

Construction Projects Cost Overrun: What Does the Literature Tell Us?

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Abstract—Construction industries have a poor reputation in terms of finishing projects on budget. Nine out of ten projects normally experience cost overrun. Different causes for cost overrun have been identified. This paper critically reviews the literature concerning cost overrun in construction projects in different countries to identify the main potential causes. 173 causes of cost overrun have been found in seventeen contexts with the main potential causes being: frequent design change, contractors' financing, payment delay for completed work, lack of contractor experience, poor cost estimation, poor tendering documentation, and poor material management.

Index Terms—Construction projects, cost overrun, literature review.

I. INTRODUCTION

Besides being unique, expensive and usually carried out within a limited time frame, construction projects have been described as complicated and uncertain in nature, as no two construction projects are ever exactly the same. Even if two construction projects are similar, the opportunity for exactly repeating the process of execution is very low, as most of the projects' elements are site-specific. Although the level of investment represented by construction projects has increased over the years, construction projects have a consistently poor record in finishing within budget. Morris [1] considers cost overrun as a "regular feature" for public projects. Himansu [2] defines cost overrun as "...the degree to which the final cost of the project exceeds the 'base' estimate".

Construction projects experiencing cost overrun have the potential to become defaulted projects, with a resultant significant impact on all the projects' parties. For example: clients will be unable to use the facility, as the projects have not finished yet, and consultation and designing fees might increase. For contractors the impact could include loss of reputation and being "trapped" in only one project for long time.

One of the most famous projects to experience cost overrun was the Channel Tunnel project. Construction costs increased from £2600 million to £4650 million (80% higher than the forecasted costs) [3]. Other examples of projects with cost overrun are found in different countries around the world such as: the Great Belt link in Denmark (54% overrun), the

Humber bridge in the UK (175% overrun) and the Paris Nord TGV in France (25% overrun) [3]. In Korea, a study done by Seung Heon, Sungmin [4] showed that the average final cost of seven megaprojects (defined as a project that cost more than \$1 billion) at completion increased by 122.4% compared to the original budgeted cost. The average cost overrun for 29 medium sized projects (defined as a project that cost between \$50 million and \$1 billion) studied within the same time span, is 32.5%. Another study conducted by Merrow, McDonnell [5] includes 52 Megaprojects from different regions around the world and their budgets between \$0.5 and \$30 billion (in 1984 value US dollars). The results show that only 4 projects met their cost goals, while the rest accrued average cost overruns of 88%. From the USA, Pickrell's [6], [7] studies of cost estimation in eight US rail projects identified an average cost overrun of 61%. Moreover, a Dutch study containing 78 projects (Road: 37 projects, Rail: 26 projects, Tunnel: 8 projects, Bridge: 7 projects) found an average cost overrun of 16.5% [8]. Finally, a study published by Flyvbjerg, Bruzelius [3] concerning the quality of the estimating of cost and demand in 258 transport projects located in twenty countries (constructed between 1927 and 1998) found that nine out of ten projects (86% of the projects) experienced cost overrun, with the overall average overrun being 28%.

In light of the above, cost overrun should be regarded as a vital issue in the management of construction projects globally; this phenomenon is not limited to a specific country as the above studies show. The variation on the percentages of cost overrun could be related to different factors such as the project size [9]-[11], project type [11] and project location as it was one of the main findings obtained from the following studies [8], [12]-[14]. Equally, the studies support the claim that the worldwide findings are not always applicable for individual countries.

II. METHODOLOGY

A large number of factors leading to project cost overruns have already been identified by previous studies. This study takes such previous studies one step forward by identifying the main potential factors leading to cost overrun within different contexts. The identification of these factors should improve the performance of construction projects and increase the probability of successful project completion. A critical literature review methodology is used to achieve this goal.

A. Previous Studies

Table I comprises the 17 national studies selected from the literature review.

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TABLE I: SUMMARY OF THE PREVIOUS STUDIES

Study	Country	Projects' type	Projects Phase
[15]	Malaysia	Building projects cost more than \$ 1.1 M.	Not mentioned
[16]	Nigeria	Telecom projects	Not mentioned
[17]	WW	Transport projects	Planning and construction
[18]	Turkey	Residential construction projects	Not mentioned
[19]	Pakistan	Construction projects	Not mentioned
[20]	Israel	Building and infrastructure projects	Not mentioned
[21]	Saudi Arabia	Infrastructure projects	Not mentioned
[22]	Kuwait	Private residential projects	Implementation Phase
[23]	Australia	Highway construction projects	Not mentioned
[24]	Gaza Strip	Building, roads, water and sewage, electro-mechanical and public works.	Implementation Phase
[25]	UK	Construction projects	Not mentioned
[26]	Indonesia	High-rise projects	Implementation Phase
[27]	Uganda	Construction projects	Implementation Phase
[28]	South Africa	FIFA World Cup stadia	Not mentioned
[29]	Nigeria	Highway projects	Not mentioned
[30]	Ghana	Groundwater projects	Implementation phase
[31]	Zambia	Road construction projects	Not mentioned

Most of the studies have not identified in which project phase the cost overrun occurred; only six out of seventeen studies identify the causes of cost overrun during the implementation phase.

B. Previous Studies Methodologies

As the summary table shows, almost all the studies (13 out of 17) used a questionnaire as the sole data collecting method. The respondents for the questionnaire typically comprised all the projects stakeholders (Owners, Contractors and Consultants) (see Table II).

TABLE II: SUMMARY OF THE PREVIOUS STUDIES

Study	Country	Methodology	Number of factors identified
[15]	Malaysia	Preliminary study (interview). Analysis 97 questionnaire survey (16 Clients, 25 Consultants, 56 Contractors).	35
[16]	Nigeria	Identified factors from the existing literature. Analysis 53 questionnaire survey (23% Clients, 41% Consultants, 36% Contractors).	42
[17]	WW	Analysis 258 projects.	3
[18]	Turkey	Identified factors from the existing literature. Analysis 79 questionnaire survey (30 PM Consultants, 26 Contractors, 23 Owners/clients).	40
[19]	Pakistan	Identified factors from the existing literature. Analysis 24 questionnaire survey (24 Construction firms).	42
[20]	Israel	Identified 15 root factors from the existing literature and from local experts. Analysis 195 questionnaire survey (45% Project Manager (owner representative), 20.6% Public	15

Study	Country	Methodology	Number of factors identified
		owners, 17.5% worked for contractors, 14.8% designers, 8% consulting companies, 2.1% as private owners).	
[21]	Saudi Arabia	Identified factors from the existing literature. Analysis 160 questionnaire survey (160 Project Manager (23% Owners, 52% Contractors, 25% Consultants)).	41
[22]	Kuwait	Identified factors from the existing literature. Analysis 450 personal interview survey of owners. (450 house owners).	7
[23]	Australia	Analysis 231 highway projects (140 open tender, 91 negotiate, and 7 panel experts)	37
[24]	Gaza Strip	Identified factors from literature review, personal interviews with a number of contractors and the experiences of the researchers. Analysis 66 questionnaire survey (66 Contractors).	42
[25]	UK	Analysis 141 open-ended questionnaire, asking professional cost estimators to list up to five reasons for cost overrun.	341
[26]	Indonesia	Identified factors from literature review. Analysis 31 questionnaire survey (31 Project Manager) The questionnaire survey was supported by follow-up interviews.	7
[27]	Uganda	Identified factors using face-to-face discussion Analysis 247 questionnaire survey (30% client, 57% consultant, 13% contractors).	22
[28]	South Africa	Identified factors from the existing literature. Analysis 22 questionnaire survey (5 clients, 3 contractors, 14 consultant).	18
[29]	Nigeria	Analysis completed highway projects. Identified factors from the existing literature. Analysis 37 questionnaire survey (9 clients, 15 contractors, 13 consultants).	23
[30]	Ghana	Identified factors from the existing literature. Analysis 72 questionnaire survey (28 owners, 25 contractors, 19 consultants).	26

III. RESULTS

The total number of factors identified across the 16 studies reaches 366 factors. After removing factors that are essentially a duplication (therefore reported more than once across the study), and merging factors with a similar meaning together, the reduced total number of factors is 175. These have then been classified according to the 'headline' cause as summarised in Fig. 1. Causes are ultimately classified as being either internal or external to the project. Each class comprises several sub-classes: project financier, project owner, and projects designer and consultants are sub-classifications for the internal causes, while system, country related,

economic related, weather and unclassified are sub-classifications for the external causes.

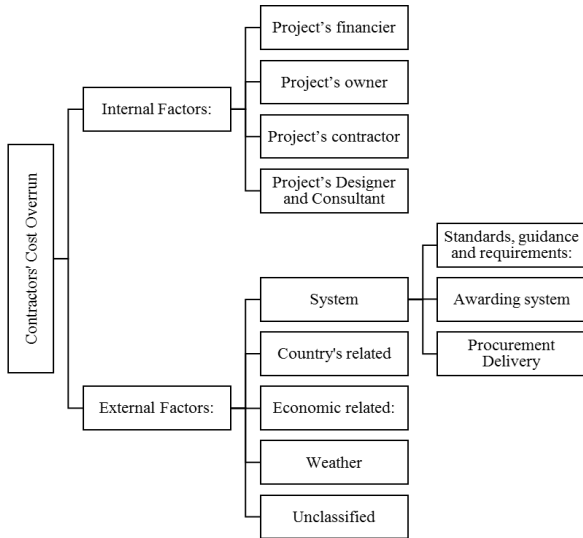


Fig. 1. Cost overrun causes.

Internal Factors:

Internal factors are divided into the following sub-factors which are:

A. Project's Financier

The project financier causes are shown in Table III:

TABLE III: PROJECT'S FINANCIER CAUSES

Factors	Frequency
Owners' financial difficulties.	2
Too small a design budget.	1
Slow and delay payment of completed work.	5

B. Project's Owner

The project's owner causes are shown in Table IV:

TABLE IV: PROJECT'S OWNER CAUSES

Factors	Frequency
Owner's lack of experience.	2
Inadequate project preparation and planning (preconstruction study).	7
Unrealistic design development periods.	1
Premature tender documents (drawings, bill of quantities, specifications, contracts and legal documents).	2
Late start of the planning process, and with too low a budget.	1
Lack of detail and definition, incomplete, or incorrect Design brief.	1
Poor project management practices.	1
Owner project management costs.	1
Long period between design and time of tendering.	2
Unrealistic/ Inaccurate duration of contract period.	4
Deficiencies in cost estimates prepared by public agencies.	1
Too many changes in owners' requirements or definitions.	1
Changes in owner's brief.	1
Frequent design changes.	8
Change in the scope of the project.	7
Change orders by client.	2
Changes in material specifications and type.	1
Additional works.	4
Shortening of contracts period.	1
Delays in decisions making and work approval.	1
Delays (decision making, in approval of drawings, material delivery).	1

Factors	Frequency
Client's over influence/interference on the construction process.	2
Lack of coordination between project's parties.	5
Lack of communication between project's parties.	4
Wrong / inappropriate choice of site.	6
Insufficient information/investigation about ground conditions.	9
Services relocation.	1
Contractual claims.	3

C. Project's Contractor

The project's contractor causes are shown in Table V:

TABLE V: PROJECT'S CONTRACTOR CAUSES

Factor	Frequency
Technical incompetence, poor organizational structure, and failures of the enterprise.	1
Lack of contractor's experience	8
Poor project management.	1
Incompetent subcontractors and suppliers.	2
Incorrect preparation and planning by contractor.	4
General poor preparation, planning and investigation of existing site conditions by contractors.	1
Inadequate review for drawings and contract documents.	1
Poor cost advice, inadequate contingency allowance or assessment of risks.	1
Optimism bias.	1
Wrong method of cost estimate.	3
Inaccurate cost estimates.	4
Lack of cost planning, monitoring and controlling during pre-and post-contract stages.	9
Some tendering manoeuvres by contractors, such as front-loading of rates.	1
Contractor's poor site management and supervision skills.	13
Cash flow and financial difficulties faced by contractor during construction stage.	3
High interest rates charged by banks on loans received by contractors.	5
Contractor's work overload	4
Mistakes during construction due to inadequate construction method.	5
Cost of the Reworks.	2
Lack of coordination between general contractor and subcontractors	1
Delay payment to supplier /subcontractor.	1
Delays in costing variations and additional works.	1
Delay in construction, supply of raw materials and equipment by contractors.	1
Delays.	3
Litigation costs.	2
Lack of contractors' manpower experience, knowledge and training.	2
Low labour productivity.	1
Low labour performance.	1
Shortage of available skilled and non-skilled labour.	11
Shortage in high-quality management personnel.	1
Lack of attracting skilful technicians for work.	1
Poor relationship between management and labour.	4
Increase in manpower cost due to environment restriction, insurance premiums and other social expenses of the workforce.	8
Cost of afterhours work of the workforce.	1
Increment of materials prices.	9
Difficulties in obtaining construction materials at official current prices.	1
Inadequate material procurement.	1
Shortages of materials due to unreliable sources of materials on the local market.	7

Factor	Frequency
Imported materials and plant items.	2
Late delivery/supply of materials and equipment by contractors.	5
Materials supplier's manipulation.	2
Market conditions (materials and labour).	1
Increment of equipment's/ equipment's maintenance prices.	5
Inadequate or inefficient equipment, tools and plants.	5

D. Project's Designer and Consultants

The project's designer and consultant causes are shown in Table VI:

TABLE VI: PROJECT'S DESIGNER AND CONSULTANT CAUSES

Factor	Frequency
Designer lack of experience.	5
lack of experience of technical consultants.	6
Lack of design team understanding of cost and value.	1
Deficient tender documentation (design, bills of quantities and specification).	13
Inaccurate cost and time estimates.	8
Difference between selected bid and the consultants' estimate.	1
Improvements to standard drawings during construction stage.	1
Inadequate monitoring and control procedures.	2
Delay Preparation and approval of drawings.	2
Delay in issuing information to the contractor, project's inspection and handing over.	5

E. External Factors

External factors are divided into the following sub-factors which are:

1) System

- Standards, guidance and requirements

The standards, guidance and requirements causes are shown in Table VII:

TABLE VII: STANDARDS GUIDANCE AND REQUIREMENTS CAUSES

Factor	Frequency
Unclear division of responsibilities and lack of clear requirements for professional management.	1
Lack of standard requirements from designers and poorly enforced professional liability of designers.	1
Disputes among the parties involved in the project (clients, contractors, consultants).	1
Absence of construction cost, specifications, and productivity standard data.	4
Insufficient, unstandardized owner's brief.	1
Culture of conflicts and lack of trust.	1
Inappropriate Government Policies.	4
Inadequate mode of financing projects.	5

- Awarding System

The awarding system causes are shown in Table VIII:

TABLE VIII: AWARDING SYSTEM CAUSES

Factor	Frequency
Practice of assigning contract to lowest bidder even if prices are unrealistically low.	4
Bureaucracy and late contract award.	3
Bidding fee competition with tight conditions.	1
Level and number of competitors.	2
General lack of information especially at tender stage.	1

- Procurement Delivery

The procurement delivery causes are shown in Table IX:

TABLE IX: PROCUREMENT DELIVERY CAUSES

Factor	Frequency
Unbalanced distribution of risk between projects' party.	2
Mistakes, ambiguity and discrepancies in contract document.	3
Nonadherence to contract conditions.	1
Inappropriate contractual procedure.	2
Inappropriate contractor policies: such as: work suspensions owing, Long period of the project maintenance.	4

F. Country Related

The country related causes are shown in Table X:

TABLE X: COUNTRY RELATED CAUSES

Factor	Frequency
Obstacles from government.	1
Change in Government policies.	1
Delays in decisions making by Government, failure of specific coordinating.	1
Political complexities, insecurity and instability.	1
Social and cultural impacts.	2

1) Economic Related

The economic related causes are shown in Table XI:

TABLE XI: ECONOMIC RELATED CAUSES

Factor	Frequency
High Inflationary pressure.	6
Changes in pricing conditions.	1
Unsettlement of the monetary exchange rate.	4
Local economic stability.	1
Effects of global economy.	1
Change of insurance cost.	2

2) Weather

The weather causes are shown in Table XII:

TABLE XII: WEATHER CAUSES

Factor	Frequency
Effect of weather conditions.	10

3) Unclassified

There are some causes which cannot be classified under any of the previous classification which are shown in Table XIII:

TABLE XIII: UNCLASSIFIED CAUSES

Factor	Frequency
High transportation cost due to Fuel shortages	3
Fraudulent practices, kickbacks, corruption.	4

IV. DISCUSSION

In this section the author will discuss the most frequently identified cost overrun causes.

A. Frequent Design Change during Construction Phase

Although it is very unlikely that a project can be delivered without any variation during the construction stage [32], a long process for processing design change orders negatively impacts on the duration and cost of a construction project. Change in a project's design could be part of a construction project nature because of its inherent complexity and uncertainty. Design change causes delay as its needs to be

reviewed and approved by clients. However, this factor was found to cause cost overrun in different developing countries such as Vietnam, Indonesia, and Nigeria as well as developed countries such as Korea. The factor scored highly among other factors of cost overrun in developing countries. For example, in Zambia it scored second highest. Lack of clearly defined project objectives and scope was mainly the cause of frequent change orders in construction projects in these countries.

B. Contractors' Financing

It is usual that contractors face financing issue during the construction phase as they normally pay for works and receive payment after completing part of projects or the whole projects. Thus, contractors should make sure that they have sufficient funds available to enable them to undertake projects. Moreover, they should put all financing processes under control by adopting an effective project financing method.

All the above points emphasise that a reliable contractor's financial status plays a primary role in delivering projects on time. Moreover, poor controlling of cost and cash flow during the construction phase would directly increase the cost of implementing a project, or it might lead to project delay that leads to financial penalties. In other words, if contractors meet financial difficulties, project progression will be affected. However, it is not unusual that contractors' face financial difficulties during the construction phase. For instance, a delay or inability to cover their direct and indirect costs.

The contractor experiencing financial problems was found as a cause of projects' underachievement in different contexts and it was ranked in the top five important causes for project underachievement in the following location contexts: Nigeria, Ghana, and Vietnam.

C. Payment Delay

Slow or delayed payment to contractors for completed works is a very common complaint of contractors about project's client. It was identified in five different contexts and appears to occur more often in government funded projects because of a typically slow payment procedure (the public sector around the world is more bureaucratic because the level of power and decision-making is centralised).

Failure to provide payment on time to contractors for the completed work will make it difficult for the contractors to meet (typically due to relatively small cash reserves) project objectives.

It is worth noting that late payment does not only consume contractor's time and money but more importantly it can affect the trust relationship between contractors and the owner. Moreover, payment delay by the owner might lead to an increase in the cost of projects as contractors increase their overhead cost to cover that risks [33].

D. Lack of Contractors' Experience

Construction projects are tending to become more complicated and therefore place pressure on time (project duration) and expertise. A lack of contractor experience (and expertise) of the projects' type and location might lead to a rework component for the project or delay which increases the cost of implementing a project.

It has been cited that lack of experience is one of the critical causes affecting the construction projects performance by different authors [34], [35].

A lack of contractor experience was one of the main causes of cost overrun in different developed countries such as Indonesia and Ghana.

E. Poor Cost Estimation

Cost estimating could be defined as the process where an estimator arrives at an expenditure of resources necessary to complete a project in accordance with plans and specifications. The preparation of a detailed cost estimate for a particular construction project requires collecting, retrieving, and manipulating large amounts of independent, but related, cost and non-cost data and information in a time-effective manner. Cost estimation for projects is a characteristically complex exercise. Although estimation techniques have improved over the years, they are still regarded as imperfect. Because of the high uncertainty of construction projects, clients along with the contractor become better informed about the specific technological and material requirements of the project works after a project moves from the design phase to the implementation phase. Eg. poor ground conditions.

There are several causes for an inaccurate cost estimate, and some of these causes may be similar to other causes of cost overrun. One of them is the psychology cause. Psychologists believe that most people tend to be more optimistic than realistic which is called optimism bias [36], [37]. In this situation, estimators and contractors make their decision based on delusional optimism (higher than actual rewards and lower than actual risks) rather than rational measuring of profits and losses. Other causes are:

- 1) The data used to estimate the bid may be unreliable.
- 2) The absence of national database for prices to rely on.
- 3) Lack of estimators' experience.
- 4) Honest mistakes.

F. Poor Tendering Documents

Immature tendering documents were identified as causes of cost overrun in thirteen out of seventeen studies. Several factors have caused this issue including: the involvement of the designer as a consultant; communication gaps occurring between the contractor and designer; insufficient details in the working drawings and a lack of coordination between the parties. Also included is a lack of human resources in the design firm, the designers' lack of knowledge of available materials and equipment and the use of incomplete shop drawings and specifications.

G. Poor Material Management

Construction material is one of the most important elements in the execution of any construction projects. The importance of material management can be seen clearly from its definition. Patel and Vyas [38] define materials management as "the system for planning and controlling all of the efforts necessary to ensure that the correct quality and quantity of materials are properly specified in a timely manner, are obtained at a reasonable cost and most importantly are available at the point of use when required". The

consequences of poor material management might result in late delivery of materials or risk of purchasing at higher prices, thus resulting in delay and cost overrun. With an increase in the number of construction projects in a single location, the local market cannot meet the high level of demand for building materials. Thus, a project's contractor might face a shortage of construction materials on the market or an increase of the material prices, which results in cost overrun. For large and complex construction projects where special materials are required, the risk of importing delay is raised as the construction industry depends on the international market to provide such materials.

Material price fluctuation and poor material management have been recognized as one of the main causes of cost overrun in fifteen studies out of the seventeen, some of the countries that suffer from this cause are: Nigeria, Indonesia, Vietnam, Ghana, and Saudi Arabia.

Different causes could lead to poor material management such as: unreliable material suppliers, shortages of materials, an absence of adequate statistics on materials availability; fluctuations in the availability of construction materials; very long average waiting times and uncertainty about the deliveries of ordered materials; shortages of funds to procure materials, and inadequacy in terms of transportation.

V. CONCLUSION

Construction projects around the world have a very poor performance record with respect to being completed within cost, time and quality objectives [3], [39]. Morris [1] considers cost overrun as a "regular feature" for public projects. Causes and factors related to cost overrun in construction projects have been traced worldwide ([39] and [17]) and in specific contexts (the USA, [6]-[7]; Nigeria, [16]-[29]; Indonesia, [26]; the UK, [25]; Ghana, [30]; Kuwait, [22]; Philippines and Thailand, [40]; Pakistan, [19]; Gaza Strip, [24]; South Korea, [4]; Australia, [23]; South Africa, [28]; Malaysia, [15]; Netherland, [8]; Turkey [18]; Israel, [20]; Uganda, [27]; and Saudi Arabia, [21]). The total number of factors reaches 366 factors. After removing the duplication and merge similar meaning factors together, the new total number of factors is 175 factors some of which are repeated in almost each study such as contractor's poor site management and supervision skills, and other of which occur in specific contexts such as high transportation cost due to fuel shortages. The studies show that the main causes of cost overrun differ from country to country. As a result, it would not be accurate to identify the causes of cost overrun for a specific country from a global literature only.

One of the potential solutions to reduce the effect of the cost overrun in construction projects is the embedding of an effective resources (human, technical and material) management system within construction projects as it seems that most of the causes of cost overrun are related to poor resources management. Moreover, effective communication between a project's internal and external stakeholders is a very important task to deliver projects successfully and reduce cost overrun [41]. This task is more important in construction megaprojects where different government

authorities are involved. To help contractors' financially and reduce the effect of payment delay for the completed projects, government should be involved to help contractors find a middle way with banks and other surety groups [33].

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