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Investigation of Cost-Influencing Factors Potentially Controllable by Main Contractors in Construction Projects in Iraq

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K E Y W O R D S

Construction cost control, Construction cost factors, Construction cost overrun, Construction cost problems, Construction industry.

A B S T R A C T

Cost overrun in construction projects is a common phenomenon in Iraq. This might occur due to diversity of factors. This study aims to identify the factors influencing construction projects cost that are potentially controllable by main contractors. A field study through a questionnaire survey was directed to a sample of related Iraqi professional engineers from general contracting companies at both public and private sectors. Their opinions on the impact and frequency of each factor were investigated. The questionnaire offered (59) factors classified in (8) categories namely*; legislations, financial and economic, design, contractual, site management, material, labor and equipment. The factors were ranked according to the highest Relative Importance Index (RII). The study revealed (10) major factors that are potentially controllable by main contractors namely; labor productivity, sub-contractors and suppliers performance, equipment productivity, site organization and distribution of equipment, experience and training of project managers, scheduling and control techniques, planning for materials supply, planning for equipment supply, materials delivery and planning for skilled labor recruitment. Recommendations to aid contractors and owners in early identification of these factors are also included in this study.*

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1. Introduction

Cost overrun is considered one of the most critical issues during the execution of construction projects [1]. The presence of cost overrun will eventually lead to project failure [2]. In Iraq, cost overrun is typical in the Construction Industry. It has become very frequent in most construction projects. Despite the introduction of different cost control techniques and software, the Iraqi

Construction Industry does not make use of them [3]. Many construction projects suffer from cost overrun due to factors emanates from poor cost control during both design and construction stages [4]. In order to survive, contractors need to continuously improve the efficiency of their cost control practices in both stages in which construction cost should be managed using the best available techniques. Hence, cost overrun can be mitigated and the contractor might not incur major losses. Early expectation of material, labor and equipment cost fluctuation should also be made before budgeting [3]. Therefore, a thorough investigation to identify construction projects cost overrun factors that are potentially controllable by main contractors is carried out in this research.

2. Research Objectives

The aim of this research paper is to identify construction projects cost overrun factors that are potentially controllable by main contractors at early stages in order to improve the performance of cost control in the Iraqi Construction Industry. Two objectives have been set to achieve this aim:

1) To investigate constituencies' opinions about cost overrun factors through a well-structured questionnaire survey.
2) To conduct statistical analysis to test the relevance of results in order to find out the most controllable factors by main contractors.

3. Research Justification

In order to upgrade the cost control practice in construction projects in Iraq, the factors causing cost overrun should be identified first. Then, the most influential factors that are potentially controllable by main contractors can be focused on to gain feasible results.

4. Research Methodology

The research was conducted according to the deduction approach. It is an exploratory research based on a questionnaire survey to elicit information on the causes of cost overrun in construction projects. A wide range of literature on construction cost issues in different countries, especially in Iraq and the region [4, 5] were investigated in order to provide a common base to start with. Then, a questionnaire was designed to cover prevailing practices in the Iraqi Construction Industry to find out the factors that are potentially controllable by main contractors. The respondents were asked to rate the severity and likelihood of the factors on a scale of (1 to 5) each according to Likret's scale. Likret's scale had been used for such purposes in similar studies such as [6, 7]. Quantitative analysis including all necessary statistical tests was conducted. The results were ranked according to its severity and likelihood, in order to identify the most important factors. The Relative Importance Index (RII) was employed to rank the factors. It is one of the most popular methods used in such studies [4, 8].

5. Literature Review

Olawale and Sun, in (2010) [8] developed a questionnaire survey consisting of twenty factors related to construction cost. The study revealed ten factors to be considered as most influential namely; design changes, risk and uncertainty, inaccurate estimation of project duration, poor performance of subcontractors and suppliers, complexity of works, conflicts between the parties, contradictions in contract documentation, disagreement on contract documents interpretation, inflation and payment for completed works.

Memon, et al., in (2010) [9] carried out a study to identify the most affecting factors to cost performance as well as the adopted procurement strategies in specific large construction projects in Malaysia. A questionnaire survey was conducted in which projects have been filtered to small and large projects according to their cost. The results showed that the fluctuation of material prices have a dominant effect on the performance of project cost. Cash-flow and financial problems have the next effect. Two factors shared the third effect, including shortage of skills and lack of communication between parties.

Xiao and Proverbs, in (2012) [10] conducted a study to identify and evaluate factors influencing construction cost. The study covered practices in three countries including; USA, UK and Japan. It was carried out using a questionnaire survey to investigate interior and exterior factors. Evaluation of the effects of the factors on contractors' cost performance was also performed and a regression model was developed. The study emphasized that 53% of cost variations belong to (3) independent

variables; unit price overheads, number of design changes during the implementation phase and using prefabrication system.

Morsy, in (2014) [4] carried out a study based on twelve factors identified by exploring literature review using a questionnaire to rank these factors. The study revealed the most influential factors; poor estimation of original cost, improper planning, inflation or construction cost under-estimation, unforeseen site conditions or omissions and errors in the bill of quantities, design errors, contractual claims, lack of experience, changes in owner's brief, force majeure and unsuitable construction equipment and methods. The survey also covered cost control techniques used in construction projects namely; inspection of works and frequent progress meeting, use of experienced sub-contractors and suppliers, frequent coordination between parties, planning of project tasks and resources, work programs records keeping, monitoring cost performance and evaluation of conducted work.

Karoriya and Pandey, in (2018) [11] conducted a study in India to address the problems occurring due to improper application of material management in construction projects. The difference between actual and planned budget was also investigated. A questionnaire survey highlighted the factors that lead to cost increase. These factors included improper planning and control of material quantities, shortage of materials when needed, poor identifications of materials types, moving materials occasionally and tight storage. The study suggested measures for effective material management in construction sites. Planning for material supply and using suitable inventory control technique were considered as most important measures for material managing problems. A material managing system based on economic quantity analysis was developed.

Paul and Binu, in (2018) [12] conducted a study to determine the most influential factors in material cost management. A questionnaire was directed to (25) construction companies in India. The most influencing factors on material procurement were found; improper scheduling of material procurement, higher rates incurred on purchase due to non-availability and non-determination of what and when materials is required. Moreover, the most influential factors on material transportation and storage were found; unrealistic delivery dates, late supply and improper stocking of material. While the most influential factors on material cost management were found; inexact records of materials consumption and stocking, poor internal communication and material wastage. Finally, a material management system was developed.

According to the aforementioned literature, it can be concluded that using a questionnaire survey is a proper tool to investigate prevailing cost over-run factors in a specific construction industry. The missing subject is to find out the most potentially controllable factors by main contractors to focus on in order to take early preventive actions. Hence, this study dealt with this missing subject using a questionnaire survey.

6. Field Study

A questionnaire form was prepared to serve the purpose of this study and directed to Iraqi professionals at six governmental general contracting companies and four private ones as shown Table 1. Their fields of experience in construction projects included buildings, highways, water supply and sewage systems, hydraulic structures, electric facilities, communications networks, mechanical works, and industrial plants.

Table 1: Respondents' affiliations

Company name	Work sector	Copies sent	Copies received	Percent responded
State Company for Implementation of Transport Projects	Public	23	20	87%
State Company for Construction and Housing	Public	15	11	73%
State Company for Building	Public	8	6	75%
Al-Rasheed State Company for Construction Contracts	Public	10	7	70%
State Company for AL-Furat Al-Awsat Transport Projects	Public	9	6	67%
Iraqi Drilling Company - Ministry of Oil	Public	2	2	100%
Kemet Company for Airport Supplies and Projects Implementing	Private	6	5	83%
Al-Yamama Group for Construction	Private	5	4	80%
Ard Al-Manasik for Construction Projects	Private	5	4	80%
Al-Sahra'a Al-kubra for construction	Private	4	4	100%

The questionnaire form consisted of three parts. Part I for general information, Part II for assessing cost control methods and Part III for assessing cost overrun factors based on its impact on construction cost (severity) and its frequency of occurrence (likelihood) using the Relative Importance Index (RII). The results of Part (I) are shown in Table 2.

Table 2: Respondents' general information

Degree	46 BSc holders		14 MSc holders		9 PhD holders	
Specialization	46 Civil Eng.	12 Mechanical Eng.		9 Electrical Eng.	2 Architects	
Experience	7 having <6 years	8 having (6-10) years	10 having (11-15) years	9 having (16-20) years	12 having (21-25) years	23 having >25 years
Current Jobs	24 at Head Office	19 Site Engineers	17 Project Managers	7 Planning and Control Eng.	2 Designers	

The results of Part II revealed information about some companies' cost control practices. Current usage techniques for scheduling, packages for planning and control and methods for cost control are shown in Tables 3 to 5 respectively.

Table3: Currently used techniques for scheduling

Scheduling techniques	Utilization
Gantt Chart	51%
Line of Balance	16%
Critical Path Method	13%
No specific technique is used	10%
Program Evaluating and Review Technique	10%
Precedence Diagram Method	0%

Table 4: Currently used packages for planning and control

Planning and control packages	Utilization
Microsoft project	43%
Primavera	22%
Microsoft Excel	16%
No specific technique is used	16%
Building Information Modelling	3%

Table 5: Currently used methods for cost control

Cost control methods	Utilization
Unite Costing (Periodic assessment of each item in BOQ)	33%
By overall profit or loss (Assessment at completion date)	29%
Profit/loss at valuation dates (Assessment at each payment)	17%
Activity Based Ratio (Periodic assessment of each activity)	9%
No specific technique is used	6%
Leading Parameter (Periodic assessment of the main item)	3%
System Variance (Periodic analysis of S-Curve variances)	3%

The results of Part III pointed out the rating of potentially controllable cost factors according to the respondents' experience. The rating was expressed using the five-score (1-5) of Likret's scale covering both impact (severity of consequences) and likelihood (frequency of occurrence). The interpretation of the scale is shown in Table 6.

Table 6: Interpretation of the ranking scale for severity and frequency

	Ranking score				
Index	1	2	3	4	5
Severity	No Effect	Low Effect	Medium Effect	High Effect	Extreme Effect
Frequency	Never	Scarcely	Occasionally	Frequently	Always

7. Statistical Analysis of Results

The Relative Importance Index (RII) of each factor was calculated using equation (1). It was separately calculated for severity (SRII) and frequency (FRII) then a combined Relative Importance Index is calculated (CRII) using equation (2).

$RII = \Sigma W \div (H \times N)$ (1)

$CRII = SRII \times FRII$ (2)

where:

W: is the total weight given by the respondent to each factor (ranges from 1 to 5)

H: is the highest rank (5).

N: is the total number of respondents (69).

The reliability and validity of the questionnaire results was tested based on Cronbach's Alpha test using SPSS (V.22). The test is employed using equations (3) and (4) for reliability and validity respectively.

$$\alpha = \frac{N}{N-1} \times \left[1 - \frac{\sum_{i=1}^{K} S_i^2}{S_t^2}\right] \quad (3)$$

$$V = \sqrt[2]{\alpha} \quad (4)$$

where:

N: is the number of factors in the group.

S_i^2: is the variance associated with item (i).

S_t^2: is the variance associated with the sum of all (N) items.

(α) values range between (0-1). When the value is closer to one, it indicates higher degree of reliability [7,13].

The results of reliability and validity tests for each group of factors are listed in Tables 7 and 8 showing severity and frequency cases respectively.

Table 7: Reliability and validity test results for severity of groups

Group	Number of items	Reliability (Cronbach's α)	Validity
Legislations	3	0.812	0.901
Financial and economic	5	0.713	0.844
Design	6	0.800	0.895
Contractual	5	0.822	0.907
Site management	11	0.929	0.964
Material	9	0.870	0.933
Labour	10	0.785	0.886
Equipment	10	0.967	0.983

Table 8: Reliability and validity test results for frequency of groups

Group	Number of items	Reliability (Cronbach's α)	Validity
Legislations	3	0.826	0.909
Financial and economic	5	0.767	0.876
Design	6	0.928	0.963
Contractual	5	0.763	0.874
Site management	11	0.820	0.906
Material	9	0.946	0.973
Labour	10	0.721	0.849
Equipment	10	0.919	0.959

8. Ranking of Cost Factors

Table 9 shows the ranking of severity and frequency for all potentially controllable factors that affect construction project cost in Iraq based on (CRII) values. The top thirteen factors that affect the contractor's ability to control construction cost from general contractors' point of view were determined. Such approach provides rapped aid to practitioners where to focus on. A subjective approach is employed to find out the vital few factors based on their (CRII) values in which factors having (CRII) values not less than (80%) of the highest one were considered as the vital potentially

controllable cost factors. When taking into account the factors that are out of the reach of contractors, ten factors remain as listed in Table 10. The neglected factors were design changes, Financing and Corruption.

Table 9: Values for (SRII), (FRII) and (CRII) with their ranking

Factors	SRII	Rank	FRII	Rank	CRII	Rank
The instructions of governmental contracts	0.62	21	0.55	29	0.343	24
The Instructions of the Federal Budget	0.59	30	0.55	32	0.324	32
Other governmental instructions	0.54	41	0.48	56	0.261	51
Inflation	0.49	54	0.51	49	0.250	55
Variation of the Rate of Exchange	0.48	56	0.54	33	0.262	50
Project financing and disbursement method	0.69	5	0.61	8	0.420	4
Variation of the Rate of Interest	0.43	58	0.41	59	0.177	59
Cost of capital due to late payment	0.42	59	0.43	58	0.179	58
Designs and specification changes	0.69	4	0.64	3	0.442	2
Design specification or BOQ contradictions	0.69	6	0.53	39	0.364	17
Exaggerated design, specifications or BOQ	0.54	46	0.48	54	0.260	53
Design specifications or BOQ inaccuracy	0.65	13	0.53	40	0.343	26
Instability of requirements	0.58	36	0.51	49	0.296	43
Weak cooperation to solve design problems	0.61	26	0.50	53	0.302	41
Contradiction of contract clauses	0.51	53	0.51	47	0.260	52
Conflicts in contract clauses interpretation	0.51	51	0.54	33	0.280	45
Hastiness of tendering procedure	0.54	46	0.63	4	0.340	27
Tendering method	0.64	14	0.54	35	0.347	20
Tight project duration	0.61	24	0.53	38	0.328	31
Experience and training of project managers	0.67	9	0.60	12	0.398	8
Ill checking of contract documents	0.52	50	0.52	42	0.272	47
Poor memos and documentation system	0.61	25	0.52	46	0.314	36
Poor scheduling and control techniques	0.66	11	0.60	11	0.397	9
Using non-appropriate software	0.55	40	0.55	29	0.303	40
Ill-precautions for potential risks	0.62	23	0.56	23	0.347	21
Poor communication and information exchange	0.59	32	0.60	9	0.353	18
Poor health and safety measures	0.62	21	0.57	20	0.352	19
Unexpected weather conditions	0.58	35	0.59	15	0.345	23
Corruption and fraud	0.68	7	0.60	9	0.412	6
Conflicts between the parties	0.54	44	0.47	57	0.253	54
Quality problems of local materials	0.54	41	0.56	23	0.306	39
Theft, vandalism and short deliveries	0.48	55	0.48	54	0.234	56
Problems in importing the required materials	0.56	39	0.57	20	0.318	34
Delay of materials delivery when needed	0.67	9	0.58	17	0.385	12
Poor management of inventory	0.63	16	0.53	40	0.335	29
Non-compliance of materials specifications	0.60	28	0.55	28	0.331	30
Delayed laboratory test results	0.66	12	0.56	27	0.365	16
Waste due to ill storage, hauling and handling	0.60	28	0.57	18	0.343	25
No planning for materials supply	0.70	3	0.56	23	0.391	10
Performance of superintendents	0.63	18	0.59	14	0.374	14
Contractors, S/C and suppliers performance	0.70	2	0.62	6	0.437	3
No planning to provide the required skills	0.67	8	0.57	20	0.380	13
Non availability of local workmanship	0.59	31	0.57	19	0.336	28
Waste and delay due to rework of defects	0.53	48	0.52	45	0.277	46
Work accidents and casualties	0.52	49	0.51	51	0.266	49
Labour productivity	0.73	1	0.65	2	0.472	1
Behaviour and discipline of workers	0.51	51	0.52	42	0.269	48
Cost of labour accommodation and transport	0.46	57	0.50	52	0.230	57
Holidays and stoppage for external reasons	0.54	45	0.56	26	0.302	42
Equipment Productivity	0.63	20	0.67	1	0.417	5
No planning for equipment supply	0.63	18	0.62	7	0.390	11
Availability of appropriate local equipment	0.60	27	0.51	47	0.308	37
Site organization and distribution of equipment	0.64	15	0.63	5	0.403	7
Cost of equipment operation and maintenance	0.58	36	0.60	12	0.346	22
Frequent malfunctions of equipment	0.54	41	0.52	42	0.286	44
Performance of equipment operator	0.57	38	0.54	37	0.308	38
Degree of mechanization	0.59	32	0.54	35	0.317	35
Lack of care in the use of equipment	0.59	32	0.55	29	0.323	33
Supervision of equipment operation and maintenance	0.63	17	0.58	16	0.366	15

Table 10: Ranking of most potentially controllable factors affecting construction cost

Rank	Code	Factor	CRII
1	46	Labour productivity	0.4721
2	41	S/C and suppliers performance	0.4371
3	50	Equipment productivity	0.4174
4	53	Site organization and distribution of equipment	0.4029
5	20	Experience and training of project managers	0.3981
6	23	Scheduling and control techniques	0.3965
7	39	Planning for required materials supply	0.3912
8	51	Planning for required equipment supply	0.3902
9	34	Delivery of materials (shortage or delay)	0.3845
10	42	Planning to provide the required skills	0.3800

9. Conclusions

It can be concluded from the scheduling techniques found currently used, as shown in Table (3), compared to the number of the contracting companies covered by this study, that these companies do not enforce one formal strategy for scheduling. This can be considered as a defect. The same can be said concerning currently used planning and control packages and cost control techniques as shown in Tables (4) and (5) respectively. These defects have bad consequences on cost control. Using Gantt chart for scheduling in most of the cases, which is a static method, means that these companies do not adopt dynamic methods that can help cost monitoring, updating and control. Microsoft Project and Primavera are only used in initial scheduling of the startup stage, and then the resulted bar chart is solely used thereafter alone.

Concerning the adopted cost control methods, the practice sticks to the traditional methods like unit costing, by overall profit or loss and profit/loss at valuation dates. This indicates that there is lack of knowledge in modern methods like variance analysis.

Out of (13) factors that were found to be the most influential factors on construction cost, (10) were closely related to contractors. These factors were confirmed to be the most potentially controllable by main contractors.

10. Recommendations

According to the conclusions of this paper, the main contractors in the Iraqi Construction Industry are recommended to adopt a cost management system using modern computerized means under one clear and sustainable strategy in order to ensure an effective cost control. Such system should pay more attention to labor and equipment productivity, S/C and suppliers' performance, site constraints, competence of project managers and resources planning and control.

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