



# COST OVERRUN GAP ANALYSIS IN CONSTRUCTION PROJECTS: STATE -OF-THE-ART

Mohamed Abdel-Monem<sup>1</sup>, Abdel-Rahman El-Mohr<sup>1,\*</sup>, Karim El-Dash<sup>2</sup>

<sup>1</sup> Civil Eng. Department, Faculty of Engineering, Shoubra, Benha University, Cairo, Egypt.

<sup>2</sup> Faculty of Engineering, Misr University for Science and Technology, Cairo, Egypt.

\*Corresponding Author

**Abstract** : Poor cost performance is a typical problem in construction projects where few projects were completed within the original estimated cost. The previous researches (literature) show that up to 90% of construction projects suffer cost overrun with amounts ranged from 5% to 200%. This paper first utilizes a literature review to identify cost overrun causes and categorizes such causes based on stakeholder, country, and project type. Secondly, an in-depth review was conducted to identify the contractors' cost overrun root causes. Thirdly, contractors' gaps and shortage of cost management processes have been identified. Finally, guidelines were concluded to resolve the identified gaps and enhance cost performance. The research conclusions depict that the top five cost overrun causes were inflation and fluctuation of construction resources, inaccurate cost estimates, poor cost control, poor owners' financial status, and work scope change. In addition, this research manifests that two top contractors' related cost overrun factors, inaccurate cost estimate, and poor cost control, were deemed the main elements of the cost management system. Another major contribution of this research is addressing the gaps in cost management processes to pave the way for future studies on identified gaps

**KEYWORDS:** Cost Overrun, Cost Management, Cost Estimation, and Cost Control.

## Introduction

The construction industry is a complex, interchangeable industry that constantly changes from the very first stage of a project to its completion [1]. It engages several parties and an enormous range of processes with several inputs and multiple phases [2]. Cost is one of the fundamental attributes of construction projects' performance. Cost management forms a significant discipline in delivering construction projects of different sizes and complexity, including estimating, monitoring, and controlling processes.

Cost management is defined as the processes required to ensure project completion(s) within the approved budget. Cost management includes the processes of cost estimating, cost budgeting, and cost control, so that project(s) can be completed within approved budget(s) [3]. Poor cost performance is a common problem in most

construction projects worldwide, which causes a significant amount of cost overrun [4]. Cost overrun is sometimes called "cost escalation", "budget overrun", or "cost increase" [5]. Cost escalation is the difference between the project's actual cost, as determined at the project's completion stage, and the projected budget before the project's commencement. Cost overruns and delays differ in severity based on several factors, for instance, country, industry, type of project, and project time [6].

Construction companies are the essential stakeholders, and they are responsible for achieving the project's requirements. They work on different projects that need effective management and coordination to maximize resource utilization and assure project completion. On the other hand, cost overruns pose a considerable financial risk to both contractors and owners; in particular, contractors encounter more severe risks than other stakeholders

for lump sum and remeasured contracts. During the construction stage, the contractor deals with thousands of construction activities and their related resources; materials, labors, equipment, and subcontractors, which makes the contractors subject to numerous risks of different natures that cause cost overruns[7].

Understanding the different causes of cost overrun is essential to recognize the mitigation measures and minimize their effect on the project performance. Thereof, the literature analysis is vital for identifying the state of the existing knowledge and prevailing research gaps where the information from different viewpoints is considered [8]. Hence, this study aims to analyze the significant causes of cost overrun in the construction industry using literature analysis and rank the top five cost overrun causes. Then, the cost overrun causes were categorized based on the related stakeholders and identified the top cost overrun factors relevant to each category. Further analysis for the root causes of the cost overrun causes related to the contractor was done to identify the gaps in the cost management process for the construction firms. In addition, review the techniques developed by previous research to enhance cost management performance in construction firms.

## RESEARCH METHODOLOGY

To fulfill the objectives of this study, as shown in Fig. 1, a critical literature review of more than 150 journal articles, conference papers, dissertations, and research reports was studied to identify the critical causes of cost overrun. After identifying the critical cost overrun causes from previous research, the critical causes have been ranked to determine the top five causes. Further, the identified critical causes have been categorized and ranked based on the related stakeholders. The causes also have been classified and ranked based on the country of the study and the project type. The root causes for cost overrun factors related to the contractor and construction companies' cost management process have been identified then analyzed the gaps caused these root causes. This paper reviewed the previous research studies that analyzed the identified gaps to recommend future research areas for the uncovered gaps. Other recommendations for future research regarding cost overrun factors and the features of the cost management system in construction firms have been provided to reduce the cost overrun.

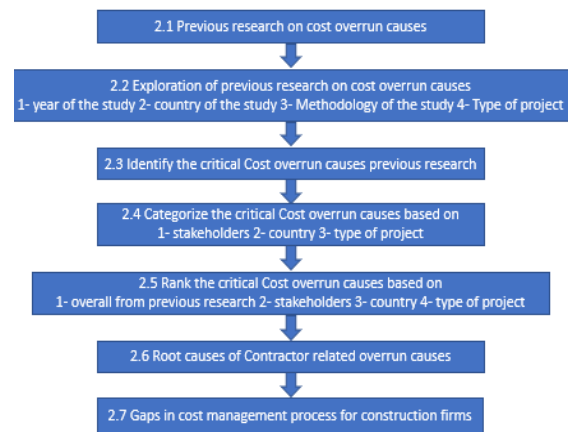


FIG 1: Research Methodology

### 1.1. Cost Overrun Causes

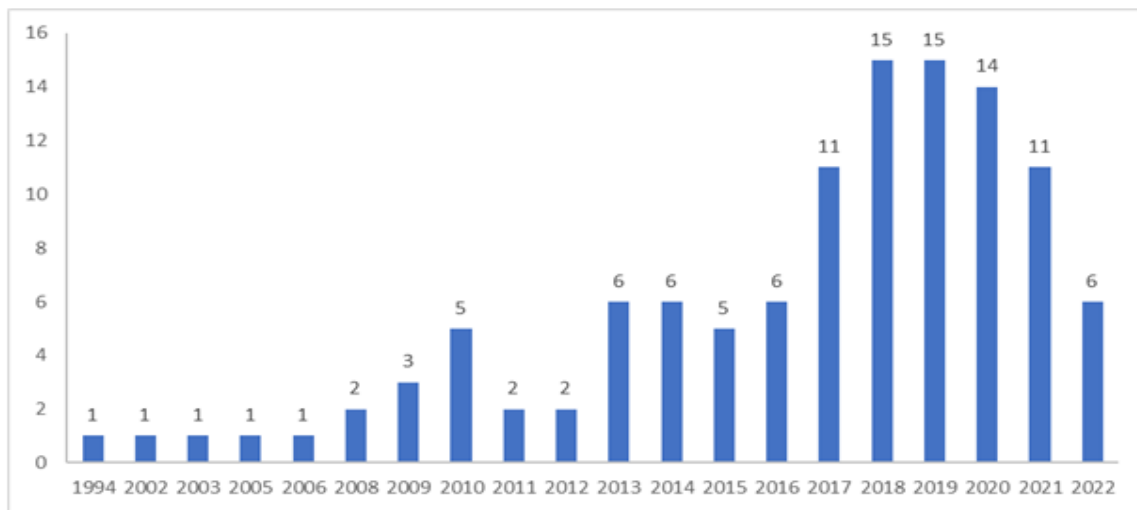
The previous cost overrun causes identification process was carried out through different search engines and databases such as Scopus, Web of Science (WoS), Google Scholar, American Society of Civil Engineers (ASCE), ELSEVIER, Emerald Insight, Taylor and Francis, Springer, Research Gate, and Academia. All the journal papers were intensively analyzed, and the essential information were extracted. This information included the type of projects covered, the year of the study, the country of the study, data collection practices/source of data, the identified cost overrun factors, and the primary/critical factors that cause cost overrun. The references which did not identify the critical factors were excluded from the analysis .

Based on the explained search process, cost overrun causes in construction projects have been examined in 114 references in different countries and regions worldwide.

### 1.2. Exploration of Previous Studies

#### 1.2.1. Year of the Study

Figure 2 shows that 104 out of the 114 studies (91%) were published in 2010 and after, and only ten studies (12%) were published before; this fact evidences the emerging nature of the research topic of cost overrun factors in construction projects. The results show an increase in cost overrun research topics from 2010 to 2020; however, the number of research tends to decrease after 2020. The analysis of cost overrun causes in the different years shows that cost overrun causes remain the same over the years. For example, inaccurate cost estimates, Inflation, and fluctuation of construction resources prices had been identified by [9] in 1994 and also by [10],[11], [12] in 2022 and cited by several references in between.

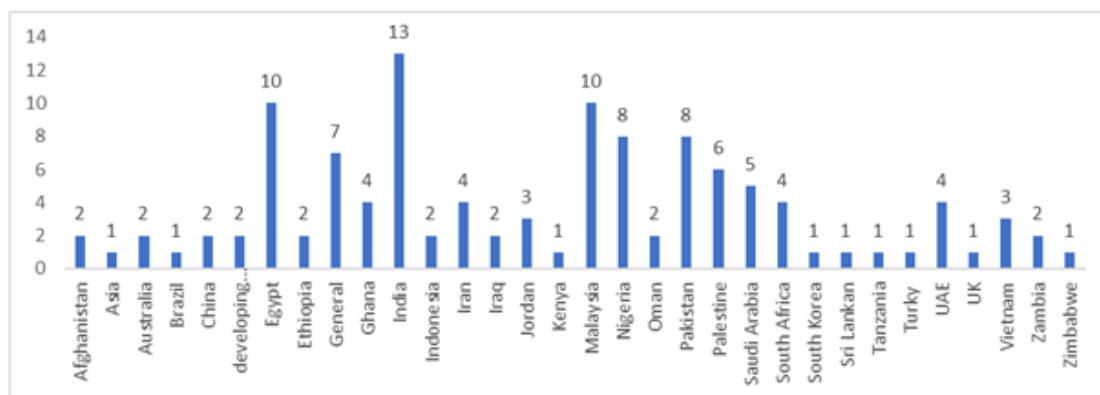


**FIGURE 2:** Previous Studies Over Time

### 1.2.2. Country of the Study

The distribution of previous studies according to the country of study has been analyzed as shown in Fig. 3. The causes of cost overruns in the construction industry have been collected and analyzed for several countries worldwide. The reviewed papers cover 26 countries, and the majority were conducted in East Asia, Africa, and

the Middle East areas. Five papers from the 114 reviewed papers were general and unrelated to a specific country, and four papers used the literature review methodology to identify cost overrun causes. Two papers identified the causes of cost overrun in developing countries, where each research study the factors generally in the developing countries (not in a specific country). While one paper identified the cost overrun for Asia continent [13].



**FIG 3:** Previous Studies According to the Country of the Study

### 1.2.3. Methodology for Previous Studies

Figure 4 shows the research methodology used to identify the critical cost overrun causes in the reviewed research. The research methodology for 102 out of 114 reviewed papers was based on questionnaire surveys to investigate the cost overrun causes in construction projects; however, these papers used different cost overrun factors and data and analysis techniques. These research studies first identified the related cost overrun factors from the existing literature, papers, books, field investigation, and interviews with experts.

Secondly, these research studies used different techniques to identify the critical cost overrun factors related to the type of studies projects.

However, as shown in Fig. 4, eight papers used literature review as a methodology for identifying cost overrun factors. Three papers adopted direct interviews to identify causes of cost overrun causes and rank the critical factors. One paper only [14] analyses the cost overrun in 30 mega infrastructure projects in India using the quarterly reports available at the Ministry of Statistics and Program Implementation web portal.

Also as shown in Fig. 4, the questionnaire survey approach was the primary methodology as access to projects databases through actual studies is not available in most cases. Also, the reviewed references showed that the ranking of the critical cost overrun factors were based on a qualitative approach through surveys or interviews.

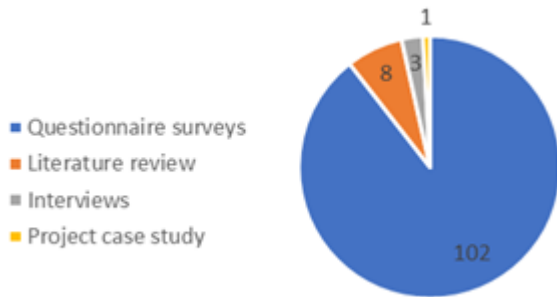


FIG 4: Previous Research Methods

1.2.4. Type of Projects in Previous Studies

The studied references covered different construction project types. Figure 5 shows the distribution of project types in previous studies. The previous studies identified the cost overrun causes in 23 different project types, including residential, high-rise, hospital, oil and gas, roads, highways, etc. In addition, 61 research identified the critical cost overrun causes in general, not for a specific project type.

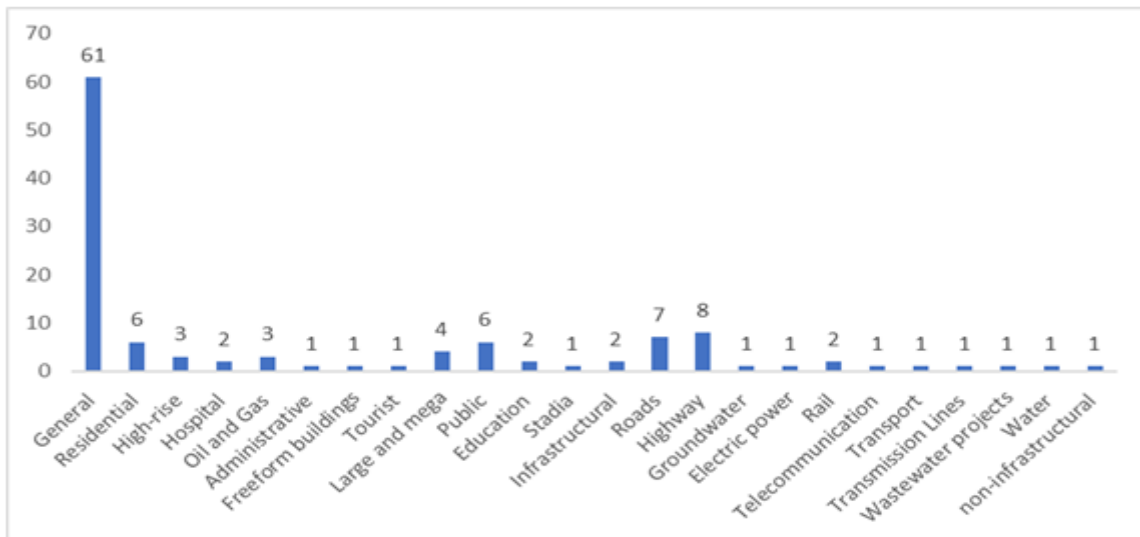


FIG 5: Type of Projects in Previous Studies

1.3. Identify the Critical/ Major Cost Overrun Causes

The analysis of the collected references shows that more than 350 factors were initially identified as the critical/ major factors from different studies. The explored studies used different statistical methods to identify the critical / major causes such as frequency, severity, mean score, regression , importance and relative importance indices. Some of these factors are similar/synonyms, while others are related to other causes or overlap with each other. Such as “inaccurate review of the plans and contract document” [15], which will lead to the incorrect cost estimate. After collecting all cost overrun factors, several subsequent steps have been done to understand and analyze these factors. For example, sorting the similar factors, classifying the

related or overlap factors, and profoundly reviewing the remaining causes in the cited reference to understand authors’ intention, for example, poor contract management, which cited by [9], [16], [17], and [18] have been considered as poor cost control. Based on the analysis of cost overrun factors as discussed hereinabove, 50 factors were selected as a short list for most cost overrun causes, as shown in Table 1.

**TABLE 1: Critical Cost Overrun Causes**

#	Causes	#	Causes
1	Inaccurate detailed cost estimate	26	Poor tender documentation
2	Poor planning and scheduling	27	Lack of experience of technical consultants
3	Lack of contractor experience and efficiency	28	Inflation and fluctuation of construction resources prices (Materials, Labour, and Equipment)
4	Poor cost control during construction	29	Conflicts, disputes, and contractual claims
5	Schedule delays in construction, engineering, or procurement activities	30	Lack of coordination between construction parties
6	Poor site management	31	Poor communication between construction parties
7	Contractor's Financial difficulties	32	Effects of adverse weather
8	Construction mistakes and defective works	33	Changes in site conditions
9	Inappropriate contractor policies	34	Governmental rules and regulations
10	The poor financial status of projects' owners leads to delay due payments	35	Shortage and poor efficiency of construction resources ( materials, labour, equipment, and subcontractors)
11	Poor decision-making process and delay in making decisions	36	Environmental protection and mitigation costs
12	Frequent change in client requirements with related changes in design and specifications	37	Strikes
13	Change the scope of work either by variation orders or additional works	38	Project complexity
14	Clients' practice for tendering and awarding	39	Fluctuations in the currency
15	Level of competition at tender stage	40	Risk and uncertainty related factors
16	Short bid preparation time	41	Political issues
17	Delays in design and delays between design and tendering	42	Poor economic conditions
18	Unrealistic contract duration	43	Bribes and corruption
19	Poor feasibility and project analysis	44	Security Issues
20	Presence of poor project-specific attributes	45	Ground/soil conditions
21	Lack of technical and managerial skills of consultant's staff	46	Social and culture
22	Delay in revision payments by consultant	47	High capital cost
23	Delay in materials and drawings approval by consultant	48	Difference between selected bid and the consultants' estimate
24	Design problems and incomplete design	49	Internal administrative problems
25	Not enough information was gathered, and surveys done before the design	50	Domination by foreign firms of construction industry

#### 1.4. Categorization of the Cost Overrun Causes

Categorizing the cost overrun causes helps owners, and contractors identify which causes may impact the final project cost. According to many previous studies, cost overruns causes have been grouped and categorized in many ways. The causes have been categorized in the previous studies from four to fourteen groups, [19] four groups, [20] five groups, [21], [22], [23] six groups, [15] seven groups, [24] nine groups and [25] fourteen groups. These groups may be related to each other, either by a specific issue or by a responsible stakeholder. In this research, the cost overrun causes have been categorized into four categories related to different construction stakeholders. These categories are the contractor-related factors category, the Owner related factors category, the consultant-related factors category, and other/external factors. In addition, the cost overrun causes are categorized based on the country of the study and based on the type of project.

#### 1.5. Rank the Cost Overrun Causes Based on the Previous Studies

##### 1.5.1. Rank the Top Five Critical Cost Overrun Causes

The cost overrun causes previously identified in Table 1 have been analyzed to rank the top five cost overrun causes based on the number of studies that cited these factors as the critical factors that lead to cost overrun. Table 2 shows the ranking for the identified fifty cost overrun causes. The top five cost overrun causes are inflation and fluctuation of construction resources prices (Materials, Labour, and Equipment) with 65 citations. Inaccurate detailed cost estimate with 38 citations. Poor cost control during construction with 37 citations. Poor owners' financial status leads to delay payments with 36 citations and change in the scope of work either by variation orders or additional works with 35 citations.

**TABLE 2:** Rank of the Top Five Critical Cost Overrun Causes

#	Causes	References	No. of studies
1	Inflation and fluctuation of construction resources prices (Materials, Labour, and Equipment)	[9], [16], [17], [18], [26], [27],[28], [29], [30], [31], [32], [33], [34], [13], [35], [36], [37], [38], [39], [40], [15], [41], [42], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53], [20], [54], [14], [55],[56], , [57], [58], [59], [60], [59], [61], [25] [62], [10], [63], [64], [65], [65], [66], [67], [11], [12], [68], [69], [70], [71], [72], [73], [74], [75], [76]	65
2	Inaccurate detailed cost estimate	[9], [26], [30], [32], [34], [77], [37] , [38], [41], [15], [78], [79], [80], [81], [44], [47], [48], [82], [13], [53], [54], [83],[84], [85], [86], [87], [10], [63], [64], [88], [89], [90], [91], [71], [72], [92], [93], [74]	38
3	Poor cost control during construction	[9], [16], [17], [18],[23], [26], [33], [34], [15], [94], [80], [78], [46], [47], [48], [82], [95], [55], [83], [57], [96], [60], [20], [57], [86], [97], [98], [99], [65], [11], [89], [100], [90], [72], [93], [74], [76]	37
4	Poor owners' financial status which leads to delay due payments	[9], [17], [18],[23], [35], [77], [37], [101], [15], [41], [102], [80], [42], [46], [47], [45], [103], [82], [50], [52], [20], [55], [58], [104], [105], [106], [88], [99], [66], [107] , [12], [68], [100], [91], [70], [108]	36
5	Change scope of work either by variation orders or additional works	[26], [29], [34], [77], [37], [40], [15], [79], [42], [81], [109], [110], [47], [45], [49], [95], [111], [54], [112], [59], [25], [87], [105], [106], [10], [65], [113], [12], [89], [100], [69], [90], [108], [75], [76]	35

### 1.1.1. Rank Cost Overrun Causes Based on the Related Stakeholder Category

The cost overrun causes previously identified in Table 1 have been categorized into four categories. The factors of each category were ranked based on the number of previous studies that cited these factors and subsequently identified the top five factors for each category. Nine cost overrun factors were cited as the critical factors related to the contractors/ construction firms. These factors are Inaccurate Cost Estimates, poor cost control, poor site management, inadequate planning and scheduling, Schedule delays, difficulties in

financing projects by contractors, Lack of contractor experience and efficiency, construction mistakes and defective works, and Inappropriate contractor policies. Table 3 shows the top five causes related to the contractor: inaccurate cost estimate ranked as the first factor caused cost overrun cited by 38 references. Poor cost control ranked as the second factor cited by 37 authors, Poor site management with 31 frequency, schedule delays in construction, engineering, or procurement activities with 31 frequency, and schedule delays in construction, engineering, or procurement activities.

**TABLE 3:** Ranking the Top Five Cost Overrun Causes Related to the Contractor

#	Causes	References	No. of studies
1	Inaccurate detailed cost estimate	[9], [26], [30], [32], [34], [77], [37], [38], [41], [15], [78], [79], [80], [81], [44], [47], [48], [82], [13], [53], [54], [83], [84], [85], [86], [87], [10], [63], [64], [88], [89], [90], [91], [71], [72], [92], [93], [74]	38
2	Poor cost control during construction	[9], [16], [17], [18], [23], [26], [33], [34], [15], [94], [80], [78], [46], [47], [48], [82], [95], [55], [83], [57], [96], [60], [20], [57], [86], [97], [98], [99], [65], [11], [89], [100], [90], [72], [93], [74], [76]	37
3	Poor planning and scheduling	[16], [114], [26], [31], [115], [13], [116], [40], [102], [79], [80], [81], [110], [44], [47], [117], [51], [52], [20], [56], [112], [59], [86], [25], [99], [65], [100], [91], [72], [73], [75], [76]	32
4	Poor site management	[17], [23], [26], [27], [115], [116], [80], [118], [103], [109], [117], [50], [52], [14], [58], [87], [104], [61], [97], [59], [63], [65], [66], [107], [11], [69], [91], [93], [74]	29
5	Schedules delays in construction, engineering, or procurement activities	[17], [18], [28], [27], [29], [115], [37], [39], [40], [43], [79], [109], [110], [14], [119], [84], [61], [61], [106], [99], [107], [12], [120], [91], [93], [108]	26

Eleven factors were cited as the critical cost overrun factors related to the owner. These factors are Poor financial status of projects' owners, poor decision-making process and delay in taking decisions, Frequent changes in client requirements with related changes in design and specifications. Change in scope of work either by variation orders or additional works, Clients' practice for tendering and awarding, Level of competition at tender stage, Allowance short time for contractors to prepare bid, Delays in design and delays between design and

tendering, unrealistic contract duration, poor feasibility and project analysis, presence of poor project specific attributes. Table 4 shows that the top five causes in this group are poor financial status of projects' owners (36 citations), change scope of work either by variation orders or additional works (36 citations), frequent changes in client requirements related to design and specifications (35 citations), poor decision-making process and delay in taking decisions (14 citations), and clients' practice for tendering and awarding (12 citations).

**TABLE 4:** Ranking the Top Five Cost Overrun Causes Related to the Client

#	Causes	Reference	No. of studies
1	Poor financial status of projects' owners which leads to delay due payments	[9], [17], [18], [23], [35], [77], [37], [101], [15], [41], [102], [80], [42], [46], [47], [45], [103], [82], [50], [52], [20], [55], [58], [104], [105], [106], [88], [99], [66], [107], [12], [68], [100], [91], [70], [108]	36

2	Frequent changes in client requirements related to design and specifications	[23], [121], [35], [122], [39], [40], [102], [79], [81], [46], [44], [47], [82], [49], [50], [51], [54], [55], [83], [84], [58], [60], [87], [123], [97], [25], [10], [63], [65], [66], [120], [70], [92], [76]	35
3	Change scope of work either by variation orders or additional works	[26], [29], [34], [77], [37], [40], [15], [79], [42], [81], [109], [110], [47], [45], [49], [95], [111], [54], [112], [87], [59], [25], [105], [106], [10], [65], [113], [12], [89], [100], [69], [90], [108], [75], [76]	35
4	Poor decision-making process and delay in taking decisions	[114], [101], [81], [47], [49], [50], [119], [84], [87], [105], [100], [92], [75]	13
5	Clients' practice for tendering and awarding	[26], [34], [13], [77], [41], [102], [42], [81], [109], [54], [85], [108]	12

Design problems and incomplete design, poor tender documentation, lack of technical and managerial skills of consultant's staff, delay in revision payments by consultant, delay in materials and drawings approval by consultant, not enough information gathered, and surveys done before design, and lack of experience of technical consultants were cited as a

critical overrun causes. As shown in Table 5, design problems and incomplete design, poor tender documentation, lack of technical and managerial skills of consultant's staff, delay in revision payments by consultant and delay in materials and drawings approval by consultant were the top factors.

**TABLE 5: Ranking the Top Five Cost Overrun Causes Related to the Consultant**

#	Causes	Reference	No. of studies
1	Design problems and incomplete design	[32], [115], [116], [38], [40], [41], [81], [95], [86], [97], [25], [105], [88], [90], [93]	14
2	Poor tender documentation	[82], [54], [84], [113]	4
3	Lack of technical and managerial skills of consultant's staff	[61]	1
4	Delay in revision payments by consultant	[31]	1
5	Delay in materials and drawings approval by consultant	[31]	1

There are twenty-two critical cited causes of cost overrun in construction projects that are out of the control of project stakeholders. Table 6 shows that the top five cost overrun causes in the external/ other factors category are the fluctuation of material prices was ranked first with 65 citations. Construction resources shortage and poor efficiency (materials, labor, equipment, and subcontractors) are ranked second with 25

citations. Poor communication between construction parties is ranked third with 11 citations. Effects of adverse weather with ten citations and conflicts, disputes, and contractual claims with nine citations are ranked fourth and fifth, respectively.

**TABLE 6: Ranking the Top Five Cost Overrun Causes for External/Other Group**

#	Causes	Reference	No. of studies
1	Inflation and fluctuation of construction resources prices (Materials, Labour, and Equipment)	[9], [16], [17], [18], [26], [27],[28], [29], [30], [31], [32], [33], [34], [13], [35], [36], [37], [38], [39], [40], [15], [41], [42], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53], [20], [54], [14], [55],[56], , [57], [58], [59], [60], [59], [61], [25] [62], [10], [63], [64], [65], [65], [66], [67], [11], [12], [68], [69], [70], [71], [72], [73], [74], [75], [76]	65
2	Shortage and poor efficiency of construction resources (materials, labour, equipment and subcontractors)	[27], [9], [31], [121], [34], [94], [40], [79], [110], [44], [118], [103], [117], [50], [83], [84], [96], [61], [97], [63], [124], [72], [73], [74]	24
3	Poor communication between construction parties	[101], [116], [38], [81], [46], [50], [86], [61], [99], [70],[73]	11



4	Effects of adverse weather	[114], [29], [31], [122], [79], [111], [50], [86], [106], [99]	10
5	Conflicts, disputes and contractual claims	[114], [31], [39], [97], [99], [113], [107], [12], [93]	9

### 1.5.2. Rank the Top Cost Overrun Factors Based on the Country of The Study

In this section, the critical cost overrun factors for the different countries have been analyzed, the reviewed studies were classified based on the country of the study, and then for the countries covered by at least three studies, the top five cost overrun causes for each country had been identified. Based on these assumptions, the top five cost overrun causes in twelve countries had been identified; these countries are UAE, Saudi Arabia, Pakistan, Iran, India, Egypt, Nigeria, Ghana, Malaysia, Jordan, Palestine, and South Africa, where the top three countries were India, Egypt, and Malaysia.

The top five cost overrun factors for these countries are presented in Fig. 6, these factors were repeated in each country regardless the ranking of these factors. From the top factors, it is noticed that inflation and fluctuation of construction resources prices in the top factors for all countries that have been analyzed except the UAE and Saudi Arabia. The absence of inflation and fluctuation of construction resources prices in the top five factors in both UAE and Saudi Arabia reflect the stable economic status of these countries. On the other hand, some factors exist

only in one country, for example, the political situation was cited only in Palestine, and fluctuations in the currency was cited only in both Egypt and Palestine.

### 1.5.3. Rank the Top Cost Overrun Factors Based on the Type of the Project

The construction project types in the previous studies were grouped into ten groups, as shown in Fig. 7. The grouping process groups the types with the same characteristics into one group. For example, transport, bridge, power plant, road, highways, Rail, telecommunication, transmission Lines, and wastewater were grouped under infrastructure projects. However, some project types may be classified under two groups; for example, roads and highway projects are exist in both infrastructure group and public construction projects. However, roads and highway projects have been separated due to the different nature and availability of many research studies for each type.

Based on the grouping process discussed above, the top five cost overrun causes were identified based on the number of citations. Figure 8 shows the top five cost overrun causes for each project type, which show the similarity of the top cost overrun causes with the differential ranking for the causes.



**FIG 6: Top Cost Overrun Causes Based on The Country Study**

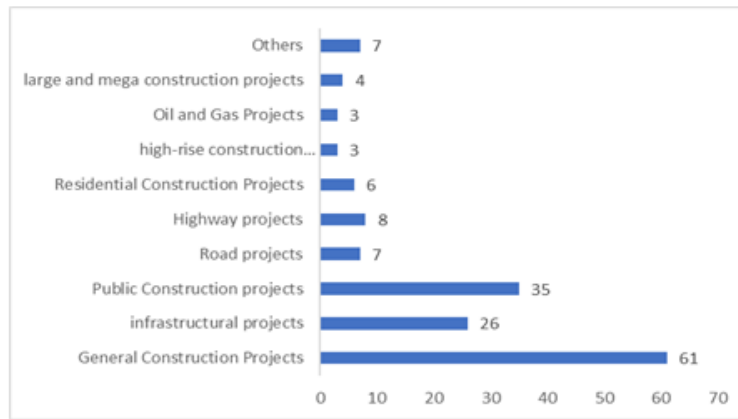


FIG 7: Top Cost Overrun Causes Based on The Country Study

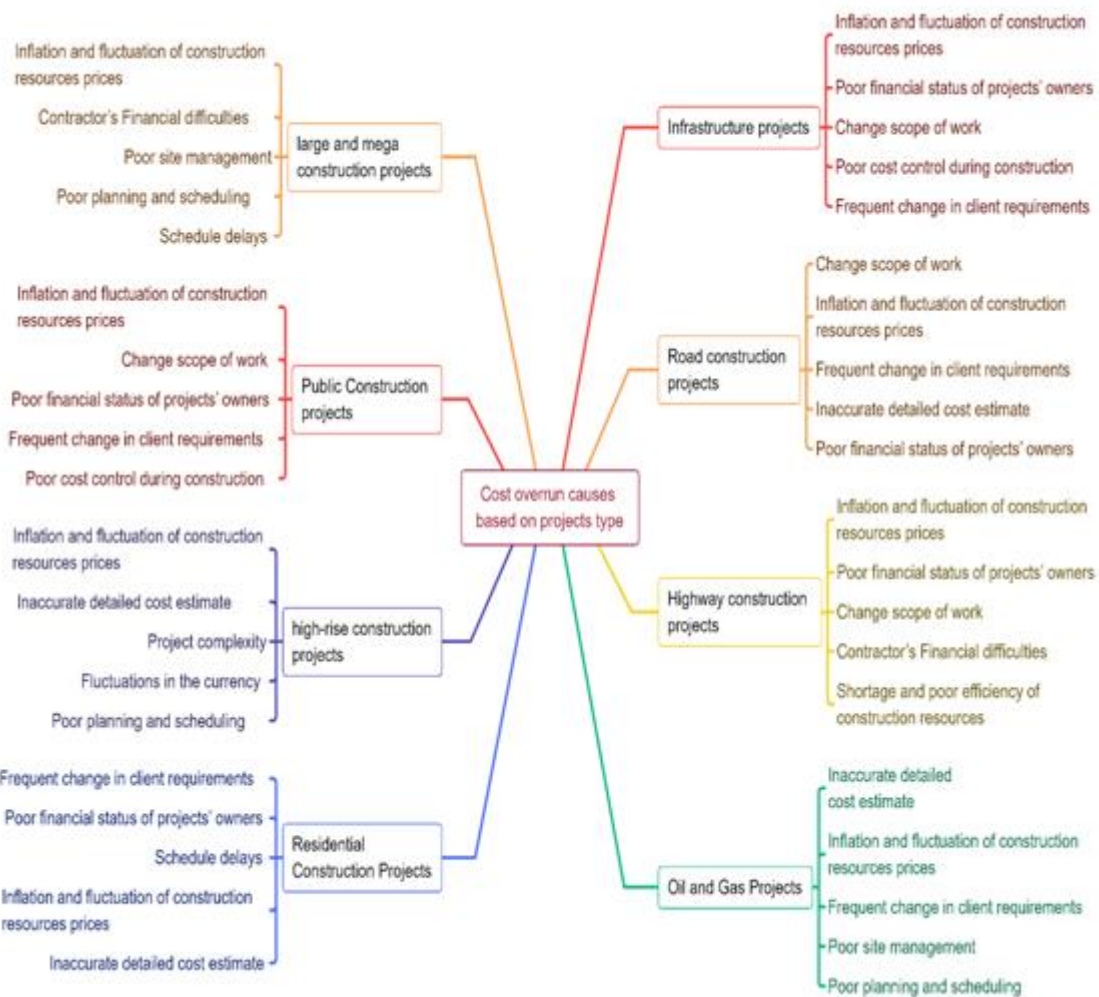


FIG 8: Top Cost Overrun Causes Based on The Type of Projects

**1.6. Contractor-Related Cost Overrun Root Causes**

One of the main objectives of this research is an in-depth analysis of contractor-related overrun causes so that the contractor should directly manage/mitigate these causes. While, for the owner, consultant, and other factors, the contractor should consider these causes either by risk contingency or negotiating during contract reviewing and signing to reduce the effect of these causes on the contractor cost. For example,

in case of delayed payment, a contract clause should be added to consider the impact of this factor on the contractor cost with a reasonable remedy. Accordingly, the following section will deeply analyze the root causes of the poor cost management causes including an inaccurate cost estimate and poor cost control.

**1.6.1. Inaccurate cost estimate**

The inaccurate cost estimate is one of the major causes of cost overrun, according to [58], [125], [47], [82], and others. The contractor must avoid low bidding or too high bidding; otherwise, the bid would not be awarded. The estimate should be high enough to generate a profit while not being low to secure the work. Accordingly, identifying inaccurate cost estimation causes factors that affect the precision of cost estimation is the key to preparing a more reliable and efficient cost estimate in the pre-construction phase of the

project. Search process was applied to identify the causes of cost overrun, accordingly the causes of inaccurate cost estimate from previous studies have been identified. The identified causes for inaccurate cost estimate are shown in Table 7, where the top five causes related to the contractor cost management system are relevant experience of estimating team, accuracy, and reliability of cost information/ the availability of prices for labor and material, availability and quality of historical cost data, availability of productivity standards, time allowed for estimation.

**TABLE 7:** Causes of Inaccurate Cost Estimate

#	Factors	References
1	Availability and quality of historical cost data	[126], [127], [128], [129], [130], [131], [132], [133]
2	Relevant experience of estimating team	[126], [134], [135], [127], [136], [137], [138], [128], [129], [139], [140], [139], [141], [130], [132], [133]
3	Accuracy of bidding documents provided by client / clear and detail drawings and specification	[134], [135], [127], [137], [142], [128], [129], [140], [130], [131], [132]
4	Accuracy and reliability of cost information/ the availability of prices for labor and material	[134], [127], [137], [143], [142], [138], [128], [129], [139], [140], [130], [131], [132], [133]
5	Availability of productivity standards	[136], [129], [139]
6	Time allowed for estimation	[128], [131]
7	Estimating method	[140], [132]
8	Project location	[140], [130]
9	Project size	[140], [132]
10	Site conditions	[140]
11	Economic instability	[140], [141], [130]

**1.6.2. Poor Cost Control**

Poor cost control was ranked the second cost overrun cause relevant to the contractor's causes and ranked as the 3rd cause relevant to the overall factors. Even if the estimates are accurate, the

cost performance for the contractors might be devastating if expenditures are not adequately controlled/monitored during the construction stage. Table 8 shows the causes for poor cost control during construction.

**TABLE 8:** Causes of Poor Cost Control

Causes	References
The actual cost data collection	[7],[144], [145], [146]
Lake of integration between cost estimation and cost control	[147], [148], [149]
Limited resources for cost control process	[150], [145]

**1.7. Gap Analysis in Cost Management Process**

The analysis of root causes impacts the cost of construction projects for factors related to the construction firms cost management process, shows that the gaps in the two major process of cost management, namely cost estimation and cost control, are as follow:

Accurate construction cost estimation is strongly dependent upon the availability and quality of historical cost data [126]. The historical data including availability of database of bids on a similar project and keeping a record for the past estimates could help in achieving an accurate estimate in the future [127]. Well-organized historical cost data should be kept in a convenient place that cost estimators can access. A historical record of all potential competitors should be kept, and bidding strategies should be developed based

**1.7.1. The gaps in the estimation process**

**A) availability and quality of historical cost data**

on available information. There is a great need for a very complex and extensive database of past project records in the construction industry[129].

**B) relevant experience of estimating team**

The experience level of the estimating team is a key factor in improving cost estimates for construction projects[126], [133]. The more relevant the experience of the estimating team, the more accurate the cost estimate [130], [135]. Experience with pricing construction projects can play an important role in the assumptions that estimators use to arrive at accurate estimates. The cost estimation process is the responsibility of the project team, who work to determine the quality and quantity of cost estimates to match the project type and quality expectations. Therefore, the poor experience of estimate team can lead to poor estimates [127].

**C) accuracy and reliability of cost information/ availability of prices for labor and material**

Cost information availability is the most important factor in any method of creating an accurate estimate[127],[129]. Availability of cost information facilitates accurate cost estimate and cost management, however, the availability of cost information remains an issue specially of small and medium- sized companies. Secure an updated data base for cost information with rapid access to cost information can improve the accuracy of estimates. [133] Contractors should understand current market conditions by obtaining cost information from manufacturers and suppliers of building materials, components and systems [134].

**D) availability of productivity standards**

One of the factors that influence the accuracy of estimates could be the non-availability of accurate labour productivity data [136], [129], [139]. There is a shortage of availability of productivity data in a formalized database for the construction industry, which also affects the overall labour costs in the estimate, while the labour rates have a vital influence on the accuracy of the estimate[129].

**E) time allowed for estimation**

The main difficulty being identified by all estimator for an accurate cost estimate was insufficient time for estimating [128], while [131]highlighted that the main cause of inaccurate cost estimates is the insufficient time for estimate development. Usually, the project's owner determines the bidding time.

**1.7.2. The Gaps in the Control Process**

**F) the actual cost data collection**

The main obstacle to monitoring and controlling project costs is the time and effort required for actual cost data collection[144]. Most of the data are in paper form and are received irregularly during the construction process. The collection process is tedious work and requires re-entering this data. The collection must also be timely and up-to-date, or the data will lose its usefulness. The actual cost data collected is used as input to the analysis. In practice, there are several actual cost data [145], [146]. For more than a decade, researchers have pointed out the shortcomings of current manual data collection practices and the need to automate the collection and processing of data to generate useful and timely feedback without significant cost investment [7].

**G) lake of integration between cost estimation and cost control**

The cost estimation process is usually performed before the construction commence, while the cost control started after the commencement of the construction works. In most construction projects, traditional cost management is seen as comprising separated estimation techniques on the one hand, and cost control procedures on the other. The department which controls the cost may be different from the department which prepares the cost estimate. In addition, different cost estimation and cost control software are used. This complicates the cost control process due to differences between cost estimates and cost control data [147], [148]. An effective cost management system should not be a stand-alone application, but an integrated system that automatically transfers cost estimation data and information to the cost control process during construction in a real-time [149].

**H) limited resources for the cost control process**

The cost control process requires a cost control department to collect the actual cost data and perform the related control tasks. Small and medium-sized contractors with limited personnel and investments normally there is no cost control department. There is no cost accounting system to capture actual incurred cost data and there is no special person to control the cost of the project which leads to failing in monitor and controlling their project costs[145],[150].

Table 9 shows the previous works' attempts to cover the gaps in the cost management process in construction firms. Based on the data presented in Table 9, there are continuous efforts to bridge the gaps in the cost management process in

construction firms; however, there are still many gaps. In addition, there is a need for more research to cover the gaps in the cost management process in construction firms regarding cost estimation and control.

**TABLE 9:** Previous Works Attempts to Cover the Gaps in the Cost Management Process

#	Reference	Gaps in estimation					Gaps in control		
		A	B	C	D	E	F	G	H
1	[148]			√				√	
2	[149]		√			√			
3	[150]						√		√
4	[145]						√		√
5	[146]							√	
6	[151]	√	√	√		√			
7	[152]		√			√	√	√	√
8	[153]						√		√

Although there has been extensive research on the factors associated with project cost overrun and the poor cost management- estimation and control- issues in construction projects, few studies have provided appropriate tools to cover some of the gaps in the cost estimation and cost control processes.

## 2. CONCLUSION AND RECOMMENDATIONS FOR FUTURE RESEARCH

The main objective of this study was to collect all identified cost overrun causes in construction projects through an in-depth analysis of previous works. Fifty factors had been identified as critical factors leading to the cost overrun in previous studies. The result shows that top five cost overrun factors based on 114 previous research are inflation and fluctuation of construction resources prices (Materials, Labour, and Equipment), inaccurate detailed cost estimate, poor cost control during construction, poor financial status of projects' owners which leads to delay due payments and, change the scope of work either by variation orders or additional works. The identified critical factors have been classified according to the relevant stakeholders as contractor, consultant, client/ employer factors, and other/external factors. The most critical factors related to the contractor are inaccurate cost estimate, poor cost control, Poor site

management, schedule delays in construction, engineering, or procurement activities, and Lack of contractor experience and efficiency. The results of this study agree with [7], who noted that effective Cost management should be in two directions the accurate estimate during the tender phase and the properly budgeted and controlled/monitored during the construction stage. In addition, this study analyzed the top cost overrun factors based on the country of the study including twelve countries; these countries are UAE, Saudi Arabia, Pakistan, Iran, India, Egypt, Nigeria, Ghana, Malaysia, Jordan, Palestine, and South Africa. The study also identified the top cost overrun causes based on the type of projects. The project types covered in the research are general construction projects, infrastructural projects, public construction projects, residential construction projects, high-rise construction projects, oil and gas construction projects, large and mega construction projects, and others.

An in-depth literature review has been conducted to deeply understand the previous analysis of the detailed construction cost estimate and identified factors affecting cost estimate accuracy. The critical factors for the contractor and the construction estimation process are availability and quality of historical cost data, relevant experience of estimating team, accuracy and reliability of cost information, the availability

of prices for labor and material, availability of productivity standards, and time allowed for estimation. In addition, the critical factors for the control process are the actual cost data collection, the lack of integration between cost estimation and cost control, and limited resources for cost control process. Based on the identified gaps, the research reviewed the previous works related to enhancing cost management performance in construction firms. The results showed that there are continuous efforts to bridge the gaps in the cost management process and there are still many gaps for future research.

Finally, the research recommends that future studies for cost overrun causes should use a quantified approach to rank cost overrun factors based on the actual overrun values in real project cases studies. The gap analysis concluded that new research should pave the way to develop an integrated cost management system that automatically transfers cost estimation data to the cost control process. The cost estimation should be based on the company database to ensure accurate cost information and subsequently shorten cost estimation process. Then integrate the estimation data with monitoring data for better project control. The cost control system must be able to collect comprehensive information about cost data and make it available at any time

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