Risks Leading to Cost Overrun in Building Construction from Consultants' Perspective

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THIS STUDY AIMS AT IDENTIFYING THE RISK MAP FOR FACTORS AFFECTING COST OVERRUN IN BUILDING CONSTRUCTION PROJECTS IN THE WEST BANK IN PALESTINE FROM THE CONSULTANTS' PERSPECTIVE. The field survey included 26 consultants. 41 factors are identified through literature review. The factors are divided into 5 groups. The analysis of the identified 41 factors indicates that 1 factor is located in the green zone, 14 factors are located in the yellow zone, and 26 factors are located in the red zone of the risk map. The results indicate that the top five affecting factors are: political situation, fluctuation of prices of materials, economic instability, currency exchange, and level of competitors. It is hoped that these findings will guide efforts to enhance the cost performance of construction industry.

INTRODUCTION

The construction industry is the tool through which society goals of urban and rural development can be achieved. It has a great impact on the economy of all countries (Leibing, 2001). However, the construction process is influenced by highly changing and unexpected variables, which could result from different sources. These sources include performance of construction parties, financial issues, managerial issues, resources unavailability, and external conditions. As a result, poor performance in terms of delay and cost overrun in construction projects could occur. The construction industry and its parties are associated with high degree of risk due to the nature of construction business activities, processes, environment and organization. Risk in construction has been the object of attention because of time and cost overruns associated with construction projects (Kartam et al., 2001).

Cost overrun is one of the most important problems in the construction. According to Azhar et al. (2008), cost overrun is a very frequent phenomenon and is almost associated with all projects of construction industry. Cost overrun is simply defined as the difference between the final actual cost of a construction project at completion and the contract amount, agreed by and between the owner and the contractor during signing of the contract. According to Ahmed et al. (2003), cost overrun and delays on construction projects are a universal phenomenon. "They have a negative effect on clients, contractors, and consultants in terms of growth in adversarial relationships, mistrust, litigation, arbitration, cash-flow problems, and a general feeling of trepidation towards each other" (Ahmed et al., 2003). So it is essential to define the actual causes of cost overrun in order to minimize and avoid increasing cost in any construction project and to avoid any other negative effects.

In Palestine, the construction sector contributes to 26% of the Palestinian GDP (MAP, 2002). This is a relatively high proportion covered by this sector comparing to what is mentioned by Chitkara (2004) in that construction industry accounts 6-9 % of GDP in many countries, thus it strongly affecting various economic, social, educational, and vocational sectors.

Palestinian construction sector plays a major role in supporting the Palestinian national economy, providing homes and facilities, improving infrastructure, and absorption labor forces. However, many local construction projects report poor performance due to many causes such as (UNRWA 2006):

- unavailability of materials
- excessive amendments of design and drawings
- poor coordination among participants
- ineffective monitoring and feedback
- lack of project leadership skills

While the observations indicate that the cost overrun is a major phenomenon in Palestinian construction industry, very few studies have been conducted to investigate it. This paper presents the findings of a survey aims at identifying the risk map for factors affecting cost overrun in building construction projects in the West Bank in Palestine from the consultants' perspective. It is hoped that these findings will guide efforts to enhance the performance of the construction industry in Palestine.

Objectives

The objectives of this paper include the following:

- To identify the factors affecting cost overrun in building construction in the West Bank in Palestine from consultants' perspective
- To identify the risk map for cost overrun factors

Literature review

Numbers of studies have been conducted to investigate the cost overrun in construction projects. Mahamid et al. (2012) conducted a study to investigate the statistical relationship between actual and estimated cost of road construction projects using data from Palestinian road construction projects awarded over the years 2004 to 2008. The study was based on a sample of 169 road construction projects. The findings reveal that 100% of projects suffer from cost diverge, it is found that 76% of projects have cost under estimation and 24% have cost over estimation. The discrepancy between estimated and actual cost has average of 14.56%, ranging from -39.3% to 98%.

Al-Zarooni et al. (2000) conducted a survey to investigate variations in UAE public projects' estimates. They found that the variations (positive or negative) between feasibility and contract cost, ranging between -28.5% and +36%. They stated that these variations could be explained by the fact that feasibility estimates in the government agencies are usually budgeted using a Single Unit Estimating (cost per square foot) basis, regardless of the nature of projects and their associated risks or the construction complexity of each building type.

Researches on construction projects in some developing countries indicated that by the time a project is completed, the actual cost exceeds the original contract price by about 30 % (Al-Momani, 1996).

Odeck et al. (1995) assessed Norwegian toll roads in order to reveal whether planning procedure shortcomings experienced by Norwegian road agencies had resulted in poorer than projected financial performances for some of the toll roads. They found overestimation of traffic forecasts and underestimation of construction costs. In their small sample of 12 toll projects, they found cost overruns on average at about 5%, but the interval was large from -210 to 170%.

Author \ Effect	Less profit to client	Less profit to contractor	Cash flow problems	Disputation	End user satisfaction	Company failure
Mbachu et al. (2004)	•	•	•	•	•	
Zainuddeen et al. (2008)		•	•			
Arditi et al. (1985)			•			
Ahmed et al. (2003)			•	•		
Charoenngam et al. (2001)						•
Nega (2008)	•	•	•	•	•	

Table 1. **Main effects of cost overrun in construction projects through previous studies**

Al-Juwairah (1997) conducted a study to identify the most severe factors affecting construction cost in Saudi Arabia. 42 factors were considered in the study. He concluded that the most severe factors affecting construction cost from the contractors' perspective are: cost materials, incorrect planning, contract management, wrong estimation method, and previous experience in contract.

Al-khaldi (1990) concluded that the top five factor affecting construction cost in Saudi Arabia from contractors' view are previous experience in contracts, payments, availability of management finance and plans, type and size of contract and its content, and project location. On the other hand, the top five factors from consultants view are previous experience of contract, type and size of contract and its content, payments, project location, and contract period.

Al-Najjar (2008) identified the essential factors and their relative importance that affect cost overrun in construction projects in the Gaza strip. The study illustrated that the top affecting factors include: prices fluctuations of constructions, contractor's delay of material delivery and equipment, and prices inflation.

Iyer et al. (2005) conducted a study to identify the factors affecting cost performance of Indian construction projects. 55 factors were identified. They concluded that the top affecting factors are: conflict among project participants, ignorance and lack of knowledge, presence of poor project specific attributes and non existence of cooperation, hostile socio- economic and climatic conditions, reluctance in timely decision, aggressive competition at tender stage and short bid preparation time.

Elinwa et al. (1993) identified 31 factors affecting the construction cost in Nigerian Construction projects. They concluded that cost of materials, fraudulent practices and kickbacks, and fluctuation of prices of materials are three of the most important factors leading to cost overrun.

Frimpong et al. (2003) concluded that the main causes of delay and cost overruns in construction of groundwater projects in Ghana are: monthly payment difficulties from agencies, poor contractor management, material procurement, poor technical performances, and escalation of material prices.

Azhar et al. (2008) conducted a study in order to identify the major cost overrun factors in construction projects in Pakistan. 42 factors were identified. They found that the top ten affecting factors are: fluctuation in prices of raw materials, unstable cost of manufactured materials, high cost of machineries, lowest bidding procurement procedures, poor project (site) management or poor cost control, delays between design and procurement phases, incorrect or inappropriate methods of cost estimation, additional work, improper planning, and unsupportive government policies.

Okpala et al. (1988) studied the causes of delay and cost overrun in construction projects in Nigeria. 20 factors were identified as causes of delay and 27 factors as causes of cost overrun. The results indicated the following:

1. "high costs can be minimized by minimizing lapses in the management of human and material resources.
2. despite some slight differences, the professionals generally agreed that shortage of materials, methods of financing and payments for completed works, and poor contract management are the three major reasons for high construction costs.
3. price fluctuation (in material) was identified as the most important factor responsible for the escalation of project costs."

Nega (2008) found that the most important causes of cost overrun in building construction projects in Ethiopia are inflation or increase in the cost of construction materials, poor planning and coordination, change orders due to enhancement required by clients, and excess quantity during construction.

Cost overrun factors	1	2	3	4	5
1) Cost estimating factors					
cost of labor					
cost of machinary					
transportation cost					
high machinary maintenace cost					
high interest rates by bankers					
wrong estimation method					
cost of insurance					
fluctuation of prices of materials					
bureaucracy in tendering method					
waste on site					
long period between design and time of tendering					
2) Factors related to construction items					
fraudulent practices and kickbacks					
contract management					
additional work					
duration of contract period					
contractual procedure					
frequent changes in design					
lack of adequate manpower					
3) Factors related to project participants					
disputes on site					
lack of coordination between construction parties					
poor financial control on site					
poor planning					
previous experience of contract					
relationship between managers and labors					
4) Environmental factors					
level of competitors					
manipulation of suppliers					
absence of construction-cost data					
economic instability					
effects of weather					
government policies					
inadequate production of raw materials by the country					
monopoly by suppliers					
number of competitors					
number of projects going at the same time					

political situation					
poor productivity					
project location					
social and cultural impacts					
5) Financing factors					
currency exchange					
inflationary pressure					
project financing					

Table 2. **List of cost overrun factors**

A number of studies were conducted to investigate the effects of cost overrun in construction projects. Table 1 summarizes some of these effects as presented in some previous studies.

Research methodology

41 factors that might affect cost overrun in building construction projects were defined through a detailed literature review. The similar factors were grouped under one main group; the factors were divided into 5 groups: cost estimating, construction items, project participants, environmental, and financing (Table 2). The factors were tabulated into a questionnaire form. Then the draft questionnaire was discussed with some construction parties who are involved in building construction to evaluate the content of the questionnaire. Modifications and changes have been done. Recommendations for minimizing cost overrun in building construction projects were emphasized in view of the results of the study.

Questionnaire design

The questionnaire is divided into two main parts. Part I is related to general information for the company. The consultants were requested to answer questions pertaining to their experience in building construction and their opinions about the percentage average cost overrun in building construction projects they have experienced. Part II includes the list of the identified factors affecting cost overrun in building construction. For each factor two questions were asked: what is the degree of severity of this factor on cost overrun in building construction? And what is the frequency of occurrence for this factor? Both frequency and severity were categorized on a five-point scale as follows: very high, high, moderate, little and very little (on 5 to 1 point scale).

Data analysis

Frequency index (F.I) and severity index (S.I) are calculated for each factor according to the following formula

Index (%) = Σ a (n/N) 100/5 (1)

Where; a is the constant expressing weighting given to each response (ranges from 1 for very low up to 5 for very high)

n is the frequency of the responses

N is total number of responses

Table 3 shows the scale used to determine the severity and frequency levels for cost overrun factors. When the factor's severity and frequency levels are calculated, its location in the risk map is identified according to Figure 1 and Table 4.

Figure 1 and Table 4 show the standard risk map which is used to determine the risk zone for each identified cost overrun factor. The map is 5x5 matrix with severity ranging from VL to VH on the horizontal axis and frequency (with the same range) on the vertical axis. Three zones are presented in the map: green, yellow and red (The U.S. Federal Highway Administration Office of International Programs, 2007).

The zones have the following characteristics:

- Green zone: risks in this zone are low level, and can be ignored.
- Yellow zone: risks in this zone are of moderate importance; if these things happen, one can cope with them and move on. However, if their frequency is moderate it should be reduced and if their severity is moderate, it should be controlled and reduced and a contingency plans should be in place just in case they do.

Index value (Scale)	Severity	Frequency
≤ 20%	very low (VL)	very low (VL)
20% - 40%	low (L)	low (L)
40% - 60%	moderate (M)	moderate (M)
60% - 80%	high (H)	high (H)
80% - 100%	very high (VH)	very high (VH)

Table 3. **Scale used to identify factor's severity and frequency level**

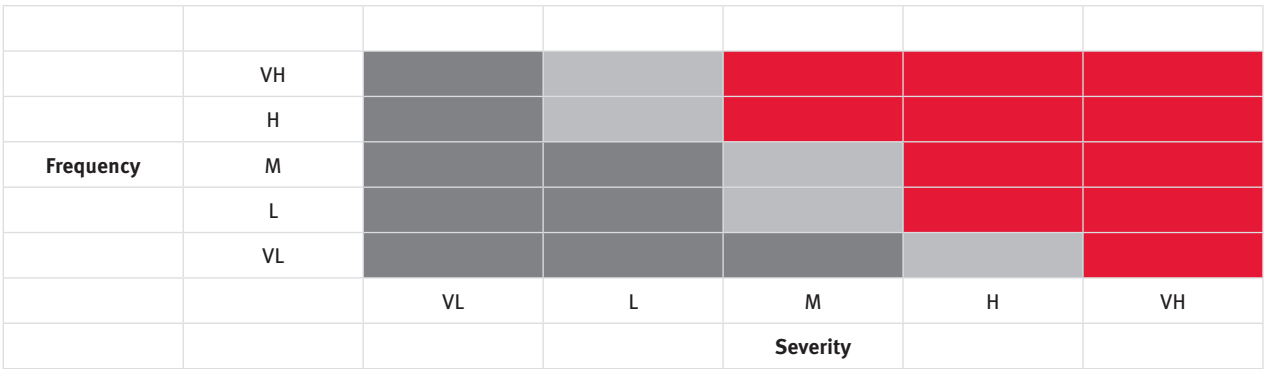

Figure 1. **Zones of the risk map**

- Red zone: risks in this zone are of critical importance. These are the top priorities, and are risks that a close attention should be paid to them.

Results and findings of the research

General characteristics of respondents

The questionnaire was sent out to a total of 30 consultants, asking their contribution in identifying the risk map for the considered 41 factors in terms of severity and frequency using an ordinal scale. A total of 26 consultants filled the questionnaire. The response rate by the consultants is 87%.

Figure 2 shows the distribution of the respondents according to their experience in building construction. It shows that most of respondents have experience of more than 15 years in building construction.

Severity / Frequency	VL	L	M	H	VH
VL	green	green	green	yellow	red
L	green	green	yellow	red	red
M	green	green	yellow	red	red
H	green	yellow	red	red	red
VH	green	yellow	red	red	red

Table 4. **The risk map**

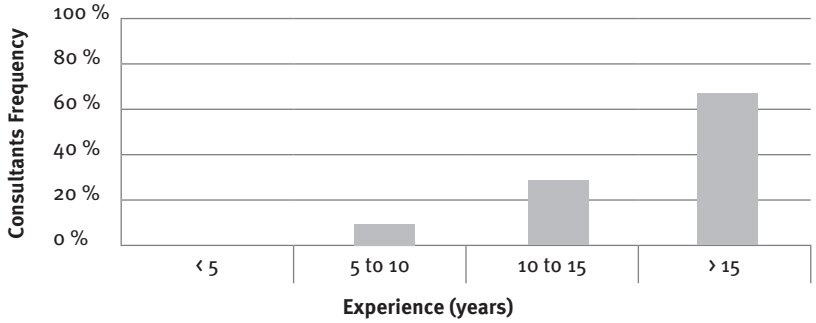

Figure 2. **Distribution of the respondents according to their experience in building construction**

Size of cost overrun in building construction projects

The analysis of the participants' responses regarding the cost overrun in building construction projects reveals that 100% of respondents indicated that the average cost overrun in building construction projects that they have experienced is between 10% and 30% of the original estimated cost of a project. More illustration is shown in Figure 3.

Factors' risk map

Cost estimating factors

Table 5 and Figure 4 illustrate the risk map for cost estimating factors. 11 factors are considered under this group. The results indicate that 4 factors are located in the red zone, 6 factors are located in the yellow zone and 1 factor is located in the green zone.

Factors related to construction items

Table 6 and Figure 5 illustrate the risk map for factors related to construction items. 7 factors are identified under this group. The results indicate that 5 factors are located in the red zone and 2 factors are located in the yellow zone. The table shows that there is no factor under this group is located in the green zone.

Factors related to project participants

Table 7 and Figure 6 illustrate the risk map for factors related to project participants. 6 factors are considered under this group. The results indicate that all factors under this group are located in the red zone.

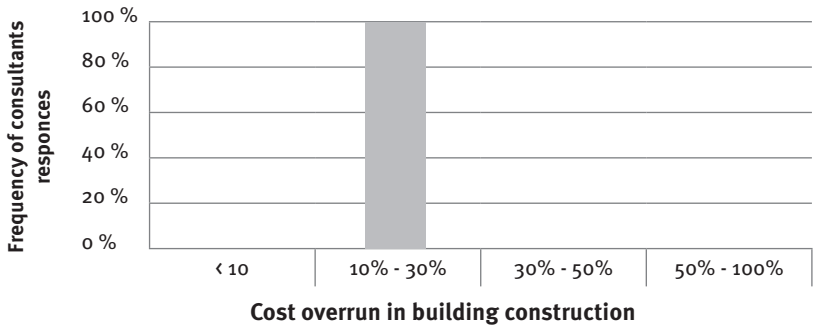

Figure 3. **Responses regarding the average cost overrun in building construction**

Environmental factors

Table 8 and Figure 7 show the risk map for environmental factors. 14 factors are identified under this group. The results indicate that 8 factors are located in the red zone and 6 factors are located in the yellow zone.

Financing factors

Table 9 and Figure 8 illustrate the risk map for financing factors. 3 factors are considered under this group. The results indicate that all factors under this group are located in the red zone.

Top affecting factors

Table 10 shows the top priority factors that affecting cost overrun in building construction projects and their related groups in ascending order. All of these factors are located in the red zone of the risk map. In order to rank them according to their degree of importance from consultants' perspective, the importance index for each factor is calculated as a function of frequency and severity indexes, as follows:

Importance Index (IMP.I) (%) = [(F.I) (%) (S.I) (%)] /100 (2)

The results indicate that there are 26 factors located in the critical zone of the risk map. Their distribution among the groups is as follow:

- 4 factors are related to cost estimating
- 5 factors are related to construction items

Factor	S.I	Severity level	F.I	Frequency level	Map zone
cost of labor	59.62	M	57.69	M	yellow
cost of machinary	54.81	M	47.12	M	yellow
transportation cost	50.96	M	50.00	M	yellow
high machinary maintenace cost	44.23	M	50.00	M	yellow
high interest rates by bankers	44.23	M	45.19	M	yellow
wrong estimation method	65.38	H	58.65	M	red
cost of insurance	44.23	M	46.15	M	yellow
fluctuation of prices of materials	81.73	VH	77.88	H	red
bureaucracy in tendering method	63.46	H	49.04	M	red
waste on site	32.69	L	50.00	M	green
long period between design and time of tendering	60.58	H	56.73	M	red

Table 5. **Risk map for cost estimating factors**

waste on site	cost of labor cost of machinary transportation cost cost of insurance high machinary maintenace cost high interest rates by bankers	wrong estimation method fluctuation of prices of materials bureaucracy in tendering method long period between design and time of tendering

Figure 4. **Risk map for cost estimating factors**

Factor	S.I	Severity level	F.I	Frequency level	Map zone
fraudulent practices and kickbacks	54.81	M	49.04	M	yellow
contract management	74.04	H	66.35	H	red
additional work	54.81	M	59.62	M	yellow
duration of contract period	68.27	H	62.50	H	red
contractual procedure	59.62	M	60.58	H	red
frequent changes in design	66.35	H	55.77	M	red
lack of adequate manpower	64.42	H	50.96	M	red

Table 6. **Risk map for factors related to construction items**

	fraudulent practices and kickbacks additional work	lack of adequate manpower duration of contract period contractual procedure frequent changes in design contract management

Figure 5. **Risk map for factors related to construction items**

Factor	S.I	Severity level	F.I	Frequency level	Map zone
disputes on site	63.46	H	55.77	M	red
lack of coordination between construction parties	67.31	H	54.81	M	red
poor financial control on site	62.50	H	53.85	M	red
poor planning	80.77	VH	58.65	M	red
previous experience of contract	78.85	H	67.31	H	red
relationship between managers and labors	62.50	H	64.42	H	red

Table 7. **Risk map for factors related to project participants**

		disputes on site lack of coordination between designers and contractors poor financial control on site poor planning previous experience of contract relationship between managers and labors

Figure 6. **Risk map for factors related to project participants**

- 6 factors are related to construction parties
- 8 factors are related to environmental group
- 3 factors are related to financing group

It can be seen that all factors related to construction parties are identified as critical factors. These factors are human related, meaning that these factors could be controlled and reduced by improving the skills of the participants (i.e. contractors, consultants, designers, owners, labors, and suppliers). The results are supported by some investigated previous studies as shown in Table 11.

Statistical analyses

Tables 12 presents the statistical analyses for the severity and frequency responses of cost overrun factors as assessed by consultants. The table contains the computation of the weighted mean, standard deviation, and coefficient of variation. These statistics are used to interpret the dispersion,

Factor	S.I	Severity level	F.I	Frequency level	Map zone
level of competitors	75.00	H	72.12	H	red
manipulation of suppliers	76.92	H	60.58	H	red
absence of construction-cost data	58.65	M	58.65	M	yellow
economic instability	80.77	VH	68.27	H	red
effects of weather	58.65	M	49.04	M	yellow
government policies	54.81	M	48.08	M	yellow
inadequate production of raw materials by the country	69.23	H	51.92	M	red
monopoly by suppliers	55.77	M	39.42	L	yellow
number of competitors	73.08	H	73.08	H	red
number of projects going at the same time	63.46	H	55.77	M	red
political situation	87.50	VH	76.92	H	red
poor productivity	58.65	M	56.73	M	yellow
project location	65.38	H	52.88	M	red
social and cultural impacts	48.08	M	48.08	M	yellow

Table 8. **Risk map for environmental factors**

	absence of construction-cost data effects of weather government policies monopoly poor productivity social and cultural impacts	level of competitors manipulation of suppliers economic instability inadequate production of raw materials by the country number of competitors number of projects going at the same time political situation project location

Figure 7. **Risk map for environmental factors**

Factor	S.I	Severity level	F.I	Frequency level	Map zone
currency exchange	73.08	H	74.04	H	red
inflationary pressure	77.88	H	66.35	H	red
project financing	75.96	H	68.27	H	red

Table 9. **Risk map for financing factors**

		currency exchange inflationary pressure project financing

Figure 8. **Risk map for financing factors**

Factor	S.I	Severity level	F.I	Frequency level	IMP.I	Related group
political situation	87.50	VH	76.92	H	67.31	environmental
fluctuation of prices of materials	81.73	VH	77.88	H	63.66	cost estimating
economic instability	80.77	VH	68.27	H	55.14	environmental
currency exchange	73.08	H	74.04	H	54.11	financing
level of competitors	75.00	H	72.12	H	54.09	environmental
number of competitors	73.08	H	73.08	H	53.40	environmental
previous experience of contract	78.85	H	67.31	H	53.07	project participants
project financing	75.96	H	68.27	H	51.86	financing
inflationary pressure	77.88	H	66.35	H	51.67	financing
contract management	74.04	H	66.35	H	49.12	construction items
poor planning	80.77	VH	58.65	M	47.37	project participants
manipulation of suppliers	76.92	H	60.58	H	46.60	environmental
duration of contract period	68.27	H	62.50	H	42.67	construction items
relationship between managers and labors	62.50	H	64.42	H	40.26	project participants
wrong estimation method	65.38	H	58.65	M	38.35	cost estimating
frequent changes in design	66.35	H	55.77	M	37.00	construction items
lack of coordination between construction parties	67.31	H	54.81	M	36.89	project participants
contractual procedure	59.62	M	60.58	H	36.11	construction items
inadequate production of raw materials by the country	69.23	H	51.92	M	35.95	environmental
disputes on site	63.46	H	55.77	M	35.39	project participants
number of projects going at the same time	63.46	H	55.77	M	35.39	environmental
project location	65.38	H	52.88	M	34.58	environmental
long period between design and time of tendering	60.58	H	56.73	M	34.37	cost estimating
poor financial control on site	62.50	H	53.85	M	33.65	project participants
lack of adequate manpower	64.42	H	50.96	M	32.83	construction items
bureaucracy in tendering method	63.46	H	49.04	M	31.12	cost estimating

Table 10. **Red zone factors and their related groups**

compactness, and the degree of homogeneity of the collected data

Table 12 shows that the standard deviations of the cost overrun factors for severity and frequency responses are ranging from 0.55 to 1.24 and 0.63 to1.06, respectively. A visual indication obtained from the scatter diagram shown in Figure 9 and Figure 10 shows that the data has good compactness, indicating that there is a good data consistency and agreement between consultants on the severity and frequency of the identified factors.

Table 12 also shows that the statistical analyses of the severity and frequency responses have reasonable coefficient of variations, ranging from 15%-40% and 16%-43% respectively. Visually, it can be seen from Figure 11 and Figure 12 that as the factors weighted mean increase, the coefficient of variation decrease, meaning that the participants are highly agreed on the impact of the top affecting factors.

Critical cost overrun factor in this study	Supported by
Political situation	Al-Najjar (2008)
Fluctuation of prices of materials	Al-Najjar (2008), Elinwa et al. (1993), Frimpong et al. (2003), Azhar et al. (2008), Okpala et al. (1988), and Nega (2008)
Level of competitors	Iyer et al. (2005)
Previous experience of contract	Al-Juwaireh (1997) and Al-khaldi (1990)
Project financing	Iyer et al. (2005), Al-khaldi (1990), Frimpong et al. (2003), and Okpala et al. (1988)
Inflationary pressure	Al-Najjar (2008) and Nega (2008)
Contract management	Al-Juwaireh (1997), Azhar et al. (2008), Frimpong et al. (2003), and Okpala et al. (1988)
Poor planning	Al-Juwaireh (1997), Nega (2008), and Azhar et al. (2008)
Duration of contract period	Iyer et al. (2005) and Al-khaldi (1990)
Wrong estimation method	Al-Juwaireh (1997) and Azhar et al. (2008)
Frequent changes in design	Nega (2008)
Lack of coordination between construction parties	Iyer et al. (2005) and Nega (2008)
Contractual procedure	Azhar et al. (2008)
Inadequate raw materials	Okpala et al. (1988)
Project location	Al-khaldi (1990)
Poor financial control on site	Azhar et al. (2008)
Long period between design and time of tendering	Azhar et al. (2008)

Table 11. **Comparison between findings of this study and previous studies**

Conclusion

This study is conducted to investigate the cost overrun in Palestinian building construction projects from consultants' perspective through a questionnaire survey. The analysis of the participants' responses reveals that the cost overrun in building construction projects is a severe problem. 100% of the respondents indicated that the average cost overrun that they have experienced is between 10% and 30% of the project's estimated cost. The study also identified the risk map for 41 cost overrun factors. 26 factors were concluded as critical factors. Inputs of the consultants underline that the top five factors affecting cost overrun in building construction projects are: political situation, fluctuation of prices of materials, level of competitors, currency exchange, and economic instability.

The statistical analyses of the severity and frequency responses indicate that the data has good compactness and homogeneity, meaning that there is a good data consistency and agreement between consultants on the severity and frequency of the identified cost overrun factors. It also shows that the participants are highly agreed on the impact and frequency of the top affecting factors.

Based on the study findings, the following points are suggested in order to minimize and control cost overrun in building construction projects:

- Training courses and workshops should be conducted to improve

Factor	Severity responses			Frequency responses		
	$\overline{X}$	Sn	CV (%)	$\overline{X}$	Sn	CV (%)
cost of insurance	2.21	0.65	29.46	2.31	0.97	41.91
fraudulent practices and kickbacks	2.74	1.10	40.00	2.45	0.77	31.55
level of competitors	3.75	0.69	18.48	3.61	0.82	22.64
manipulation of suppliers	3.85	0.63	16.32	3.03	0.86	28.28
transportation cost	2.55	0.72	28.26	2.50	0.89	35.78
absence of construction-cost data	2.93	0.80	27.18	2.93	0.80	27.18
additional work	2.74	1.01	36.77	2.98	0.85	28.59
bureaucracy in tendering method	3.17	0.95	29.87	2.45	0.87	35.52
contract management	3.70	0.96	25.89	3.32	0.89	26.88
contractual procedure	2.98	0.80	26.97	3.03	0.76	25.01
cost of labor	2.98	0.64	21.38	2.88	0.74	25.51
cost of machinery	2.74	0.85	31.00	2.36	0.71	30.20
currency exchange	3.65	0.80	21.79	3.70	1.00	26.99
disputes os site	3.17	0.86	27.08	2.79	0.71	25.48
duration of contract period	3.41	0.83	24.24	3.13	0.81	26.00
economic instability	4.04	0.76	18.93	3.41	1.00	29.36
effects of weather	2.93	0.89	30.41	2.45	0.66	27.01
fluctuation of prices of materials	4.09	0.60	14.78	3.89	0.77	19.66
frequent changes in design	3.32	0.98	29.46	2.79	0.71	25.48
government policies	2.74	0.94	34.26	2.40	0.98	40.63
high interest rates by bankers	2.21	0.82	36.86	2.26	0.98	43.40
high machinary maintenace cost	2.21	0.65	29.46	2.50	0.89	35.78
inadequate production of raw materials by the country	3.46	0.99	28.67	2.60	0.93	36.01
inflationary pressure	3.89	0.86	22.18	3.32	0.98	29.46
lack of adequate manpower	3.22	0.90	28.01	2.55	0.82	32.33
lack of coordination between construction parties	3.37	0.74	21.87	2.74	0.85	31.00
long period between design and time of tendering	3.03	0.76	25.01	2.84	0.92	32.40
monopoly by supplier	2.79	1.03	37.00	1.97	0.76	38.43
number of competitors	3.65	0.74	20.37	3.65	0.74	20.37
number of projects going at the same time	3.17	0.95	29.87	2.79	0.82	29.24
political situation	4.38	0.71	16.16	3.85	0.63	16.32
poor financial control on site	3.13	0.91	28.98	2.69	0.92	34.35
poor planning	4.04	0.95	23.55	2.93	1.06	36.01
poor productivity	2.93	0.80	27.18	2.84	0.87	30.83
previous experience of contract	3.94	1.24	31.54	3.37	0.97	28.83
project financing	3.80	0.72	18.96	3.41	0.78	22.78
project location	3.27	0.85	26.07	2.64	0.71	26.91
relationship between managers and labors	3.13	0.81	26.00	3.22	0.81	25.10
social and cultural impacts	2.40	0.89	37.06	2.40	0.93	38.89
waste on site	1.63	0.55	33.59	2.50	0.85	33.94
wrong estimation method	3.27	0.90	27.46	2.93	0.89	30.41

Table 12. Statistical analyses for severity and frequency responses

managerial skills of project participants

- Material prices and labor rates should be updated continuously.
- Sufficient time should be given for preparing feasibility studies, planning, design, information documentation and tender submission. This helps avoiding or minimizing late changes
- Progress payment should be paid on time
- More communication and coordination between project participants during all project phases.
- Top management must react positively to political and environmental changes by means of managerial and financial policies

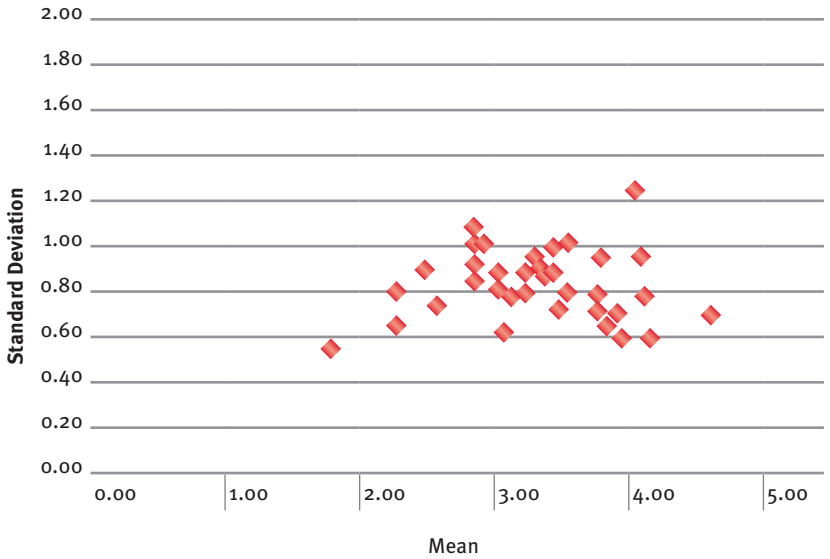

Figure 9. Factor mean vs. standard deviation for severity responses

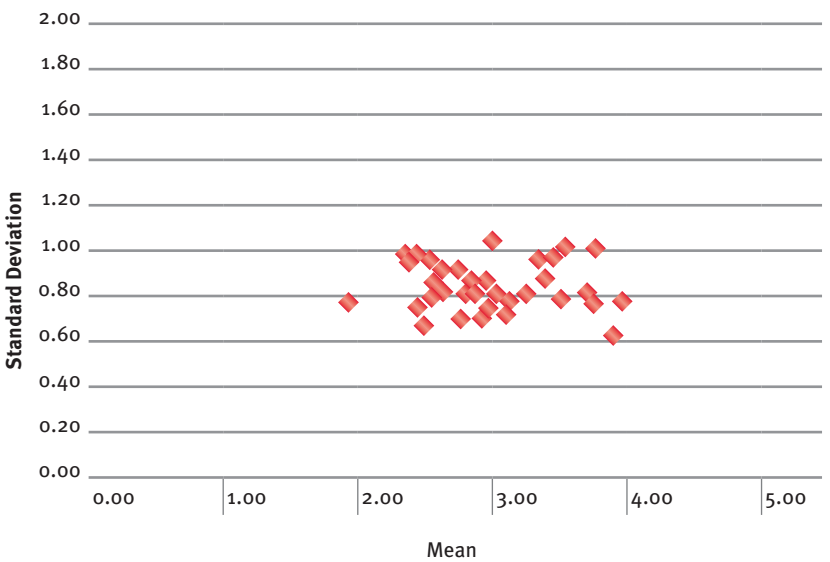

Figure 10. Factor mean vs. standard deviation for frequency responses

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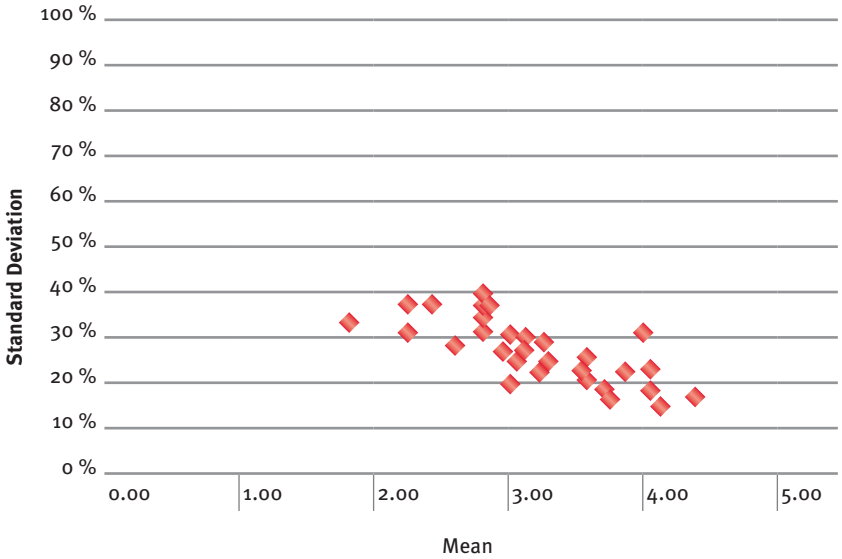

Figure 11. **Factor mean vs. coefficient of variation for severity responses**

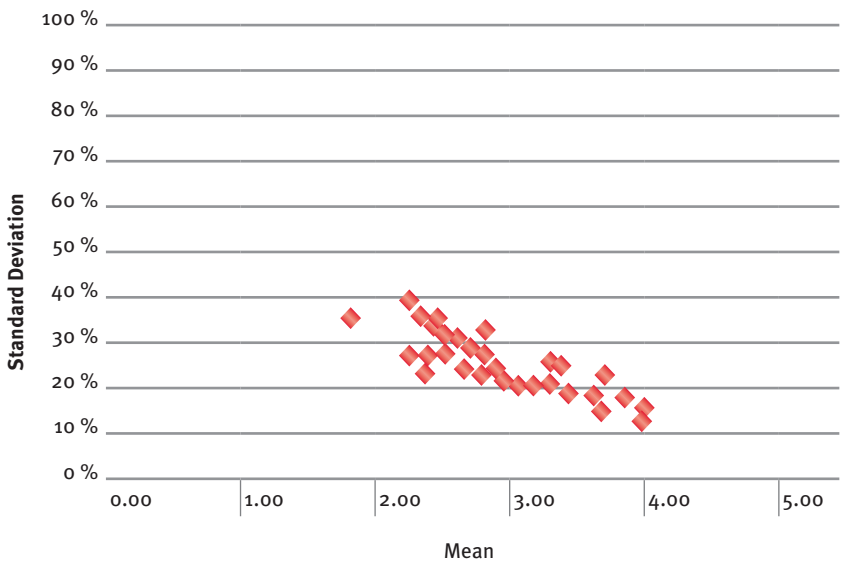

Figure 12. **Factor mean vs. coefficient of variation for frequency responses**

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