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Causes and Effects of Change Orders on Construction Projects in Kuwait

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ABSTRACT
This research investigates the change orders in public and private construction projects in Kuwait. The study in this research presents the results of a questionnaire surveying the owners, contractors and consultants on a sample comprising 385 engineers representing the construction industry. The responses to the questionnaire help in identifying the general characteristics of the construction industry in Kuwait as well as ranking the most common causes of changes, their effects on the projects and the control measures to address the changes. The results of the questionnaire indicate that the owner is the most responsible party causing changes. The study identifies that the first cause is change of plans by owner, otherwise increase in cost of the project is the first effect. All changes to design documents are checked and reviewed is the first control.
Keywords-: Causes of change order, change orders, control of change order, and effects of change order.

I. INTRODUCTION

Change orders have long been an inherent part of the construction industry. It is seldom to spot a construction project being executed without a change which normally arises as a result of some causes attributed to the different parties involved in the project execution. Upon acknowledging its existence, the change – or variation is formally regularized by the issuance of a change order which is a document describing the scope of the change and its impact on both cost and / or time. If no agreement is reached between the parties of the project on the change, it turns into a claim or dispute that may negatively affect the execution of the project and curtail its chances of successful completion. A number of researchers gave several definitions to be change order. It is work that added to or deleted from the original scope of work of a contract which alters the original contract amount or completion date(Zawawi, et al. 2010, [1]).

Osman et al. (2009) [2] defined the change as any deviation from an agreed upon well-defined scope and schedule. The words "Change Order" conjure strong feelings of negativity for all involved in construction projects.Owners do not like them because they generally feel they are paying for other's mistakes. In some cases, contractors believe that Change Orders disrupt workflow and require additional paperwork and time. In other cases, contractors would find the change orders a mean to improve their outcome of the project. However, it is generally accepted that consultants, contractors and owners agree that projects would be better without change orders.

Change Orders strain the relationships of the owners, engineer, contractors, subcontractors, and others involved in the construction process as well as add cost and schedule delay. Changes on one project can also affect other unrelated projects by tying up resources that are committed elsewhere. Negative relationships between the parties are another by-product of changes on a project. Not only is workflow disrupted, but also trying to get quick responses quotes, shop drawings, and many other things required to get back schedule causes a strain on working relationships (Rashid, et al. 2012, [3]). Homaid et al. (2009), [4] investigated 21 causes and 11 potential impacts of change orders. Also, nine practices reported to management and control of change orders. The study identified eleven important causes and seven important impacts. It is further concluded that the consultant is the most responsible party for the change orders. The overall average increase in total cost of construction projects due to change orders was found to be 11.3%. The research concluded that change of project scope due to owner requirements is the most important cause and cost overruns are the most important impacts of change orders in those projects.

According to Aljeshi and Almarzouq (2008) [5], Aldubaisi (2000) [6] and Zawawi (2010) [1], changing the plans by the owners is the main source of change orders, change in mind, substituting materials and/or procedures is the second source of change orders and errors and omissions in design is another source. Increase in project cost and duration were founded as the main two effects of change orders.In another study it was concluded that the best way to manage change orders is to reach a negotiated

solution between the different parties. The initiation of change orders in a construction project correlated with the level of integration of the services of design and construction (Soares 2012) [7].

Keane (2012) [8] used a questionnaire survey to identify causes and effects of variations on construction projects and make suggestions on how variation can be avoided or minimized on future projects. Jawad (2009) [9] presented causes, effect, and controls of variation orders in large building construction. The study concluded that the owner is the major source of variation and that most variation is civil and structural. Statistical analysis of causes for design change in highway construction on Taiwan studied by Wu (2005) [10]. Olsen (2012) [11] reviewed the most common causes of change orders to uncover which divisions of work are most susceptible to the greatest number of changes orders. It is found that design errors were responsible for the majority of changes.

The main sources of change orders in Kuwaiti building construction were investigated by Bassioni and Hamza (2005) [12]. They found that owners are responsible for 47% of change orders, A/E for 26% and contractor 12%. The study showed that the sources weredesign changes -owner 38%, design mistakes and error-A/E 24%, problems on site-contractor 12% and changes by regulatory agencies 12%.Wambek (2011) [13] examined the similarities and differences between craft workers, foremen, and project managers in terms of starting time and task duration variation. He summarized the causes of variation, which account for a total of over 19 hours of variation per week. Variation in public construction projects in Oman was discussed by Alnuaimi (2010) [14].Arain and Pheng (2005) [15] provided an in- depth analysis of the potential effect of variations in building projects. The significance of variation as a cause of cost and time overruns explored by Oladapo (2007) [16]. The study showed that changes in specification and scope initiated mostly by project owners and their consultants are the most sources of variation.

Osman (2009) [2] performed a comprehensive analysis of the potential effects of variation orders in construction projects in Malaysia. The study summarized that the five most effects of variations are: increase in project cost, additional payment for the contractor, and increase in overhead expenses, completion schedule delay, rework and demolition.

Even though the majority of the construction projects are owned by government, there is a major difficulty in obtaining such data on the change orders considering the rules and regulations applied within the government entities. Further, although the execution of all projects – public and private – is conducted by private sector, the release of data with regard to the change orders is also faced with issues of confidentiality considering the high competition in market. having identified such a serious lack in the data of the change orders, it was then decided to survey the personnel involved in the construction industry representing the three major parties; owners, consultants and contractors. The purpose of the survey is to explore the personal experience of those individuals with regard to the change orders to identify the causes, effects and the measures of controls. In the following sections, the contents of the questionnaire and the scoring system are presented, followed by analysis of the data to identify the most common causes, effects and controls of change orders.

II. DATA COLLECTION

Data were gathered through a questionnaire and owners, contractors and consultants were further requested to answer questions pertaining to their experience in the construction industry and their opinions about change orders. Accordingly, the data are collected using the 129 questionnaire from engineers working in government entities represented owner, 128 engineers in contractors companies and 128 questionaaire from engineers working in consultant offices.

The questionnaire is divided into four sections. Section one is related to information on the Respondent, section two includes twenty causes of change orders, section three lists twelve effects of change orders and section four suggested thirteen control measures to minimize the impact of change orders on the projects. See Table 1 for all the elements above. All the elements of causes, effects and controls were selected from the previous studiesbeing the most important.

No.	Causes of change orders
1	Change of plans by owner
2	Errors and omission in design (main element)
3	Change in material
4	Poor design ,poor working drawing details (secondary element)
5	Problems on Site
6	Technology changes (if time between design and construction is long)
7	Owner's change of schedule
8	Change of project scope by owner (additional – enhancement)
9	The scope of work for the contractor is not well defined
10	Value engineering (study the required elements which practiced in a simple and unorganized way to save cost)
11	Poor planning by contractor
12	Change in procedures
13	Change in design by consultant
14	New government regulation
15	Conflict between contract documents
16	Weather conditions
17	The required equipment and tools are not available
18	The required labor skills are not available
19	Safety consideration
20	Owner's financial problems
No.	**Effects of change orders**
1	Increase the cost of the projects
2	Increase in duration of individual activities
3	Delay in completion schedule
4	Delay in payment
5	Demolition and re – work
6	Decrease in productivity of workers
7	Increase in overhead expenses
8	Decrease in quality of work
9	Delay of materials and tools
10	Disputes between owners and contractor
11	Hold on work in other areas
12	Additional money for contractor
No.	**Controls of change orders**
1	Change order is negotiated by knowledgeable persons
2	Contract document are checked and reviewed
3	The procedures for handling change orders are clear from the beginning
4	The scope of change orders is made clear
5	Pricing of change orders considers indirect effects
6	Freeze the design after a certain stage
7	Changes are not made without appropriate approval in writing
8	Reviewed for design before change approval
9	Gray areas of contract documents are highlighted and reviewed before contract award
10	Encourage team effort among all parties
11	Areas of concern (monthly reports and meetings)
12	Use of WBS (Work Breakdown Structure)
13	Justification of change

2.1 STATISTIC TEASING

The sections use an ordinal scale. This scale is transformed into an interval scale by assigning a weight to each interval. So, if we think of intervals from (never) to (very often) as an interval scale from zero to four, we can achieve this transformation which will enable us to conduct the required parametric statistics.

Sections two, three, and four on causes, effects, and controls respectively will be scored as follow to come up with an index to indicate its importance: (Very often) equals to number (4), (Often) equals to number (3), (Sometimes) equals to number (2), (Seldom) equals to number (1) and (Never) equals to number (0). X_1: Number of respondents answering (Very often), X_2: Number of respondents answering (Often), X_3: Number of respondents answering (Sometimes), X_4: Number of respondents answering (Seldom) and X_5: Number of respondents answering (Never). The evaluation of each element is conducted considering the weightage average of the responses. The Importance index (II) is used to get the weightage average to rank the causes, effects and control measures. The basis of calculating Importance Index is the same as follows:Zaneldin (2006) [17], calculated the Importance Index of each cause as follows:

$$Importance\ Index = Weighted\ Average\ x\ \frac{100}{4} \quad \text{Eq. (1)}$$

$$Weighted\ Average = \frac{\sum Wi\ x\ Xi}{N}, \quad \text{Eq. (2)}$$

Where $W_i$the weight is assigned to the*ith*option of cause;X_i is the number of respondents who selected the*ith*option of cause; and*N*is the total number of respondents. To better understand the Importance Index percentage is calculated as follows:

$$\text{Importance Index} = \frac{4\,(x1) + 3\,(x2) + 2\,(x3) + 1\,(x4) + 0\,(x5)}{x1 + x2 + x3 + x4 + x5} \times \frac{100}{4} \qquad \text{Eq. (3)}$$

Similarly, the Importance Index of each effect and control respectively will be calculated.

2.2 HYPOTHESIS TEASING

Hypothesis testing was used to compare the means from two or more groups to determine if they were significantly different. The degree of significance between the contractors, consultants and owners on the causes, effects, and controls of change orders are examined. To do this, the One-Way ANOVA test is used and the analysis is done on the mean values of causes, effects, and controls. Numbers of causes, effects, and controls indicated on Figures 13 to 15 refer to their order as they appear in the questionnaire forms. Two hypotheses were developed.

The null hypothesis (Ho) was that the means of the three subsets were equal (not significant difference), the responded had agreement opinion on causes, effects or controls of change orders. This was compared to the alternative hypothesis (Ha), which states that the means of the three subsets were unequal (significant difference), reject the hypothesis (Ho) that the responded had disagreement opinion on causes, effects or controls of change orders.

A test statistic, One-Way ANOVA, was calculated to determine if the Ho should be rejected in favor of the Ha. The test statistic determines the p-value. The p-value is the probability of seeing the observed test statistic, or a more extreme value, assuming that the null hypothesis is true. For example, p-value is less than 0.05 would indicate that the Ho reject (significant difference). The p-value is compared to a predetermined significance level to determine whether the null hypothesis should be rejected in favor of the alternative hypothesis. It is common in research of this type to set the significance level at 0.05. This represents a 5% probability that the Ho will be rejected when it is actually true (Hanna et al. 2002) [18].

Figure 1 shows a similarity opinion in some change orders causes between owners, contractors and consultants. “Change of project scope by owner” is the first important cause with 89.6% agreement. The results also indicate that ‘‘owner’s change of schedule’’ was ranked second with 76.6% agreement while ‘‘technology changes’’ was ranked third with 29.8% agreement. ‘‘Weather conditions’’ cause of change orders was ranked fourth with 28.7% agreement. “Safety consideration” was ranked fifth with26.2% agreement. “The required labor skills are not available” cause of change orders was ranked sixth with 19.5% agreement. The results also indicate that ‘‘change in material’’ was ranked seventh with 18.1% agreement while ‘‘value engineering’’ was ranked last with 15% agreement.

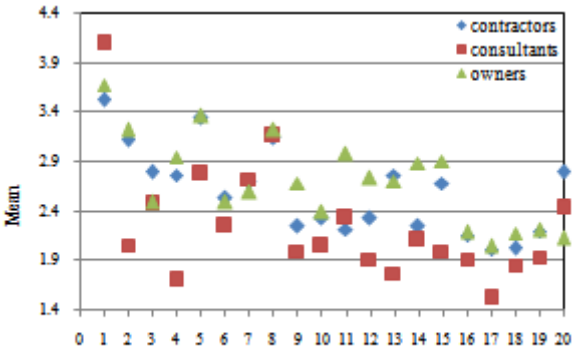

Figure 1: Contractors, Consultants and Owners significant different on causes

The similarity opinion in some change orders effects between respondents shows in Figure 2. Similar results were: “decrease in quality of work” which is ranked first with68.6% agreement. The results also indicate that ‘‘hold on work in other areas’’ was ranked second with 28.7% agreement while ‘‘additional money for contractor’’ was ranked third with 28.1% agreement. ‘‘Decrease in productivity of workers’’ effect of change orders was ranked fourth with 11.8% agreement. “Delay in payment” was ranked the last with9.2% agreement.

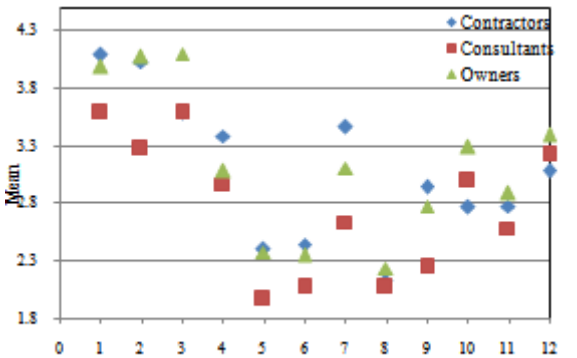

Figure 2: Contractors, Consultants and Owners significant different on Effects

Finally, in Figure 3 the respondents agree in their opinion to a large extent on the controls of change orders adopted. This is contrary to the common perception that respondents would not agree. The

normally adversarial relation did not affect their evaluation of the problem.

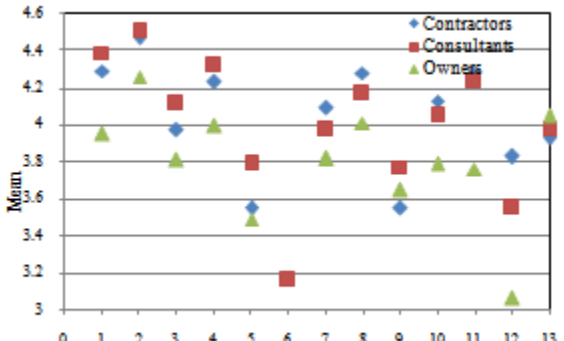

Figure 3: contractors, Consultants and Owners significant different on controls

The correlation results show that there are significant positive relationships between parties of participants (owner, consultant, and contractor) which reveal that the respondents perceptions on the items of the three groups of variables (change orders causes, effects, and controls) are highly reliable and dependable and hence generalizations of the results are acceptable.

III. RESULTS AND FINDING

The results show on average a cost overrun due to changes in the order of 6 to 10% of the contract value. The schedule overrun was shown to be in the range of 10 to 20%. The general section of the questionnaire indicated that the majority of the changes arise from the civil discipline more than 50% of the responses indicated civil discipline.

3.1 Causes of change orders

Figure 4 shows the results of responses of owners on the twenty cause items of change orders. Out of the twenty cause items listed in the questionnaire, the five most common causes of change orders from owner's point of view are: Change of plans by owner, problems on site,errors and omission in design (main element), Change of project scope by owner (additional-enhancement), and New government regulation.

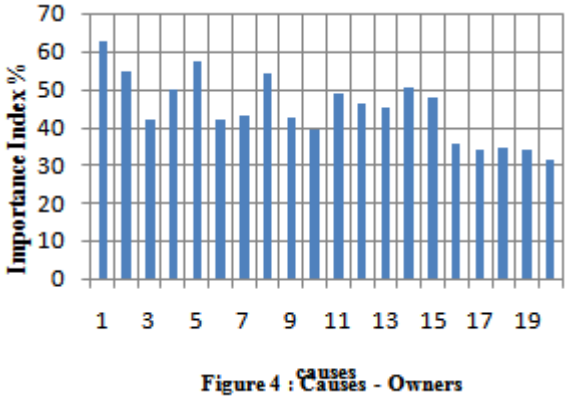

Figure 4 : Causes - Owners

Similarly, the responses from contractors are shown in Figure 5 with the most common causes as follow:Change of plans by owner, Problems on Site, Change of project scope byowner (additional-enhancement), Errors and omission in design (main element), and Change in material.

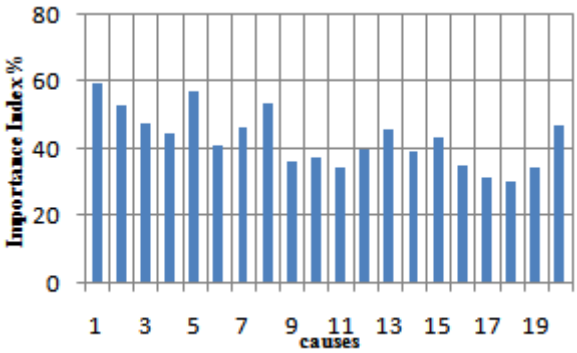

Figure 5 : Causes - Contractors

Figure 6 shows the responses of consultants with the five most causes of change orders as:Change of plans by owner, Change of project scope byOwner (additional-enhancement), Owner's change of schedule, Problems on Site, and Change in material.

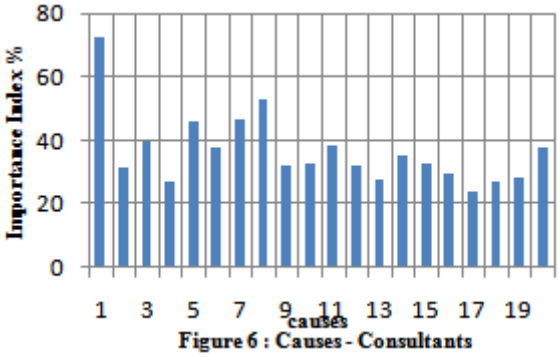

Figure 6 : Causes - Consultants

Figure 7 show, the results of the survey for owners, contractors and consultants. The overall ranking of the top five causes of change orders among all government, contractors and consultants is as follows: Change of plans by owner, Change of project scope by owner(additional-enhancement), Problems on Site, Errors and omission in design (main element), and Owner's change of schedule.

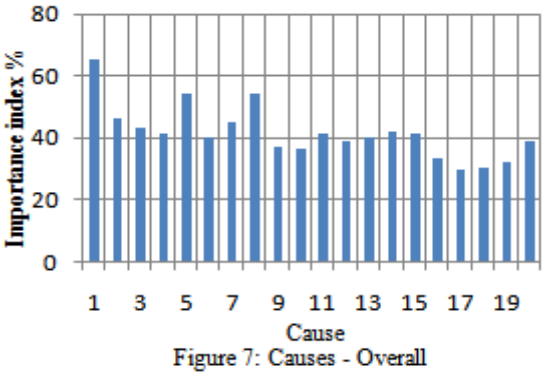

Figure 7: Causes - Overall

3.2 Effects of change orders

Figure 8 summarizes the results of owners in the survey on the effects of change orders. From owner's point of view, the top five effects of change orders listed as: Delay in completion schedule, Increase in duration (of individual activities), Increase in cost of the project, Additional money for contractor, and Disputes between owners and contractor.

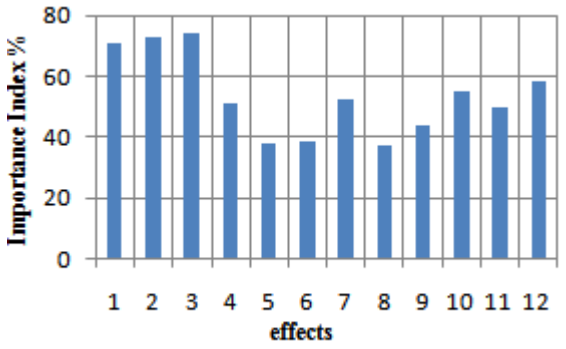

Figure 8 : Effects - Owners

The most five effects from contractor's point of view as shown in Figure 9 are:Increase in cost of the project, Increase in duration (of individual activities), Delay in completion schedule, Delay in payment, and Increase in overhead expenses.

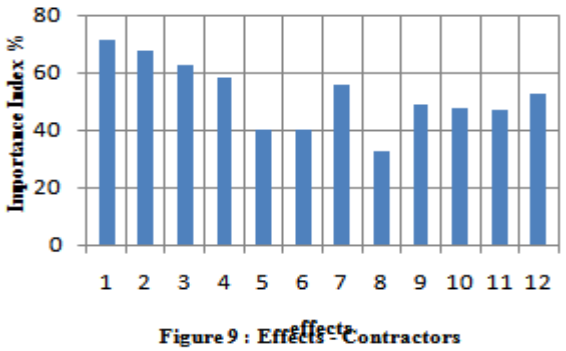

Figure 9 : Effects - Contractors

Figure 10 shows the similar results of consultants with the five most effects as: Increase in cost of the project, Delay in completion schedule, Additional money for contractor, Increase in duration (of individual activities), and Disputes between owners and contractor.

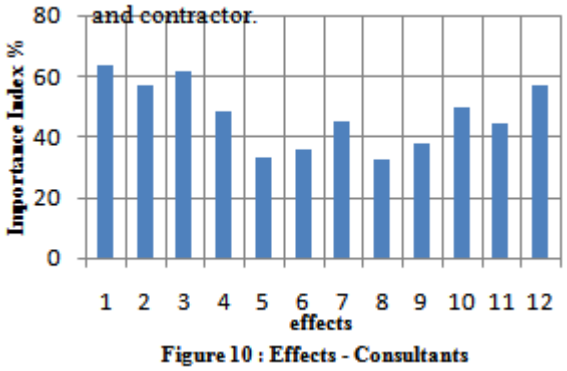

Figure 10 : Effects - Consultants

Figure 11 shows the overall results of effects with the most five effects as follows: Increase in cost of the project, Delay in completion schedule, Increase in duration (of individual activities), Additional money for contractor, and Delay in payment.

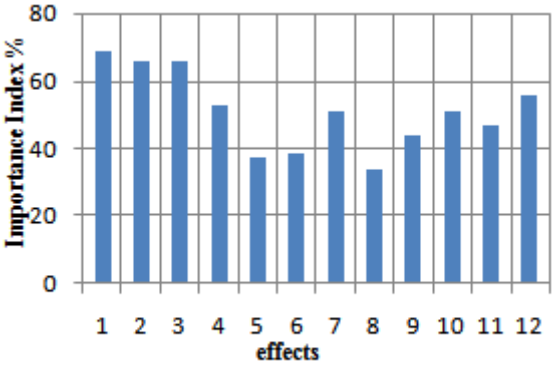

Figure 11 : Effects - Overall

3.3 Controls of change orders:

Figure 12shows the results of owners on the thirteen controls items of change orders. Out of them, the five most controls to minimize their impacts:Contract document are checked and reviewed, Reviewed for design before change approval, Justification of change, The scope of change orders ismade clear, and Changes are not made withoutappropriate approval in writing.

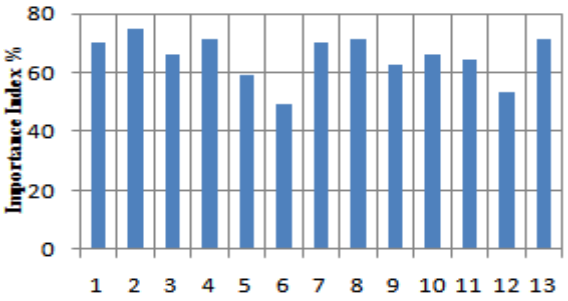

Figure 12 : Controls - Owners

The most five important controls from contractor's the point view as show in Figure 13 are:Contract document are checked and reviewed, Change order is negotiated by knowledgeable persons, Reviewed for design before change approval, Changes are not made without appropriate approval in writing, and Areas of concern (monthly reports and meetings).

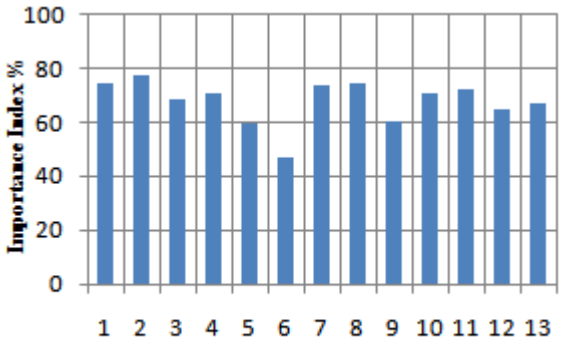

Figure 13 : Controls - Contractors

Similarly, the responses from consultants are shown in Figure 14 with the five most controls as follow:Contract document are checked and reviewed, Change order is negotiated by knowledgeable persons, The scope of change orders is made clear, Reviewed for design before change approval, and The procedures for handlingchange orders are clear from thebeginning.

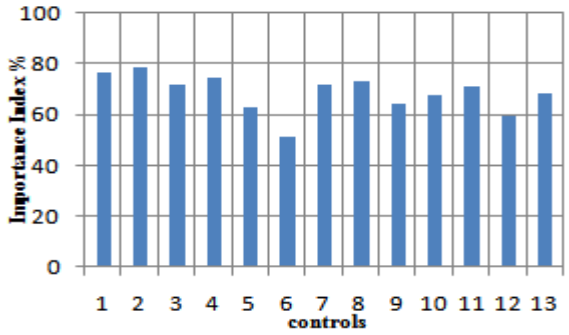

Figure 14 : Controls - Consultants

Figure 15 shows the results of the survey for responses and the top five controls of change order among all responses is as follows: Contract document are checked and reviewed, change order is negotiated byknowledgeable persons, Reviewed for design beforeChange approval, the scope of change orders is made clear., and changes are not made without appropriate approval in writing. /Areas of concern (monthly report).

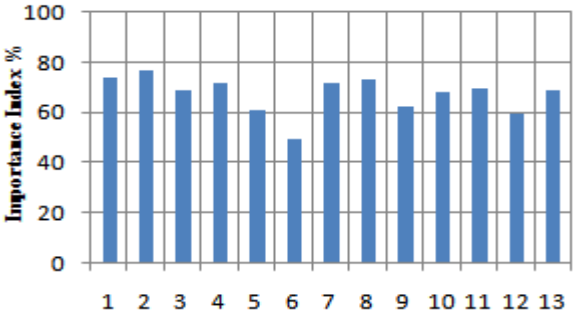

Figure 15 : Controls - Overall

IV. CONCLUSION

This research investigated the change orders in construction projects in Kuwait by conducting a field survey to identify the major causes of change orders, their effects on projects and controls measures. The hypothesis testing was carried out to verify the agreements between the means of the responses from the owner, consultants and contractors. The mostfive common causes of change orders can be identified as: change of plans by owner,change of project scope by owner (additional-enhancement), problems on site,errors and omission in design (main element), poor design and poor working drawing details (secondary element). The most five common effects of change order are increasing the project's cost, increasing the duration of individual activities, delaying in completion schedule, additional money for contractor, and delaying in payment. Finally, the most six common control measures are: checking and reviewing the contract documents, reviewing design before change approval, the change order must be negotiated by knowledgeable persons, the scope of change orders must be clearly made, appropriate approval in writing must be handed, and the good tools to control the occurrence of change including the areas of concern in monthly reports and meetings.

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