# Cost Overruns in Public Construction Projects: The Case of Jordan

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**Abstract:** Cost is the essential part for any construction project. It is observed that cost overrun is one of the most frequently occurring issues in construction projects worldwide and it is more severe in developing countries. Like many other developing countries, construction industry in Jordan is also affected by the cost overrun. To reduce construction cost overrun, the first step is to identify and analyze the root causes and factors responsible for this issue. Therefore, this paper aims to identify the factors that have major roles in affecting the projects' cost so these factors can be alleviated in the future. Factors affecting cost overruns were identified from literature and ranked according to their priorities. This study involves a questionnaire survey of 30 engineers working in Jordanian construction projects and secondary data from the Ministry of Housing and Public Works relating to 57 major public construction projects. Results of the questionnaire survey showed that the design changes, lack of experience of project type and location were the main variables affecting cost overrun. While based on the secondary data the major factors that cause cost overruns were governmental delay, severe weather conditions and design changes.
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## 1. Introduction

Construction activity requires major investment outlays in most developing countries; moreover, cost overruns are frequent phenomena and are almost associated with nearly all projects in the construction industry (Kaming et al., 1997; Abd El–Razek et al., 2008; Le Hoai et al., 2008).

Cost overruns can be defined as when the project objectives have not been achieved within the estimated budget (Dlakwa and Culpin, 1990). A construction project comprises two distinct phases: the preconstruction phase and the construction phase. There is no particular element in any project solely responsible for cost overruns however; the construction phase holds a wider proportion of major troubles.

The core economic activities of Jordan consist of real estate and tourism. The real estate and construction sector have been one of the most active sectors of the Jordanian economy lately. Construction sector accounted for 4.6 % of the Gross Domestic Product (GDP) on average over the period 2002 – 2011. The sector has achieved an average growth rate of 13.3% over the same period. Residential construction accounts for the bulk of Jordanian construction accounting for an average of 87% of all construction permits during the period 2005–2011 (Department of Statistics, 2012; Attar and Sweis, 2010).

The construction sector in Jordan is the spine of the country and plays a major role in providing employment. As in other developing countries of the world, Jordan's public construction sector is facing cost overruns. The responsibility of cost overruns is distributed over several factors. The aim behind this research is to answer the following question: What are the major factors causing cost overruns in the Jordanian public construction sector?

## 2. Literature review

### *2.1 Causes of cost overruns*

Cost is one of the key drivers for construction projects and cost overruns are considered as the major concern within this industry. A survey of 104 public projects in Singapore indicated that nearly two thirds suffered from cost overruns and more than half were delayed (Ke et al., 2013).

(George et al., 2012) suggested that the construction industry's current cost overruns and delays would be resolved if effective project management processes were to be implemented. Furthermore, (Peter et al., 2010) found that the effective processes such as the selection of an appropriate procurement method may decrease cost and time overruns, claims, and disputes.

(Al-Tabtabai, 2002) also confirms the importance of project management skills to avoid cost and time overruns. He showed that most of the

contractors' organizations are in need of professionalism and proper training for their engineers.

(Kaming et al., 1997) identified the prime variables of cost overruns such as: unpredictable weather, inflationary material cost, inaccurate materials estimates, complexity of projects, contractor's lack of geographical and project type experience, and non-familiarity with local regulations. Moreover, (Stephen 1997) found that poor schedules cause cost overruns about 70% of the time.

Ten factors influencing cost overruns of construction projects have been mentioned by (Morris, 1990). These factors are: inadequate project preparation, planning and implementation, delay in construction; supply of raw materials and equipment by contractors; change in the scope of the project; resources constraint: funds, foreign exchange, power; associated auxiliaries not ready; delays in decisions making by the government, failure of specific coordinating bodies; wrong/inappropriate choice of site; technical incompetence and poor organizational structure; labor unrest; natural calamities and Indo-Pakistan war; and the lack of experience of technical consultants, and inadequacy of foreign collaboration agreements.

After examining the factors influencing construction cost overruns on high rise projects in Indonesia, (Kaming et al., 1997) found that cost overruns occur more frequently, thus, they are considered a wider problem than time overruns on high-rise construction in Indonesia. The predominant factors influencing cost overruns are material cost increases due to inflation, inaccurate materials estimating and degree of project complexity. The four categories arrived at were: variations, measurement of provisional works, contractual claims and fluctuations in the cost of labor and materials.

On the other hand, in a study that was conducted by (Sweis et al., 2008) concerning the most common causes of construction delays in Jordan. Causes include financial difficulties that the contractor faced, change orders which were initiated by the owner, severe weather conditions and changes in government regulations and laws.

Other studies (Datta, 2002; Mansfield et al., 1994; NAP, 2003) identified cost overruns to be a result of factors such as unexpected problems in supply of raw materials, delay in land acquisition, illegal encroachment on land or internal problems in government organizations.

(Frimpongs et al., 2003) studied 26 factors that cause cost overruns in construction of ground water projects in Ghana. They distributed 55 questionnaires to owners, 40 to contractors and 30 to consultants. The overall ranking results indicate that the three groups felt that the major factors that can cause excessive groundwater project overruns in developing countries are poor contractor management, monthly payment difficulties from agencies, material procurement, poor technical performances and escalation of material prices according to their degree of influence.

According to (Frimpong et al., 2003) major delay and cost overruns occur during the project implementation phase; they studied the construction of ground and examined many factors such as; monthly payment difficulties, material procurement, poor contractor management, escalation of material prices and poor technical performances.

The finding of a study conducted by (Xianhai, 2012) demonstrates that the possibility of poor performance such as cost overruns usually increases gradually when the supply chain relationships decreases, also he connected the cost overruns with the poor communication, and he recommended that if there are any signs of cost performance problems, it is possible to take corrective actions to improve the communications in the project.

According to (Koushki et al., 2005), the amount of cost overruns increases with an increase in the total cost of a residential project. However, private residence owners who spent more time on the pre-planning phase spent more money on the design phase; issued less change orders; selected more experienced contracting companies; and hired a supervising engineer to independently supervise the progress of work and ensure the delivery of materials. A major factor contributing to the projects' cost increase was the insufficiency of money and time allocated to its design phase.

More recently, some of the studies that have been conducted in different countries show somewhat similar results to the studies mentioned earlier. Major factors affecting cost overruns in public construction projects were: materials price fluctuations, lack of experience of contractors, incomplete drawings, government delays, incompetence, inaccurate estimates, improper planning and poor labor productivity (Kasimu, 2012; Tabish, 2011; Memon et al., 2012; Le – Hoai et al., 2008; Doloi et al., 2012).

*2.2 Cost overruns in Jordan*

In the study of the problem of construction delays in Jordan, conducted by (Al-Momani, 2000), causes of delay in construction of public projects were related to designers, user changes, weather, site conditions, late deliveries, economic conditions and increase in quantity.

In a similar study conducted by (Abdalla and Battaineh 2002) concerning the construction projects with traditional contracts from the contractors and consultants perspective, it was found that the

following factors are among the most important factors causing the project delays and cost overruns:

1. The agreement among contractors and consultants about owner interference with project work
2. Inadequate contractor experience
3. Financing and payments
4. Labor productivity
5. Slow decision making
6. Improper planning
7. Subcontractors

Project cost overruns in Jordan constitute a major issue in the construction management field. Besides, lack of current research in this field is the major reason behind conducting this research. In this paper, factors influencing cost overruns in the Jordanian public construction sector will be identified and ranked by professionals in the field.

**3. Methodology**

The major causes of cost overruns in the building project were identified through literature review. These factors were tabulated in a questionnaire form. The factors that cause cost overruns in building project are classified into: Material cost increase by inflation, Fuel cost increase, Design changes, inaccurate quantity takeoff, Lack of experience in project location and type as well as local regulations, Unpredictable weather conditions and Equipment shortage.

Two types of data were collected, secondary data from the Ministry of Public Works and Housing, and primary data. The secondary data was collected from 57 public construction projects. A final evaluation report of each project was studied. A spread sheet was created to summarize the data and conduct further descriptive analysis.

The primary data was collected by distributing questionnaires to 30 randomly–selected engineers at the Ministry of Public Works and Housing and the Association of Construction Contractors. The respondents had different levels of work experience. Principle Component and Factor Analysis (PCFA) was conducted on the data collected from the questionnaire.

The cost overrun variables were analyzed and ranked by calculating the Importance Index, the frequency Index, and the Severity Index formula (the product of Importance Index and Frequency Index). This methodology has been used before by (Abd El-Razek et al., 2008) and (Le-Hoai et al., 2008) to rank factors of cost overruns through calculating the weighted indexes of the importance and frequency of cost overrun factors.

Importance Index (I.I) = (a × n) /4N

Index range is [0, 1]

Frequency Index (F.I.) = (b × n) /4N

Index range is [0, 1]

Severity Index (S.I) = (I.I) × (F.I)

Index range is [0, 1]

a = constant that represents a weight assigned to the importance scale (ranges from 4 for very significant to 0 for not significant).

b = constant that represents a weight assigned to the frequency scale (ranges from 4 for extremely frequent to 0 for not at all frequent).

n = the frequency of each response.

N = the total number of responses.

The top nine factors were analyzed using the Principal Component and Factor Analysis (PCFA) technique to arrive at the main factors contributing to quality. The objective of PCA is to explain the variance of the observed data through a few linear combinations of the original data. Even though there are Q variables, x1, x2, ….xQ, much of the data's variations can often be accounted for by a small number of variables – principal components, or linear relations of the original data, Z1, Z2, …….ZQ, that are uncorrelated.

Factor analysis is similar to PCA. It aims to describe a set of Q variables x1, x2 ….xQ in terms of a smaller number of factors and to highlight the relationship between these variables. However, while PCA is based simply on linear data combinations, FA is based on a rather special model (Vermunt and Magidson 2005). Contrary to PCA, the Factor Analysis (FA) model assumes that the data is based on the underlying factors of the model and that the data variance can be decomposed into that accounted for by common unique factors (Nicoletti et al., 2000).

**4. Data Analysis and Discussion**

*4.1 Questionnaire*

The importance of factors causing cost overruns was measured using a perceptual measure on a five - point likert scale to ensure consistency and the ease of data computation. The perceptual measures are in the form of attitude statements about the importance of the factors with (0= not significant, 1 = somewhat insignificant, 2 = neutral, 3= somewhat significant and 4 = very significant) and with attitude statements about the frequency of the factors with ( 0 = not at all frequent, 1 = slightly frequent, 2 = moderately frequent, 3 = very frequent, 4 = extremely frequent).

*4.2 Ranking of factors*

The cost overruns factors were ranked according to their Severity Index. Results are summarized in table 1. The higher the severity index, the greater the factor's contribution to cost overruns.

Table 1. Ranks of cost overruns factors (I, Index; R, Rank)

| | Importance | | Frequency | | Severity | |
|---|---|---|---|---|---|---|
| | I | R | I | R | I | R |
| Material cost increase by inflation | 0.63 | 1 | 0.62 | 1 | 0.39 | 1 |
| Fuel cost increase | 0.61 | 3 | 0.58 | 2 | 0.35 | 2 |
| Design changes | 0.63 | 1 | 0.51 | 3 | 0.32 | 3 |
| Inaccurate quantity takeoff | 0.60 | 4 | 0.48 | 5 | 0.29 | 4 |
| Lack of experience in project location | 0.57 | 5 | 0.50 | 4 | 0.28 | 5 |
| Lack of experience in project type | 0.53 | 7 | 0.43 | 6 | 0.23 | 6 |
| Lack of experience in local regulations | 0.54 | 6 | 0.41 | 7 | 0.22 | 7 |
| Unpredictable weather conditions | 0.52 | 8 | 0.33 | 8 | 0.17 | 8 |
| Equipment shortage | 0.47 | 9 | 0.24 | 9 | 0.11 | 9 |

*4.3 Principle Component and Factor Analysis (PCFA)*

PCFA is a reduction technique used to classify and reduce the number of variables. It was applied on the top nine factors according to index ranking. A test for the suitability of data has been conducted before starting the analysis. The test is based on Kaiser-Meyer-Olkin measure of sampling. A KMO value > 0.5 indicates that the sample is suitable for the analysis. The KMO value for cost overrun sample data was 0.717. Both values indicate that the sample is suited for analysis. Table 2 shows some descriptive statistics of the sample.

Table 2. Descriptive Statistics of cost overrun variables

| | Mean | Std. Deviation | Analysis N | Missing N |
|---|---|---|---|---|
| Unpredictable weather conditions | 2.683 | 1.1853 | 30 | 0 |
| Material cost increase by inflation | 3.500 | 1.0422 | 30 | 0 |
| Inaccurate quantity takeoff | 3.167 | 1.0613 | 30 | 0 |
| Lack of experience in local regulations | 2.900 | 1.0205 | 30 | 0 |
| Lack of experience in project location | 2.853 | 1.760 | 30 | 0 |
| Lack of experience in project type | 2.933 | .9890 | 30 | 0 |
| Fuel cost increase | 3.367 | 1.4559 | 30 | 0 |
| Design changes | 3.283 | 1.0642 | 30 | 0 |
| Equipment shortage | 2.417 | 1.0674 | 30 | 0 |

According to (Kaming et al., 1997), the total number of common factors that can be extracted is equal to or less than the total number of variables involved. However, the important factors are those whose Eigen values are greater than 1, because an Eigen value is a measure of how a standard variable contributes to the principal components. A factor with Eigen value of less than 1 is considered less important than an observed variable and therefore can be ignored. Since the objective of this research is to reduce the number of original variables to a smaller set of uncorrelated variables, Varimax rotation was used; due to being the most commonly used rotation. It minimizes the complexity of components by making the large loadings larger and small loadings smaller. Of course, there are other rotational models such as QUARTIMAX and EQUAMAX that could produce similar results. There is also the oblique rotational model. The oblique model is a more flexible model in which the factor axis will not necessarily be orthogonal. Two factors of cost overruns were extracted. Factor loading is the correlation coefficient between the original variables and the extracted factors as shown in Table 3. Factor loading of less than 0.5 is ignored.

Table 3. Factor loading of cost overrun variables

| Cost overrun variables | Component | |
|---|---|---|
| | CF1 | CF2 |
| Unpredictable weather conditions | | .647 |
| Material cost increase by inflation | .764 | |
| Inaccurate quantity takeoff | .853 | |
| Lack of experience in local regulations | | .501 |
| Lack of experience in project location | | .873 |
| Lack of experience in project type | | .894 |
| Fuel cost increase | .718 | |
| Design changes | .918 | |
| Equipment shortage | | .555 |

As shown in table 3, two factors were extracted.

- Design changes (CF1)

- Lack of experience of project type and location (CF2)

*4.4 Secondary Data*

Different types of projects were analyzed in our sample (Educational, General, Health – related, Residential, Municipality, Sports and Youth). (Figure 1) shows the distribution of public projects comprising the sample.

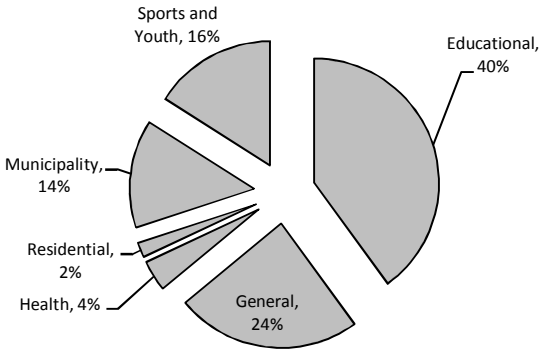


Figure 1. Project type percentages in data sample

The data revealed that only 35% of projects were on budget, as shown in (Figure 2).

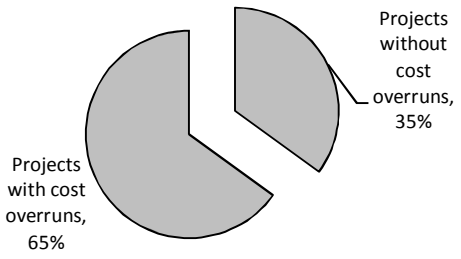


Figure 2. The cost overruns percentages of the projects

The cost overruns factors documented in the final project report were summarized. (Figure 3) represents the percentage of each factor to the total cost overruns in the study's sample and shows that the top factor of cost overruns in public construction was governmental delay 32% (mainly slow decision making on the part of the owner/government), followed by severe weather conditions 23%, and 18% for design changes. These three factors account for 73% of cost overruns.

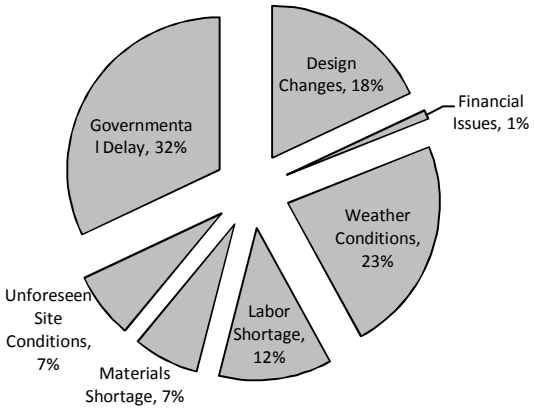


Figure 3. Top cost overrun factors documented in actual data sample

The average cost overrun for each sector was calculated and a comparison between the different sectors of the study was conducted. The top sector contributing for cost overrun is municipality with a percentage of 30% of the total cost overruns, followed by Educational sector with 26% of cost overruns among. (Figure 4) shows cost overruns by sector.

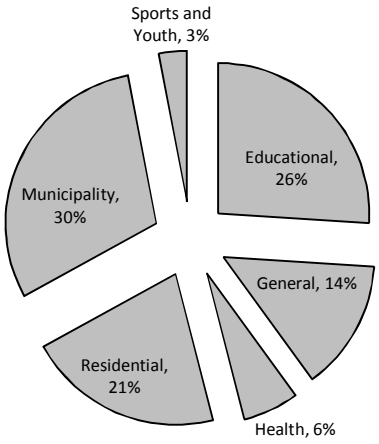


Figure 4. Percentage of cost overrun contribution for different public sectors

This study uses two sources of data: primary and secondary. Primary data is gathered through a questionnaire survey distributed to a sample of 30 engineers working in Jordanian public construction projects. Secondary data was collected by accessing available information from the Ministry of Housing

and Public Works relating to 57 major public construction projects. The results of the two types of data were analyzed for the purpose of identifying the major factors that cause cost overruns in the public construction projects in Jordan. Primary and secondary data are significant inputs for any study; however, the results of these two types of data may include some differences like in our case; the results of the primary data showed that the major cost overruns factors were ranked as follows:

1. The design changes
2. Lack of experience of project type
3. Location

On the other hand, the result of the secondary data showed that the major factors that cause the cost overruns were ranked as follows:

1. Governmental delay
2. The severe weather conditions
3. Design changes.

These three factors account for 73% of cost overrun causes.

If the results of the primary and secondary data are compared, the following will be noted:

1. According to the results acquired from the primary data, design changes was ranked first. Also, the same factor is considered third most important factor affecting cost overruns in the secondary data set representing actual public projects.
2. Severe weather conditions was ranked second according to the viewpoint of respondents. Nevertheless, it was not listed among the factors resulting from the primary data.
3. Using the primary data, lack of experience was ranked as the second factor but it was not among the factors defined after analyzing the secondary data. Nevertheless, while governmental delay was not considered a cost overrun factor in the primary data, it was ranked as the first factor when analyzing the secondary data.

The differences between primary and secondary data results are partially due to the fact that both data sets were acquired at different times. The different methods of collection or different circumstances surrounding the collection may also have affected the results.

**5. Conclusions and Recommendations**

The major objective of this study was to identify factors influencing cost overruns in the Jordanian public construction sector. Through a careful literature review, several factors affecting cost overruns in building projects are classified into: Material cost increase by inflation, Fuel cost increase, Design changes, Inaccurate quantity takeoff, Lack of experience in project location, Lack of experience in project type, Lack of experience in local regulations, Unpredictable weather conditions and Equipment shortage.

These cost overruns factors were examined and ranked according to perceptions of 30 engineers working in the Jordanian public construction sector. Consequently the design changes, lack of experience of project type and location were extracted after treating the nine factors using PCFA analysis.

Different types of public construction projects were analyzed and it was found that 65% of them were not finished on budget. The major factors that cause the cost overruns were governmental delay, followed by severe weather conditions and design changes. These three factors account for 73% of cost overrun causes.

The findings presented in this study can be used by the contractors, governments and owners of the construction projects in developing countries and any investors who intend to do business in these countries. Taking these factors into consideration will help to avert the cost overruns of the projects.

These cost overrun factors can be alleviated by taking some actions from the major project stakeholders; the government should think of improving their procedures and creating special regulations to avoid delays in large public construction projects. The contractors should be aware of the materials and have time schedules for material delivery in order to avoid any shortage. Contractors are also recommended to have qualified and experienced technical staff with suitable experience of the project type and should monitor the cash flow and payments to avoid any problems in the financial aspects.

The owners are recommended to revise the design documents of the projects to minimize the change orders during the implementation; moreover, the owner should choose the qualified contractor and not the lowest price offer.

In addition to the benefits above, researchers can also use these findings in studying the overruns factors of different types of projects in similar developing countries as well as conducting comparisons between the severities of each factor on the developing countries' projects and similar projects in the developed countries.

Furthermore, in comparison to other similar studies conducted in Asian and developing countries, results of this paper showed agreement with Inadequate early planning (Faridi, 2006), financial constraints (Koushki, 2005), poor contract management (Frimpong, 2003) and client's cash flow problems ( Aibinu, 2006).

While this paper stressed the importance of poor planning and scheduling of the project, other studies showed a mixture of causes such as inadequate contractor experience (Sambasivan, 2003), slowness of the owners' decision making process (Faridi, 2006), owner's lack of experience (Koushki, 2005), material procurement (Frimpongg, 2003) and Architect's incomplete drawings (Aibinu, 2006).

Results above showed that there are a variety of reasons for cost overruns in the construction projects. It is interesting to note that the major factors are greatly differing among countries, although most developing and Asian countries possess similar characteristics in their construction environment, they still hold opposing views regarding factors affecting cost overruns.

**6. Implications**

Reforms and change of regulations are required to accelerate the approval process of the government. Moreover, more attention should be given during the design phase, as well as more accurate cost estimation and increasing supply of materials and machinery.

It is also recommended that the project should involve experienced members who can support the project during all phases. Also, similar studies should be conducted in other developing countries. The relatively small sample size used in this study may limit the ability to generalize the findings. Future studies could be performed to replicate the results of this study using a larger sample size.

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