposed twenty-two factor cost overrun factors which were given the code (CPF). And for the defect liability period, the fifteen cost overrun factors resulted from the interviews were assigned the code (DLPF). Next, a questionnaire was constructed using Google Forms as a 5-point Likert interval scale questionnaire to facilitate data collection.

The primary objective of the questionnaire was to obtain relevant information from the stakeholders' representatives regarding the factors that might result in cost overruns in building construction projects in the UAE during four phases

of projects lifecycle. The questionnaire's main question was to indicate the degree to which the participant agrees to the fact that a given factor could result in cost overrun in the construction industry during the different lifecycle phases. (Table 3) Participants selected one of the following answers: Strongly Agree, Agree, Neither Agree nor Disagree, Disagree, Strongly Disagree.

Table 3. Cost Overrun Factors Related to the four lifecycle Phases of Buildings Construction Projects in the UAE

No.	ID	Design Phase Related Cost Overrun Factors
1	DPF1	Inadequate preliminary planning and scheduling
2	DPF2	Fluctuation of prices of materials to estimate budget
3	DPF3	Lack of communication between involved parties
4	DPF4	Mistakes and errors in design
5	DPF5	Financial difficulties of owners
6	DPF6	Delay in modification of designs
7	DPF7	Delay in obtaining approvals of drawings by client
8	DPF8	High cost of skilled resources
9	DPF9	Selection of material
10	DPF10	Market economic condition
11	DPF11	Knowledge in authorities' standards and requirements
12	DPF12	Inaccuracies in technical documents
13	DPF13	Poor designs
14	DPF14	Inadequate consideration of risks
15	DPF15	Lack of communication between designers

No.	ID	Bidding Phase Related Cost Overrun Factors
16	BPF1	Inaccurate time estimate of Bidding process
17	BPF2	Incomplete design at the time of tender
18	BPF3	Inaccurate quantity take-off
19	BPF4	Selection process of invited contractors
20	BPF5	Complexity of design
21	BPF6	Delay in submission of biddings
22	BPF7	Unclear/ not achievable client requirements
23	BPF8	Unclear scope of work
24	BPF9	Market economic condition
25	BPF10	High tender bond
26	BPF11	Selection of contractor based on lowest bidding cost only
27	BPF12	Coordination and communication with specified Sub- contractors
28	BPF13	Not involving contractors in biddings opening/results
29	BPF14	Outdated mandatory terms in contracts
30	BPF15	Inefficient budgeting schedule

No.	ID	Construction Phase Related Cost Overrun Factors
31	CPF1	Changes in the scope (goals, deadlines, and project deliverables) of the project
32	CPF2	Delays in decision making by client
33	CPF3	Late delivery of materials & equipment
34	CPF4	Frequent design changes
35	CPF5	Lack of experience
36	CPF6	Financial difficulties faced by Contractor
37	CPF7	Poor site management & supervision
38	CPF8	Equipment availability & failure
39	CPF9	Lack of coordination between parties
40	CPF10	Labors productivity
41	CPF11	Cash flow difficulties & delay in progress payment by owner
42	CPF12	Slow information flow between parties
43	CPF13	Shortage of technical personnel
44	CPF14	Delay in engineering submittals by contractors
45	CPF15	Delay in engineering approvals by consultant
46	CPF16	Incompetent Subcontractors
47	CPF17	Compressed time schedule
48	CPF18	Inadequate consideration of risks
49	CPF19	Market economic condition
50	CPF20	Inadequate monitoring and control
51	CPF21	Contractual claims
52	CPF22	Mistakes during construction

No.	ID	Defect Liability Period Related Cost Overrun Factors
53	DLPF1	Improper Installation of materials
54	DLPF2	Frequent request for maintenance by Client
55	DLPF3	Not completing snag list notes in proper way
56	DLPF4	Incompetency of Maintenance team
57	DLPF5	Main Contractor failure to pay sub-contractors
58	DLPF6	Changes to project made by client after construction
59	DLPF7	Wrong usage of equipment
60	DLPF8	Defects due to lack of supervision by Contractor
61	DLPF9	Not involving maintenance team during earlier phases
62	DLPF10	Not providing or using project closing documents (Warranties-As built drawings)
63	DLPF11	Delay in handing out (receiving) the project by client
64	DLPF12	Lack of communication between Contactor and Client
65	DLPF13	Sub-contractor not attending to maintenance request
66	DLPF14	Poor design leading to issues
67	DLPF15	Poor quality of material

5. Results and Discussion

Questionnaire 5 answers were given a scale from 1 to 5, with the 'Strongly Disagree' option allocated the wight of 1 and the 'Strongly Agreed' option allocated the wight of 5. The results were then calculated and ranked based on the relative frequency index and categorized under two different categories. The first category is the lifecycle phase which can be the design, bidding, construction or DLP. The second category is stakeholders specifically client, consultant and contractor, Figure 2 below shows survey participants role in UAE construction projects. The most frequent four factors in each lifecycle phase under each stakeholder category were analyzed and presented as shown in the Tables 4, 5 and 6 below.

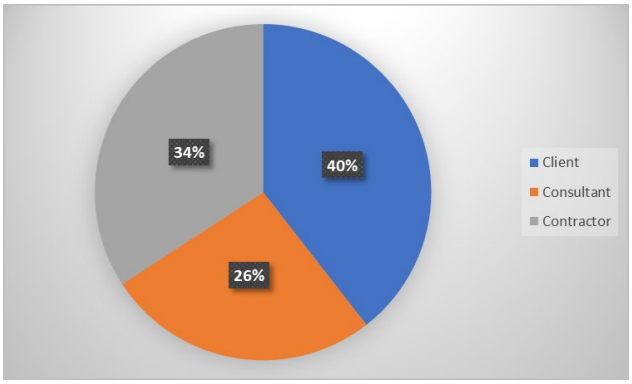

Figure 2. Participants Role in the Project

Table 4. Most Relevant Cost Overrun Factors in UAE by Clients

Lifecycle Phase	Stakeholder			
	Client			
	Ranking	Factor ID	Cost Overrun Factor	Total Weighted Average
Design Phase	1	DPF6	Delay in modification of designs	5.0
	2	DPF1	Inadequate preliminary planning and scheduling	4.3
	3	DPF4	Mistakes and errors in design	4.3
	4	DPF14	Inadequate consideration of risks	4.0
Bidding Phase	1	BPF2	Incomplete design at the time of tender	4.7
	2	BPF1	Inaccurate time estimate of Bidding process	4.0
	3	BPF3	Inaccurate quantity take-off	4.0
	4	BPF8	Unclear scope of work	4.0
Construcion Phase	1	CPF2	Delays in decision making by client	4.7
	2	CPF12	Slow information flow between parties	4.3
	3	CPF1	Changes in the scope (goals, deadlines, and project deliverables) of the project	4.0
	4	CPF9	Lack of coordination between parties	4.0
DLP	1	DLPF5	Main Contractor failure to pay sub-contractors	4.3
	2	DLPF6	Changes to project made by client after construction	4.3
	3	DLPF9	Not involving maintenance team during earlier phases	4.0
	4	DLPF14	Poor design leading to issues	4.0

Table 5. Most Relevant Cost Overrun Factors in UAE by Consultants

Lifecycle Phase	Stakeholder			
	Consultant			
	Ranking	Factor ID	Cost Overrun Factor	Total Weighted Average
Design Phase	1	DPF7	Delay in obtaining approvals of drawings by client	5.0
	2	DPF3	Lack of communication between involved parties	4.5
	3	DPF8	High cost of skilled resources	4.0
	4	DPF6	Delay in modification of designs	4.0
Bidding Phase	1	BPF2	Incomplete design at the time of tender	4.0
	2	BPF8	Unclear scope of work	3.7
	3	BPF11	Selection of contractor based on lowest bidding cost only	3.5
	4	BPF15	Inefficient budgeting schedule	3.5
Construcion Phase	1	CPF2	Delays in decision making by client	4.2
	2	CPF1	Changes in the scope (goals, deadlines, and project deliverables) of the project	3.9
	3	CPF18	Inadequate consideration of risks	3.7
	4	CPF3	Late delivery of materials & equipment	3.6
DLP	1	DLPF6	Changes to project made by client after construction	4.1
	2	DLPF9	Not involving maintenance team during earlier phases	4.0
	3	DLPF14	Poor design leading to issues	4.0
	4	DLPF12	Lack of communication between Contactor and Client	3.9

Table 6. Most Relevant Cost Overrun Factors in UAE by Contractors

Lifecycle Phase	Stakeholder			
	Contractors			
	Ranking	Factor ID	Cost Overrun Factor	Total Weighted Average
Design Phase	1	DPF6	Delay in modification of designs	4.6
	2	DPF1	Inadequate preliminary planning and scheduling	4.5
	3	DPF3	Lack of communication between involved parties	4.1
	4	DPF4	Mistakes and errors in design	4.0
Bidding Phase	1	BPF11	Selection of contractor based on lowest bidding cost only	4.5
	2	BPF7	Unclear/ not achievable client requirements	4.3
	3	BPF3	Inaccurate quantity take-off	4.2
	4	BPF8	Unclear scope of work	4.0
Construcion Phase	1	CPF1	Changes in the scope (goals, deadlines, and project deliverables) of the project	4.5
	2	CPF18	Inadequate consideration of risks	4.0
	3	CPF13	Shortage of technical personnel	3.7
	4	CPF17	Compressed time schedule	3.5
DLP	1	DLPF9	Not involving maintenance team during earlier phases	4.5
	2	DLPF6	Changes to project made by client after construction	4.3
	3	DLPF12	Lack of communication between Contactor and Client	4.2
	4	DLPF14	Poor design leading to issues	4.1

It is noticed that similar factors were cited by the different stakeholders, which suggests the need to investigate the root causes of such factors and to set up a procedure to mitigate them and reduce their negative impact on the project. For example, the three stakeholders suggested that DPF6 (Delay in modification of designs) will cause a cost overrun during the design phase. Similarly, CPF1 (changes in the scope of the project) was ranked among the top four factors that might affect the project cost during the construction phase. Overall, the most common seven cost overrun factors

during the design phase are (DPF 1,3,4,6,7,8 and 14). Likewise, the most suggested seven cost overrun factors during the bidding stage are (BPF 1,2,3,7,8,11 and 15). Respondents focused on eight of the twenty-two factors during the construction stage which are (CPF 1,2,3,9,12,13,17 and 18). Finally, the survey results show that five out of the fifteen cost overrun factors are the most common causes of cost overrun during the DLP which are (DLPF 5,6,9,12 and 14). By filtering out the data to focus on the limited causes of cost overruns with the highest impact on the project cost, further study and analysis should be done to generate new engineering methodologies to mitigate the factors negatively impacting the project.

5.1 Proposed Improvements

The researcher will consider constructing more questionnaires to enhance data accuracy. Data will also be used to suggest mitigation measures and build a solid solution framework.

5.4 Validation

The questionnaire went through numerous validation steps. First, the face Validity was done through face-to-face interviews and experts reviews for the questions and the cost overrun factors. Second, a pilot study was conducted to filter out irrelevant questions. Finally, internal consistency was checked using Cronbach's Alpha test which resulted in values 0.92, 0.98 and 0.98 for replies by client replies, consultant, and contractor respectively.

6. Conclusion

The research objective was to look into the causes and determinants of construction project cost overruns in the UAE during the design, bidding, construction, and DLP phases of the construction project lifecycle. An extensive literature analysis was conducted to identify cost overrun factors whose impact needs to be accounted for. At the level of the phases discussed in this paper, many factors seem to have contributed to overrun costs in many of the UAE's projects, and experts have suggested solutions on how to mitigate issues in every phase. Common cost overrun factors during the design phase include delays in modification of designs, lack of communication between involved parties, mistakes and errors in design. While the relative common cost overrun factors during bidding phase have included incomplete design at the time of tender, unclear scopes of work and selection of contractor were based on lowest bidding cost only. Likewise, the questionnaire results suggested that the most common cost overrun factors during the construction phase are changes in the scope (goals, deadlines, and project deliverables), delays in decision making by client, and inadequate consideration of risks. In addition, relevant cost overrun factors during the defect liability period include changes to project made by client after construction, not involving maintenance teams during earlier phases, and poor design leading to issues.

Moreover, beyond the literature analysis, this research paper conducted a questionnaire survey distributed to a group of professionals representing construction project stakeholders in the UAE, including clients, consultants, and contractors. Sixty-seven probable reasons of cost overruns in construction projects have been identified and classified into two groups: lifecycle phases and project stakeholders. The relative importance index approach was used to analyse the relevance of these aspects, resulting in the identification of the most significant four factors at each phase of the project lifecycle as per different stakeholders. This research has highlighted the major cost overrun factors in UAE construction projects. The findings have significant implications for the construction industry in the UAE and abroad. In addition, different steps were taken to verify the research findings. Future action includes collecting more data and investigating possible mitigation measures to reduce the negative impact of cost overruns. In order to reduce the study's limitations, we may need to consider the sample size and methodology.

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