Variation Orders and Their Effects of Erbil Governorate Projects

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ABSTRACT

Variation order plays an important role in calculating the final cost and time. The paper aims to determine the causes of variation orders in projects performed between 2007-2014 in Erbil governorate projects. Data was collected from contract documents. Performed in the Erbil governorate projects from 2007-2014. The study seeks to identify the most significant causes of delays by assessing the common causes of delays in terms of frequency, severity and important indices of owners, consultants and contractors related to the implementation of public construction projects in Erbil Governorate. The data acquired from the questionnaire given to the engineers involved in executing of these projects and 73 forms were returned. The results showed that the ranking of overall causes of variation order from highest to lowest was "Contractor's financial difficulties", "Change of plans or scope by owner", "The required labor skill are not available", "Differing site conditions", "Owner's financial problems", "Design change originated by owner", "Errors and omissions in design", "The required equipment and tools are not available", "Inadequate working drawing details", and "Change in design by the engineer or consultant". The source of "Errors and omissions in design", "Inadequate working drawing details", and "Change in design by the engineer or consultant" is consultant.

Keywords: construction; variation order; overruns; owner; contractor; consultant

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Peer review under the responsibility of University of Baghdad.
https://doi.org/10.31026/j.eng.2021.05.06
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Article received: 4/11/2020
Article accepted: 3/1/2021
Article published:1/5/2021
INTRODUCTION

Variation order Definition

It is actually rare for a construction project to be completed without changes being made. The standard construction contract contains a provision authorizing the owner or owner representative to order changes or modification to the project within the general scope of the contract. A change (variation) order is referred to as the document directing such changes (Nunnally, 2007). Mokbel (Mokbel, 2003) defined the variation (change) order as: "an action that specifies and justifies a change to the scope of a construction contract that alters the original time of completion of the total project cost, or both" (Cited by Enshassi et al. 2010).

Variations in Iraqi Conditions of Contract for Civil Engineering Works

The REPUBLIC OF IRAQ, MINISTRY OF CONSTRUCTING AND HOUSING, (2010) and the REPUBLIC OF IRAQ, MINISTRY OF PLANNING, LEGAL DEPARTMENT (1987) authorize the engineer to make a variation in works as follows:

1. Increase or decrease the quantity of any work included in the contract.
2. Omit any part of the work.
3. Change the character or quality or kind of any of the works.
4. Change the levels, lines, position, and dimensions of any part of the work, and
5. Execute additional work of any kind necessary for the completion of the works.

Types of Variation Orders

Variation orders are of different types based on benefit and detrimental or directed and constructive (nature) (Sherif, 2016).

Beneficial Variation Orders

Beneficial variation orders are issued for reducing the cost, time, or project difficulty. These variation orders lead to remove the extra costs and raise the benefits of the owner (Ndihokubwayo and Haup, 2009).

Detrimental Variation Orders

Detrimental variation orders that negatively affect the value of the owner or his performance. Due to financial difficulty, the owner may sacrifice the quality of the work(s) (Enshassi, et al., 2010).
**Directed Variation Order**

The owner directs the contractor to perform work that varies from that defined in the contract or is an addition to the stated work that specified in the contract. In keeping with the relevant clauses in the contract, guided variations are typically given. This form can also be deductive in nature. The scope of the work could, for example, be reduced from the original scope of the work specified in the contract. After the owner's order, the contractor will determine the works needed and agree with the owner on the works (A-Dubaisi, 2000).

**Construction Variation Order**

Due to an informal approving act or guiding a change by an act or failure to act as per contract, this type of variation is provided. In this case, the contractor will conduct various works other than those specified in the contract, increasing the contractor's costs and/or time of performance, which must be treated as a variation order (Sherif, 2016; Klee, 2015).

**Impacts of Variation Orders**

The impact of variation of orders is mostly an increase in the project's cost (i.e., cost overruns), delay in delivery of the project (or time overrun), delay in payment, quality degradation, etc. Later details of these impacts will be covered in some previous research works. Out of 81 projects, the data of 72 projects (about 90%) are obtained.

**2. LITERATURE REVIEW**

**Causes of Variation Orders**

The occurrence of variation orders in the construction industry is a regular trend all over the world. They are the major problems in construction projects. Many research papers were conducted locally and abroad. (Agele and Al-Hassan, 2009) studied the reasons for cost deviation in Iraqi construction projects. They concluded that the major causes are: the inability of the company to meet project requirements, inadequate planning, inaccurate estimation of the cost, delayed cash flows by owners, inefficient executive manager of the project, lack of control by the time of the project or predict the date of its end, the negative impact of the population in the project area, multiple sources of the decision and the overlap of powers, poor performance of the contractor. (Mustafa and AL Hariri, 2015) studied the causes of variation in a Syrian project. They showed that the owner or the engineer supervising the project is the party who is responsible for change orders in the project. The ten most important causes of variation of highway projects studied by (Msallam, et al., 2015) are change of schedule, ambiguous design details, change of plan or scope, the conflict between contract documents, lack of coordination, safety considerations, client financial problem, change in design by the consultant, socio-cultural factors, and change in government regulations. (Alaryan, et al., 2014) identified the causes and effects of variation orders on construction projects in Kuwait. The first cause was the change of plans by the owner, and the increase in cost was the first effect. Otherwise an increase in the cost of the project is the first effect. (Enshassi et al., 2010) identified the ten top causes of variation orders in Ghazza projects are: lack of materials and equipment spare parts due to closure, change in design by the consultant, lack of consultant's knowledge of available materials, errors and omission in design, conflicts between contract documents, owners financial problems, lack of coordination among project parties, using the inadequate specification for local markets by international consultant, internal politics, and change
in specification by owners. In South Africa, (Ndihokwubwayo and Haupt, 2009) found that the most predominant origin agent of variation orders resulted from unclear briefing and changing requirements.

In another study (Memon, et al., 2014), most variation order causes in Malaysia's JKR projects are unavailability of equipment, poor workmanship, and design complexity. The most significant VO effects on the projects are increased project cost, delay in completion, and logistic delays. (Mohammad, et al., 2010) studied the causes of variation. They concluded that the three most significant cause variation orders are: 'Change of plan by owner', 'Substitution of materials by owner', and 'Changes of design by consultant'. (Staiti, et al., 2016) studied the main causes of change orders of construction projects in West Bank to highlight change order management's potential effects on the Palestinian Industrial construction. The main source of the causes was the owner due to financial problems, changes in mind, or non-compliant design with the owner's requirement. The second main cause was Consultant wrongs and canceling in design, specifications, and contract documents clashing.

In roadway construction projects, (Ismail, et al., 2012) studied the causes and effects of variation orders. The most causes of variation orders were: the change in scope by the owner, errors, and omissions in design, and site condition changing. Also, the financial difficulties of contractors are the critical factors causing variation orders. The study in a mega hydropower project in Pakistan (Hanif, et al., 2016) showed that the error and omissions in design, change in scope, and change in design were among the three causes of variation orders. In Oman, a study was conducted on the change orders and effects on public construction projects (Al-Nuaiml, et al., 2010). It was found that the most frequent causes are the clients' additional works and design modification. The second, later cause was due to the nonavailability of manuals and procedures. (Sherif, 2016) showed that the three significant causes of change orders for the repetitive residential units in Egypt are change of plans or scope by the owner, change of schedule sequence by owner, and change in specifications by owner. Table 1. illustrates the summarized causes of variation orders referred to previously.

(Mohammad N., et al., 2017) studied the causes and effects of change orders in the Construction of Terrace Housing Project in Malaysia revealed four most significant causes variation orders which are: 'Change of scope by owner', 'Substitution of materials by owner', 'Changes of specification by owner' and 'Changes of design by consultant'. Meanwhile, the effects of the variation orders are time and cost overrun. The finding concludes that the owner is the major source of the variation orders in construction of building projects and suggested that the owner should have adequate planning and recourses before initiating a project to avoid variation order during the construction stage. (Varghese and Xavier 2018) found that there were two main causes for change orders in construction sites by owner and financial problems while the effects of change orders were cost overrun and increase in project duration. The cost and time effect of variation orders in the Sulaimani Govenotate projects performed between 2007 and 2012 was assessed by (Muhamad et al., 2020).

With an average of 16 percent cost overruns, more than 95 percent of the projects surveyed were affected with an average of 16 percent cost overruns and more than 98 percent of the projects were affected with time overruns of more than 40 percent.
| Causes                                                                 | Authors                                                                 |
|----------------------------------------------------------------------|-------------------------------------------------------------------------|
| Inability of the company to meet project requirements                | Agele and Al-Hassan (2016)                                              |
| Inadequate planning                                                  | Mustafa and AL Hariri (2015)                                            |
| Inaccurate estimation of the cost                                    | Msallam et al. (2015)                                                  |
| Delayed cash flows by owners                                          | Alaryan et al. (2014)                                                  |
| Inefficient executive manager of project                             | Enshassi et al. (2010)                                                 |
| Lack of control to the time of the project or predict the date of its end | Ndihokubwayo and Haupt (2009)                                          |
| Predict the date of its end                                           | Memon et al. (2014)                                                    |
| Owner                                                                | Mohamm ad et al. (2010)                                                |
| Engineer supervising                                                  | Statti et al. (2016)                                                   |
| Schedule (Time)                                                      | Ismail et al (2012)                                                   |
| Ambiguous design details                                             | Hanif et al (2016)                                                    |
| Change of plan or scope                                              | Nuaiml et al. (2010)                                                  |
| The conflict between contract documents                              | Sherif (2016)                                                         |
| Lack of coordination                                                 | Iraq                                                                    |
| Safety considerations                                                | Syrian                                                                  |
| Clientfinancial problem                                              | Jordon                                                                 |
| Change in design by consultant                                       | Kuwait                                                                  |
| Socio-cultural factors                                               | Gaza Strip-Palestine                                                  |
| Change in government regulations                                     | South Africa                                                           |
|                                                                     | Malaysia                                                               |
|                                                                     | South Africa                                                           |
|                                                                     | Malaysia                                                               |
|                                                                     | Malaysia                                                               |
|                                                                     | West Bank Palestine                                                   |
|                                                                     | Iran                                                                   |
|                                                                     | Pakistan                                                               |
|                                                                     | Oman                                                                   |
|                                                                     | Egypt                                                                  |
### Table 1. Summary of Studies in Review

| Causes                                                                 | Authors                                                                 |
|------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Lack of materials and equipment, spare parts due to closure            | Agele and Al-Hassan (2016)                                              |
|                                                                        | Mustafa and AL Hariri (2015)                                            |
|                                                                        | Msullam et al. (2015)                                                  |
|                                                                        | Alaryan et al. (2014)                                                  |
|                                                                        | Enshassi et al. (2010)                                                 |
|                                                                        | Ndhokubwayo and Haupt (2009)                                           |
|                                                                        | Memon et al. (2014)                                                   |
|                                                                        | Mohamm ad et al. (2010)                                                |
|                                                                        | Statti et al. (2016)                                                   |
|                                                                        | Ismail et al (2012)                                                    |
|                                                                        | Hanif et al (2016)                                                     |
|                                                                        | Nuaml et al. (2010)                                                    |
|                                                                        | Sherif (2016)                                                          |
|                                                                        | Iraq                      | Syrian                  | Jordon                  | Kuwait                     | Gaza | Strip-Palestine | South Africa | Malaysia | Malaysia | West Bank | Palestine | Iran       | Pakistan | Oman     | Egypt    |
| Errors and omission in design                                          | √                                                                       |
| Owner's financial problems                                              | √                                                                       |
| Using inadequate specification for local markets by international consultant | √                                                                       |
| Internal politics                                                      | √                                                                       |
| Change in specification by owner/or consultant                          | √                                                                       |
| Unclear briefing and changing requirements                             | √                                                                       |
| Poor workmanship and design complexity                                  | √                                                                       |
| Substitution of materials by owner                                     | √                                                                       |
| Owner due to financial problems                                         | √                                                                       |
| Client's additional works                                               | √                                                                       |
| Design modification                                                     | √                                                                       |
| No availability of manuals and procedures                               | √                                                                       |
| Financial problems                                                      | √                                                                       |
| Safety considerations                                                   | √                                                                       |
| Client financial problem                                                | √                                                                       |
| Change in design by consultant                                          | √                                                                       |
| Socio-cultural factors                                                  | √                                                                       |
Table 1. Summary of Studies in Review

| Causes                                                                 | Authors                                                                 | Authors                                                                 |
|-----------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Change in government regulations                                      | Agele and Al-Hassan (2016)                                              | Enshassi et al. (2010)                                                 |
|                                                                        | Mustafa and AL Hariri (2015)                                            | Ndihokubwayo and Haupt (2009)                                          |
|                                                                        | Msallam et al. (2014)                                                  | Memon et al. (2014)                                                   |
|                                                                        | Alaryan et al. (2014)                                                  | Mohamm ad et al. (2010)                                               |
|                                                                        |                                                                        | Statti et al. (2016)                                                  |
|                                                                        |                                                                        | Ismail et al (2012)                                                   |
|                                                                        |                                                                        | Hanif et al (2016)                                                    |
|                                                                        |                                                                        | Nuaiml et al. (2010)                                                  |
|                                                                        |                                                                        | Sherif (2016)                                                        |
| Iraq                                                                  | Syrian                                                                  | Kuwait                                                                  |
| Jordon                                                                | Gaza Strip-Palestine                                                   | South Africa                                                           |
| Kuwait                                                                 |                                                                        | Malaysia                                                               |
|                                                                        |                                                                        | Malaysia                                                               |
|                                                                        |                                                                        | West Bank Palestine                                                   |
|                                                                        |                                                                        | Iran                                                                   |
|                                                                        |                                                                        | Pakistan                                                              |
|                                                                        |                                                                        | Oman                                                                  |
|                                                                        |                                                                        | Egypt                                                                  |
| Lack of materials and equipment, spare parts due to closure            | √                                                                       |                                                                        |
|                                                                        |                                                                        |                                                                        |
| Lack of consultant's knowledge of available materials                  |                                                                        |                                                                        |
|                                                                        |                                                                        |                                                                        |
| Errors and omission in design                                          | √                                                                       | √                                                                      |
|                                                                        |                                                                        | √                                                                      |
| Owner's financial problems                                             |                                                                        |                                                                        |
|                                                                        |                                                                        | √                                                                      |
| Using inadequate specification for local markets by international consultant |                                                                        |                                                                        |
|                                                                        |                                                                        | √                                                                      |
| Internal politics                                                      |                                                                        |                                                                        |
|                                                                        | √                                                                       |                                                                        |
| Change in specification by owner for consultant                       | √                                                                       | √                                                                      |
|                                                                        |                                                                        |                                                                        |
| Unclear briefing and changing requirements                             |                                                                        | √                                                                      |
| Poor workmanship and design complexity                                 |                                                                        |                                                                        |
|                                                                        | √                                                                       |                                                                        |
| Substitution of materials by owner                                     |                                                                        |                                                                        |
|                                                                        | √                                                                       |                                                                        |
| Owner due to financial problems                                        |                                                                        |                                                                        |
|                                                                        | √                                                                       |                                                                        |
| Client's additional works                                              |                                                                        |                                                                        |
| Design modification                                                    |                                                                        | √                                                                      |
| No availability of manuals and procedures                             |                                                                        | √                                                                      |
| and site condition changing                                            |                                                                        | √                                                                      |
3. RESEARCH METHODOLOGY

The data collection is conducted in two phases. The first step consisted of literature reviews similar to previous studies of local and international countries through papers, conference proceedings, the internet, and international project management journals. The purpose of reviewing is to get information on the causes of variation orders likely to be occurring in our region. The second phase involved developing the questionnaire that provides a list of 26 causes of variance orders found in construction projects. To minimize the low number of a hand-delivered questionnaire strategy was used for respondents. The questionnaire was broken down into three primary elements. The first part was to describe the concept and purpose of the survey and to identify the field of research in question. The profile of the respondent was requested in the second section, such as the number of years employed in the building and the number of projects executed successfully by them.

The third part concerned the causes of the order of variance in the construction project in the form of a simple statement. Variation order considerations are grouped into 4 main participant categories: owner, consultants, contractors and other externals. Two measures, frequency and severity, are used for each factor. The respondents have four choices for each measure in the form of digit ranking from 1 to 4. Table 2 shows the ordinary scale, and the given digits 1, 2, 3, and 4 are a numerical indication of the dissimilar level of grade. Questionnaires were delivered to respondents in the public project from almost all governorate sectors who directly participated in the construction of projects as a project manager. The procedure used was aimed at establishing the relative importance of various factors of a project variation order.

The following statistical techniques were used to analyze the data:

**Frequency Index:**

The following equation is used to evaluate the causes of the order of variance based on the frequency of respondents' occurrences.

\[
\text{Frequency Index (F.I)} = \left( \frac{\sum fi x_i}{4 \sum x_i} \right) \times 100
\]  

Where the
- \( x_i \) = constant expressing weight (scale) given to \( i^{th} \) response: 1, 2, 3, 4
- \( f_i \) = variable expressing frequency of \( i^{th} \) response
- \( i \) = response category index of 1, 2, 3, 4

**Severity Index:**

The following equation is used in the manner of frequency to evaluate the severity index:

\[
\text{Severity Index (S.I) (\%) } = \left( \frac{\sum si x_i}{2 \sum x_i} \right) \times 100
\]  

Where
- \( s_i \) = variable expressing the severity of \( i^{th} \) response.

**Important Index:**

By using the following equation, the important index (I.I) of each cause is calculated:

\[
\text{Important Index (I.I) (\%) } = \left( \frac{\text{F.I(\%)} \times \text{S.I(\%)}}{100} \right)
\]  

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For this purpose, a survey is conducted on a sample of executed projects after 2006 in almost of all sectors of Local Governorate, Works and Housing, High Education, Health, Awqaf (Religions affairs), Water Supply, Sanitary, Irrigation, Roads and Electrical Works. The survey involves data on cost of contract, time of contract, actual cost (per final measurement), and completion time. The percentages of cost and time are calculated.

| Table 2. Scale Used for Measurements of Variation Order Factors |
|--------------------------------------------------------------|
|                | Frequency  | Severity |
| Delay Scale xi  | 1          | 2        |
|                | 3          | 4        |
| Scale          | 1          | 2        |
|                | 3          | 4        |
| Factors        | f1         | f2       |
|                | f3         | f4       |
| Scale          | S1         | S2       |
|                | S3         | S4       |

4. RESULT ANALYSIS AND DISCUSSION

Based on results and literature review, some common causes are available and discussed in the followings.

Respondent Profiles

The respondents are all practices engineers who carried out and supervised public projects in most facilities in the governorate institution; local government, works and housing, municipality, highways, irrigation, water supply, wastewater, electricity, religious affairs (Awqaf), and health. As shown in Table 3, the respondent's years of experience differs from 1 year to more than 25 years.

| Table 3. Respondent's Year of Experience. |
|------------------------------------------|
| Years of Experience | 1-4 | 5-9 | 10-14 | 15-19 | 20-24 | ≥ 25 |
| Percentage          | 13  | 15  | 29    | 23    | 10    | 10   |

The number and percentage of projects carried out and supervised by respondents are 1 to 50 projects as shown in Table 4, and the types of projects and their percentages are shown in Table 5.

| Table 4. Number of Projects Executed and Supervised by the Respondents. |
|-------------------------------------------------------------------------|
| Number of Projects | 1-9 | 10-19 | 20-29 | 30-39 | 40-49 | ≥ 50 |
| Percentage         | 23  | 28    | 16    | 11    | 6     | 16   |

| Table 5. Types of Projects Executed by the Respondents. |
|----------------------------------------------------------|
| Sector Name | Buildings | Educational | Electrical | Irrigation | Health Buildings | Water Supply | Sewerage | Roads | Dwellings | Sport Centers |
| Percent     | 20        | 13          | 7          | 10         | 9                 | 10           | 10       | 17    | 2         | 2             |

The results of frequency, severity, and important indices are shown in Table 6. The highest rank of causes is due to contractor's financial difficulties related to the frequency
index of 61.8 percent (second rank), severity of 68.5 (first rank) percent, and an important index of 42.3 percent of the first rank. The second cause is the modification of plans or scope by owner with highest frequency of 62 percent, severity of 63.3 percent (second rank) and important index of 39.2 percent the second rank. The third cause of variation order is the required labor skill are not available (lack in skill labor) which is related to the contractor.

Table 6. Evaluation of Causes of Variations.

| Source of Variation order | Causes of Variation Orders                                      | F.I % | S.I % | I.I % | Rank |
|---------------------------|-----------------------------------------------------------------|-------|-------|-------|------|
| Owner Related             | Owner's financial problems                                      | 55.3  | 62.5  | 34.5  | 5    |
| Change of plans or scope by owner | Change of plans or scope by owner | 62.0  | 63.3  | 39.2  | 2    |
| Modification of material or procedures | Modification of material or procedures | 51.0  | 53.2  | 27.1  | 15   |
| Design change originated by owner | Design change originated by owner | 54.5  | 60.8  | 33.1  | 6    |
| Change of schedule by owner | Change of schedule by owner | 50.3  | 58.0  | 29.1  | 12   |
| Impediment or/and slow in prompt decision making process | Impediment or/and slow in prompt decision making process | 52.0  | 56.3  | 29.3  | 11   |
| Change in specifications by owner | Change in specifications by owner | 43.4  | 63.5  | 27.5  | 14   |
| Change in design by engineer or consultant | Change in design by engineer or consultant | 51.8  | 58.2  | 30.1  | 10   |
| Conflict between contract documents | Conflict between contract documents | 48.0  | 54.8  | 26.3  | 19   |
| Errors and omissions in design | Errors and omissions in design | 50.5  | 61.0  | 30.8  | 7    |
| The scope of work for the contractor is not well defined | The scope of work for the contractor is not well defined | 49.2  | 54.0  | 26.6  | 18   |
| Technology change | Technology change | 34.7  | 38.7  | 13.4  | 26   |
| Inadequate working drawing details | Inadequate working drawing details | 45.5  | 48.5  | 22.1  | 22   |
| Design complexity | Design complexity | 39.8  | 51.5  | 20.5  | 24   |
| Inadequate working drawing details | Inadequate working drawing details | 53.5  | 56.4  | 30.2  | 9    |
| Consultant's lack of experience | Consultant's lack of experience | 44.2  | 50.7  | 22.4  | 21   |
| Lack of consultant's knowledge of available materials and equipment | Lack of consultant's knowledge of available materials and equipment | 43.5  | 49.5  | 21.5  | 23   |
| Ambiguous design details | Ambiguous design details | 45.5  | 56.3  | 25.6  | 20   |
| Differing site conditions | Differing site conditions | 57.3  | 62.0  | 35.5  | 4    |
| Contractor's financial difficulties | Contractor's financial difficulties | 61.8  | 68.5  | 42.3  | 1    |
| The required labor skill are not available | The required labor skill are not available | 61.3  | 58.5  | 35.8  | 3    |
| The required equipment and tools are not available | The required equipment and tools are not available | 52.0  | 59.1  | 30.7  | 8    |
| Workmanship or material not meeting the specifications | Workmanship or material not meeting the specifications | 50.8  | 56.5  | 28.7  | 13   |
| New government regulations | New government regulations | 47.0  | 56.8  | 26.7  | 17   |
| Strikes | Strikes | 34.0  | 50.3  | 17.1  | 25   |
| Quality improvement | Quality improvement | 48.8  | 55.0  | 26.8  | 16   |

Table 7 presents the ten top of most causes related to owner and contractor which are: "Contractor's financial difficulties", "Change of plans or scope by owner", "The required labor skill are not available", "Differing site conditions", "Owner's financial problems", "Design change originated by owner", "Errors and omissions in design", "The required equipment and tools are not available", Inadequate working drawing details", "Change in design by engineer or consultant". While out of these causes, only three of them, which are "Errors and omissions in design", "Inadequate working drawing details", and "Change in design by engineer or consultant"
drawing details", and" change in design by the engineer or consultant," are due to the consultant. The third source of variation order is the consultant's errors and omissions in design, inadequate working drawing details, and change in design by the engineer or consultant within the ten top causes of variation orders.

Table 7. Ranking of Overall Ten Top Causes of Variation Orders.

| Causes of Variation Orders | Related to | Rank |
|----------------------------|------------|------|
| Contractor's financial difficulties | Contractor | 1 |
| Change of plans or scope by owner | Owner | 2 |
| The required labor skill are not available | Contractor | 3 |
| Differing site conditions | Contractor | 4 |
| Owner's financial problems | Owner | 5 |
| Design change originated by owner | Owner | 6 |
| Errors and omissions in design | Consultant | 7 |
| The required equipment and tools are not available | Contractor | 8 |
| Inadequate working drawing details | Consultant | 9 |
| Change in design by engineer or consultant | Consultant | 10 |

Considering the source of variation order, the first ranked causes are "Change of plans or scope by owner", "Errors and omissions in design", and "Contractor's financial difficulties" relating to owner, contractor and consultant respectively as shown in Table 8.

Table 8. Ranked Causes of Variation Orders Sources.

| Owner Cause | Consultant Cause | Rank |
|-------------|------------------|------|
| Change of plans or scope by owner | Errors and omissions in design | 1 |
| Owner's financial problems | Inadequate working drawing details | 2 |
| Design change originated by the owner | Change in design by engineer or consultant | 3 |
| Impediment or/and slow in the prompt decision-making process | The scope of work for the contractor is not well defined | 4 |
| Change of schedule by owner | The conflict between contract documents | 5 |
| Change in specifications by owner | Ambiguous design details | 6 |
| Replacement of material or procedures | Consultant's lack of experience | 7 |
| | Inadequate working drawing details | 8 |
| | Technological change | 9 |

| Consultant Cause | Rank |
|------------------|------|
| Contractor's financial difficulties | 1 |
| The required labor skill are not available | 2 |
| Differing site conditions | 3 |
| The required equipment and tools are not available | 4 |
| Workmanship or material not meeting the specifications | 5 |
| Ambiguous design details | 6 |
| Consultant's lack of experience | 7 |
| Inadequate working drawing details | 8 |
| Technological change | 9 |
Comparing Variation Orders with Other Studies

Some causes of variation orders in this study are already in several studies. Some of them are as follows. Table 6 illustrates these causes.

Change of plans or scope by owner

The change of plans or scope by owner factor is the second-ranked cause of variation order in this study and also pointed out in other earlier studies: Msallam, et al., (2015)- Jordan; Alaryan, et al., (2014)- Kuwait; Ndihokubwayo and Haupt (2009)- South Africa; Mohammad et al. (2010)- Malaysia; Staiti et al. (2016)- West Bank (Palestine); Hanif, et al., (2016)- Pakistan; and Sherif (2016)- Egypt also confirmed this result. In a study of Alaryan (2014) - Kuwait, this cause of variation order is in the first rank while in this it is at the second rank.

Change in design by consultant

The change in design by the consultant is at the 10th rank of overall causes also referred in the studies of Msallam et al. (2015)- Jordan; Enshassi et al. (2010)- Gaza Strip-Palestine; Ndihokubwayo and Haupt (2009)- South Africa; Mohammad et al. (2010)- Malaysia; Ismail et al. (2012)- Iran; In the study of Alaryan (2014) - Kuwait, this cause factor is at 13th rank.

Errors and omissions in design

Errors and omissions in design cause are at the 7th rank in this study at different ranks of previous studies: Enshassi et al. (2010)- Gaza Strip- Palestine; Ndihokubwayo and Haupt (2009)- South Africa; Ismail et al. (2012)- Iran and Hanif et al. (2016)- Pakistan.

5. CONCLUSIONS

The study aimed to identify the causes of variation and the their sources. The study concluded the high ranked cause of the overall cause is contractor financial difficulties, lack of skilled labor, differing site conditions, and the owner's financial problems. The main sources are the contractor. Based on the source causes presents the ten top of most causes are related to the Owner and the Contractor which are: "Contractor's financial difficulties", " Change of plans or scope by owner", "The required labor skill are not available", "Differing site conditions", "Owner's financial problems", "Design change originated by owner", " The required equipment and tools are not available".

The major causes of variation related directly to consultant "Errors and omissions in design", "Inadequate working drawing details", " Change in design by the engineer or consultant".

It is worthwhile that the causes "Change of plans or scope by owner", " Change in design by a consultant" and "Errors and omissions in design" in this study confirm their existence in other foreign studies.

Finally, based on review and findings to avoid the variation orders, it is recommended to:

- Select a reputed consultant firm with similar project experience.
- Involve professionals of high experts at the beginning phase to clarify the requirements of the project.
- Involve experts in detailed design and minimize errors and ambiguous design details.
- Select a qualified contractor.
- Increase coordination and collaboration.

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