Study the causes of formal change orders and analyze their impact on building projects:case of Syria

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Abstract

Many studies have tried to determine the impact of change orders on the cost and time of the project, which in turn leads to differences and disputes between contractors and owners. Where change orders dealt with in various engineering projects.

This search displays formal causes of change orders occurring during the life cycle of the project in Syria and in particular building projects, and the most important impact on completion of the project indicators (cost _ time). It also identifies the party responsible for the change, and shows the weak points during follow the change order life cycle and provides recommendations for each of the responsible parties, stressing the need to monitor performance in order to manage change order and address the causes and impact alleviation. The prediction models were drafted at additional cost that may result from change orders.

Keywords

Project Management - formal change orders - cost of change orders.

1 Introduction

The change became a key feature of construction projects, and it is rare that any project is implemented according to its plans, Changes become part of the project, which creates challenges for the parties to the project.
And changes often lead to an increase in the duration and cost of the project, but also its in many cases necessary and important to improve the performance and function of the project or to correct design flaws or harmonize the project with site conditions.

Identify changes in contracts construction projects as a written agreement between the owner and the contractor to make developments in the project documents, these developments are either an amendment or add or shed or any change within the scope

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of work specified in the contract, and affects the area of the contract itself, if so necessary action changes in the contract itself, That Change order is the only legal means available that can change the requirements of the contract.[1]

2 Causes of the change

Construction projects contain a large number of documents specifications, drawings and bills of quantities, prepared jointly by the number of engineers with diverse disciplines, so there are errors in these documents is improbable necessitates a change to fix a bug or to avoid the lack [2].
When the causes of change orders in large building projects in the Kingdom of Saudi Arabia were limited, the design change came by the owner was in the first place [3].
The same is repeated with respect to the causes of the change taking place in private buildings, Malaysia University of Science and Technology [4].

3 The impact of change orders

3.1 The impact of change orders on the delay of the project

Changes cause an increase in the time up to 10% of thecontractual duration, and the most common reason for the delay and agreed upon by all parties to the project is the change request by the owner [3].

3.2 The impact of change orders on the cost of the project

Confirmed [5] that the lack of planning for changes in the construction projects would lead to additional work and thus to the additional cost and time.
The average increase was calculated in the cost of large-scale building projects, as was between 6_10% of the original value of the project [3].

4. Research Methodology

Research Methodology statistical analysis, through the filing Survey (40) of the draft government buildings in Syria, as required study conduct several field visits and interviews with project managers and engineers supervision (the owner) and contractor engineers, The required data was recorded and entered into a computer program SPSS.

5. Results and Discussion

5.1 Causes of change in buildings projects in Syria

After completion of the study of archival and field causes the change was rated as causative Party, and arrange them according to the degree of recurrence as follows:

5.1.1 Causes of change resulting from the administration

By reviewing the projects studied, and the registration of the change of management and classified under appropriate names, and know the frequency of each of them, was to reach the most important of these reasons, which is in the following order:

Owner management defect, contractual problems,material substitution, change items, change the warks program , speed up work, lack of funding.

Figure (1) shows the frequency ratios causes of change resulting from the administration.

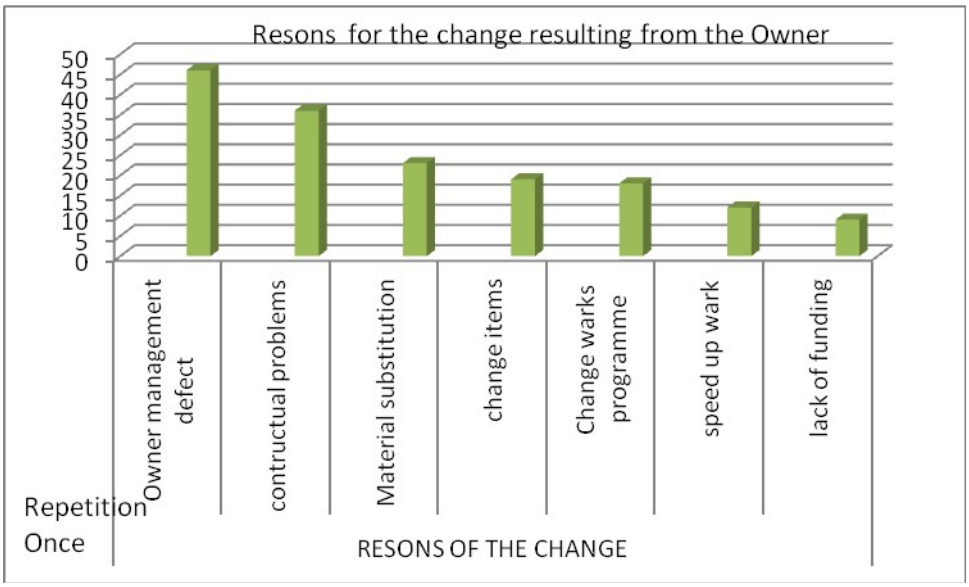

Fig.1) the causes of the change resulting from the owner according to the degree of recurrence.

The figure shows the significant role of the owner of the causes of the change through a delay to respond and make decisions or delay commissioning a quarter of the business or the receipt and delivery and often there is a weakness of communication between the owner and the public bodies relevant, as he may think to start the project before the completion of the designs.

5.1.2 Causes of change resulting from the engineering office

Reasons for the change can be arranged from the engineering office also according to the degree of recurrence as shown in Figure (2), as follows:
Design errors, inclusive price error, omission of items, lack of office student eligibility, the absence of the schedule.

As a result of the study and count the number of times to repeat the formal change request within the studied sample projects show us that various changes and repeat the request by the Owner comes primarily by 60% while the engineering office took second place when analyzing repeated formal change request by 40%.

5.2 Analyze the impact of change orders

The effect of change orders on the cost and time of projects studied was reached the following conclusions:

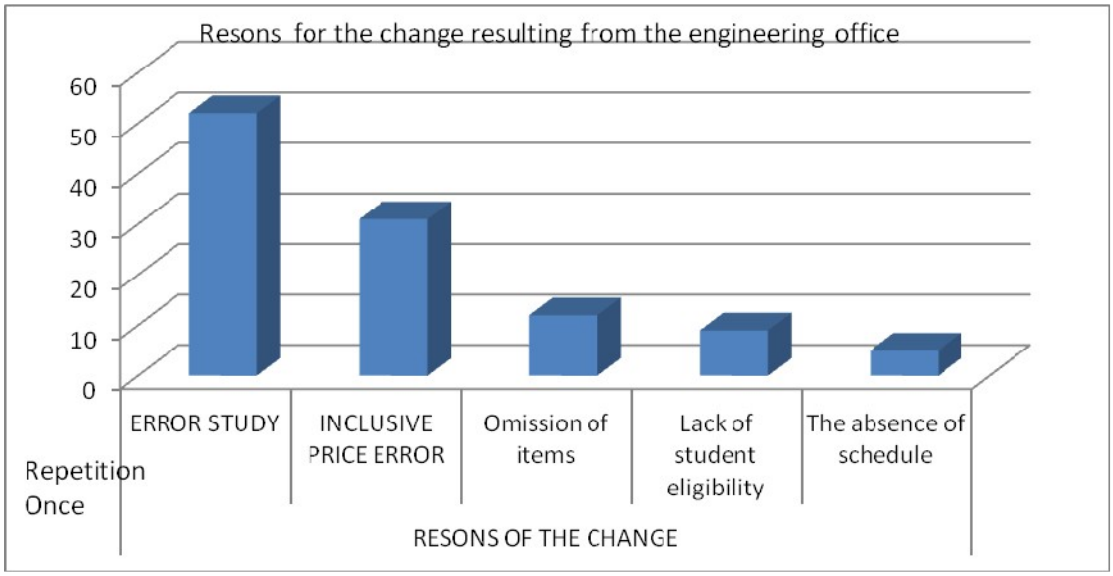

Fig. 2) reasons for the change resulting from the engineering office.

5.2.1 The impact of change orders on the cost of the project

Calculation shows that the percentage of the cost of deviation from contractual costs of the projects studied all (final value - Streptococcus value) is 33%.
It also has been found costs change by recording the values of the change under the terms of the contract supplements, and then calculate the value of those changes within each item and the total value of the change, and find it as a percentage of the deviation in the cost of which was previously calculated. As a result, the percentage of formal change orders only nodal values of 31% projects.

5.2.2 The impact of change orders on the duration of the project

Some delays are justified and sometimes irreversible without any effect on the time of the final completion of the project, and there are further delays may affect the order of operations of the project, and delay without stopping, but the most serious delays that lead to shut down the entire project**.**

Deviation were calculated timeline of the projects studied (the final period - contractual duration = delay), where the average time deviation was 30%.Have also been identified periods necessary to accomplish all the items that modifications undergone change, and knowing the overall duration of the change was to find the percentage deviation in time for the contractual duration and output due to formal change orders only and is equal to 29%.

6. Predict the cost of change

Several research using administrative and engineering programs and using technological development to be able to find a solution to the changes that you can not predict or control its borders.

The researcher managed by linking (the CBR and ANN) to provide a conceptual model to determine the potential for lawsuits resulting from change requests occurring within construction projects [5].

Although given the Syrian government a lot of attention to reduce the changes, but that guidance is still under implementation.Accordingly, due to the worsening problem of funding and not linked to planning the state budget and the significant impact of change on the cost of the project, including more than funding, we developed a mathematical model to predict the added cost as a result of the change.

6.1 model to calculate the cost of the change of government buildings projects in Syria

To find a model of the excess cost of warks items causes of change orders, we will be relying on the statistical program SPSS,
Are selected form among several models (each of which represents an equation: a linear first_degree _ second _ the third _ equation exponential _ logarithmic, etc.), by testing the correlation coefficient for each of them, and the selection of the model with a laboratory bulk, which indicates greater representation of the sample studied.

6.1.1 Model to calculate the cost of the change of construction works

After testing the mathematical relationships in the statistical analysis program (SPSS), show that the relationship represented the cost of structural change with Streptococcus cost of government projects is the equation of the third degree :

$$Y = b_0 + b_1 X + b_2 X^2 + b_3 X^3$$

Where Y: represents the cost of structural change (S. P).X: contractual cost of government projects. And provided that the value of $X \neq 0$.

Dependent	Mth	Rsq	d.f	F	Sigf	b0	b1	b2	b3
	CUB	**0.994**	**10**	**548.58**	**0**	**6587708**	**-0.189**	**2.5E-09**	**-4. E-18**

Through the compensation of those constants be the final form of the equation:

$$Y = 6587708 - 0.1895X + 2.5 * 10^{-9} X^2 - 4 * 10^{-18} X^3$$

The value of the correlation coefficient, which is equivalent (0.988) indicates a strong relationship between the function and the independent variable, and the coefficient of determination) (Rsq = 0.994) which represents the square root of the correlation coefficient), that the model represents a good representation relationship.

.Case Based Reasoning :CBR
.Artificial Neural Networks :ANN

Figure (3) representation through the occurrence of most Representative curved points to the reality of the sample under or tangent to the curve resulting from the equation provided by the program.
Where increasing value changes whenever increased contractual value (by increasing from 10 to 20%), and this is logical because of the increased complexity and overlapping processes, and thus the requirements of the project more sophisticated equipment.

6.1.2 Model to calculate the cost of the change of architectural works

the equation that represents this model is**:**

$$Y = 1220752 + 0.386X + 1.8*10^{-10}X^2 + 3*10^{-19}X^3$$

The value of the correlation coefficient (R = 0.919) which shows a very strong relationship between variable and function.

6.1.3 Model to calculate the cost of the change of mechanical works

Also the equation that represents this model is:

$$Y = 218129 + 0.0719X - 4*10^{-10}X^2 + 7.9*10^{-19}X^3$$

Where it was (Rsq = 0.928) and thus the correlation coefficient (R = 0.861).

6.1.4 Model to calculate the cost of the change of electrical works

the equation that represents this model is**:**

$$Y = 3504021 + 0.0384X - 2*10^{-10}X^2 + 7*10^{-19}X^3$$

The value of the correlation coefficient (R = 0.828).

6.1.5 Model to calculate the cost of the change of sanitation works

Similarly, after the selection of the appropriate type equation and according to the value of the correlation coefficient (R = 0.962), the equation representing the relationship between the value of the change in the sanitation work and the contractual value of government projects as follows:

$$Y = -406620 + 0.0309X - 2*10^{-10}X^2 + 4.6*10^{-19}X^3$$

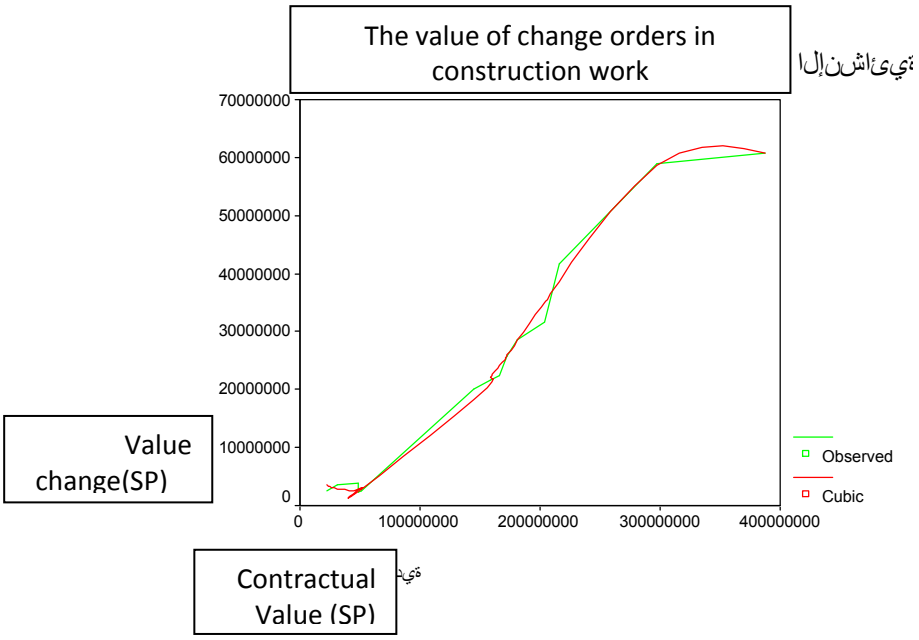

Fig. 3) the relationship between the contractual value and change orders for construction work

7. Conclusions and recommendations

7.1 Conclusions

This research was in determining the size and responsibility of each of the causes of the change clearly, and identify the party responsible for each of them, as has been to give an idea of the different effects of change orders and in particular the impact on cost and time.

Percentages were found and put them as indicators of a clear and unambiguous about the impact of the change, and as a result of the analysis of all the data relating to the change, it was found that Management (Owner + Supervisor) is the largest cause of change orders by (60%) and that the engineering office is the second cause of change orders by(40%).

The five most important reasons for the change orders are:

Poor management of the owner, Poor contract management, Replacement of materials. (Management).
Error Study (design), Error quantities (eng. Office).

The most important effects of the change orders are:

1. Delays in the time of completion of the project as: Percentage deviation in time for the period contractual and output because of change orders only (29%).
2 .An increase in the cost of the project where the cost deviation from contractual value resulting from change orders only about / 31% / of the contractual value of the projects studied.

7.2 Recommendations

Management-related recommendations:

_Mandate of sub-departments and speed up the correspondence.

_With senior management continues to manage the project through periodic reports.

_Early few the transformative expected orders, and the development of an information system for the management of change orders.

Recommendations related to engineering office:

_Truncated portion of designer fees until the end of the implementation during a certain period.

_Ensure feasibility of the solutions provided by the designer.

_Motivate learners by rewarding the owner of the most successful design solution and most capable of implementation.

8. References

[1] Fisk,E.,(1990).management of construction projects, the General Directorate of Research, Institute of Public Administration Higher, Saudi Arabia, Riyadh.

[2] Ashich, Z., S.(1996). managing the implementation of engineering projects, Riyadh, library Alabikan.(pp340).

[3] Al-Dubaisi,H,.A,.(2000): Change Orders in Construction Projects in Saudi Arabia; A Master Thesis Presented to the KING FAHD UNIVERSITY OF Petroleum & Minerals Dhahran, Saudi Arabia; pp 231-246.

[4] Nor Binti,I,.(2006): Variation Orders in Universiti Teknologi Malaysia (UTM) Construction Projects; A Master Thesis Presented to the Universiti Teknologi Malaysia; 234.

[5] Chen,J,.H,.(2007): Hybrid ANN-CBR model for disputed change orders in construction projects, Journal of Construction Engineering and Management, ASCE 17 ,pp 56–64.