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An Investigation into Cost Overrun in Construction Projects in United Arab Emirates

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Abstract The construction industry contributes to the overall economy of United Arab Emirates (UAE) significantly, but it is plagued by cost overrun due to various factors. This paper looks at the, various factors influencing cost overrun in UAE construction industry and the mitigation measures. The most important causes of cost overrun are poor productivity, insufficient early planning, delayed completion, and lack of skilled resources and motivation. The most effective mitigation measures for cost overrun are detailed estimation, conducting brain storming sessions for cost control, procurement planning, mobilizing resources at the right time and training of workers. The paper recommends that higher management should focus and provide more support to Human resource related issues for controlling cost overrun, as they are the predominant causes of cost overrun. In addition, improving productivity, efficient estimation process, value management, change management and procurement management are also crucial to minimize cost overrun in construction industry in the United Arab Emirates.

Keywords Project management, Cost Overrun, Delays, Causes, Mitigation measures, United Arab Emirates

1. Introduction

1.1. Background

One of the important criteria for project success is project completion within budget, time and the satisfaction of the client's requirement. In the construction industry, completing a project within budget is even more critical, as companies work on narrow margins. Completing a project within budget is a complex task. Even with various cost control software and techniques, cost overruns in construction projects are not uncommon all over the world (Olawale & Sun, 2010). Cost overruns, whether they are due to delay or estimation errors or any other factors, do not just happen; they are caused (Maieli, 2001). The construction industry significantly impacts the economy of all countries (Leibing, 2001).

The cost of construction project is affected by a large number of factors (Chan and Park, 2005). Eden, Ackermann & Williams (2005) illustrated that the growth in project cost is "amoebic" in nature. According to them, it is not easy to track down what drives total cost overrun. They suggested it tends to spread in an amoebic manner. They also stated that project costs escalate in an exponential manner and not linearly.

There has been extensive research on the causes of cost overrun in construction projects in various countries like Vietnam (Hoai, Lee & Lee, 2008) Nigeria (Mansfield, Ugwu and Doran, 1994), Ghana (Frimpong, Oluwoye, and Crawford, 2003), Kuwait (Koushki, Al-Rashid & Kartam, 2007) Turkey (Arditi, Akan & Gurdamar, 1985), Malaysia (Abdul kadir et al., 2005), Libya (Al Gathafi, 2005), Pakistan (Azhar, Farooqui & Ahmed, 2008) and Indonesia (Kaming et al., 1997). These studies concluded that cost overrun is a common phenomenon on construction projects all over the world.

Factors causing cost overrun differ from country to country and depend on the political, economic and cultural factors. United Arab Emirates (UAE) looks different from that in most other countries in many ways. Its GDP annual growth during 2001-2008 was 7.2%. The construction industry contributed about 8% of GDP in the last years which is high compared to western countries. UAE construction industry had witnessed an unprecedented boom and doom in recent years. The 2007 recession affected UAE only in 2009 and house prices declined by 35%. The above factors warrant an exclusive study on cost overrun & mitigation measures in UAE industry.

1.2. Research aim and Objectives

This paper, therefore, aims to answer the following research question: What are the causes of cost overruns in construction projects in UAE and how can they be mitigated? The following research objectives address this research question:

- To determine the factors which, influence cost overruns in construction projects, in UAE,
- To explore the interrelationships between the factors.

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- To rank the factors in terms of frequency and impact.
- To identify measures that could be taken to mitigate against the factors causing the cost overruns
- To propose a model on best practice to avoid cost overruns in construction projects

2. Litreature Review

2.1. Causes of Cost Overrun

A literature review was carried out to list out the various factors causing cost overrun and their importance in various countries.

The top five ranked causes of cost overrun in the survey conducted by Olawale & Sun (2010) in the U.K are tabulated in Table 2.1.

Table 2.1. Top 5 Ranked factors inhibiting effective cost control

Cost control inhibiting factor	Rank
Design changes	1
Risk and uncertainty associated with projects	2
Inaccurate evaluation of projects time/duration	3
Non-performance of subcontractors and nominated suppliers	4
Complexity of works	5

Source: Olawale & Sun (2010)

Also, the top five ranked causes of cost overrun in the research carried out by Memon, Rahman & Aziz (2011) in Malaysia are tabulated in Table 2.2.

Table 2.2. Top 5 ranked causes of delay & cost overrun in Malaysia

Cause	Rank
Poor design & delays in Design	1
Unrealistic contract duration & requirements imposed	2
Lack of experience	3
Late Delivery of materials &equipment	4
Relationship between Management & Labour	5

Source: (Memon, Rahman & Azis 2011)

Love & Li (2000) found that the cost of rework was 3.15% and 2.4% of the contract value for case study projects in Australia. Changes, errors, omissions in design as well as construction, damages during construction were the reasons for rework. The above percentage of cost of rework is substantial and needs to be investigated in UAE projects.

Panda's (1996) study revealed that inadequate project formulation, deficient estimation of cost, midstream changes in scope and volume of work, improper vendor selection and late starting of work were significant factors responsible for time and cost overrun in India. Koushki, Al-Rashid & Kartam (2007), identified contractor related problems, material related problems and owner's financial constraints, design deficiency as the main causes of cost overrun in private residential projects, in Kuwait.

Azhar, Farooqui and Almed (2008) identified fluctuation in prices of raw materials, unstable cost of manufactured materials, High cost of machineries, Lowest bidding procurement method and poor project management / poor cost control as top five cost overrun factors in Pakistan.

Based on a questionnaire survey with 87 Vietnamese construction experts, Hoai, Lee & Lee (2008) identified various causes of delay & cost overrun and the top 5 causes are listed in Table 2.3.

Table 2.3. Top 5 Causes of delay & cost overrun in Vietnam

Causes	Overall Rank	Important Index	Group
Poor site Management & supervision	1	0.664	Contractor
Poor Management assistance	2	0.644	Consultant
Financial difficulties of owner	3	0.620	Owner
Financial difficulties of contractor	4	0.597	Contractor
Design changes	5	0.505	Project

Source: Hoai, Lee & Lee, 2008

Mansfield, Ugwu & Doran's (1994) research on Nigerian construction projects revealed poor contract management as one of the most significant causes of delay and cost overrun. Al Gathafi (2005) pointed out that political instability, interference, corruption, requirements of permits, periodic regulatory changes, and bureaucracy in government agencies were causes of cost overrun. Shortage of materials and price fluctuations are typical problems in third world countries as they have unstable monetary and economic policies (Al Gathafi, 2005).

From the above review of the literature, the common causes of cost overrun identified from the various surveys conducted in different countries are provided in Table 2.4.

2.2. Mitigation Measures for Cost Overrun

Roachanakanan (2005) suggested the need for project owners and architects to work together to complete the design drawings before project estimates are prepared or contracts are awarded in order to prevent inaccurate project estimates and cost overruns subsequently. Oberlender & Pevrifoy (2002) suggested that risk analysis of uncertainties needs to be performed in order to arrive at a proper contingency cost, and this should be added to the budget estimate. In cost planning process, both design economists and the architect should participate (Brandon & Ferry (1984).

Table 2.4. Common causes of Cost overrun in various countries

	Country surveyed	**United Kingdom**	**Vietnam**	**Indonesia**	**Kuwait**	**Ghana**	**Nigeria**	**Turkey**	**Nigeria**	**Pakistan**	**Libya**
Sl No	**Cost Overrun factor**	**Olawale & Sun (2010)**	**Hoi , Lee & Lee (2008)**	**Kaming et al. (1997)**	**Koushki, Rashid & Kartam (2005)**	**Frimpong, Oluwoye and Crwford, (2003)**	**Mansfield, Ugwu, Doran (1994)**	**Arditi,, Akan and Gurdamar (1985)**	**Dlakwa & Culpin (1990)**	**Azhar, Farooqui, Ahmed (2008)**	**Al Gathafi (2005)**
1	Design changes										
2	Inaccurate evaluation of Project duration /time /cost										
3	Non-performance of subcontractor										
4	Discrepancies in contract documentation										
7	Contract & Specification interpretation disagreement										
8	Increase in material prices Inflation of price										
7	Financing & payment for completed works										
8	Poor site Management										
9	Financial difficulties of contractor										
10	Un foreseen/ Changes in site condition										
11	Shortage of material										
12	Poor contract Management										
13	Bad unpredictable weather										
14	Increase in labour cost										
15	Lack of experience of Project location/Project type										
16	Delays										
17	Additional work										
18	Shortage of labour / low skilled manpower										
19	Unstable government policy										
20	Corruption										

Halpin (1985) states that management should detect the actual cost overrun in field construction at the start of the project and plan remedial measures at the beginning itself to reduce the impact of cost overrun. Hoai, Lee and Lee (2008), concluded that most causes of delay and cost overrun of construction project relate to human and management problems and hence improving the ability of managers and engineers may mitigate cost overrun.

Frimpong, Olvwoye, & Crawford (2003) recommended measures such as determination of appropriate funding at the planning stage, continuous work-training programs with project management techniques and processes, effective and efficient procurement system and adequate contingency allowance for mitigating cost overrun and delays.

To minimize time delays and cost overruns Koushki, Al Rashid & Kartam (2007) recommended the following:

- ✓ Ensure adequate finance,
- ✓ Perform proper preconstruction planning on tasks & resources
- ✓ Allocate sufficient time & money for the design phase
- ✓ Hire an independent, supervising engineer
- ✓ Select a competent consultant & reliable contractor.

Mansfield, Ugwu & Doran (1994) recommended that the

client should perform the following to minimize time delays and cost overruns.

- ✓ Allow sufficient time to prepare project briefs and feasibility studies
- ✓ Ensure that adequate funds are available before projects are started
- ✓ Ensure that contractors establish an efficient material Management system
- ✓ Carry out institutional strengthening and manpower development in the areas of project management, information and data base management.

Chan & Kumaraswamy (1997) recommended continuous professional development schemes, thorough site investigation, clearly defined roles and responsibility matrix, client brief, value management techniques, bridging the gaps in perception between the different groups as some of the measures to mitigate project delay, which in turn, will mitigate cost overrun, as well. According to them, effective site management is the key for productivity.

Olawale & Sun (2010) identified 90 measures to mitigate the effect of the top five leading project cost and time control inhibitors and classified them under preventive measures, predictive measures, corrective measures and organizational measures. They concluded that although external factors are generally difficult to control or even beyond the control of project managers, the frequency of their occurrence is generally low. On the other hand, internal factors are persistent and require constant control.

Bubshait's (2001) research in petrochemical plant on incentive/disincentive (I /D) contracting supports the use of incentive/disincentive provision to improve labor productivity and reduce cost overrun. Jergeas (2009) recommended the following for the development of efficient and effective best practices to improve construction productivity:

- ✓ Incentive and recognition program.
- ✓ Proper transport system for people to reach remote sites.
- ✓ Improving labour management & relationship.
- ✓ Overtime & work schedule.
- ✓ Proper management of tools, equipment, scaffolding.
- ✓ 80% engineering completion& 100% IFC drawings before construction.

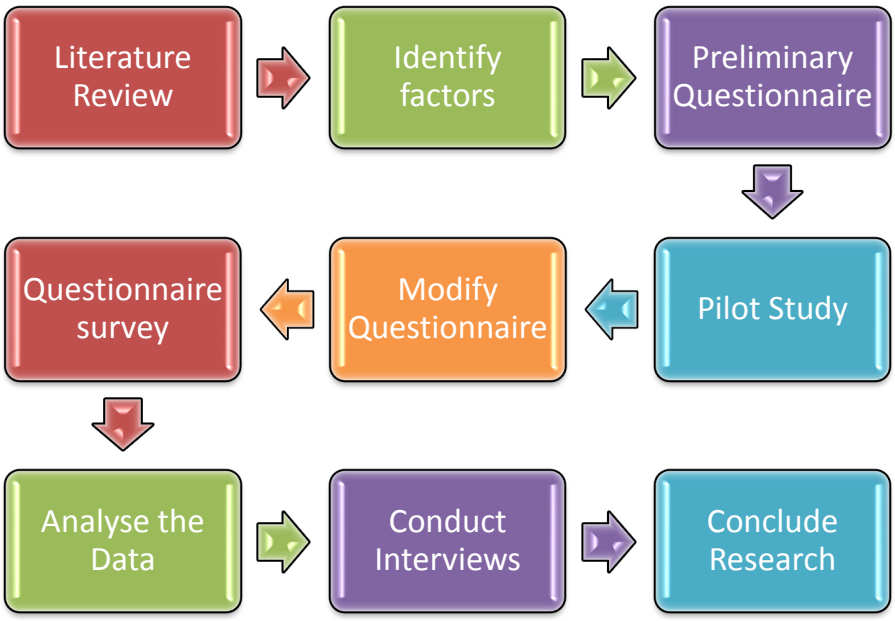
Kaming et al. (1997) recommended the following to eliminate delays and cost overruns based on the interviews carried out with project managers, in Indonesia:

- ✓ To avoid price hikes, select the long term contracts with construction material suppliers, sub-contractors, labor suppliers.
- ✓ Avoid substructure work during the rainy season.
- ✓ Maintain & update cost data base of materials, equipments at a unit price.
- ✓ Establish the site/logistics properly to maximize productivity.
- ✓ Provide accommodation & arrange welfare facilities to workmen to minimize absenteeism and maximize productivity.

Based on the above literature review, 83 significant variables that cause cost overrun and 69 best practices which can mitigate the cost overrun were identified in the literature review.

3. Methodology

3.1. Research Strategy & Design



Source: Author

Figure 3.1. Flow Chart of Proposed Research Process

As illustrated in Figure 3.1, the research methodology adopted to address the research objectives to answer the research question was a combination of both quantitative and qualitative methods with quantitative as the predominant method via a questionnaire survey. The triangulation of quantitative and qualitative methods was highly useful for this study as both methods complemented each other, yielded a comprehensive picture and provided a range of perspectives to enhance the study. Further a simple random sampling was done for each sub group. This ensures representation of not only the overall population, but also key subgroups of the population; especially small minority groups. It gives higher statistical efficiency than simple random sampling (Krishnaswami and Sathyaprasad, 2010, p.62).

3.2. Sample Criteria and Selection

3.2.1. Quantitative Sample

To determine the sample size for the large population of respondents, the following Cochran formula was used.

$$n_o = Z^2pq / e^2$$

Where

n_o = Sample size

Z^2 =Abscissa of the normal curve that cuts off an area at the tails

E = Desired level of precision

P = Estimated proportion of an attribute that is present in the population

Q = 1-p (Cochran, 1963)

Assuming maximum variability i.e., p = 0.5, 93% confidence level, +/- 7% precision and Z^2=1.96 (Unit normal distribution table, Vassar stats), size required = 1.96^2 x 0.5 x 0.5 / $(0.07)^2$ = 196 respondents.

Hence the proposed total sample size for the questionnaire survey was 200.

Furthermore, stratified random sampling method was employed. In this method, the population was divided into homogeneous sub groups such as Contractors, Sub contractors, Cost Consultants, Developers & Project Managers. Further a simple random sampling was done for each sub group. This ensures representation of not only the overall population, but also key subgroups of the population; especially small minority groups. It gives higher statistical efficiency than simple random sampling (Krishnaswami and Sathyaprasad, 2010, p.62).

Accordingly responses were solicited from **127 Main Contractors, 68 Sub-Contractors, 20 Cost Consultants, 23 Architects, 22 Developers and 35 Project Management firms**. The questionnaire was addressed to chief estimators, cost consultants, cost controllers, Project Managers, Planning Engineers etc, in order to obtain appropriate answers to the questionnaire.

3.2.2. Qualitative Sample

For the qualitative method, the sampling approach was based on purposive sampling since the objective was to select participants who have knowledge or experience of the issues being investigated. Purposive sampling is particularly useful for this situation as it helps to reach a targeted sample quickly, and sampling for proportionality is not the primary concern here. Purposive sampling is more convenient and guarantees inclusion of relevant elements in the sample (Krishnaswami and Sathyaprasad, 2010, p.77).

3.2.3. Qualitative Data Collection

The qualitative method via semi structured interviews was used after the questionnaire survey. Semi structured interviews were used because they provide a wide deal of freedom to probe various areas and to raise specific queries (Naoum, 1998, p.58). They also provide the flexibility and detailed information to support exploratory research and also the opportunity to compare responses (Bryman, 2004:320-324). In addition, they can also provide insights and in-depth explanations (Saunders, Lewis, and Thornhill, 2009, p.323). Thus, the semi structured interviews were invaluable as a tool to investigate further. The interviews were conducted with a selected number of participants who were determined based on the outcome of the questionnaire survey. However, in view of the time limitation of this dissertation the total number of interviewees was restricted to three.

3.3. Data Collection

3.3.1. Quantitative Data Collection

The data collection was conducted in three stages, with the first two stages involving the quantitative method. In the first stage, a preliminary questionnaire based on the literature reviews was pre tested on a small sample population. This was mainly to check to ensure that the wording of the question is not ambiguous (Royer and Zarlowski, 2001).

3.4. Data Analysis

3.4.1. Index Analysis

The primary data collected from the questionnaire survey was quantitatively analyzed using the following four types of indices (Hoai, Lee & Lee, 2008).

- **Severity index** expresses the severity of the factors that cause overrun, and it is calculated as follows:

Severity Index (S.I) = $\sum W_s$ / (H x N)

W_s= Total of severity weight given to each factor

H= Highest Ranking Available which is 5 in this case

N= Total Number of Respondents who have answered the question.

- **Frequency index** expresses the frequent occurrence of the factors that cause cost overruns, and it is calculated as follows:

Frequency Index (F.I) = $\sum W_f$ / (H x N)

W_f = Total of severity weight given to each factor

H= Highest Ranking Available which is 5 in this case

N= Total Number of Respondents who have answered the question.

- **Importance Index** is the overall importance based on the severity and frequency, and it is calculated as follows:

Important Index (IMP.I) = F.I x S.I

- **Effectiveness index** expresses the effectiveness of the mitigation measure to control the cost overrun and it is calculated as follows:

Effectiveness Index (E.I) = $\sum W_e / (H \times N)$

W_e = Total of Effectiveness weight given to each factor

H = Highest Ranking Available which is 5 in this case

N = Total Number of Respondents who have answered the question.

3.4.2. Spearman's Rank Order Correlation

Spearman's coefficient of rank order correlation was used to analyze the agreement or disagreement among each pair of parties. (I.e. Owners & Contractors, Contractors & Consultants, etc.), and it was calculated using Statistical Package for Social Sciences (SPSS). This was crucial to measure and compare the association between the rankings of two parties (Wakijara, 2011).

3.4.3. Factor Analysis

Principal component factor analysis (PCFA) technique was used to summarize a large number of original variables into a smaller number of factors in order to determine the relationship among sets of variables (Krishnaswamy, Sivakumar and Mathirajan, 2006). Correlation matrix table, KMO & Barlett's test of sampling adequacy, Communalities, and Rotated factor matrix table were done with the aid of SPSS. Rotated factor matrix table was calculated by principal axis factoring extraction method and varimax rotation method. This was used to group the top 20 ranked variables in to the small number of groups. (Leech, Barrett, Morgan, 2005, pop. 78-90).

4. Research Findings and Discussion

4.1. Respondent's General Information

The questionnaire was sent to a total of 295 construction professionals and 194 professionals responded to the questionnaire. The overall response rate was 66%, which is good. The total of 194 respondents consisted of 5 designated groups namely Project Managers, Cost controllers, Planners, Chief Estimators, and General Managers. Project Managers and estimators formed the largest group. 46% of the respondents had more than 20 years' experience, and 93% of respondents had more than 10 years' experience. The overall average experience of the respondents was 17 years, reflecting response to the survey by sufficiently experienced professionals, a factor that enhanced the reliability of the study's results.

4.1.1. Level of Project Cost Overrun

7% of the respondents stated that cost overrun occurred in all their projects while 34% of the respondents stated that cost overrun occurred in 50% of their projects. 46% of the respondents confirmed that cost overrun occurred in about 25% to 50% of their projects and only 16% of the respondents stated that cost overrun occurred in less than 25% of their projects. This confirmed Olawale & Sun's view that cost overruns in construction projects are not uncommon all over the world (Olawale & Sun, 2010) and it is indeed a serious problem in the UAE construction industry.

4.2. Index Analysis

4.2.1. Frequency Index & Ranking

Based on the rating on the factors causing cost overrun given by the 194 respondents, frequency index was calculated and ranked. The top ten ranking of extremely highly likely causes of cost overrun is tabulated in Table 4.1.

Work force in UAE is predominantly made up of expatriates from south Asian countries. There is no proper mechanism to check the skill level of the workforce before deploying them on the job. This leads to poor productivity. The welfare of the workforce is generally ignored by the construction companies, and this result in lack of motivation towards work. Short and demanding project schedules cause insufficient preconstruction planning. There is no skilled construction resource readily available locally and, therefore, this needs to be recruited overseas, based on the specific requirement of the project. Mobilization of human resources from South Asian countries takes time, and until they are available, the contractors tend to hire at higher rates from other contractors locally (if available). This incurs additional cost.

Short tender period and hasty evaluation of techno commercial offers results in improper / unclear scope definition. These results in scope creep and ends in cost and time overrun. A review of the above causes shows that problems in human resource management alone contribute 5 causes: integration management contributes 4 causes and time management contributes 1 cause.

However, surprisingly lack of quality awareness and delayed completion were ranked 26 and 19 respectively by the developers compared with their overall rankings of 7 and 9.

Change in policies, wrong procurement method, inclement weather, force majeure and political instability are ranked at the bottom. All groups of respondents stated that, external as well as government related factors rarely caused cost overrun. This is understandable because of the dynamic leadership and business friendly policies of the UAE government.

4.2.2. Severity Index & Ranking

Based on the rating of the factors causing cost overrun by the 194 respondents, severity index was calculated and ranked. The top ten ranking of very highly severe causes of cost overrun is tabulated in Table 4.2.

Table 4.1. Top Ten Frequency Index and ranking

	Over all		Developer		Architect		Cost Consultant		Project Management Consultant		Main contractor		Sub-Contractor	
CAUSE OF COST OVERRUN	**Frequency Index**	**Rank**	**Frequency Index**	**Rank**	**Frequency Index**	**Rank**	**Frequency Index**	**Frequency Index**	**Frequency Index**	**Rank**	**Frequency Index**	**Rank**	**Frequency Index**	**Rank**
Poor productivity	0.78	1	0.76	3	0.78	2	0.80	2	0.75	1	0.80	1	0.75	2
Lack of motivation	0.76	2	0.78	1	0.74	3	0.81	1	0.75	1	0.76	2	0.74	3
Insufficient early planning	0.73	3	0.78	1	0.66	13	0.72	6	0.71	4	0.74	3	0.76	1
Lack of skilled Resources	0.71	4	0.67	12	0.79	1	0.71	8	0.72	3	0.70	5	0.72	4
Scope creep	0.69	5	0.70	8	0.68	6	0.73	5	0.66	7	0.70	5	0.68	8
Lack of Training	0.68	6	0.67	12	0.69	5	0.75	3	0.67	5	0.69	8	0.64	14
Delayed completion	0.68	7	0.64	19	0.68	6	0.68	11	0.66	7	0.70	5	0.68	9
Experience on similar projects	0.66	8	0.76	3	0.61	22	0.67	14	0.65	12	0.66	14	0.66	12
Lack of quality awareness	0.66	9	0.62	26	0.71	4	0.75	3	0.63	17	0.66	12	0.64	14
Lack of control over resources	0.66	10	0.71	7	0.52	58	0.59	38	0.66	7	0.66	12	0.70	5

Source: Author

Table 4.2. Top Ten Severity Index and ranking

	Overall		Developer		Architect		Cost consultant		Project Management Consultant		Main Contractor		Sub Contractor	
Severity of Cause of Cost Overrun	**Severity Index**	**Ranking**	**Severity Index**	**Ranking**	**Severity Index**	**Ranking**	**Severity Index**	**Ranking**	**Severity Index**	**Ranking**	**Severity Index**	**Ranking**	**Severity Index**	**Ranking**
Cost of Rework	0.79	1	0.86	1	0.79	3	0.77	2	0.74	3	0.76	2	0.87	1
Error in Estimate	0.76	2	0.79	3	0.74	10	0.72	13	0.79	1	0.77	1	0.76	6
Client's financial difficulties	0.76	3	0.73	11	0.81	1	0.73	6	0.76	2	0.75	3	0.79	3
Poor cost monitoring method	0.74	4	0.77	5	0.81	1	0.73	6	0.70	6	0.74	4	0.71	15
Poor productivity	0.73	5	0.74	8	0.75	6	0.83	1	0.69	8	0.73	6	0.73	12
Delayed completion	0.73	6	0.80	2	0.78	4	0.68	23	0.65	23	0.70	15	0.83	2
Lack of Training	0.72	7	0.76	7	0.71	20	0.73	6	0.70	6	0.71	10	0.73	11
Conflict between client & contractor	0.71	8	0.69	23	0.71	20	0.73	6	0.71	5	0.72	8	0.71	15
Insufficient early planning	0.71	9	0.69	23	0.73	13	0.73	6	0.71	4	0.70	13	0.71	19
Lack of skilled Resources	0.70	10	0.70	17	0.59	52	0.68	23	0.69	8	0.70	15	0.77	4

Source: Author

Rework impacts project in many ways. It causes friction between the Engineer and the Contractor, delays the work, and needs additional resources for rectifying the work / redoing the whole work. It also negatively impacts the motivation of the work force. Even though, its likelihood is low, (FI = 0.58), severity is rated as high. This survey revealed that error in estimate also directly impacts the project cost severely. Most of the projects in UAE are based on fixed lump sum contracts. Hence, misunderstanding the scope, error in quantity take off, error in unit rates and error in the estimation of general requirements & preliminaries will impact the cost severely. The likelihood of error in estimate was medium (FI = 0.6), but its severity was high (SI = 0.76).

Clients financial difficulties results in stoppage/suspension of work, delayed payments, labour wastage, machinery idling and impacts the cost severely. This survey shows that, in UAE, the likelihood of experiencing clients financial difficulties is medium (F1=0.63) and its severity is high (S1=0.73).

Poor cost control & monitoring was mentioned as another cause of cost overrun with high severity index (0.74). Severity index of poor productivity was also high (S1=0.73). This factor was the topmost frequent cost overrun factor, as well. Based on Author's experience, the labour component of a construction project used to be 10 to 12% of the project cost and productivity impacts this segment of the cost.

The common factors in both the top ten frequency index and severity index are delayed completion, poor productivity, lack of skilled resource, lack of training and insufficient early planning.

4.2.3. Important Index & Ranking of Causes of Cost Overrun

Based on the frequency index and severity index, important index was calculated and ranked. The top ten ranking of the extremely important causes of cost overrun is tabulated in Table 4.3.

This research concurs with the study in Vietnam by Hoai, Lee & Lee (2008), that most causes of delay & cost overrun in construction project relate to human and management problems.

This research shows inadequate planning and scheduling (Rank 2) as immensely important. Considering the complexity of the projects in UAE, this is understandable. A similar study in Malaysia showed Inadequate planning and scheduling as the seventh ranked delay and cost overrun factor (Memon, Rahman & Aziz, 2011) and another in Pakistan showed it as the ninth ranked (Azhar, Farouqui and Ahmed, 2008).

Delayed completion was the third ranked important cause of cost overrun, which concurs with the view of Panda (1996), that timely completion is essential to avoid cost overrun.

Client's financial difficulty is rated as the seventh important factor causing cost overrun in UAE. This factor was also stated as one of the most influential factors of delay and cost overrun in the survey conducted in Nigeria by Mansfield, Ugwu and Doran (1994) and Kuwait, by Kaushki, Al Rashid and Kartam (2007).

Table 4.3. Top Ten Importance Index and ranking

	Overall		Developer		Architect		Cost consultant		Project Management Consultant		Main Contractor		Sub-Contractor	
Importance of Cause of Cost Overrun	**Important Index**	**Ranking**	**Important Index**	**Ranking**	**Important Index**	**Ranking**	**Important Index**	**Ranking**	**Important Index**	**Ranking**	**Important Index**	**Ranking**	**Important Index**	**Ranking**
Poor productivity	0.571	1	0.56	2	0.58	1	0.66	1	0.52	1	0.58	1	0.55	3
Insufficient early planning	0.52	2	0.54	3	0.48	9	0.53	4	0.51	2	0.52	2	0.54	4
Delayed completion	0.50	3	0.52	4	0.53	2	0.46	10	0.43	9	0.49	6	0.56	1
Lack of skilled Resources	0.50	4	0.47	13	0.46	11	0.48	7	0.50	4	0.49	6	0.55	2
Lack of motivation	0.49	5	0.48	11	0.51	3	0.59	2	0.45	8	0.51	3	0.46	11
Lack of Training	0.49	6	0.50	5	0.49	6	0.55	3	0.47	6	0.49	4	0.47	8
Client's financial difficulties	0.47	7	0.46	17	0.50	5	0.44	18	0.50	3	0.46	11	0.47	9
Cost of Rework	0.46	8	0.58	1	0.44	15	0.47	9	0.43	11	0.43	23	0.49	6
Error in Estimate	0.46	9	0.48	10	0.43	17	0.44	17	0.49	5	0.45	13	0.45	12
Conflict between client & contractor	0.45	10	0.45	19	0.37	36	0.40	29	0.42	13	0.49	5	0.43	16

Source: Author

Material related problems & shortage of materials were stated as one of the main causes of cost overrun in studies conducted in Kuwait (Kouski, Al Rashid & Kartam, 2007), Turkey (Arditi, Akan & Gurdamar, 1985) and Vietnam (Hoai, Lee & Lee, 2008). However, this research rated this factor as low likelihood (FI = 0.523) and low severity (SI = 0.542) in UAE. This may be due to the recession in the market for the past few years.

Fluctuation in prices of raw materials and inappropriate government policies were stated as particularly crucial factors causing cost overrun in studies conducted in Pakistan (Azar, Farouqui and Ahmed, 2008) and Nigeria (Elinwa & Buba, 1993). However, this research suggested that, these factors are not critical in UAE.

El Sayegh (2008) pointed out that social, political and cultural risks are low in UAE. This research results confirms the same. It is particularly relevant to note that the external factors do not significantly impact cost overrun in UAE but rather the internal issues in particular Human Resource issues are the most fundamental causes of cost overrun.

4.2.4. Effectiveness Index & Ranking of Mitigation Measures for Cost Overrun

Based on the rating on the effectiveness of mitigation measures factors given by the 194 respondents, an effectiveness index was calculated and ranked. The top ten ranking of extremely effective mitigation measure for cost overrun is tabulated in Table 4.4.

The top most ranking of effective measures to mitigate cost overrun was proper estimation by measuring and pricing bills of quantities properly during the tender stage. It has effectiveness index of 0.85. Proper estimation can mitigate many causes of cost overrun, which includes, scope bifurcation, unclear information, discrepancy in design, complexity in design, fluctuation in price, site location difficulties, site logistics, onerous contract clauses, vogue contractual clauses, risk assessment, etc..

Table 4.4. Top Ten Effective Index and Ranking

	Overall		Developer		Architect		Cost consultant		Project Management Consultant		Main Contractor		Sub-Contractor	
Effectiveness of Mitigating Measure	**Effective Index**	**Ranking**	**Effective Index**	**Ranking**	**Effective Index**	**Ranking**	**Effective Index**	**Ranking**	**Effective Index**	**Ranking**	**Effective Index**	**Ranking**	**Effective Index**	**Ranking**
Ensure proper estimation	0.85	1	0.91	1	0.80	4	0.83	5	0.84	1	0.86	1	0.82	4
Conducting cost control workshops	0.84	2	0.82	4	0.86	1	0.89	1	0.81	6	0.85	3	0.84	2
Proper procurement planning	0.83	3	0.86	3	0.75	17	0.84	3	0.83	2	0.85	2	0.83	3
Mobilizing resources at right time	0.83	4	0.82	4	0.85	2	0.85	2	0.82	4	0.82	4	0.86	1
Providing effective training	0.80	5	0.79	10	0.73	27	0.80	7	0.81	6	0.81	7	0.80	9
Implement incentive & recognition program	0.80	6	0.77	20	0.80	4	0.80	7	0.83	2	0.82	6	0.74	25
Ensure project finance is availability	0.79	7	0.77	20	0.74	22	0.77	13	0.80	10	0.80	8	0.81	7
Follow proper quality control procedures	0.79	8	0.81	6	0.78	11	0.83	5	0.78	14	0.80	9	0.76	17
Implement effective cost control & monitoring	0.79	9	0.87	2	0.75	17	0.76	18	0.81	6	0.77	14	0.81	6
Organize site for maximum productivity	0.78	10	0.79	10	0.84	3	0.84	3	0.77	16	0.77	14	0.74	24

Source: Author

Conducting workshops/brainstorming sessions to identify cost control/saving measure was the second ranked mitigation measure. Involving the relevant stakeholder will certainly lead to better procurement plan, less wastage, right selection of plant & machinery, better productivity, improved motivation, better communication, planning, improved risk response plan & monitoring. This will ultimately mitigate the cost overrun. This finding does not appear to have been reported in previous studies. The Projects in UAE are large and complex and it requires a lot of coordination and synchronization between various special trades and services. Probably, this could be the reason why, conducting workshop / brain storming session is rated as very important.

Implementing proper procurement plan in line with project planning was the third ranked mitigation measure. (E1 = 0.83) Failure of this measure could result in idle labour & machinery, scarcity of material, higher % age of wastage, delayed completion and lead to cost overrun. Mobilizing resources at the right time was ranked as fourth effective mitigation measure (E1 = 0.83). Improper Mobilization of resources could result in delayed completion, crushing of schedule, poor productivity, improper sequencing of work and rework. Providing effective training and implementing incentive/ recognition program was ranked as fifth and sixth effective mitigation measures (E1 = 0.83). These measures could improve productivity, safety and quality awareness, motivation, and reduce rework & wastage.

This study reveals implementing recognition & incentive scheme as one of the very effective measures to mitigate cost overrun. This view was supported by the research studies of Bubshait (2001) and Jergeas (2009).

Ensuring project finance before the start of the project is ranked as the seventh effective mitigation measure in this study. This confirms with the recommendations of Mansfield, Ugwu & Doran (1994) and Koushiki, Al Rashid & Kartam (2007).

Properly organizing the site was also found to be a very effective measure for controlling cost in UAE. This was recommended by Kaming et al. (1997) based on the interviews carried out with the Project managers in Indonesia.

4.3. Spearman's Rank Order Correlation

4.3.1. Frequency Index Correlation

Spearman's Correlation coefficient for frequency index was calculated and it shows an excellent correlation of the frequency of causes of cost overrun among the various stakeholders of the construction industry. In particular the correlation between the developer category and Main Contractor category is high with the coefficient of 0.837. This is followed by the correlation between PMC category and subcontractor category with the coefficient of 0.807. The correlation between Developer category and Architect category is the lowest with the coefficient of 0.566. As the correlation between the parties in ranking the frequency of causes of cost overruns is good, the data could be considered reliable for further analysis.

4.3.2. Severity Index Correlation

Spearman's Correlation coefficient for severity index was calculated and it shows an excellent correlation on the severity of causes of cost overrun among the various stakeholders of the construction industry. Particularly correlation between Main Contractor category and Sub Contractor category is high with the coefficient of 0.789. This is followed by the correlation between Cost Consultant category and Main Contractor category with the coefficient of 0.783. On the other hand, the correlation between Cost Consultant category and Sub Contractor category is the lowest with the coefficient of 0.59. As the correlation between the parties in ranking the severity of causes of cost overruns is good, the data could be considered reliable for further analysis.

4.3.3. Important Index Correlation

Spearman's Correlation coefficient for important index was calculated and it shows an excellent correlation on the importance of causes of cost overrun among various stakeholder of the construction industry. Particularly the correlation between Main Contractor category and Architect category is high with the coefficient of 0.859. This is followed by the correlation between the Main Contractor category and Sub Contractor category with the coefficient of 0.851. On the other hand, the agreement between Architect category and Developer category is the lowest with the coefficient of 0.714. As the correlation between the parties in ranking the importance of causes of cost overruns is good, data could be considered reliable for further analysis.

4.3.4. Effectiveness Index Correlation

Spearman's Correlation coefficient for effectiveness index was calculated and it shows an excellent correlation on the effectiveness of mitigation measures for cost overrun among various stakeholder of the construction industry. Particularly the correlation between Main Contractor category and Sub Contractor category is high with the coefficient of 0.919. This is followed by the correlation between the Main Contractor category and PMC category with the coefficient of 0.813. The correlation between Architect category and Developer category is the lowest with the coefficient of 0.616. As the agreement between the parties in ranking the effectiveness of mitigation measures is good, data could be considered reliable and used for further analysis.

4.4. Factor Analysis

Factor analysis with principal component extraction technique was employed to extract a manageable subset of factors for the following.

- Top 20 ranked frequent causes of cost over runs
- Top 20 ranked severe causes of cost over runs
- Top 20 ranked mitigation measures.

4.4.1. Factor Analysis on Frequency of Cost Overrun

KMO and Bartlett's test shows sampling adequacy of 0.646.

The Kaiser – Meyer – Olkin measure of sampling adequacy was found to be 0.646 (>0.50) with a significant level of 0.000 level for Bartlett's test of sphericity. These measures confirmed the suitability of the data for proceeding with factor analysis. Initial Eigen values and rotation sums of squared loading for the 20 variables were calculated and found that seven factors have Eigen values greater than 1.0, which is a common criterion for a factor to be useful.

The rotated component matrix sorted out the 20 variables in to 7 overlapping groups of items, having loading of absolute value of 0.3 and above. The groups of variables identified are,

- ✓ Human resource Management
- ✓ Time Management
- ✓ Risk Management
- ✓ Planning & Control
- ✓ Safety & Quality
- ✓ Estimation & Scope control
- ✓ Inexperience

4.4.2. Factor Analysis on Top 20 Severe Causes of Cost Overrun

KMO and Bartlett's test shows sampling adequacy of 0.699.

The Kaiser – Meyer – Olkin measure of sampling adequacy was found to be 0.699 (>0.50) and significant at 0.000 level for Bartlett's test of sphericity. These measures confirmed the suitability of the data for proceeding with factor analysis. Initial Eigen Values and Rotation sum of squared loading were calculated for the 20 variables and found seven factors have Eigen values greater than 1.0, which is a common criterion for a factor to be useful.

The rotated component matrix sorted out the 20 variables in to 7 overlapping groups of items, having loading of absolute value of 0.3 and above. The groups of variables identified are,

- ✓ Human resource Management
- ✓ Time Management
- ✓ Planning, Control & Monitoring
- ✓ Procurement & Quality
- ✓ Estimation
- ✓ Change Management
- ✓ Project Finance

4.4.3. Factor Analysis on Top 20 ranked Mitigation Measures

The Kaiser – Meyer – Olkin measure of sampling adequacy was found to be 0.64 (>0.50) and significant at 0.000 level for Bartlett's test of sphericity. These measures confirmed the suitability of the data for proceeding with factor analysis. Initial Eigen Values and Rotation sums of squared loading were calculated for top 21 variables and found that seven factors have Eigen values greater than 1.0, which is a common criterion for a factor to be useful.

The rotated component matrix sorted out the 21 variables in to 8 overlapping groups of items, having loading of absolute value of 0.3 and above. The groups of variables identified are,

- ✓ Human resource & communication Management
- ✓ Procurement
- ✓ Value Management
- ✓ Estimation
- ✓ Risk management
- ✓ Quality
- ✓ Experience

4.5. Interviews

The outcome of the interviews with the three construction professionals was generally in agreement with the ranking of the factors causing cost overrun as well as the mitigation measures. Discussion with these professionals revealed many fascinating insights into how the factors are interlinked and how the mitigation measures could be implemented more effectively.

4.5.1. Productivity, Motivation & Training

All interviewees agreed that poor productivity is indeed a critical problem in UAE. The Project Director said "*Train to gain is the slogan in my project*" He explained that productivity depends on the skill level and motivation of the work force. He suggested the importance of ensuring that critical materials are available on time to avoid idle labour. The Cost Control Manager suggested that detailed workshops should be conducted with the consultant, the Main contractor & subcontractors at regular intervals so that the workforce can be planned properly to enable discrepancies to be sorted out at the right time. The Project Management Consultant suggested that the need for management to invest in both offsite and onsite training of workmen. This will increase the productivity, quality of work, improve motivation and reduce rework and delays. He was certain that the benefits of training would be much higher than the cost of training and it is a Project Manager's duty to convince higher management about the importance of training and also arrange suitable training for the project staff and workmen. "*Project Manager is largely responsible for success or otherwise of the project. Unless he is proactive, project's goal can't be achieved*" he summed it up.

4.5.2. Project Planning & Control

All three interviewees agreed that poor project planning is extremely crucial to limiting delays and cost, and it is not generally carried out meticulously in UAE. The Project Director opined that lack of company data base on activity duration and productivity norms leads to poor planning. The Cost Control Manager opined that the lack of involvement of all parties in project planning leads to poor planning. He suggested that expertise in operating a planning tool like Primavera Project planner (P3) alone cannot ensure a proper

project plan, because the involvement of the Project Manager, as well as specialist subcontractors, is paramount in developing a workable project plan. The Project Management consultant said "*Fail to plan indeed is a plan to fail"* He suggested that the project plan should be prepared, taking into consideration the specific characteristics of the project such as logistics, location, complexity, funding arrangement and should be modified based on changing market conditions. He insisted the Project Manager should envisage the changes in market condition and take proactive measures.

The Project Management consultant added that Earned Value Management (EVM) is the best tool for monitoring & control, but unfortunately, only few companies were adopting this control system in UAE. He suggested activity based cost booking along with EVM will be helpful to identify the problem exactly, so that remedial measures can be implemented early. The Cost consultant quipped "*you can't reach goal post without knowing where you are now"* He mentioned that on many projects, due to poor monitoring systems, the reasons of cost overrun are identified only after project completion.

4.5.3. Risk Management

The Project Management consultant mentioned that risk assessment and monitoring are done on many projects in UAE, as a formality only and not as a critical process. He suggested that it is necessary for Project Managers to change their mindset about risk management and take it seriously. He insisted that risk management is even more crucial in a volatile market conditions as exists in the UAE. He pointed out the need for the risks to be identified, throughout the project life time and control measures implemented. The Cost consultant said "*Never ignore your instincts. It smells the risks better*" He mentioned that failure to envisage the impending risks resulted in the termination of many projects in 2009.

4.5.4. Procurement

All interviewees agreed that proper procurement planning is critical for preventing not only time overrun, but also cost overrun. The Project director pointed out that, in many projects in UAE, the developer delays the appointment of nominated sub-contractors such as Mechanical, electrical & Plumbing (MEP) works, Interior decoration works. However, main contractors are forced to accept the delayed nomination without extension of time. For mitigating the delays, the Main contractor tries to fast track and crash the schedule. This results in rework and additional cost to the Main contractor. To avoid this, the main contractor's schedule should have milestones for the nomination of sub-contractors. The Main contractor should proactively work with the developer for the nomination of sub-contractors at the right time.

The Project management consultant suggested that the actual construction progress should be coordinated with the suppliers properly, so that they are delivered just in time to avoid double handling, wastage and to reduce inventory cost. "*Bid shopping is a curse to this market*" said the Cost consultant. He insists that the developer should not go for bid shopping, as it will tarnish the image of the developer in the long run. He opined that specifying a single source in the tender document leads to unethical practice.

4.5.5. Experience

The Project management consultant pointed out that appointing inexperienced contractors based on low bid was not a wise decision. Generally it leads to time overrun, disputes, low quality and ultimately cost overrun. The Project director mentioned that relevant experience is necessary for proper coordination between various trades, and lack of experience leads to rework and delays.

4.5.6. Estimation

The Project director opined that, contractors were forced to estimate the project cost on lump sum basis with incomplete information and scope bifurcation. Pressure from the client to submit unqualified lump sum offer in a short time compounds the problem. He pointed out that queries raised by contractors are vaguely answered by consultants and results in improper estimation during tender stage and disputes / cost overrun in later stage. To overcome this, pre bid meeting should be conducted in the presence of the client's representative. The Project management consultant pointed out that, the main contractor is ultimately responsible for the project cost in lump sum contracts. Based on his experience, he should allow contingency for such unclear items. The Cost consultant pointed out that on many projects, clients themselves evaluate the contractor's bid based on lump sum prices, but they could not identify the contractor's estimation errors. Early involvement of a cost consultant may reduce estimation errors.

He suggested that every company should have their productivity norms and other cost data from their current projects and the same shall be used for the estimation of tenders.

4.5.7. Change Management

"*Claims & dispute settlement is a big business here, which is a loss loss situation to both client and contractor. Mutual trust is the key to avoid dispute"* said the Project Director. He mentioned that approvals for change order costs are usually delayed by consultants and clients and settled only at the end of the project. This leads to dispute and cash flow problems to contractors. The Project Management Consultant pointed out that mistrust between the contractor & the client is the main reason for such disputes. He suggested that change management procedure should be agreed between all the main stakeholders at the beginning of the project and strictly adhered to. The Cost consultant admitted that "*We are supposed to be unbiased but we couldn't be so"*. He insisted that impartiality of the consultant is paramount for settling

the cost of change but many clients expects cost consultant to act in their favor. He suggested that partnership contract is ideal for projects where frequent changes are expected. However, the Project Director pointed out that partnership contract in UAE is rare and failed miserably on a beach development project he worked on. He expressed the view that the construction industry in UAE is not matured enough for partnership arrangement.

4.5.8. Value Management

All the interviewees concurred that Value Management was an ignored concept in UAE until the economic downturn. They pointed out that it was ignored due to the urgency of the client for starting the project. They were of the view that Value Management is extremely effective only if it is carried out at the beginning of a project. The Project Management Consultant pointed out that, in some cases, value management will shorten the project time. He further explained that, after the economic downfall, most of the projects are going through Value Management and Value Engineering processes. The Project Director mentioned that client's awareness and the involvement of the contractor at the design stage are paramount for effective Value Management. However he cautioned that dilution of specification and compromise on the design for short term benefits in the name of Value Engineering may back fire in the long term. "*All for me attitude of client desist the contractor from value engineering"* said the Cost Consultant. He suggested that Value Management can be implemented effectively only if the benefits are shared between the contractor and client.

4.5.9. Project Finance and Client's Financial Difficulty

The Interviewees felt the client's financial difficulty is a serious problem causing cost overrun, but they pointed out that this has been a prevalent phenomenon only after 2009 and unexpected changes in the economy account for it. However, the project director pointed out that, underestimation of the cost of projects and overestimation of the financial returns from the projects are the other reasons for the client's financial difficulty. The Cost Control Manager opined that change in scope & design without evaluating the cost and time impacts compounds the client's financial difficulty. The Project Management Consultant explained that, the over estimation of demand, non-consideration of current projects results in oversupply. The projects become unviable due to over -supply of buildings and puts the client in financial woes. He noted that starting the project without sufficient financial arrangements does not only affect the contractor, but also the developer and the investors. This leads to dispute and loss of reputation. The Project director mentioned that there are some instances where the developer siphoned the investor's money for purposes other than project purposes and thus jeopardizing the project, the contractor and the investor's interests. He suggested that government should regulate the project finance, so that investors and contractors interests are protected.

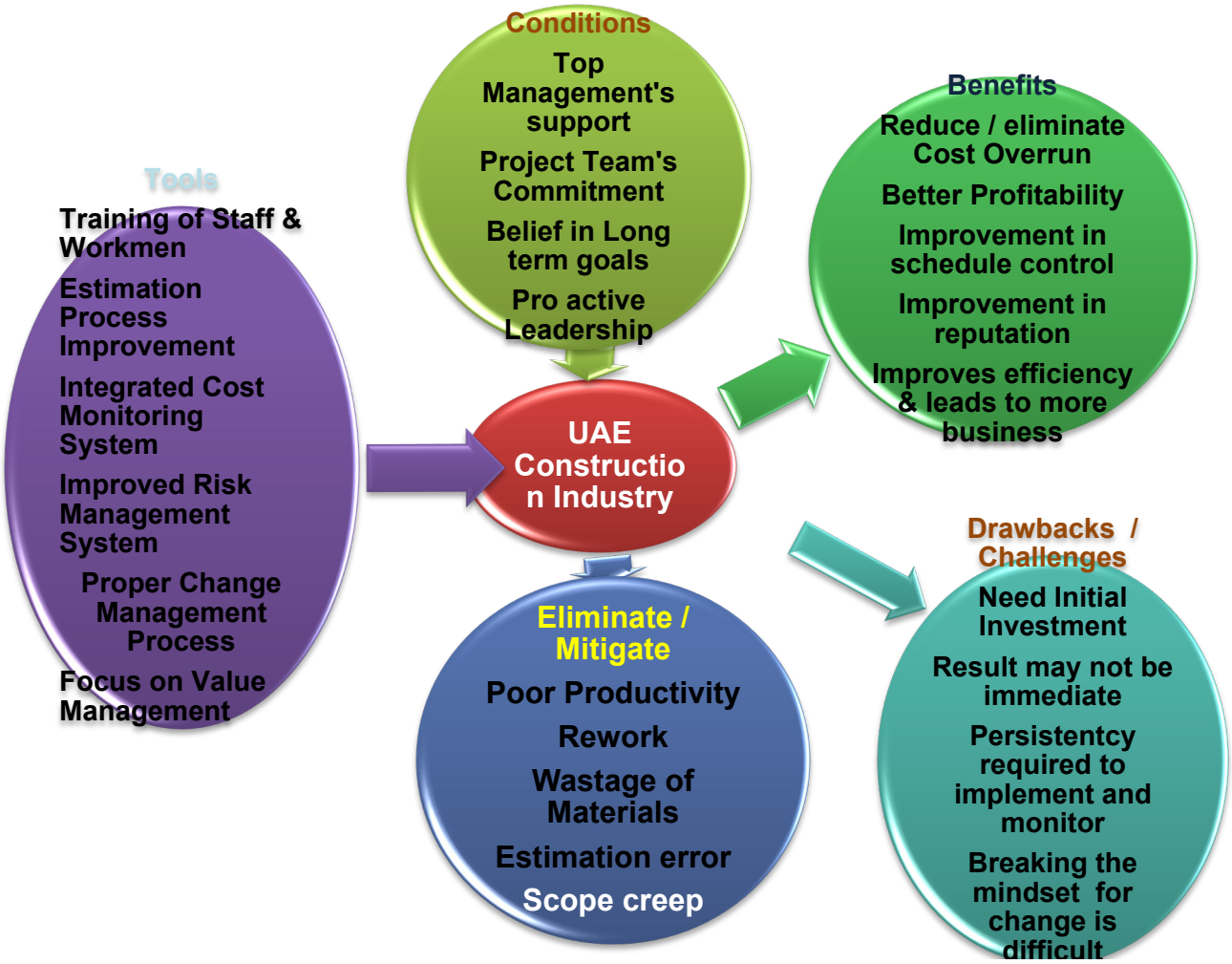
Some of the salient concepts surfaced during the interview are the following:

- ✓ Project Managers are responsible to prevent cost overrun, and they should be proactive and not reactive.
- ✓ Higher management should support and take the initiative to implement training programs, recognition and reward programs to improve productivity and motivation.
- ✓ Updating the cost data from current projects is crucial for reducing estimation errors. Lessons learnt from previous projects are valuable to prevent cost overrun.
- ✓ Changes cause friction. Effective client management & Change management process are paramount to mitigate the same.
- ✓ Collaborative approach improves value management and benefits the Contractor as well as Client.

4.6. Model for Mitigating Cost Overrun

Based on the literature review, questionnaire survey and interview outcomes a general model for mitigating cost overrun in UAE Construction industry is presented in Figure 4.4. This model proposes the need for training of staff & workmen, estimation process improvement, integrated cost monitoring system, risk management system improvement, proper change management process and focuses on value management. Conditions like top management's support, project team's commitment, belief in the long term goals and proactive leadership are necessary to reduce cost overrun, improve profitability and schedule control. This would also improve the reputation of the organization, efficiency and leads to more business. However, process improvements & training need investment and results may not be immediate. Persistency is crucial to implement and monitor the recommended process improvements. Breaking the mindset of the employees towards the changes may also be a challenging task. Nevertheless, since these drawbacks have been highlighted, efforts could be directed to mitigate them.

Finally in the next section, a discussion on measures that could be taken to improve the following is presented based on the outcomes of the study: (i) Productivity, (ii) Estimation Process, (iii) Value Management, (iv) Change Control Process, and (v) Procurement Management.



Source: Author

Figure 4.4. General Model for Mitigating Cost Overrun in UAE Construction Industry

4.6.1. Improving Productivity

Improving productivity requires strict recruitment procedure, training of staff & workmen, rewards & incentive scheme, improving welfare, better construction methodology, efficient & effective communication and sufficient material inventory at the site. As noted by Jergeas (2009), incentive and recognition program is pivotal in improving productivity. Conditions like top management support, project team's commitment, unbiased incentive scheme, and proper trainers are essential to reduce or eliminate cost overrun, improve profitability, improve relationship improve productivity & motivation, reduce employee turnover and improve efficiency. However, training requires investment and results may not be immediate. Persistency is crucial to implement and monitor the recommended process improvements. A caution is that incentive scheme may also trigger unethical practices.

4.6.2. Improving Estimation Process

Improving estimation process proposes the need for a risk assessment for bid / no Bid decision, analyze impacts of techno commercial conditions, integrated software for estimation, cost & productivity data from organization's projects, regular update on cost data, clear understanding of scope and sufficient time to cross check the estimate. Hence as suggested by Olawale & Sun (2010), risk register shall be prepared from tender stage. Cost data base shall be updated regularly to avoid estimation error. Conditions like top management support, estimation team's commitment, avoiding impulsive decisions are crucial to improve estimation process, which improves accuracy of estimate, reduce / eliminate cost overrun, scope creep, reduce disputes, improve order booking and reduce risks.

However, the drawbacks or challenges are that declining to quote may upset the client, and a refusal to accept an onerous clause could lead to loss of tender.

4.6.3. Improving Value Management

Improving value management needs early involvement of the contractor, cost / benefit analysis of all major items, specification audit, and benefit sharing between the client &

the contractor, and preferably a partnership contract. Value engineering exercise should not be disruptive to the progress of the project. Conditions like top management support, and trust between the client, the consultant & the contractor are paramount to ensure maximum value and better profitability. However, the drawbacks or challenges are that value management may lead to dilution of quality, if the purpose is misunderstood. Breaking the mindset for change is also difficult. Nevertheless, since these drawbacks have been highlighted, efforts could be directed to mitigate them.

4.6.4. Improving Change Control Process

As recommended by Love & Li (2000), efforts shall be focused on proper understanding of the client requirements, coordinating and checking design documentation and conducting design analysis review to reduce design changes, errors and omissions. Improving the Change Control Process requires a change control board with a well-defined authority. Conditions like top management support, project team's commitment and strong leadership are necessary to support the change control board in its work to ensure the elimination or mitigation of scope creep and thereby help to reduce or eliminate cost overrun to improve profitability and lessen disputes. However, the drawbacks or challenges are that the process might affect the project progress if this process becomes rigid, bureaucratic and decisions are delayed.

4.6.5. Improving Procurement Management

Lastly, improving procurement management requires, procurement planning, envisaging inflation / deflation & planning accordingly, written procedure & approval levels, risk transfer measures, integrated software, just in time, inventory control and principled negotiation. Conditions like top management support, strict adherence to procedure, avoiding impulsive decisions, no political & psychological influence and ensuring transparency are critical to improve procurement management in its bid to reduce / eliminate cost & time overrun, reduce disputes, reduce idling time, and reduce risks. However, the drawbacks or challenges are that adherence to procedure may upset some stakeholders / political class. Also, foreseeing inflation / deflation is also difficult. Furthermore, supply chain must be efficient for the implementation of just in time process.

5. Conclusions

5.1. Key Research Findings

The cost overrun mitigation strategy was developed to deal with the common challenges in UAE Project Management system. In general, the findings indicated that the external & government factors were rarely influencing the cost and only internal factors and more particularly Human Resource related factors were highly influencing the cost overrun. As the principal causes are internal, it is possible to minimize the cost overrun by adopting proper project management methodology and the mitigation measures discussed in this study. Since the crux of the cost overrun is found to be issues related to human resource and estimation, higher management could give due importance to training at all levels. They could also focus on establishing a proper estimation procedure, as estimation will make or mar the future of the company. Estimation should also be adjusted continually, based on the feedback from the current projects.

5.1.1. Research Objective 1

This first objective was to determine the factors that influence cost overrun in construction projects, in UAE. A total of 83 factors were identified through various literature reviews and listed in appendix 1. It was classified under eleven categories.

5.1.2. Research Objective 2

The second objective was to explore the inter relationship between the cost overrun factors. The correlations between the top twenty ranked cost overrun factors were identified using SPSS software and grouped in to seven categories.

Correlation matrix for Top 20 ranked frequent causes of cost overrun is identified. Some of the highly correlated frequent causes of cost overrun are:

- ✓ Between, delays in project financing arrangement and delayed completion.
- ✓ Between, poor productivity and lack of skilled resources.

Correlation matrix for Top 20 ranked severe causes of cost overrun in displayed in table 4.13. Some of the highly correlated severe causes of cost overrun are:

- ✓ Between, defective material / poor quality and cost of rework.
- ✓ Between, delayed completion and liquidated damages.

5.1.3. Research Objective 3

The third objective was to rank cost overrun factors in terms of frequency and severity. 83 causes of cost overrun identified in appendix 1 were ranked based on the rating of respondents in the questionnaire survey.

5.1.4. Research Objective 4

The fourth objective was to identify the measures that could be taken to mitigate cost overrun. A total of 69 mitigation measures were identified and tabulated in appendix 2. Based on the questionnaire survey ratings, these 69 measures were ranked. In addition, with the help of SPSS software, the top 20 effective mitigation measures were sorted out to 7 groups.

5.1.5. Research Objective 5

The fifth objective was to propose a model on best practices to avoid cost overrun in construction projects. Based on the literature review, the questionnaire survey and

further interviews with experienced professionals, a general model with supporting models were prepared and presented in figures 5.1.

5.2. Contributions to the Knowledge

The main contributions of this research study are as follows.

a. The factors influencing the cost overrun of construction projects in UAE are identified. Their likelihood as well as severity is rated, ranked and grouped. This can be used as a checklist at the project initiation stage to ward off cost overrun.
b. The mitigation measures for cost overrun factors are identified. Their effectiveness is rated and ranked. The conclusion of the research emphasizes the need for training and motivation for the human resources for preventing cost overrun. This author believes this research conclusion could change or influence the mindset of higher management regarding human resource management.
c. The study presents a model that could be employed to mitigate the cost overrun in UAE was developed. This could help the construction professionals to minimize cost overrun.

5.3. Research Limitations

This research is limited to construction projects in UAE and also public infrastructure projects are not included. Thus, the respondents of this research were mostly from the private sector. Hence the results and the recommendations of this research would appear to be more suitable for private sector construction projects in UAE. Therefore, caution is required, when using this data and recommendations for infrastructure /government projects, as the causes of cost overrun and their mitigation measures for government & infrastructure projects could be different.

This research was carried out at a time when the construction industry was facing severe recession. Hence some cost overrun factors like non availability of materials, inflation which is rated as less important in this study could become extremely important when boom time comes.

5.4. Suggestions for Further Research

While this study focused only on the cost overrun factors and their mitigation measures, further research could include time overrun factors, their correlation with cost overrun factors and also mitigation measures for time overrun.

Another area for future research could be to measure the cost of training against the cost benefits of training since a key finding of this research was that providing training is one of the most effective mitigation measures for cost overrun. This will enable the higher management to make an informed decision on investing on the training of human resources.

Appendix

1.1. Summary of Causes of Cost overrun – Appendix 1

Sl No	Cost Overrun Factor	Knowledge Area
1	Poor Project scope planning	Scope Management
2	Unclear scope bifurcation	Scope Management
3	Scope change in middle	Scope Management
4	Misunderstanding of Scope by contractor	Scope Management
5	Insufficient feasibility study	Cost Management
6	Delay in Project financing arrangement	Cost Management
7	Improper financial analysis by client	Cost Management
8	Error in Estimate	Cost Management
9	Unclear information in Tender	Cost Management
10	Delay in payment approval	Cost Management
11	Poor cost monitoring method	Cost Management
12	Client's financial difficulties	Cost Management
13	Contractor's financial difficulties	Cost Management
14	Sub contractor's financial difficulties	Cost Management
15	Delay in contractor's payment	Cost Management
16	Change in Taxation	Cost Management
17	Unethical practices	Cost Management
18	Delay in design	Time Management
19	Delay in design approval	Time Management
20	Owner's indecision	Time Management

Sl No	Cost Overrun Factor	Knowledge Area
21	Inadequate planning by owner	Time Management
22	Delay in change order approvals	Time Management
23	Crashing of schedule	Time Management
24	Delayed completion	Time Management
25	Liquidated damages	Time Management
26	Errors, Discrepancy in design	Quality Management
27	Complexity in design	Quality Management
28	Defective material / poor quality	Quality Management
29	Cost of Rework	Quality Management
30	Cost of non-conformance	Quality Management
31	Poor procurement plan	Procurement Management
32	Fluctuation in price	Procurement Management
33	High % age of Wastage	Procurement Management
34	Scarcity of material	Procurement Management
35	Wrong selection of plant & Machinery	Procurement Management
36	Failure of Plant & Machinery	Procurement Management
37	Improper procurement method	Procurement Management
38	Improper selection criteria	Procurement Management
39	Poor productivity	Human Resource Management
40	Lack of safety awareness	Human Resource Management
41	Lack of quality awareness	Human Resource Management
42	Lack of motivation	Human Resource Management
43	Lack of supervision	Human Resource Management
44	Language barrier	Human Resource Management
45	Unskilled operator	Human Resource Management
46	Lack of skilled Resources	Human Resource Management
47	Lack of Training	Human Resource Management
48	Failure to identify all stakeholders initially	Communication Management
49	Lack of communication among stakeholders	Communication Management
50	Excessive formal documentation procedures	Communication Management
51	Midstream design change	Integration Management
52	Scope creep in Design	Integration Management
53	Inexperience on similar projects	Integration Management
54	Accidents on site	Integration Management
55	Insufficient early planning	Integration Management
56	Poor construction methodology	Integration Management
57	Poor site logistics	Integration Management
58	Lack of control over resources	Integration Management
59	Poor administration & supervision	Integration Management
60	Site location difficulties	Integration Management
61	Midstream Changes in specification	Integration Management
62	Accepting Onerous contract clauses	Integration Management
63	Less / no contingency allowance	Integration Management
64	Vogue contractual clauses	Integration Management
65	Misinterpretation of specification	Integration Management
66	Lack of proper claim procedure	Integration Management
67	Lack of change control process	Integration Management
68	Conflict between client & contractor	Integration Management

Sl No	Cost Overrun Factor	Knowledge Area
69	Conflict between contractor &sub-contractor	Integration Management
70	Lack of Risk Assessment	Risk Management
71	Lack of Risk Response plan	Risk Management
72	Lack of Risk Monitoring	Risk Management
73	Failure to recognize secondary Risk	Risk Management
74	Change in Visa cost for expatriate labour / staff	Government Factors
75	Bureaucracy in approvals	Government Factors
76	New /Change in policies and regulations	Government Factors
77	Political instability	Government Factors
78	Preference for employment to locals	Government Factors
79	Inflation	External factors
80	Foreign Exchange fluctuation	External factors
81	Inclement weather	External factors
82	Culture effect	External factors
83	Force majeure	External factors

1.2. Summary of Mitigating Measures – Appendix 2

Sl No	Mitigating Measure
	Scope Management
1	Thorough scrutiny of scope of work before tendering. Make scope bifurcation tables between the various trades. Wherever required.
2	Ensure soil investigation is done & provide report along with tender/before design phase.
3	Design the project in great detail at the beginning.
4	Before proceeding with design change, assess the time and cost impact and agree upon.
5	Highlight and Communicate the design/scope changes to all relevant stakeholders.
	Cost Management
6	Secure additional cash flow in advance.
7	Enter into fixed rate loan contract with lending banks.
8	Include contingency in budget.
9	Ensure adequate project finance is available before start of the project.
10	Employ Value Management techniques.
	Time Management
11	Use latest computerized planning & monitoring techniques.
12	Plan realistically and built up from first principle.
13	Schedule the project considering the seasonal weather particularly summer.
14	Schedule the project considering the reduced work hours during Ramadan.
15	Ensure/Train the project planner in construction process.
16	Refuse to accept unrealistic project time scale by client.
	Quality Management
17	Conduct specification audit by experts before tendering.
18	Carryout pre project planning to minimize design errors.
19	Appraisal of drawings & design criteria by independent consultant.
20	Adopt standardized designs to the maximum extent wherever possible.
21	Follow proper quality control procedures to avoid rework.

Sl No	Mitigating Measure
	Procurement/Contract Management
22	Allow sufficient time for Tender Estimation
23	Do not accept onerous conditions just to bag project.
24	Minimize the influence of psychological & political reasons in Tender price decisions.
25	Update the cost data periodically for accuracy in the Estimate
26	Procuring materials directly from supplier without middleman.
27	Ensuring availability material by keeping an inventory at optimum level.
28	Proper procurement planning in line with project planning.
29	Adopting Principled negotiation & adhere to ethical code.
30	Get design liability insurance.
31	Ensure proper estimation by measuring and pricing bills of quantities properly during tender stage.
32	Select long term fixed price contract for material supply/subcontract.
33	Specify extension or compensation clause in contract.
34	Ensure clauses on schedule delay, additional payments are fair.
35	Develop proper selection criteria for evaluation of bids.
36	Developing small closely knit, high quality supply chain.
37	Encouraging healthy competition by having more than one subcontractor for a particular trade.
	Human Resource Management
38	Providing effective training for plant operators & workers.
39	Provide training on code of ethics.
40	Offer training to new and existing staff.
41	Define roles and responsibilities of each team member and communicate to them.
42	Proper site organization of consultants to expedite site/design decisions.
43	Implement incentive & recognition program at all levels.
	Communication Management
44	Identify all stakeholders and prepare proper communication management plan
45	Ensure openness in communication.
46	Without fear, right information should be communicated to top management on right time.
	Integration Management
47	Well integrate design & construction phase to minimize design changes.
48	Organize site properly for maximum productivity.
49	Adopt safely control program.
50	Use of mechanized construction methods.
51	Implementing effective cost control & monitoring systems.
52	Implementing effective change control system to prevent scope creep.
53	Ensure no one makes design/scope change without authorization/approval of change control board.
54	Mobilizing resources at right time.
55	Acquiring project professionals with similar project experience.
56	Conducting workshops/brainstorming sessions to identify cost control/saving measures.
57	Employ time study technique to determine labour outputs.
58	Address constructability issues at the beginning.
59	Adopt modularization and prefabrication to the maximum extent.
	Risk Management
60	Identify potential design change and devise a strategy to manage.
61	Analyze the direct/indirect impact of changes on other areas of the project.

Sl No	Mitigating Measure
62	Identify cost risks at early stage through brain storming sessions and workshops.
63	Review risk register in all progress meetings.
64	Identify & evaluate secondary risks emanate from Risk response plans
	Government Factors
65	Ensure the compliance with government Planning & government regulations.
66	Submit the necessary document appropriate government bodies for approval in a timely manner.
	External Factors
67	Hedge exchange rates by use of money transfer tools.
68	Obtain guarantees of exchange rates and convertibility.
69	Insure all the insurable force majeure risks.

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