Journal of Engineering and Applied Sciences 11 (7): 1532-1537, 2016
ISSN: 1816-949X

Analyzing the Change Orders Impact on Building Projects

Sonia Ahmed, Bassam Hasan, Fayez Jrad and Petr Dlask
Faculty of Civil Engineering, Czech Technical University in Prague, Prague, Czech Republic

Abstract: Many studies have tried to determine the causes and impacts of change orders on the cost and time of the project which in turn leads to differences and disputes between contractors and owners who dealt with change orders in various engineering projects. This search displayed the causes of formal change orders occurring during life cycle the building project and its most important impacts on performance of the project through its indicators. The search also showed that the owner has 60% of responsibility for the change orders and provided recommendations for each of the responsible parties (owner, designer) according to the causes coming by him. Stressing the need to monitor performance in order to manage change orders and address the causes and decreasing the impact where the time overruns caused by formal change orders is 29% and the cost overrun caused by change order is 31%. The prediction models were drafted at additional cost that may result from change orders; it showed that there is a positive relation shape between the change orders and the cost overruns. (The sample studied of projects is a random sample of buildings projects in Syria). Changes control and reduction can minimize the excess of the cost and lost time and paid the projects to better results in the future.

Key words: Building projects, change orders, overrun cost, overrun time, modeling

INTRODUCTION

The change became a key feature of construction projects and it is rare that any project is implemented according to its plan. Changes become part of the project, which creates challenges for the parties of the project.

Changes often lead to an increase in the duration and cost of the project but also it is 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. Change orders constitute one of the main causes of conflicts between owners and contractors but we have to allow the management to do it with a view to appropriate changes in the project (Hanna *et al*., 1999). In Wu *et al*. (2005) found that the contractors provided better alternative solutions that reduced the cost summation, also FIDIC contract allowed the proposal for change orders in several cases, in order to speed the completion of the work, reducing the cost to the owner or to achieve a result more efficient (Al Jamal, 2011).

Identify changes in contracts of construction projects as a written agreement between the owner and the contractor to make developments in the contract documents, these developments are either an amendment or add or any change within the scope of work specified in the contract, if necessary changes are in the contract itself, change order is the only legal means available that can change the requirements of the contract (Fisk, 1990).

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 defect or to avoid the lack (Ashich, 1996). 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 (Dubaisi *et al*., 2000), the same is repeated with the causes of the change taking place in private buildings, Malaysia University of Science and Technology (Binti, 2006). By investigating causes of variations in public construction projects in Oman, the contractor was found to be the party most benefiting from the change orders followed by the consultant and then the client (Alnuaimi, 2010). The statistical analysis of the reasons for the change orders in the public sector projects, Wu *et al*. 2005 showed that: administrative reasons accounted for 46.5% of the reasons for the change orders.

The impact of change orders: By reviewing the literature in most countries of the world and private in the field of construction projects and the reasons for the delay and

Corresponding Author: Sonia Ahmed, Department of Economic and Management, Faculty of Civil Engineering, Czech Technical University in Prague, Prague, Czech Republic

Table 1: The impact of change orders on the projects due to the literature review (researcher data, 2013)

The impact of change orders on	Researcher, country, year	The impact according to the results of searches
Delay	Odeh and Battaineh (2002). Jordan Uni, Western Michigan Uni, Assaf and Al-Hejji (2006). King Fahd University of Petroleum and Minerals, Saudi Arabia, Sambasivan and Soon (2006). Universiti Putra Malaysia Selangor, Malaysia	The first reasons for the delay are the change orders resulting from the owner during the implementation phase. Change request coming by owners caused about 10% of contractual duration. Top ten reasons for the delay have been identified and linked with the resulting effects, including: poor contract management by owner
Cost	Assaf and Al-Hejji (2006). King Fahd University of Petroleum and Minerals, Saudi Arabia; Frimpong *et al.* (2003). International Journal of Project Management; Wu *et al.* (2006). Taiwan	The first impact of the change orders is: the increase in the cost of the project, between 6-10% of the contractual value. The second reason for the increase in the cost of construction projects is the change orders from the owner. The cost summation caused by alternative solutions proposed by contractors is 16% of the total CV
Productivity	Hanna and Gunduz (2004). Turkey, USA; Assaf and Al-Hejji (2006). King Fahd University of Petroleum and Minerals, Saudi Arabia	There is difference in workers effectiveness for the projects affected by change orders and others not affected. It is very difficult to estimate the cost of labor because the change directly affects the productivity rate
Claims	Chen and Hsu (2007), AbouRizk and Dozzi (1993); J. Constr. Eng. Manag	The lack of planning for changes in the construction projects lead to additional cost and time and it causes the claims in projects. The researcher developed a computerized simulation program in order to resolve differences in the field of construction projects resulting by change orders

increase the cost and impact on the completion of the project, in addition to research Master's and doctoral theses about the change orders, their causes and their important impacts on the project, researcher was able to summarize the most important effects of the change on the construction projects in the Table 1.

MATERIALS AND METODS

Research methodology is statistical inferential analysis, through surveying 40 of the government buildings projects in Syria have been chosen randomly. With several field visits and interviews with project managers and supervisors (on the side of the owner) and the implementing engineers (on the side of the contractor) to collect the required data and recorded it in a statistical program SPSS to calculate and predict the added cost and time coming by change orders and programing the results using Visual Basic language to put it in use.

RESULTS AND DISCUSSION

Causes of change in buildings projects in syria: After completion of the archival and field study and classification the collected data, the causes of change orders was rated according to the causative party and arrange them according to the degree of recurrence as follows.

Reasons of change resulting from the owners: By reviewing the (40) projects were studied and registration the change orders and classified it in appropriate groups, the frequency of each of them shows the most important reasons which is in the following order: the defect in the owner's management includes:

- Delay of owner in answering and decision-making
- Delay of owner in commissioning in quarter regulars
- Delay of owner in receipting and delivering the location
- Weakness of owner relation with the relevant public institutions with the project
- The desire of the owner in early beginning in the implementation even before the end of the study in some cases

Contractual problems: this item appears in the following:

- Inaccurate review of the contract
- Loading the project non contractual items

Replace the materials by other with less price and same qualities:

- Cancellation and addition of items
- Change the works program
- Speed up work
- Lack of funding

Figure 1 shows the frequency ratios reasons of change resulting from the owners. The figure shows the important role of the owner management defect in the causes of the change orders and this result is coming from the calculating of both the collection data and the opinion of all parties also the engineers (supervisor) from Owner's side.The second important reason is contractual problems and this give an index that it is so necessary treating these reasons when a step of solution begins.

Reasons of change resulting from the engineering office: Reasons of change orders coming by engineering

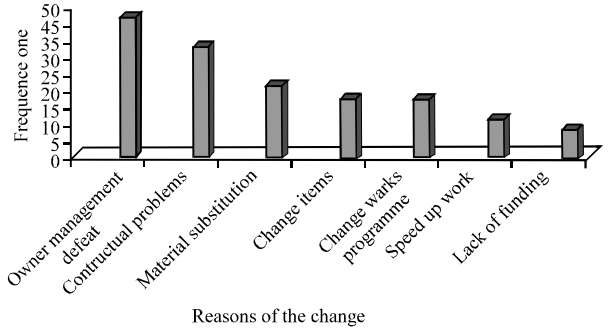

Fig. 1: The reasons of the change resulting from the owner

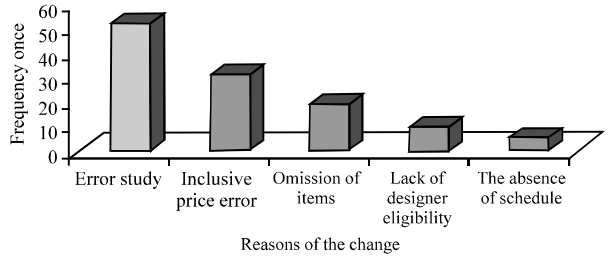

Fig. 2: Reasons for the change resulting from the designer

office (designer) can be arranged also according to its frequency as shown in Fig. 2 as follows: errors study (Initial study stage): shows within the following items:

Mismatch the charts with bills of quantities:

- The incompatibility between the various disciplines
- Lack of study of soil mechanics
- The carelessness of details of designing
- The designer does not following up work at the site

Inclusive price error:

- Increasing the amounts detected in the estimated quantities for real
- A lack of quantities: because of the short time given to the designing phase
- Omission of items
- Lack of eligibility of designer
- The absence of the schedule

The figure shows that the most important reasons are the errors in preparing the project documents (in initial study stage), so it is very necessary giving a good time for this stage and maybe must have another stage to audit preliminary study, also good relation between the different parties will give the best work.

Table 2: Contractual value and change orders value

Variables	Values
The contractual value (SP)	5,562,996,014
Change orders value (SP)	1,736,306,360
Change orders value as a percentage (%)	31
The contractual duration (day)	25,585
Changes duration (day)	8,501
Changes duration as a percentage (%)	33.2264999
Total delay (day)	25,168

Change orders have been classified due to the frequency come by every partner (owners, designers) in the projects and as a result of the calculating the frequency of the formal change orders requests, shown us that various changes and repeat the request by the owner comes primarily by 60% while the designers took second place when analyzing and calculating formal change request by 40%.

Analyze the impact of change orders: The Law No. (51) of the contract system for public entities in Syria authorized to the paymaster increase or decrease the contracted volumes (25%) of the total value of the contract and determine the rate of increase and diminishing each item or material separately (30%) per item. But the reality of experience and through the analysis of data on this aspect, show that the average percentage deviation the cost of the projects cost is more than the allowable limits. From the archival and field studies, the researcher had some information about the type of contract (traditional type), the type of projects (housing, administrative, offices and schools), the contractual value of the projects, the contractual duration of the projects, also the value and duration of the change orders. Value of change orders found in more than one level, that the researcher analyzed their effects on all the items of the projects (construction, architectural, mechanical, electrical and sewage works). Some of these results shown in Table 2. Then, he analyzed the effects of change orders on the time and cost of projects studied and was reached the following conclusions.

The impact of change orders on the duration of the project: Deviation were calculated timeline of the projects studied (the final period-contractual duration = delay), where the average deviation was 30%. Have also identified periods necessary to accomplish all the items that undergo to change and knowing the overall duration of the changes, to find the percentage of time deviation due to formal change orders only and is equal to 29%. Some delays are justification andsometimes irreversible any effect on the time of the final completion of the project and there are further delays may affect the order of

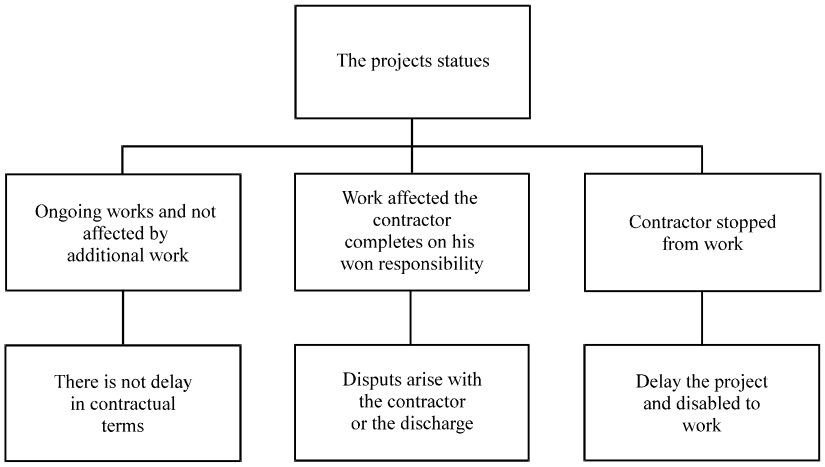

Fig. 3: The project statues due to delay

operations of the project and delay without stopping but the most serious delays that lead to shut down the entire project (Fig. 3).

The impact of change orders on the cost of the project: Calculation the author has done using excel program and the data he had from the archival and field studies, showed that the deviation in the cost from contractual costs of the studied projects (final value-contractual value) is 33% with knowledge that some projects had a deviation about 200% of contractual value. It also has been found change orders costs 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 value of formal change orders only caused increase in contractual values of projects about 31%.

Predict model in the cost of change: Several research said using administrative and engineering systems and models to be able to find a solution for the changes that you cannot predict or control its limits. The researcher managed by linking Artificial Neural Networks (ANN) and Case Based Reasoning (CBR) to provide a conceptual model to determine the potential for lawsuits resulting from change requests occurring within construction projects (Chen and Hsu, 2007). 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 planning for the projects does not linked with 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.

Model to predict the added cost by the change orders in buildings projects in Syria: Model will be offered to find the increase cost of each item of the work items in the order of their importance and priority according to their affected by the change. After testing mathematical relationships in the Statistical Program for Social Sciences (SPSS) through the correlation coefficient values, possibility value and scatter plots of all types of existing equations, are selected a 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 selection of the model with a higher correlation coefficient which indicates greater representation of the sample. Test shown that the relationship represented the cost of change with contractual cost of all item works of projects is an equation of the third degree:

$$Y = b_0 + b_1 x + b_2 x^{\wedge 2} + b_3 x^{\wedge 3} \quad (1)$$

Where:

Y = Represents the cost of structural change (SP)

X = Contractual cost of government projects. And provided that $X \neq 0$

b_0, b_1, b_2, b_3 = Constants

Researcher chose the construction works items example to illustrate how the program works because it took the first place in terms of vulnerability to the orders of the change in terms of increased cost.

Table 3: The results of data analysis in the statistical analysis program (SPSS)

Dependents	Values
Mth	CUB
R^2	0.994
df	10
F	548.58
Sig.	0
b0	6587708
b1	-0.189
b2	2.5E-09
b3	-4.0E-18

Mth: the type of the equation, in this case it is cubic; R^2: the coefficient of determination is the square root of the correlation coefficient (R); Sig. 0.005 that is mean the sample is good

Table 4: The equations and correlation coefficient for every items work.

Item work	Equation	Correlation
Architectural works	$Y= - 0.386x+1.8E-10x^2+ 3. E-19x^3$	R = 0.919
Mechanical works	$Y= + 0.07196x-4E-10x^2+ 7.9E-19x^3$	R = 0.861
Electrical works	$Y= +0.0384x-2E-10x^2+ 7. E-19x^3$	R = 0.828
Sewage works	$Y= -406620+0.0309x- 2E-10x^2 +4.6E-19x^3$	R = 0.962

Resource (researcher calculation, 2013)

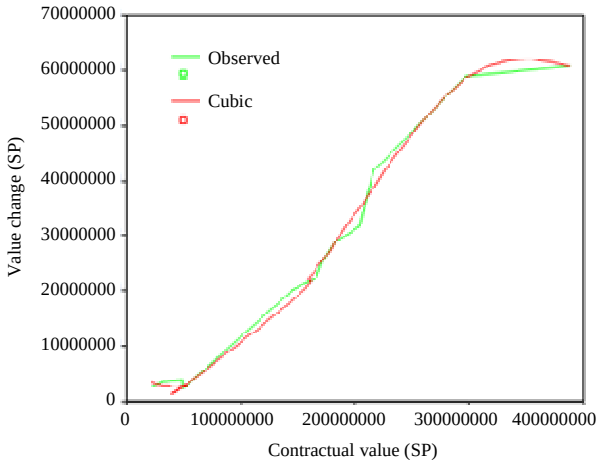

Fig. 4: The relattionship between the contractual value and change orders value

Model to predict the added cost by the change orders in construction works: After testing the mathematical relationships between x, y in the statistical analysis program (SPSS), program shows the results as appear in the Table 3. Through the compensation of those constants, the final form of the equation is:

$$Y = 6587708- 0.189x+2.5E-09x^2- 4.0E-18x^3 \quad (2)$$

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) ($R^2 = 0.994$) which represents the square root of the correlation coefficient) that the model represents a good representation relationship. Table 4 shows the equations that represents the model and correlation coefficient for every items work in the projects have been studied in this research.

Figure 4 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 10-20%) and this is logical because of the increased complexity and overlapping processes and thus the requirements of the project more sophisticated equipment.

CONCLUSION

This research determined the size and responsibility of each of the causes of the change clearly and identifies 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 owner is the largest cause of change orders by (60%) and that the designer 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, (owner) errors study, error quantities (designer).

The most important effects of the change orders are: delays in the time of completion of the project as: Percentage deviation in time for the contractual duration and output because of change orders only equal 29%. Increases 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.

RECOMMENDATIONS

Management-related recommendations:

- Mandate of sub-departments and speed up the correspondence
- Connecting with senior management to manage the project through periodic reports
- 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 the designers by rewarding the design most successful solution and most capable of implementation

REFERENCES

AbouRizk, S.M. and S.P. Dozzi, 1993. Application of computer simulation in resolving construction disputes. J. Constr. Eng. Manage., 119: 355-373.

Alnuaimi, A., R. Taha, Mohsin, A.M. and A.A. Harthi, 2010. Causes, effects, benefits and remedies of change orders on public construction projects in Oman. J. Constr. Eng. Manage., 136: 615-622.

Ashich, Z.S., 1996. Managing the Implementation of Engineering Projects. Library Al Abikan, Riyadh, Saudi Arabia, Pages: 340.

Assaf, S.A. and S. Al-Hejji, 2006. Causes of delay in large construction projects. Int. J. Project Manage., 24: 349-357.

Binti, N.I., 2006. Variation orders in Universiti Teknologi Malaysia (UTM) construction projects. Master Thesis, Universiti Teknologi Malaysia, Bahru, Malaysia.

Chen, J.H. and S.C. Hsu, 2007. Hybrid ANN-CBR model for disputed change orders in construction projects. Autom. Constr., 17: 56-64.

Dubaisi, A.H.A., 2000. Change orders in construction projects in Saudi Arabia. Master Thesis, Presented to the King Fahd University of Petroleum and Minerals Dhahran, Saudi Arabia.

Fisk, E., 1990. Management of construction projects. The General Directorate of Research Institute of Public Administration Higher, Riyadh, Saudi Arabia.

Frimpong, Y., J. Oluwoye and L. Crawford, 2003. Causes of delay and cost overruns in construction of groundwater projects in a developing countries, Ghana as a case study Int. J. Project Manage., 21: 321-326.

Hanna, A.S. and M. Gunduz, 2004. Impact of change orders on small labor-intensive projects. J. Constr. Eng. Manage., 130: 726-733.

Hanna, A.S., J.S. Russell, T.W. Gotzion and E.V. Nordheim, 1999. Impact of change orders on labor zfficiency for mechanical construction. J. Constr. Eng. Manage., 125: 176-184.

Sambasivan, M. and Y.W. Soon, 2007. Causes and effects of delays in Malaysian construction industry. Int. J. Project Manage., 25: 517-526.

Wu, C.H., T.Y. Hsieh and W.L. Cheng, 2005. Statistical analysis of causes for design change in highway construction on Taiwan. Int. J. Project Manage., 23: 554-563.