Time and Cost Overruns in Jordanian Building Construction Projects

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Abstract

Construction industry supports investment in Jordan and other Arab countries. Professional practices of construction parties highly affect the performance of construction processes. Time delay and cost overrun are the most important performance measures in construction process. Current research aims at identifying the main expected factors that affect and cause time delay and cost overrun in building projects in Jordan. A group of 12 experts from all firms were selected to identify these factors in a questionnaire designed for the purpose of research. 150 copies of the questionnaire were prepared and sent to the personnel in each party (clients, consultants, and contractors) to rate these factors. Through the analysis, individual rate was calculated for each factor given by each party, separately. A group factor (financial, design, technical, management, external, competency, workmanship, communication, material, site, and regulation) issues were calculated. A comparative test between means of rates was conducted among clients, consultants, and contractors to test the significance of difference between means, if any. Clients agree with contractors that financial and competency issues significantly affect time delay and cost overrun, while they agree with consultants that design issues have a significant effect too In addition, consultants see that a considerable effect on time delay and cost overrun is attributed to workmanship issues. Results will be of great help to contract parties and engineers to avoid time delay and/or cost overrun in planning for or administrating projects.

Keywords: (Time overrun**,** Cost overrun**,** Delay**,** Project Construction**,** Contract analysis).

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تجاوز الوقت والتكلفة في المشاريع الانشائية للابنية الأردنية

ملخص

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يخدم قطاع الانشاءات الاستثمارات في الاردن وباقي الدول العربية. وعلية فإن الممارسات المهنية لأطراف البناء تؤثر بشكل كبير على أداء عمليات البناء. ولذلك يعد التأخير الزمني وتجاوز التكلفة للمشاريع الانشائية من أهم المعايير لقياس الأداء في عملية البناء. يهدف هذاالبحث الى تحديد العوامل الرئيسية المتوقعة التي تؤثر وتسبب تأخير الوقت وتجاوز الكلفة في مشاريع البناء في الأردن. لقد تم اختيار مجموعة من 12 خبيرا من جميع الشركات لتحديد هذه العوامل في استبيان مصمم لغرض البحث. حيث تم إعداد 150 نسخة من الاستبيان وإرسالها إلى الموظفين في كل طرف (أصحاب العمل والاستشاريين والمقاولين) لتقييم هذه العوامل. من خلال التحليل ، تم حساب المعدل لكل عامل من العوامل التي قدمها كل طرف على حدة. حيث تم حساب مجموعة من العوامل (المالية ، والتصميم ، والتقني ، والإدارة ، والعوامل الخارجية ، والكفاءة ، والمصنعة ، والاتصالات ، والمواد ، والموقع ، والتنظيم او التعليمات). كما وتم إجراء اختبار للمقارنة بين معدلات الاجابة بين أصحاب العمل والمستشارين والمقاولين لاختبار أهمية الفرق بين هذه المعدلات ، إن وجدت. أظهرت النتائج إتفاق أصحاب العمل مع المقاولين على أن المشكلات المالية وقضايا الكفاءة تؤثر بشكل كبير على تأخير الوقت وتجاوز التكاليف ، بينما يتفقون مع الاستشاريين على أن مشكلات التصميم لها تأثير كبير أيضًا. بالإضافة إلى ذلك ، يرى الاستشاريون أن تأثيرًا كبيرًا على تأخير الوقت وتجاوز التكلفة يعزى إلى العوامل المتعلقة المصنعة. نتائج هذا البحث ذات فائدة كبيرة لاطراف العقد والمهندسين والمقاولين لتجنب تأخير الوقت و / أو تجاوز التكاليف في التخطيط للمشاريع الانشائية أو إدارتها.

مفاتيح البحث: (تجاوز الوقت ، تجاوز التكلفة ، التأخير ، إنشاء المشاريع ، تحليل العقود).

1. Introduction

Gross Domestic Product (GDP); of $12.6 Million in 2005 and $27.5 Million in 2010 show that the economic growth of Jordan has been doubled, where the construction industry contributes 4.7% of GDP which, means that an excessive demand on the constructions industry of Jordan.

Since 2004, the construction industry has been a very competitive sector in Jordan; where 674 construction companies have been established. The sector is expected to continue emerging due to the country's rapid growth. Over $2 billion worth of projects are expected in the near future and this is related to growth of population.

The Greater Amman Municipality completed its master plan to expand Amman from 700 km^2 in 2009 to 1700 km^2 in 2025 but, Jordanian construction industry is facing entry barriers such as the rising construction costs i.e. the steady increase in prices of construction materials (cement, steel, etc.) and the removal of fuel subsidies by the government. These barriers are decreasing the profit margin. The study concluded that the delay occurred repeatedly in medium to large size projects is considered stable in small projects. There are important reasons for delay related to human factors such as owner involvement, contractor performance, and the early planning and design of the project (Al-Khalil and Al- Ghafly, 1999).

Jordan with its natural construction resources possesses substantial mineral resources used in the construction industry such as building and ornamental stones, cement raw materials, sand gravel, crushed stone and natural sand which facilitated the opportunities for many investments in the construction industry. Surveys indicated 56 of the main reasons of delay in the large construction projects. Delay factors are split into major groups of different levels of importance. Sixty reasons were identified and classified (Assaf et. al, 1995).

Both time and cost are important aspects that can affect a construction project in Jordan. These factors are considered of the biggest challenges to have a well-managed construction project that is considered successful in order to limit the barriers facing this industry. These two aspects are some of the most important concerns for any party involved in a construction project. It is vital for the client, contractor and other parties to finish the project on or ahead to schedule and within the allocated budget. This concern can differ from one part in Jordan to another depending on projects' scale and location (The growth in large cities is much higher and more important than in smaller cities in Jordan), but the time and cost

issues are important concerns for all parties anywhere in Jordan. Due to the complex nature of construction, it is difficult to avoid challenges that might risk the pace of the process (time) and the cost limit as well (Al-Hazeem and Abu Salem, 2014).

These risks are generated by many factors like lack of professional labor, weather, and inefficient contractor's management, low productivity of contractor's workforce, low productivity of equipment, client's responsibility, and design errors by consultants. It is essential to define reasons of time delay and cost overruns in construction projects in order to reduce its adverse effects on construction process efficiency. Many studies and articles were conducted on the reasons of time delay and cost overruns in projects; many as well suggest some methods to overcome this grossing problem.

2. Related Studies and Cases

This section reviews previous studies that focus on time and cost overruns in construction projects, the reasons of this problem, and some mentioned suggestions to reduce it and provide a brief description on the findings of these studies. In order to come out with the best results it is important to understand the definition of time and cost overruns. Time overruns is defined as" the extension of time beyond planned completion dates traceable to the contractors" (Kaming et al, 1997), and Cost overrun is defined as excess of actual cost over budget. Cost overrun is also sometimes called "cost escalation," "cost increase," or "budget overrun" (Nonaka et al, 2007).

In a study to identify and to examine the factors that may influence time and cost overruns on construction project in the south eastern part of Nigeria, the researcher noticed that levels of deterioration in roads and other constructional and infrastructural projects can attribute to a bad performance in construction project management. Among the studied factors, the materials and external group factors were found to have the greatest effect that can lead to project delay and cost overrun along the project life cycles. Many important reasons of delay are related to owner involvement, contractor performance, and the early planning and design of the project. Important reasons are financial problems, changes in the design and scope, delay in making decisions and approvals by owner, difficulties in

obtaining work permit, and coordination and communication problems (Ubani et. al, 2013).

Others studied the evaluation of the factors proposed to have an influence on time and cost overruns of the telecom tower construction projects in Ghana. The study declared that 15 of the studied factors influenced time overruns while 14 of the studied factors lead to cost overruns in telecom tower construction projects. It was also noticed that telecom tower construction projects implemented between 1992 and 2011 exhibited as much as 82% time overruns, and the cost of the projects increased by 50%. The factors were separated into three main groups, which were the Client-, Consultant-, and Contractor-related factors. The client related factors included the Clients delay of payment certificates, unrealistic client's requirements, and lack of tower materials in the local markets, delays in design work and design information, contract modifications, late arrival of shipment of materials from abroad, absence of efficient project progress tracking. The contractor related factors included : Poor workmanship leading to rework, Poor site Management, Unethical behavior of contractors to achieve high profits, Uncompromising attitudes between parties, Major disputes/ negotiations on site, Inexperienced tower construction engineers/technician, Low productivity of labor, Lack of quality assurance/control, Delays in preparation of Interim certificates, Poor subcontractor selection processes, short periodical sessions to address work problems, Centralization of decision making process of client. Finally the Consultant related factors included design scope changes, lack of quality assurance / control, Inadequate managerial skills for all Parties, Poor contract management by consultant, Lack of job security for consultants team, Governmental Policies and requirement needs, Inappropriate construction method. The Important reasons included financial problems, changes in the design and scope of the project, delay in decision making and owner approvals, difficulties in obtaining work permission, and miss-coordination and communication (Danso and Antwi, 2012).

Delays that affected projects progress and postponed its activities, whether the delays were caused by controllable or uncontrollable factors, affected by the cost overrun which; mean that both time and cost were related in affecting the projects progress. In order to assure a successful progress to any construction project, both factors must be managed well. There are many suggested ways to calculate the efficiency of the time and cost overruns in a construction project (Choudhury and Phatak, 2004). Time overruns was defined as the difference between the actual completion time

and the estimated completion time. It is measured by number of days (Chan, 2001).

The cost overrun was defined as the difference between the original cost estimate of project and actual construction cost on completion of works of a commercial sector construction project. So, it is the change in contract amount divided by the original contract award amount. This calculation can be converted to a percentage for ease of comparison (Jackson, 1990).

In a study which investigated reasons for delay in 130 public projects in Jordan, they were related to designer, user changes, weather, site conditions, late deliveries, economic conditions and increase of quantity. The study suggested that special attention to factors would help industry practitioners to minimize contract disputes. Delays have strong relationship with failure and ineffective performance of contractors (Al-Momani, 2000).

In a discussion for the main reasons of failure in construction industry in Saudi Arabia by surveying 68 contractors and about 34 different causes of failure, the study concluded that lack of experience, poor estimation practices, bad decisions in regulating company's policy, and national slump in the economy were the severe factors (Al-Barrak, 1993).

Through a person-interview survey of 450 randomly selected project owners and developers in Kuwait (Koushki et al, 2005) to identify and estimate the time of delay and cost increase and their reasons, the results indicated three reasons of delays were changing orders, owners' financial constraints, and owners' lack of experience.

The three most important reasons of cost overruns were contractor-related problems, material-related problems and owners' financial constraints. Project owners recommended that to minimize the time delays and cost overruns, project owners require the availability of adequate funds, allocation of sufficient time and money at the design phase, and selection of a competent consultants and reliable contractor to carry out the work. In Middle East countries, where petroleum and natural gas exports have played an important role in the economy, construction boom has attracted many research efforts. Major studies implemented were (Assaf and Al-Hejji, 2006) in Saudi Arabia, (Koushki et al, 2005) in Kuwait, (Faridi and El-Sayegh, 2006) in UAE, and (Odeh and Battaineh, 2002) and (Sweis et al, 2007) in Jordanian construction industry are prominent.

The objectives of the current research are to present the important factors for time delay and cost overrun in construction of projects in Jordan,

and to prioritize their importance according to the perspectives of the clients, contractors, and consultants.

3. Research Problems

Construction projects contribute significantly to the development of any country. However, there can be some factors that may inverse this contribution, and consequently affect development unless they are considered properly, particularly in developing and emerging countries. Unfortunately, in many cases, it is difficult to avoid time and cost overruns and their ramifications on the progress and financial stability of projects. Hence project management is a critical and challenging process, especially with respect to governmental projects, but on the other hand, well-planned time and cost management is essential to success of the project, where processes run according to an accurate schedule and allocated budget. ,

Due to unsuccessful planning and management, time delay and cost overrun crisis began to appear in this sector; the general factors that affect time and cost overrun in a construction project can be caused by any party of the contract, therefore it can be classified into these types: design related factors, owner related factors, contractor related factors, executive supervisor related factors, and compelling circumstances.

This study investigates various factors that can potentially cause time and cost overruns in construction projects in Jordan, and consequently influence projects and their role in national development. The study was implemented through a survey that targeted different parties involved in construction projects.

4. Research Methodology

This research mainly focuses on the factors that influence time and cost overrun in public building projects in Jordan. Based on previous researches, about 121 items were suggested by different researchers to cause time and cost overruns in construction projects. The designed questionnaire was preliminary presented to a group of experts in questionnaire design to review and judge. Meanwhile, the suggested 121 items were reviewed by 12 individuals; four from each party each party involved in a construction project, i.e., from clients, consultant and contractor firms.

The final version of the questionnaire was sent out to 150 respondents randomly selected from list of experienced engineers including clients, consultants and main contractors' firm. The results were collected and sorted

considering the project parties in Jordan. The required analysis to identify the most and least important factors affecting time delay and cost overrun was conducted, considering the rates given for the proposed factors for time delay and cost overrun by each party and denoted as the individual rate for factor. The group factor (the mean of factors in each group; financial, competence, design, etc.) was calculated for each group. Then the individual rates that were calculated for each party were tested against each other by suggestion of the equality of means for the individual and group factor respectively considering the Tukey-Kramer's rule for means testing.

5. Data Collection and Discussion of the results

The questionnaire of time and cost overrun was sent to 150 randomly selected respondents (50 clients, 50 consultants, and 50 contractors). Out of the sent questionnaires 27 of responses were received from clients' group, 27 of responses received from consultants' group, and 26 of responses were received from the contractors' group. The questionnaire included 121 factors related to time delay and cost overrun that were ordered randomly. The personnel of the Consultants, contractors firms, and client operators responded by giving a scale from 1 (strongly disagree), 2 (disagree), 3 (not known), 4 (agree), 5 (strongly agree) to these factors depending on their experience. Then the weighted average was calculated for each factor using the consultant's, contractors and client's given response scale (from 1 to 5) and clients, contractors, and consultant's personnel experience using equation (1).

$$F_{average} = \frac{\sum F_i X_i}{\sum X_i} \qquad (1)$$

Where $F_{average}$ is the calculated average for the factor of delay and cost indicated as individual rate, F_i is the rate (from 1 to 5) given to the factor of time delay and cost by client's, consultant's, and contractor's personnel in the questionnaire, and X_i is the experience in years for the personnel. Table 1 shows the maximum and the minimum three factors evaluated by the clients', consultants', and contractors' groups for the time delay and cost overrun.

Table1: Maximum and MinimumRate of Factors Related to Time Delay and Cost Overrun

Classification Category	Client Rate		Consultant Rate		Contractor Rate	
Maximal Factors	Financial Issue (A8)	4.63	Technical Issue (E1)	4.7	Financial Issue (A8) Technical Issue (E1)	4.62
	Design Issue (I5)	4.41	Design Issue (I2)	4.67	Financial Issue (A10)	4.46
	Competence (B7) and (B9)	4.33	Workmanship Issue (H8)	4.44	Competence Issue (B8) Design Issue (I5)	4.42
Minimal Factors	External Issue (D10)	2.89	External Issue (D3) Material Issue (G3)	2.74	External Issue (D7)	2.88
	External Issue (D14)	3	External Issue (D1)	2.85	External Issue (D4)	2.85
	Regulation (C1) External Issue (D3)	3.11	Workmanship (H9)	2.93	External Issue (D3)	2.42

In addition, a comparison between client, contractor, and consultant individual factor rate was conducted on the means of all rates given by client, contractor, and consultant using the inference of the difference in means (The Tukey Kramer Procedure), randomized design / simple comparative experiment. The following equations explain the procedures that were applied in the calculations and results sections. The proposed hypothesis H_O: $\mu_1 = \mu_2 = \mu_3$ which stated that all equal means would be tested against the rejection hypothesis which stated that at least will be a difference between two means. μ_1 and μ_2 and $\mu 3$ are the means in the null hypothesis H_O that were replaced by the averages $\bar{y}1$ and $\bar{y}2$ and $\bar{y}_3$ for factors rate given by the client, consultant, and contractor respectively, $\delta 1^2$ and $\delta 2^2$ and $\delta 3^2$ were the variances for factor rating given by the client, consultant, and contractor, n_1 and n_2 and n_3 were the number of clients', consultants, and contractors' samples respectively, α was the confidence interval of 5% considered (Walpole et.al., 2007). Table 2 represents the required calculations for Tukey Kramer's rule for making an inference about the averages of samples tested.

Table 2: Tuckey Kramer's Rule Calculation Explanation

Source of Variation	Df	SS	MS (Variance)	*P*-value	F-Ratio
Between Groups	c-1	SSA	MSA	P(X=F)	
Within Groups	n-c	SSW	MSW		
Total	n-1	SST = SSA+SSW			

Where c is the number of groups (here we have 3 groups: clients, consultants, and contractors), and n is the sum of all samples respondents in the groups, and df is the degree of freedom at the respective level. Then the null hypothesis would be rejected if F was greater than F tabulated at $\alpha = 0.05$. So averages, $\bar{y}_1$, $\bar{y}_2$, and $\bar{y}_3$ and $\bar{y}_{Total}$ were calculated. The critical range was calculated using the following expression in equation (2):

$$Critical\ Range = Q_u \sqrt{\frac{MSW}{2}\left(\frac{1}{n_j} + \frac{1}{n_{j'}}\right)} \qquad (2)$$

where Q_U was Value from Studentized Range Distribution with c and n-c degrees of freedom for the desired level of freedom, and MSW was the Mean Square Within n_j and $n_{j'}$ = Sample sizes from groups i and j. Then the absolute differences $\bar{y}_1$- $\bar{y}_2$, $\bar{y}_1$-$\bar{y}_3$, and $\bar{y}_2$-$\bar{y}_3$ were calculated and compared to the critical range, so if the absolute differences were greater than the critical range, then there would be a significance differences between two pairs of means respectively.

The total sum of squares (SST) was calculated using the following excepression equation (3):

$$SST = \left(X_{11} - \bar{\bar{X}}\right)^2 + \left(X_{12} - \bar{\bar{X}}\right)^2 + \cdots + \left(X_{kn_k} - \bar{\bar{X}}\right)^2 \qquad (3)$$

Where X_{11} X_{12}, …., X_{kn} are measurements from populations, and $\bar{\bar{X}}$ is the grand mean (the mean of all data values), whereas k was the number of populations, and n was the number of data in the population equation (4).

$$SST = SSB + SSW \quad (4)$$

Where SSB can be calculated as:

$$SSB = \sum_{i=1}^{k} n_i \left(\bar{X}_i - \bar{\bar{X}}\right)^2$$

And $\bar{X}_i$is the mean of the population i. Then MSB = SSB/(k-1) is the mean square between levels of populations. The sum of squares within population (SSW) was calculated by the following equation (5).

$$SSW = \sum_{i=1}^{k} \sum_{j=1}^{n_j} \left(X_{ij} - \bar{X}_i\right)^2 \quad (5)$$

The calculation of the mean squares within the level of populations MSW = SSW/(n-k). Finally to calculate the F statistics F=MSB/MSW, and estimating F using k-1 and n-k degrees of freedom at $\alpha = 0.05$. The comparison was applied on individual rank for factors related to time delay and cost overrun, and on the group of factors gathered in one group. Considering the inference on means of individual factors in groups, and its average, with comparative rank for all factors, it is shown for the financial issues that all parties disagreed on the importance of the majority of factors, except for Deficiency in cost estimates preparation, Difficulties in financing project by contractor, Contractors financial difficulties, and Ignoring items with abnormal rates during tender evaluation, especially items with provisional quantities.

Along with the above result, for the competence issues, the majority of parties disagreed on the importance of four factors including: Experience of project type, Inadequate contractor experience, Original contract duration is too short, and Improper construction methods implemented by contractor. On contrary with the previous two groups, all parties disagreed on all factors except for Type of project bidding and award (negotiation, lowest bidder) for factors related to regulate issues.

However, the same was found for external issues, where all parties agreed on most of the factors, except for Unpredictable bad weather, Effects of subsurface conditions (e.g., soil, high water table, etc.), Problems with project neighbours, and Delay to furnish and deliver the site to the

contractor by the owner. It is found that all parties agreed on all factors related to technical issues.

Furthermore, all parties agreed on most of the factor related to managerial issues and disagreed on half of the number agreed upon. Similar results were found about the workmanship issues and also for design issues. And, all parties disagreed on most of the factors related to design issues. In addition all parties agreed on all factor related to material issues except for Difficulties in obtaining construction materials at official current prices and delay in manufacturing special building materials. At the same time, all parties agreed on all the factors related to communication issues except for the factors named as lack of periodic meetings between all parties. Finally, all parties also agreed on all the factors related to site issues except for slowness in decision making process by owner. For more details on the above discussion, inference of all parties can be shown in Appendix A.

Appendix A presents the averages of factors related to time cost overrun and delay for the projects in Jordan in main eleven groups branched to financial, competence, regulation, external, technical, management, material, workman shop, design, communication, and site issues. Also, the comparison for rank between factors in the same groups, and the comparison for rank of groups averages are calculated and presented. Client, contractor, and consultant agree or differences are presented also for the factors.

6. Conclusions and Recommendations

According to the results, the clients considered that financial, design, and competence issues have large effects on time delay and cost overrun, while the regulation and external issues have the minimum effect on time delay and cost overrun. Financial and competence issues were interrelated areas for changes by all parties (the abilities of contractors, the excellence of consultants, and the needs of clients), that might be of less changes involved by designers. The projects encountered problems in financing process, while selection of the design still a problem to accommodate the use of new and high technology in materials and process of construction. The competency problems were due to the market status, labor, company fund and financial situation, and employed technology were all

interrelated issues and problems. Regulations are tools of impact on time delay and cost overrun, because they would be part of the contract before and after changes.

The consultants found that technical, design, and workmanship issues have a large effect on time delay and cost overrun (because the specifications may not be justified on time and with accepted quality by at least one party), while material and external issues have the minimal effect on time delay and cost overrun. On the contrast of the clients' and consultants' group the contractors' group found that the financial, and competence issues have the maximum effect on time delay and cost overrun, while the external issues have the minimal effect on time delay and cost overrun. The rate of the contract company implied the financial situation and the size of work that the company could attain once, so the competency in bidding and contracting has a large effect on time delay and cost overrun.

According to clients the financial, ineffective delay penalties have a great effect on time delay and cost overrun, followed by the competency issues like inadequate contractor experience and ineffective planning and scheduling of project by contractor, and finally change orders by owner during construction from design issues. While, external and regulation issues have the minimal effect on time delay and cost overrun. According to consultants, external issues (unpredictable bad weather), design issues (misunderstanding of owners requirements by design engineer), and workmanship (low level of equipment-operators skill) have the largest effect on time delay and cost overrun. According to contractors, financial issues (ineffective delay penalties and unavailability of incentives for contractor for finishing ahead of schedule) competency issues (original contract duration is too short) have the largest effect on time delay and cost overrun.

It can be concluded from this study the following recommendations:

1. The time delay and cost overrun are the most critical issues for projects and construction parties in Jordan. Clients, consultants, and contractors and their teams from man crafts, subcontractors, and labors will be highly affected by time delay and cost overrun.
2. Clients should take care of financial issues in acquiring fund for projects, and try to give an appropriate and reasonable time for construction and advise contractors of infeasible conditions.
3. Consultants should take care of specifications and penalties for more control on construction contracting, and give the right time and price for

contracting within the minimum and maximum limits according to the market status and competency.

4. Contractors should take care of work volume that should be attained and be suitable for their financial status. Contractors have to study carefully the terms of each contract separately in order to be successful in time and within the allocated budget.
5. Responses of clients, consultants and contractors to different items of the questionnaire varied between agreement and disagreement However, they all agreed, that time delay and cost overrun are among the most critical issues and pose significant challenges to the performance of construction projects.

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References

Al-Barrak, A. A. (1993). Causes of contractors' failures in Saudi Arabia, MS Thesis, King Fahd University of Petroleum and Minerals.

Al-Khalil M. and Al- Ghafly, M.A. (1999). Important causes of delay in public utility projects in Saudi Arabia, International Journal of Project Management Vol 17, Issue 2, pp 647-655.

Al-Momani, A. H. (2000). Construction delay: A quantitative analysis. International Journal of Project Management, 18(1), 51-59.

Al-Hazeem, Nabeel and Abu Salem, Zaydoun (2014). Delay and Cost Overrun in Road Construction Projects in Jordan. Global Advanced Research Journal of Engineering, Technology and Innovation, Vol. 3 (8), December, 2014.

Assaf, S. A. and Al-Hejji, S. (2006). Causes of delay in large construction projects. International Journal of Project Management, 24(4):349-357.

Assaf, S. A., Al-Khalil, M, and Al-Hazmi, M. (1995), Causes of Delay in Large Building Projects, ASCE, Journal of Management in Engineering, 11(2):45-50, March/April.

Chan, Albert, P.C. (2001). Time cost relationship of public sector projects in Malaysia‖, International Journal of project Management, Vol. 19, No.4, pp. 223-229.

Choudhury, I. and Phatak, O. (2004). Correlates of time overrun in commercial construction, ASCE proceeding of 4th Annual Conference, Brigham Young University- provo-Utah, April 8-10.

Danso, Humphrey and Antwi, John Kobina (2012). Evaluation of the Factors Influencing Time and Cost Overruns in Telecom Tower Construction in Ghana. Civil and Environmental Research, Vol 2, No.6, 2012.

Faridi, A. S. and El-Sayegh, S. M. (2006). Significant factors causing delay in the UAE construction industry. Construction Management and Economics,14:1167-76.

Jackson, Simon (1990). Project Cost Overruns and Risk Management. School of Construction Management and Engineering, The University of Reading, Whiteknights, can be accessed at: http://www.reading.ac.uk/web/FILES/innovativeconstructionresearchc

entre/icrc-31-c-ProjectcostoverrunsandriskmanagementARCOM2002.pdf

Kaming, Peter, Paul Olomolaiye, Gary Holt and Frank Harris (1997). Factors influencing construction time and cost overruns on high-rise projects in Indonesia. Construction Management and Economics, 1997, vol. 15, issue 1, pages 83-94.

Koushki,P.A.; K. Al Rashid; and N. Kartam (2005). Delays and cost increases in the construction of private residential projects in Kuwait. Construction Management and Economics, Vol (23), Issue (3), 2005.

Odeh, A. M. and Battaineh, H. T. (2002). Causes of construction delay: traditional contracts. International Journal of Project Management, 20(1):73-67.

Nonaka, Makoto; Zhu, Liming; Ali Babar, Muhammad; Staples, Mark (2007). Project cost overrun simulation in software product line development. Conference: Product-Focused Software Process Improvement, 8th International Conference, PROFES 2007, Riga, Latvia, July 2-4, 2007, Proceedings.

Sweis, G., Sweis, R., Abu Hammad, A. and Shboul, A. (2007). Delays in Construction Projects: The Case of Jordan. International Journal of Project Management, Manuscript #:JPMA-D-07-00094R1, Elsevier Editorial System.

Ubani, E.C., K.A. Okorocha, S.C. Emeribe (2013). Analysis of Factors Influencing Time and Cost Overruns on Construction Projects in South Eastern Nigeria. International Journal of Management Sciences and Business Research Volume 2, Issue 2- ISSN (2226-8235).

Appendix A

Individual and Group Factor Rank with Comparative for Factors

Group	Factor	a	N	F_0	$F_{\alpha, a-1, N-a}$	P-value	State	Notes
Financial Issues (A)	Deficiency in cost estimates preparation	3	81	1.1	3.174	0.33	=	
	Difficulties in financing project by contractor			0.6		0.56	=	
	Contractors financial difficulties			1.3		0.27	=	
	Low bid price			4.5		0.02	≠	$m_2 \neq m_3$
	Omissions and errors in the bills of quantities			4.9		0.01	≠	$m_1 \neq m_2$
	Ignoring items with abnormal rates during tender evaluation, especially items with provisional quantities			1.1		0.32	=	
	Some tendering maneuvers by contractors, such as front-loading of rates			3.7		0.03	≠	$m_1 \neq m_2$
	Ineffective delay penalties			10.5		0.00	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Delay in progress payments by owner			14.3		0.00	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Unavailability of incentives for contractor for finishing ahead of schedule			19.1		0.00	≠	$m_1 \neq m_2 \neq m_3$ $m_2 \neq m_3$
	GA	3	30	12.6	3.35	0.00	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
Group	Factor	a	N	F0	Fα, a-1, N-a	P-value	State	Notes
Competence Issues (B)	Inadequate control procedure	3	81	1.49	3.147	0.23	=	
	Inadequate contractors work			0.24		0.10	=	
	Delay in workshop preparation			2.71		0.072	=	
	Delay in workshop approval			1.07		0.35	=	
	Mistakes during construction			1.483		0.233	=	
	Experience of project type			3.61		0.032	≠	$m_1 \neq m_3$
	Inadequate contractor experience			3.43		0.037	≠	$m_1 \neq m_3$
	Original contract duration is too short			10.9		0.00	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Ineffective planning and scheduling of project by contractor			6.37		0.003	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Improper construction methods implemented by contractor			2.52		0.087	=	
	GB	3	30	8.957	3.35	0.00	≠	$m_1 \neq m_3$
Group	Factor	a	N	F0	Fα, a-1, N-a	P-value	State	Notes
Regulate Issues (C)	Type of construction contract (Turnkey, construction only)	3	81	11.0	3.147	0.000	≠	$m_1 \neq m_2$ $m_2 \neq m_3$
	Type of project bidding and award (negotiation, lowest bidder			0.24		0.787	=	
	Delay in obtaining permits from government authorities			19.1		0.000	≠	$m_1 \neq m_2$ $m_2 \neq m_3$
	Unavailability of utilities in site (such as, water, electricity, telephone, etc.)			7.93		0.01	≠	$m_1 \neq m_2$ $m_2 \neq m_3$
	GC	3	12	18.6	4.26	0.000	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
Group	Factor	a	N	F0	Fα, a-1, N-a	P-value	State	Notes

External Issues (D)	Unpredictable bad weather	3	81	4.65	3.147	0.000	≠	$m_1 \neq m_2$
	Effects of subsurface conditions (e.g., soil, high water table, etc.)			3.84		0.109	≠	$m_1 \neq m_2$
	Hot weather effect on construction activities			2.41		0.392	=	
	Rain and cold effect on construction activities			2.98		0.00	=	
	Effect of social and cultural factors			0.20		0.958	=	
	Changes in government regulations and laws			0.91		0.186	=	
	Delay in providing services from utilities (such as water, electricity)			2.22		0.131	=	
	Delay in performing final inspection and certification by a third party			0.94		0.189	=	
	Bureaucracy and political influence (Govt. changes)			0.18		0.838	=	
	Effect of terrorist activities			1.70		0.395	=	
	Environment restriction			2.09		0.116	=	
	Location restriction of the project			1.72		0.406	=	
	Regulatory changes and building Code			0.04		0.822	=	
	Problems with project neighbors			9.17		0.057	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Unforeseen ground conditions			0.95		0.097	=	
	Delay to furnish and deliver the site to the contractor by the owner			34.0		0.026	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	GD	3	48	2.28	3.21	0.012	=	
Group	Factor	a	N	F0	Fα, a-1, N-a	P-value	State	Notes
Technical Issues (E)	Deficiencies in Planning and scheduling	3	81	2.43	3.147	0.621	=	
	Frequent breakdown of construction plants and equipments			0.31		0.613	=	
	Shortage of technical persons			0.83		0.050	=	
	Inaccurate prediction of equipment production rate			0.52		0.050	=	
	Accurate quantity take-off			3.11		0.594	=	
	Inadequate definition of substantial completion			3.11		0.441	=	
	Inadequate experience of consultant			0.49		0.733	=	
	GE	3	21	0.48	3.55	0.088	=	
Group	Factor	a	N	F0	Fα, a-1, N-a	P-value	State	Notes
Management Issues (F)	Waiting for information from client	3	81	1.39	3.147	0.000	=	
	Inappropriate overall organizational structure link in			3.36		0.194	≠	$m_2 \neq m_3$
	Lack of cost planning/monitoring during pre-and-post contract stages			0.12		0.165	=	
	Lack of cost reports during construction stage			8.20		0.195	≠	$m_1 \neq m_2$ $m_2 \neq m_3$
	Indecision by the supervising team in dealing with the contractor's queries in delays			0.76		0.007	=	
	Legal disputes b/w various parts			11		0.162	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Slowness in decision making process by owner			2.76		0.060	=	
	Conflicts between joint-ownership of the project			8.04		0.333	≠	$m_1 \neq m_2$ $m_1 \neq m_3$

	Suspension of work by owner			1.24		0.010	=	
	Conflicts in sub-contractors schedule in execution of project			1.08		0.009	=	
	Poor site management and supervision by contractor			1.45		0.375	=	
	Poor contract management			0.19		0.000	=	
	Delay in site mobilization			10.8		0.008	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Delay in approving major changes in the scope of work by consultant			5.09		0.000	≠	$m_1 \neq m_3$
	Equipment breakdowns			14.2		0.825	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Shortage of equipment			0.99		0.240	=	
	Low productivity and efficiency of equipment			5.01		0.345	≠	$m_1 \neq m_3$
	Traffic control and restriction at job site			4.89		0.295	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Slow decision making			1.11		0.001	=	
	Poor quality assurance/control.			2.91		0.069	=	
	Accurate prediction of craftsmen production rate			1.86		0.000	=	
	Subcontractors poor management			5.31		0.469	≠	$m_1 \neq m_2$
	Poor Site management			1.67		0.001	=	
	Mistakes and discrepancies in contract documents			1.85		0.887	=	
	Major disputes and negotiations			1.68		0.040	=	
	GF	3	75	179	3.134	0.256	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
Group	Factor	a	N	F0	Fα, a-1, N-a	P-value	State	Notes
Material Issues (G)	Escalation of material prices	3	81	0.03	3.147	3.846	=	
	Late in selection of finishing materials due to availability of many types in market			2.64		0.078	=	
	Difficulties in obtaining construction materials at official current prices			3.42		0.038	≠	$m_1 \neq m_2$
	Accuracy of materials estimate			0.34		0.713	=	
	Shortage of construction materials in market			2.14		0.124	=	
	Changes in material types and specifications during construction			1.77		0.177	=	
	Delay in material delivery			0.53		0.592	=	
	Damage of sorted material while they are needed urgently			2.01		0.141	=	
	Delay in manufacturing special building materials			3.52		0.034	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Late procurement of materials			0.53		0.592	=	
	GG	3	30	41.8	3.35	0.000	≠	$m_1 \neq m_3$
Group	Factor	a	N	F0	Fα, a-1, N-a	P-value	State	Notes
Workmanship Issues (H)	Skilled labor unavailability problem	3	81	0.05	3.147	3.180	=	
	Low productivity level of labors			1.84		0.166	=	
	Accident during construction			4.61		0.013	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Rework due to errors during construction			5.18		0.008	≠	$m_1 \neq m_3$
	Delays in sub-contractors work			2.22		0.116	=	
	Frequent change of sub-contractors because of their inefficient work			3.64		0.031	≠	$m_1 \neq m_3$
	Poor qualification of the contractors technical staff			0.54		0.583	=	
	Low level of equipment-operators			11		0.000	≠	$m_1 \neq m_2$

	skill							$m_1 \neq m_3$
	Shortage of labors			1.94		0.150	=	
	Unqualified workforce			0.34		0.715	=	
	Nationality of labors			5.04		0.003	≠	$m_1 \neq m_2$
	GH	3	33	5.94	3.32	0.009	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
Group	Factor	a	N	F0	Fα, a-1, N-a	P-value	State	Notes
Design Issues (I)	Incomplete design at the time of tender	3	81	0.13	3.147	0.882	=	
	Misunderstanding of owners requirements by design engineer			10.5		0.000	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Inadequate design-team experience			4.52		0.014	≠	$m_1 \neq m_2$
	Un-use of advanced engineering design software			7.73		0.001	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Change orders by owner during construction			0.73		0.486	=	
	Late in revising and approving design documents by owner			5.19		0.008	≠	$m_1 \neq m_3$
	Late in reviewing and approving design documents by consultant			2.43		0.095	=	
	Mistakes and discrepancies in design documents			7.6		0.001	≠	$m_1 \neq m_2$ $m_2 \neq m_3$
	Delays in producing design documents			1.51		0.227	=	
	Unclear and inadequate details in drawings			4.31		0.017	≠	$m_1 \neq m_2$
	Complexity of project design			0.40		0.675	=	
	Insufficient data collection and survey before design			5.98		0.004	≠	$m_1 \neq m_2$
	GI	3	36	41.3	3.293	0.00	≠	$m_1 \neq m_2$ $m_2 \neq m_3$
Group	Factor	a	N	F0	Fα, a-1, N-a	P-value	State	Notes
Communica-tion Issues (J)	Delay in approving shop drawings and sample materials	3	81	0.7	3.147	0.502	=	
	Poor communication and coordination by owner and other parties			0.94		0.395	=	
	Lack of periodic meetings between all parties			7.51		0.001	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Conflicts b/w contractor and other parties (consultant and owner)			2.26		0.112	=	
	Poor communication and coordination by contractor with other parties			0.53		0.592	=	
	Delay in performing inspection and testing by consultant			2.89		0.061	=	
	Inflexibility (rigidity) of consultant			1.66		0.198	=	
	Conflicts between consultant and design engineer			1.54		0.222	=	
	Personal conflicts among labours			0.20		0.821	=	
	GJ	3	27	111	3.4	0.00	≠	$m_1 \neq m_2$ $m_1 \neq m_3$

Group	Factor	a	N	F0	Fα, a-1, N-a	P-value	State	Notes
Site Issues (K)	Unsafe work place	3	81	1.42	3.147	0.248	=	
	Differing site (ground) conditions			0.83		0.44	=	
	Slowness in decision making process by owner			5.07		0.009	≠	$m_1 \neq m_2$ $m_1 \neq m_3$
	Conflicts between joint-ownership of the project			1.73		0.184	=	
	Poor communication/coordination between consultant and other parties			1.53		0.222	=	
	GK	3	15	34.6	3.89	0.248	≠	$m_1 \neq m_2$ $m_1 \neq m_3$

GA* to GK are the group average of A, B, C, .. to K groups m_1, m_2, and m_3 are referred to client, consultant and contractor ranking or perspective about the reasons for time delay and cost overrun.