Statistical Analysis of Factors Causing Cost Overrun in Construction Industry (Case Study: Jordanian Construction)

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I. INTRODUCTION

Construction is a dynamic industry which is constantly facing uncertainties in its budgets, processes and technology. Combined with other factors such as project complexity and an increase of stakeholders involvement, these uncertainties tend to form the

difficult task of managing a construction project in terms of its time and cost (Doloi, 2011). Even though management of construction projects have come a long way over the years with the application of technology to its fundamental role of *scheduling* and cost control, the problems of cost and time overruns in the construction industry are still as critical today as when identified by Reichelt and Lyneis, (1999). This is why a lot of studies and research including this research are being directed at present to improving construction cost in an attempt to increase the faith of financial institutions and investors in this important industry.

The success of any construction project is measured by time, cost and quality. During the execution of construction projects, managing construction cost has been considered one of the most critical and difficult issues to handle (Chan, et al., 2004). Although cost overruns are usually expected in construction projects, but identifying the main factors causing cost overruns forms the essence of the problem. Azhar and Farouqui, (2008) observed that the phenomenon of cost overrun in construction projects is common worldwide but is more prevailing and severe in developing countries as these overruns sometimes exceed 100% of the estimated and budgeted project cost.

Cost overruns in construction projects has been a major challenge to the industry in Jordan as construction projects usually end up with the actual cost being exceeded by at least 30% with change orders forming a minimum of 8.3% of those overruns (Al Momani, 1996). An example of such projects is the mega project TAJ MALL constructed in the prestigious area of Abdoun – Amman where the final actual cost reached 150 million JD as compared to the project budgeted cost estimated at around 90 million JD (i.e., a 60% increase) (www.albaladnews.net).

Despite the importance of the issue, reviewed research has come up with few research papers that covered the subject as related to the Jordanian construction market. The research papers

concentrated primarily on identifying the causative factors of cost overruns in the public sector. Furthermore it was noted that no historical records or documentation were maintained whether in the public and private sectors or can be made available on cost overruns due to the reluctance of the entities to show the extent of their financial overruns which clearly indicates that no major efforts were performed to tackle this phenomenon from its fundamentals other than a case by case at the time of occurrence.

In view of the above, it was essential that research studies be conducted to identify the causative factors for cost overruns in the Jordanian market in general and at the same to be complemented with actual case studies from the market to provide a practical analysis and findings. Furthermore, such studies should go further and try to propose systems by means to tackle such causes in order to minimize their affects and to reinforce such proposals with practical trials to be performed in projects to test their applicability.

II. LITERATURE REVIEW

The element of cost overruns today is one of the most critical elements affecting the construction industry. The phenomena of cost overrun in construction projects is common worldwide but is more prevailing and severe in developing countries. Many studies have been conducted to identify the causes of cost overrun in projects over the last years. There are many researches in the area of construction cost overrun, but, in general, the emphasis of the literature search is on research dealing with the identification of main factors causing cost overruns in different countries.

Factors affecting cost overrun vary from time to time and from country to another. Arditi, et al. (1985) concluded that the top factor that cause cost overrun in building construction projects in Turkey is: escalation in material's prices resulted from the rapid growth of Turkish inflation. In a later study of factors affecting

cost overrun conducted also in Turkey, Durdyev et al. (2012) reported that improper planning was the most important factor, while the escalation of material prices was not among their top five factors.

Flyvbjerg, et al. (2003) stated in their book "Megaprojects and Risk: an Anatomy of Ambition" that the factors that affect cost performance and caused cost overruns in a developing country can be generalized to all developing countries because they have similar problems in construction projects. Similarly, some studies were conducted in Nigeria by Okpala and Aniekwu (1988) who aimed to understand the main causes of high costs of construction projects. The study consisted of 450 questionnaires which were given to architects, contractors, engineers and clients in three different cities in the south of Nigeria [Port-Harcourt, Ibadan and Benin City]. The results were analyzed taking into account the different professions and the role of each respondent in the project. Therefore, the authors concluded that the three main reasons for cost overruns in Nigerian projects were: "shortage of materials, finance and payment for completed works, poor contract management, price fluctuations and fraudulent practices" (Okpala and Aniekwu, 1988).

Meanwhile, Doloi, H., (2013) in Australia studied the critical factors that impacts cost performance across the design consultants, contractors and client perspectives. The study involved three types of projects which are construction industry, comprising residential, commercial and industrial buildings. This study was found the five significant factors which are planning and scheduling deficiencies, methods/ techniques of construction, effective monitoring and feedback process, complexity of design and construction and improper control over site resource allocations.

Koushki et al. (2005) conducted a study in Kuwait. They concluded that the main affecting causes of cost overrun are:

design changes and changing orders, owners' financial constraints, financial difficulties of contractors and owners' lack of experience. Similar results were obtain by Le-Hoai, et al. (2008) in a study carried out in Vietnam coincided with those from the study in the State of Kuwait due to the fact that the lack of supervision, owners' financial resources, financial difficulties of contractors and design changes were also part of the five more frequent factors that caused overruns in Vietnam. In addition, changes in the design and poor project management were also causes of cost overruns. The review of some studies has shown that the main causes of cost overrun in developing countries are similar in the construction industry which reinforced the idea suggested by Flyvbjerg, et al (2003).

Kaming et al. (1997) conducted a study to identify the main factors affecting cost overrun in Indonesian construction projects. They concluded that inflationary increases in material cost, inaccurate material estimating, and project complexity are the main causes of cost overrun.

Iyer et al. (2005) concluded that the most factors affecting the cost overrun of construction projects in India are: conflict among project participants, ignorance and lack of knowledge, presence of poor project specific attributes and nonexistence of cooperation.

Al-Najjar, (2008) concluded that the top affecting factors that cause cost overrun in building construction projects in Gaza Strip as perceived by contractors were: strikes, Israeli attacks and border closures, lack of materials in markets, shortage of construction materials at site, delay of material delivery to site, cash problem during construction, and poor site management. Another Study Gaza Strip was conducted by Enshassi et al., (2009) concluded that the main factors affecting cost overrun in Gaza are: location of the project, segmentation of the Gaza strip and limitation of movements between areas, political situation, and financial status of the owner.

In Jordan, two studies concerned with cost overrun were conducted by Al-Momani, (1996), in which he included (125) school projects in Jordan concluded that cost overrun resulted of up to 30% of the original contract price for the main factors: variation orders, incompetent project brief; and faulty project specifications and design. On the other hand, the other study was conducted by Sweis et al., (2013) investigated the factors of cost overruns in the public construction projects in the Jordan and concluded the most prevailing factors that cause cost overrun, which were: design modifications, poor experience of project type, poor experience of project location, governmental delay, and severe weather conditions. Furthermore, the researchers compared these results with data of actual projects collected from the Ministry of Housing and Public Works. They concluded that the factors: delays in governmental processes, adverse weather conditions and design modifications are the major variables representing 73 percent of project cost overruns.

The first of the three studies that tapped project time delay was done by Al-Momani, (2000), in which he investigated the causes of time overruns in construction of public projects in Jordan. The second study investigated factors causing time overruns in traditional construction contracts in Jordan from both the consultant and contractor viewpoints (Odeh and Battaineh, 2002). The third study ranked the major identified causes of delay in the Jordanian residential construction sector from the viewpoint of the construction stakeholders, specifically consulting engineers, contractors, and owners (Sweis, et al., 2008).

III. RESEARCH METHODOLOGY

For the purpose of this study, the research question that formulated the process is identified as “What are the most important factors causing cost overrun in construction projects in Jordan?” . At present, there is little written literature or solid

evidence that identifies the causative factors of cost overruns in the Jordanian construction industry despite the fact that there is a common understanding among construction individuals of such factors. Therefore dependency will be on extracting such information from individual and construction related entities thru surveys and collective data.

The research follows, generally, the engineering scientific research approach and comprises the following steps:

- Literature review to identify the causative factors as established in the construction industry worldwide;
- Establish listing of causative factors applicable to the Jordanian market after consultation with construction related practitioners;
- Design and formulate a questionnaire for distribution to construction entities and individuals to gain their insights on such causative factors. Such questionnaire shall cover all factors as shown in stage one divided into main and sub-main factors;
- Conduct a pilot survey using the draft questionnaire to obtain practitioner's feedback;
- Modify the questionnaire according to practitioner's feedback;
- Distribute the final questionnaire to the targeted private and public construction related entities (project managers, contractors in private and public sectors, consultants and clients) to start the data analysis;
- Test the validity and reliability of the survey instrument by conducting two tests:
    1. Validity test using the Pearson Coefficient Correlations to validate the questionnaire, and
    2. Cronbach’s Coefficient Alpha to test the reliability of the questionnaire;

- Undertake data analysis and statistical modeling using frequency, severity indices for calculating the importance index and establishing ranking of factors by sectors and by entities;
- Studying compatibility of obtained ranking between the different sectors and also between the different entities using spearman coefficient correlation in order to justify the use of importance ranking established by the overall data collected;
- Take the top ten important factors and redistribute its importance by conducting a factor analysis to extract the most causative factors within the whole construction industry.

IV. IDENTIFYING THE GENERAL CAUSATIVE FACTORS

The task of finding and reviewing previously completed studies that are related to the research subject formed the first stage of the methodology to be implemented. The emphasis of the literature search was on that dealing with the identification of main factors causing cost overruns in different countries. Different resources were used to collect this literaturefrom previous research studies that effected cost in construction projects. All factors investigated by previous researchers worldwide were identified with a summary of those applicable for the region presented in table (1).

Table (1): Extract of performed literature review

Author (s)/Year	Country	Major factors causing cost overruns
(Sweis, et al., 2013)	Jordan	1. Design modifications; 2. The poor experience of project type; 3. The poor experience of project location; 4. Governmental delay, and 5. The severe weather conditions.

(Aziz, 2013)	Egypt	1. Lowest bidding procurement method; 2. Additional work; 3. Bureaucracy in bidding/tendering method; 4. Wrong method of cost estimation, and 5. Funding problem.
(Enshassi , 2009)	Gaza Strip	1. Strikes, Israeli attacks and borders closures; 2. Lack of materials and equipment in markets; 3. Mismanagement of project from the three parties which lead to time and cost overruns of project; 4. Poor planning of project and poor documentation at the site, and 5. Disputes between the parties of project and the absence of trust.
(Koushki , 2005)	Kuwait	1. Change orders; 2. Financial constraints; 3. Owner's lack of experience; 4. Materials, and 5. Weather.

V. DATA COLLEDCTION

Establishing the means by which the primary data was to be collected formed stage two of the research methodology. Taking into consideration the wide range of targeted entities (i.e., private clients, governmental clients, project managers, designers, supervising consultants and contractors), the most suitable method for data collection was found to be through conducting a survey by which the opinions of the different entities can be gathered through a structured questionnaire. Before distribution, a pilot survey was performed to obtain and study the feedback from the sample of the population to check the validity of the questionnaire. Based on the results of the pilot study, a modified version of the questionnaire was established for distribution to the targeted sample population.

A. Development Of Survey Questionnaire

Through literature review of similar studies performed in different countries around the world, (89) variables are identified as affecting cost overrun in construction industry. After consultation with local construction practitioners, (52) variables are filtered from the (89) variables. This filtration took into account the economical, geographical, political, environmental, and cultural circumstances of Jordanian construction industry. The (52) variables are then categorized into eight major factors namely: (1) governmental factor, (2) design and documentation factor, (3) contractor factor, (4) information and communication factor, (5) client factor, (6) financial factor, (7) environmental and project factor, and finally (8) resources factor. A questionnaire draft is then formulated and prepared as a pilot study for distribution to construction stakeholders. Two pilot surveys are performed to obtain the feedback from the targeted sample. This is done by distributing the first questionnaire draft to five construction practitioners: a senior architect, a project manager, a specialist in claims, a supervising engineer manager, and a client representative. An interview is held with each of them to obtain their feedbacks on the questionnaire and to verify the full understanding of the content. Based on their feedback, a modified version of the questionnaire is obtained. This version is then distributed to (36) respondents as a pilot study and to test the reliability and validity of the questionnaire. According to the pilot study's results, the final version of the questionnaire is prepared that contained three sections: (1) general information; (2) questions tapping causative variables of construction cost overruns; and (3) an open-ended part in which comments and recommendations are to be filled by the respondents.

The answers to the questions in the second section are constructed in a five-point Likert scale; one as being "does not

happen" or in some sections "not significant"; and five being "always happens" or "extremely significant".

The final version of the questionnaire is distributed to the targeted sample from private and public construction related entities. Only building contractors with First Grade thru Third Grade (283 contractors), as classified by the Ministry of Public Works in Jordan are considered. This is because only such contractors are permitted to work in large building projects of more than five Million Jordanian Dinars (JD). After calculating the sample size that represents the total population, (70) questionnaires were distributed to such contractors. Forty questionnaires were distributed to consultants specialized in building construction. These consultants were among the (164) legalized consultancy engineering firms who were registered in the Jordan Engineers Association (2013).

Clients dealing with relatively large projects (with a value of five million JD or above) are considered. Example of such projects are Ayla, Saraya, Almabar, etc. Eighty five of such clients were identified at the time of the study. Forty questionnaires were distributed to such clients.

B. Validity of the Research

The usefulness of a questionnaire is determined by its validity and its reliability. Validity is defined as its ability to measure what it aims to, while reliability is the degree of consistency which measures the attribute it is supposed to be measuring. (Poilt and Hungler, 1985) In other words, it is an instrument that measures what it is supposed to measure and performs what it is designed to perform. For the purpose of this study, it is decided to test the content validity of the questionnaire (which tests each main factor with its related variables) and to examine the overall validity using the construct validity test.

Content validity test is performed on the sample by measuring the correlation coefficients between each dimension and its respective components. The calculated ρ-values are found to be less than 0.05, indicating that the correlation coefficient of each dimension is significant at $\alpha = 0.05$. The results of the internal validity test, therefore, shows that the results obtained are found satisfactory and that the components are consistent with the related dimension and measures.

Construct validity is the second statistical tool used to test the validity of the questionnaire. It tests the validity of each dimension against the whole questionnaire through measuring the correlation coefficient between one dimension and all other dimensions of the questionnaire that have the same level of Likert scale. The ρ-values calculated are found to be less than 0.05, indicating that the correlation coefficients of all the dimensions are significant at $\alpha = 0.05$, and the said dimensions are valid to measure what it is set for. The conclusion to make here is that the questionnaire is valid.

C. Reliability of the Research

When testing reliability, the less variation a questionnaire produces in repeated measurements of an attribute, the higher is the reliability of this questionnaire. It can be equated with the stability, consistency, or dependability of a measuring tool. The test is repeated to the same sample of people on two occasions and then the obtained scores are compared by computing a reliability coefficient (Poilt and Hungler, 1985).

The method used to measure the reliability of the questionnaire between each dimension and the whole questionnaire is Cronbach's Coefficient Alpha. The normal range of Cronbach's coefficient alpha value is between 0.0 and + 1.0, with the higher values reflecting a higher degree of internal consistency. The obtained results of this test for each category of the questionnaire show high values of Cronbach's Alpha (i.e., results ranged between 0.856 and 0.979) which means a high reliability of each dimension

of the questionnaire. Furthermore the obtained results also show high value of Cronbach's Alpha for the overall questionnaire (0.949) indicating a high reliability for the overall questionnaire. From the above results, it can be concluded that the questionnaire is valid and reliable.

D. Sample characteristics

From the (150) questionnaires, (100) copy are mailed or faxed, and (50) are distributed by hand. The total number of returned questionnaires is (95) forming a (63%) respondent rate (for more details see Table 2). With regard to ownership, the respondents from the public sector formed (58 %) of the total replies while the private sector formed (66 %).

Table 2: Questionnaire responses according to construction group category

Population	**Distributed**	**Responded**	**% Res.**	**Min required**
Contractors	70	42	60%	40
Consultants	40	27	67.5%	31
Clients	40	26	65%	29
Total	**150**	**95**	**63%**	**100**

With regard to experience, almost all the respondents (97.75%) had construction work experience of five years or more (see Table 3). With regard to value of the projects, the respondents that are executing projects less than (15 million JD) formed 20 percent; 35.79 percent for projects between 15 million and 100 million JD; and 44.21 percent for projects with the value of more than 100 million JD.

Table 3: Experience of Respondents

Experience in years	**Frequency**	**%**
< 5	4	4.21%
5 – 10	20	21.05%

10 – 15	23	24.21%
> 15	48	50.53%
Total	**95**	**100.00%**

VI. RESULTS ANALYSIS

This part concerns the data analysis, and the discussion of the results obtained for the ranking of variables causing cost overruns. The ranking is done first for the whole sample for all variables. Then the ranking of the top ten variables obtained for the respondents of the public and private sector and for each construction group: clients, consultants, and contractors is presented. To test the degree of agreement between the rankings of the respondents of these groups, a pair wise comparison is made using Spearman's rank coefficient correlation.

Table 4: Ranking of Top Ten Cost Overruns Variables From Public Sector Viewpoint (R=Rank).

Variables Causing Cost Overruns	FI	SI	II %	R *	Group
Cash flow and financial difficulties faced by contractors	0.130	0.154	2.01	1	Financial
Delay in payments by client	0.122	0.162	1.98	2	Financial
Delay in approving contractor's submittals and requests	0.122	0.149	1.82	3	Info & Communication
Design errors and omissions	0.130	0.136	1.77	4	Design and Documentation
Delays in issuing information to the contractor	0.122	0.144	1.76	5	Information and Communic

during construction stage					ation
Inadequate contract duration	0.122	0.144	1.76	5	Client
Incomplete design at tender	0.117	0.146	1.71	7	Design and Documentation
Financial difficulties of client	0.117	0.144	1.68	8	Financial
Additional work /Direct change orders by client	0.125	0.133	1.66	9	Client
Lack of prompt decision making	0.117	0.138	1.62	10	Information and Communication

The ranking of the variables according to frequency, impact of factors on cost is done by calculating the frequency index (FI), the importance index (Imp.I), and the severity index (SI) as follows (Le-Hoai et al., 2008):

Frequency Index (%) $F.I. = \sum_0^4 (\sigma_i * F_I / N)$ ……. (1)

Severity Index (%) $S.I. = \sum_0^4 (\sigma_i * S_I / N)$ ……(2)

Importance Index $Imp.I = FI * SI$ ……..... (3)

Where σ = Constant expressing the weight assigned to each responses (ranges from 0 for dose not happen to 4 for always).

F_i *= Frequency of each response*

S_i *= Frequency of each response on impact*

n= Frequency of each response

N= Total number of responses

In the following section, the ranking of variables by respondents according to ownership type (public, or private) is presented. Using Spearman rank correlation coefficient, a degree of agreement between the viewpoints of the surveyed respondent from the public and private sector in the ranking of the top ten variables will be made. This is done to determine if a significant difference exists in their answers.

A. Ranking of Cost Overrun Variables According to Ownership Type

Table (4) and Table (5) show the ranking of the top ten variables cost overruns by the respondents from the public sector and the private sector, respectively. The tables show that only four variables of the top ten are common between public and private sectors namely: (1) "Delay in payments by client" which is ranked 2nd by public sector respondents and 6th by private sector respondents, (2) "Incomplete design at tender" which is ranked as 7th by public sector respondents and 3rd by private sector respondents, (3) "Design Error or Omission" which is ranked as 4th by the surveyed respondents from the public sector and 10th from the private sector, and (4) "Additional work/Direct change orders by client" is ranked as 9th by public sector respondents and 1st by private sector respondents. However, it is noted that out of the ten top ten ranked variables by the private sector, four variables are related to "design and documentation" factors and three variables are related to "client" factor.

Table 5: Ranking of Top Ten Variables Causing Cost Overruns From Private Sector Viewpoint (R=Rank).

Variables Causing Cost Overruns	F.I.	S.I.	Imp. I. %	R	Group
Additional work/Direct change orders by client	0.468	0.457	21.41	1	Client
Inaccurate budget estimation	0.415	0.439	18.21	2	Design and documentation
Incomplete design at tender	0.378	0.476	17.98	3	Design and documentation
Lack of coordinated construction doc.	0.415	0.404	16.77	4	Design and documentation
Work acceleration	0.380	0.434	16.49	5	Client
Delay in payments by client	0.399	0.410	16.34	6	Financial
Design changes during	0.380	0.426	16.18	7	Client

construction					
Omissions &errors in the bills of quantities	0.367	0.431	15.81	8	Design and documentation
Improper planning and scheduling	0.407	0.383	15.58	9	Contractor
Design error/omission	0.367	0.423	15.52	10	Design and documentation

B. Spearman's Rank Correlation

To test the degree of agreement between the respondents from public and private sectors, The Spearman's rank coefficient correlation is used. The formula used to calculate the Spearman's coefficient is:

$$\rho = 1 - \frac{6\sum d^2}{n(n^2-1)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where; d = difference in paired ranks,
and n= number of cases.

It is found that the obtained Spearman's rank coefficient between private and public sector is 0.56, with a 0.001 significance level. It can be concluded from the above results that despite some considerable differences existing between the two groups in terms of certain variables, there is a moderate agreement between the private and public sectors in the ranking of top ten variables of cost overruns (56.0 percent). Due to the moderate degree of agreements between respondents of the two sectors, the null hypothesis $H0$ (there is no difference in the rankings of private sector and public sector in the top ten variables of cost overrun) is not rejected. Therefore, it can be concluded that there is insufficient evidence to support the alternative hypothesis $H1$.

C. RANKING OF COST OVERRUN VARIABLES

Each of the Tables 6, 7 and 8 show the ranking of top ten variables by the surveyed three construction groups: clients,

consultants, and contractor, respectively. Using Spearman rank correlation coefficient, a pair wise comparison is made between the responses of these construction groups to determine if significant differences exist in their ranking of the top ten variables.

According to the results in Table (6), the client group ranks "Additional work/Direct change orders by client" as the highest ranked cost overruns variable; “Lack of prompt decision making” the second; “Poor contract documentation” the third; “Cash flow and financial difficulties faced by contractors” the fourth; and “Improper planning and scheduling” the fifth.

Table 6: Ranking of Top Ten Variables Causing Cost Overruns from Clients Viewpoint (R=Rank).

Variables Causing Cost Overruns	FI	SI	II%	R	Group
Additional work/Direct change orders by client	0.226	0.242	5.47	1	Client
Lack of prompt decision making	0.207	0.245	5.08	2	Information and Communication
Poor contract documentation	0.197	0.245	4.82	3	Design and Documentation
Cash flow and financial difficulties faced by contractors	0.197	0.245	4.82	3	Financial
Improper planning and scheduling	0.215	0.223	4.81	5	Contractor
Omissions and errors in the bills of quantities	0.205	0.234	4.79	6	Design and Documentation
Lack of coordinated construction documents	0.210	0.226	4.75	7	Design and Documentation
Poor site management	0.197	0.237	4.66	8	Contractor

Delays in issuing information to the contractor during construction stage	0.200	0.231	4.62	9	Information and Communication
Inadequate contract duration	0.189	0.242	4.57	10	Client

Table 7: Ranking for top ten variables causing cost overruns from Consultant's Viewpoint (R=Rank).

Variables causing Cost Overruns	FI	SI	II%	R	Group
Additional work / Direct change orders by client	0.215	0.200	4.30	1	Client
Incomplete design at tender	0.189	0.218	4.12	2	Design and documentation
Lack of designer's experience on certain type of projects	0.207	0.189	3.92	3	Design and documentation
Improper planning and scheduling	0.213	0.173	3.68	4	Contractor
Re-measurement of provisional works	0.194	0.186	3.61	5	Design and documentation
Lack of prompt decision making	0.194	0.186	3.61	5	Information & communication
Inaccurate budget estimation	0.168	0.205	3.43	7	Design and documentation
Acceleration work	0.178	0.181	3.22	8	Client
Delay in payments by client	0.181	0.178	3.22	8	Financial
Design changes during construction	0.178	0.176	3.13	10	Client

As seen from Table (7), consultants rank " Additional work/Direct change orders by client" as the highest ranked variable in terms of importance with II of 4.30%. It is followed by

"Incomplete design at tender" with II of 4.12%, "Lack of designer's experience on certain type of projects" with II of 3.92%, "Improper planning and scheduling" with II of 3.68%, and "Re-measurement of provisional works" with II of 3.61%. It is to be noted that both surveyed clients and consultant group ranks "Additional work/Direct change orders by client" as the top ranked variables.

Table (8) shows that contractor group ranks "Delay in payments by client" as the most important variable causing cost overruns with (II) of 8.01%t. It is followed by "Incomplete design at tender" at II = 7.39 %, "Additional work/direct change orders by client" at II of 7.36 %nt, "Delay in approving contractor's submittals and requests" at II of 6.93 %, and "Financial difficulties of client" at II of 6.66%.

Table 8: Ranking for Top Ten Variables Causing Cost Overruns by Contractors(R=Rank).

Cost Overruns Variables	FI	SI	II%	R	Group
Delay in payments by client	0.274	0.293	8.01	1	Financial
Incomplete design at tender	0.253	0.293	7.39	2	Design and documentation
Additional work/direct change orders by client	0.277	0.266	7.36	3	Client
Delay in approving contractor's submittals and requests	0.258	0.269	6.93	4	Information & Communication
Financial difficulties of client	0.234	0.285	6.66	5	Financial
Cash flow and financial difficulties faced by contractors	0.245	0.269	6.57	6	Financial
Inaccurate budget	0.253	0.255	6.45	7	Design and

estimation					documentation
Inadequate contract duration	0.239	0.261	6.24	8	Client
Lack of designer's experience on certain type of projects	0.226	0.274	6.19	9	Design and documentation
Omissions and errors in the bills of quantities	0.245	0.250	6.12	10	Design and documentation

Furthermore, Spearman ranking coefficient is used to test the degree of agreement between the three construction groups. Table (9) illustrates the results of and the significance level calculations for the three construction groups.

Table 9: Spearman Rank Correlation

	Spearman rank coefficient	**Sig. level**
Client – Consultant	0.612	0.001
Client- Contractor	0.805	0.001
Consultant –Contractor	0.571	0.001

From table (9), it can be concluded that there is a very strong agreement between the clients and contractors in ranking these causes (80.5 %), and between the client and consultants is strong (61.2 %); while it is moderate between the consultant and contractors (57.1 %). Due to the high degree of agreements to moderate between these construction groups, the null hypothesis (H0: There are no differences in ranking of cost overrun variables between the three groups) is not rejected, and consequently, there is insufficient evidence to support the alternative hypothesis H1. The conclusion is; the data can be treated as one group and an overall viewpoint for all construction groups can be considered.

D. Ranking of Cost Overrun Causative Variables From Overall Viewpoint

The ranking of the top ten variables causing cost overruns from an overall viewpoint is shown in Table (10).

Table 10: Overall ranking of top ten variables causing cost overruns *(Note: R=Rank*).

Variables Causing Cost Overruns	Frequency		Severity		Importance	
	FI	R	SI	R	II%	R
Additional work/Direct change orders by client	0.718	1	0.707	2	50.80	1
Incomplete design at tender	0.625	6	0.742	1	46.38	2
Delay in payments by client	0.630	5	0.702	3	44.25	3
Lack of coordinated construction documents	0.654	3	0.662	12	43.33	4
Inaccurate budget estimation	0.638	4	0.668	10	42.61	5
Omissions and errors in the bills of quantities	0.617	8	0.689	5	42.50	6
Cash flow and financial difficulties faced by contractors	0.609	10	0.689	5	41.95	7
Improper planning and scheduling	0.665	2	0.625	22	41.56	8
Lack of prompt decision making	0.622	7	0.654	15	40.72	9
Inadequate contract duration	0.609	10	0.665	11	40.49	10

E. FACTOR ANALYSIS

Factor analysis is a reduction technique used to classify and reduce the number of variables. For the purpose of this research, factor analysis is applied on the top ten variables according to importance index ranking, Table (11). A test based on Kaiser-Meyer-Olkin (KMO) that measures the suitability of the data for analysis is conducted. If the value of the KMO is larger than 0.5, then the sample is suitable for analysis. the top ten factors in terms

of severity are considered. For the chosen variables, KMO test is conducted twice, first on data obtained from frequency measures and the second on data obtained from severity measures (Table 11). Both obtained KMO values, (0.742) for frequency and (0.691) for the severity, indicate that the sample is suitable for factor analysis.

Table 11: Descriptive Statistics of cost overrun variables

	Frequency		**Severity**	
Variable	**Mean**	**SD***	**Mean**	**SD**
Incomplete design at tender	2.50	1.00	2.97	0.92
Omissions and errors in the bills of quantities	2.47	0.86	2.76	1.00
Inaccurate budget estimation	2.55	0.90	2.67	1.06
Lack of coordinated construction documents	2.62	0.93	2.65	0.97
Improper planning and scheduling	2.66	0.89	2.50	1.01
Lack of prompt decision making	2.49	0.86	2.62	1.05
Additional work/Direct change orders by client	1.88	0.91	2.13	1.10
Cash flow and financial difficulties faced by contractors	2.44	0.90	2.76	1.02
Delay in payments by client	2.52	0.94	2.81	1.07

According to (Kaming et al., 1997), the total number of common factors that can be extracted is equal to or less than the total number of variables involved. Important factors can be identified using Eigen values, which measure how a standard variable contributes to the principal components. An important factor is the one that has Eigen values greater than one. A factor with Eigen value of less than one is considered less important than an observed variable and therefore can be ignored. Applying this criterion on the sample data, two factors (F1 and F2) are extracted for frequency, while three factors (S1, S2 and S3) are extracted for

severity. The factors are then rotated using the most commonly used rotation method, Varimax Rotation method.

Tables (12) and (13) show the factor loading, which is the correlation coefficient between the original variables and the extracted factors. For this research, the loadings are set to be acceptable if their values are greater or equal to (0.50).

Table 12: Factor loading of cost overruns variables using frequency descriptive data

Sub – Factors	F1	F2	Latent root	Explained variance
Incomplete design at tender	0.605		3.52	35.21
Omissions and errors in the bills of quantities	0.689			
Inaccurate budget estimation	0.683			
Lack of coordinated construction documents	0.692			
Improper planning and scheduling	0.685			
Lack of prompt decision making	0.627			
Additional work/Direct change orders by client		0.526	1.55	15.56
Inadequate contract duration		0.539		
Cash flow and financial difficulties faced by contractors		0.891		
Delay in payments by client		0.831		

It is suggested to name F1 factor as “Lack of coordinated construction documents” since the variables that are loaded on it (Table 12) are “Incomplete Design at Tender”, “Omissions and Errors in the Bill of Quantities”, “Inaccurate Budget Estimation” and “Lack of coordinated construction documents”. On the other hand, F2 is to be named as “Cash flow and financial difficulties faced by contractors” since it includes “Cash flow and financial difficulties faced by contractors” and “Delay in Payments by Client”.

Table 13: Factor loading using severity descriptive data

SUB-FACTORS	S1	S 2	S3	Latent Root	Explained Variance
Incomplete design at tender	0.65			3.71	37.91
Omissions and errors in the bills of quantities	0.50				
Inaccurate budget estimation	0.79				
SUB-FACTORS	**S1**	**S 2**	**S3**	**Latent Root**	**Explained Variance**
Lack of coordinated construction documents	0.58				
Improper planning and scheduling	0.66				
Lack of prompt decision making	0.36				
Additional work/Direct change orders by client			0.80	1.32	13.23
Inadequate contract duration			0.65		
Cash flow and financial difficulties faced by contractors		0.87		1.16	11.63
Delay in payments by client		0.79			

It is suggested to name S1 factor as "Inaccurate Budget Estimation" since the variables that are loaded on it (Table 13) are "Incomplete Design at Tender", "Omissions and Errors in the Bill of Quantities", "Inaccurate Budget Estimation" and "Lack of coordinated construction documents" have close values of loadings and relate to the same group namely "Design and Documentation Related Factors". Factor S2 is named "Cash flow and financial difficulties faced by contractors" since it includes "Cash flow and financial difficulties faced by contractors" and "Delay in Payments by Client". Furthermore, "Additional Work/Direct Change Orders by Client" is the name for S3 factor because it contains the variables "Additional work/ Direct change orders by client" and "Inadequate duration of contract".

VII. DISCUSSION

The overall top ranked causative variables for cost overruns is established for the overall sample viewpoint as illustrated in table (10). The top ten variables formed five factors out of eight grouped factors. Below is a discussion of the five factors for each group.

A. Contractor Factor

Contractors' experience, competency and technical capabilities reflect on projects' planning and construction in terms of resource planning, quality workmanship, performance, productivity and time scheduling. The lack of such experience may end in serious project complications in terms of cost overruns resulting from a combination of escalating construction costs, time delays, and increasing interest payments. (Flyvberg et al, 2004).

Results for the overall ranking have shown that, among the top ten ranked variables, only one variable correspond to contractor factor. It is "Improper planning and scheduling" which, overall, ranked 8th It ranked 4th by consultant's, and 5th by clients the respondents working for private sector ranked this variable 9th It is interesting to note that contractors did not rank this variable, against the researchers' expectations, among the top ten variables.

B. Client Factor

Results for the overall ranking have indicated that, among the top ten variables, there are two variables variable to client factor: "Additional work/direct change orders by client" and "Inadequate contract duration". Additional work/direct change orders by client are considered to be a common variable usually results in considerable increase in the construction cost and causes cost overruns in construction projects (Construction Industry Institute, 1990). As a major reoccurring phenomenon in the construction industry worldwide, FIDIC has opted to provide a special section in its conditions (Clause 13 in FIDIC 1999) for that. According to Al-Momani study of the Jordanian construction market (1996),

variations orders averaged 8.3 percent of the project's additional cost. By referring back to the top ten ranking by the different sectors and entities, it can be noted that this variable is ranked 1st by the private sector, client, and consultant group, while it is ranked 3rd by contractor. No ranking within the top ten is given by the Public sector.

"Inadequate duration of contract" variable is caused by clients since they tend, in many cases, to impose shorter project durations than normal due to the need to recover their investment or to repay the borrowed capital faster. It is obvious that shorter construction duration means higher contract price, since the contractor has to crash the schedule. Moreover, even though contractors tend to agree to deliver within the given short periods, they look throughout the construction operations to extend the construction duration by taking advantages of client related changes, variations, and delays in approvals. The result of all the above is cost overruns, especially to the owner. The emphasis on a proper contract duration is highlighted by (Odeh and Battaineh, 2002), by indicating the importance of determining the duration of the project precisely and realistically by the client, taking into account project type, volume, and location.

Overall, the variable "inadequate project duration" ranked 10th, while it is ranked 8th by contractors, 10th by clients, and no ranking within the top ten is given by consultant, public sector, and private sectors.

C. Design and Documentation Factor

Results have indicated that among the overall ranking of the top ten variables, there are four variables related to Design and Documentation Factor. These are "Incomplete design at tender", "Lack of coordinated construction documents" "Inaccurate budget estimation" and "Omissions and errors in the bills of quantities". These results reflect the importance of design and documentation,

as well as its contribution to the increase of project cost. Each of these four variables will be highlighted as follows.

Incomplete design at tender: sometimes, clients tend to put the project to tender while still in the early stages of design in an effort to reduce the overall tendering and construction period. In such cases, the contractor bases his tender on estimated bills as well as incomplete detailing of elements which are changed as construction progresses, resulting in excess quantities, design change orders, and time extensions and cost overrun. By referring back to the top ten ranking by the different sectors and entities, it can be noted that this variable is ranked 2nd by both consultants and contractors, while it is ranked 3rd by the private sector, and 7th by the public sector. No ranking within the top ten is given by the clients.

Lack of coordinated construction documents: in many complex projects such as hospitality projects, the list of disciplines working on the design is long and it may include architecture, structures, mechanic, electric, interior design, soil investigation, kitchen equipment, infrastructure, landscape, fire compartments, signage, district cooling, etc. The amount of coordination required between these disciplines is vast. In many instances, short time given by the client to accomplish the design work and/or low prices of design works may lead to poor quality and coordination in construction documents.

By referring back to the top ten ranking by the different sectors and groups, it can be noted that this variable is ranked 3rd by consultants, 4th by the private sector, and 7th by clients. This variable is not among the top ten when ranked by the public sector and by contractors.

Inaccurate Budget Estimation: In the Jordanian construction market, developed project budgets in general have been on the low side, resulting in major cost overruns. One of the causes for such

low budgeting is that the budgets are not based on actual data developed from the most recent completed projects and, therefore, no consideration is given for construction productivity and inflation changes. By referring back to the top ten ranking by the different sectors and entities, it can be noted that this variable is ranked 2nd by the private sector, 5th by consultants and 7th by Contractors. No ranking within the top ten is given by the public sector and clients.

Omissions and Errors in the Bills of Quantities: In Jordan, Bills of Quantities (BOQ) usually is the most important document by which the Contractor bases his tender prices. Often, tender period is too short and insufficient time is given to Contractors to look over the full tender documentation. This is aggravated by the limited tendering staff within the contractor's organization. Furthermore, unit rates given in the contract BOQ in general form the basis by which new works are estimated as well as the preparation of interim and final payments. As discussed in earlier sections, changes by client, incomplete designs and lack of coordinated drawings may result in change orders, and/or amendments to the contract BOQ. The changes to the BOQ normally result in cost overruns, and delays. The latter may result in claims raised by the contractor resulting in additional costs to the client. By referring back to the top ten ranking by the different sectors and entities, it can be noted that this variable is ranked 6th by the clients, 7th by the consultants, 8th by the private sector, and 10th by contractors perspective. No ranking within the top ten is given by the public sector.

D. Financial Factor

Results of the overall ranking have shown that among the top ten ranked variables, there are two variables correspond to Financial factor, namely "Delay in payments by client " and "Cash flow and financial difficulties faced by contractors".

Delay in payments by client: Delay in client payments are normally the result of incorrect budget estimates which require the client to reschedule payments until additional funding is provided, or due to financial difficulties faced by the client. This is a major reoccurring phenomenon in the construction industry that required FIDIC to establish a special clause in its conditions to cover it. Normally contractors are compensated for payment delay in forms of interest on the delayed payments based on bank lending interest rates, or on fixed legal rate determined by Central Bank of Jordan (currently 9 percent). In more stringent measures, FIDIC gives the contractor the choice (only after prior notice) to reduce resources, suspend works, or to terminate the contract if the phenomenon continues. Furthermore, short period delays in client payments may force contractors into financial difficulties that, in turn, result in resources procurement delays and/or delayed payments to suppliers and subcontractors.

By referring back to the top ten ranking by the different sectors and entities, it can be noted that this variable is ranked 1st by contractors, 2nd by the Public Sector, 6th by the Private sector, and 9th by Consultants. It is interesting to note that this variable is not among the top ten variables when ranked by clients, who are not willing to admit their faults in causing payment delays.

Cash Flow and Financial Difficulties Faced by Contractors: Financial difficulties faced by contractors are the result of many variables, some of which are due to his poor management, while others are related to the client. Variables caused by clients are primarily related to delayed payments, delayed response, variation orders, approval delays, etc. Variables caused by contractors relate to work quality and rework, Contractor financial capabilities, delays in work progress, lack of cost monitoring and control, etc. The financial difficulties of the contractor affect project progress, which is considered by clients as a main reason for contract termination. To assist the contractors through their difficulties,

many clients tend to allow the contractors to receive a down-payment against proper bank guarantee.

With regard to the top ten ranking by the different groups and sectors, it is worthwhile to note that public sector placed this variable as the most important one by ranking it 1st. Other groups ranked it as follows: 3rd by clients, 6th by contractors, and no ranking among the top ten variables is given by the Private sector and by Consultants.

E. Information and Communication Factor

Results of the overall ranking have shown that, among the top ten variables, there is only one variable correspond to Information and Communication factor namely "Lack of prompt decision making". It is essential element in the success of any construction project. Decisions required by the client during the concept and design phases cover at approvals of: (a) materials to be used, (b) project space program, (c) architectural design layouts and sections and (d) MEP equipment. During construction, decisions by the supervising engineer and client are usually required for: (1) materials (2) shop drawings, (3) variations, (4) payment certificates and (5) testing and commissioning. As seen above, prompt decisions making by all concerned construction groups affects the main aspects of the design and construction and, therefore, lead to the either successful project completion or in delays with consequential project cost overruns. By referring back to the top ten ranking by the different sectors and groups, it can be noted that this variable is ranked 2nd by clients, 5th by the Consultants and 10th by the Public sector's viewpoint. No ranking within the top ten is given by contractor and the Private sector viewpoints.

VIII. CONCLUSIONS

The main objective of this study was to identify factors influencing cost overruns in the Jordanian construction sector

during construction stage. Through a general literature review, (52) factors causing cost overruns in construction projects were selected by two examining their relevancy to Jordanian construction industry through interviewing local construction practitioners. The selected (52) attributes associated with project cost overruns were examined and ranked according to perceptions of 95 construction practitioners working in the Jordanian construction industry. Consequently the additional work/direct change orders by client, lack of coordinated construction documents, cash flow and financial difficulties faced by contractors and inaccurate budget estimation were extracted after treating the top ten factors using PCFA analysis.

The findings presented in this study can be used by the contractors, consultants and owners of the construction projects in developing countries and any other stakeholder who intend to do invest in construction industry in developing countries.

Taking these factors into consideration will help to alleviate the influence of these cost overrun factors by identifying a proper mitigations and implementing accordingly a course of action by the main project stakeholders, the government and agencies specific clients should start thinking about improving their procedures and to assign a third party to review the design documents to verify that it meets the client objective to minimize the additional works and direct change orders in large construction projects. The contractors should monitor the cash flow and payments on monthly basis to avoid any problems in the financial aspects. The consultant should start thinking of improving their producers and using a high technology software to detect clashes in designs and avoiding the miss coordination in design documents. Also, consultant should assign expert cost engineers and quantity surveyors to produce accurate budget estimation.

In addition to the benefits above, researchers can also use these findings in conducting a similar study but limited to the study of

the factors affecting cost overruns during design stage as well as expanding this study to cover all types of construction projects such as the different infrastructural type projects and large utility plants.

Furthermore, in comparison to other similar studies conducted in Asian and developing countries, results of this paper showed agreement with additional work/ direct change orders by client (Momani, 1996), (Koushki, 2005) and (Aziz, 2013), lack of coordinated construction documents (Oladapo, 2007)cash flow and financial difficulties faced by contractors (Frimponget al., 2003), (Koushki, 2005), (Le-Hoai et al., 2008), (Ameh et al., 2010), and (Rahman, 2013), and inaccurate budget estimation (Jergreas and Ruwanpura, 2010), (Durdyev et al., 2012) and (Aziz, 2013).

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Abstract:

Cost overruns problem is still a critical issue in the construction industry worldwide as it is in Jordan. This paper attempts to identify the main factors influencing the cost overruns in building projects covering both private and public sectors. This research commenced by performing a literature review to identify the factors influencing cost overruns followed by the preparation and distribution of a questionnaire to 150 local Jordanian construction practitioners to distinguish those most significant factors.

A statistical analysis was carried out on the survey results to identify the significant top ten causative factors using the importance index ranking method as perceived by each construction group and sector. The compatibility between different construction groups and sectors were tested using Spearman rank correlation. While the differences between constructions groups were determined by the ANOVA technique.

The top ten causative factors were determined from all construction groups viewpoints followed by conducting a factor analysis to extract the most critical. Results of the questionnaire survey showed that the additional work/ direct change orders by client, lack of coordinated construction documents, cash flows and financial difficulties faced by contractors and inaccurate budget estimation were the main variables affecting cost overrun.

Keywords: cost overrun, factors causing cost overrun, construction industry.

الملخص :

لا تزال مشكلة تجاوز التكاليف تمثل مشكلة حرجة في صناعة البناء والتشييد في جميع أنحاء العالم كما هي في الأردن. تحاول هذه الورقة تحديد العوامل الرئيسية التي تؤثر على تجاوز التكاليف في بناء المشاريع التي تغطي كل من القطاعين العام والخاص. بدأ هذا البحث بإجراء مراجعة للأدبيات لتحديد العوامل التي تؤثر على تجاوزات التكاليف ، يليه إعداد وتوزيع استبيان على ١٥٠ من ممارسي البناء الأردنيين المحليين لتمييز تلك العوامل الأكثر أهمية.

وقد تم إجراء تحليل إحصائي على نتائج المسح لتحديد أهم عشرة عوامل مسببة باستخدام طريقة تصنيف مؤشر الأهمية كما تتصورها كل مجموعة بناء وقطاع. تم اختبار التوافق بين مجموعات البناء والقطاعات المختلفة باستخدام ارتباط رتبة سبيرمان، بينما تم تحديد الاختلافات بين مجموعات الإنشاءات بواسطة تقنية ANOVA.

تم تحديد العوامل المسببة العشرة الأولى من جميع وجهات نظر مجموعات البناء متبوعة بإجراء تحليل عامل لاستخلاص أكثر العوامل أهمية، وأظهرت نتائج استبيان الاستبيان أن أوامر العمل/التغيير المباشر الإضافية من قبل العميل، والافتقار إلى وثائق البناء المنسقة ، والتدفقات النقدية والصعوبات المالية التي يواجهها المقاولون والتقديرات غير الدقيقة للميزانية هي المتغيرات الرئيسية التي تؤثر على تجاوز التكاليف.

الكلمات المفتاحية: تجاوز التكلفة، العوامل المسببة لتجاوز التكلفة، صناعة البناء والتشييد.