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A STUDY FOR THE CAUSES OF VARIATION ORDERS IN DIFFERENT SECTORS OF CONSTRUCTION PROJECTS IN ERBIL GOVERNORATE FROM THE POINT OF VIEW OF THE INVOLVED PARTIES

*Aksana Jihad Mohammed

Lecturer, Civil Engineering Department, Erbil Technical Engineering College, Erbil, Iraq.

Abstract: A Variation order is a common phenomenon in any project. There are many causes that may lead to variation order in a construction project. This paper aims to investigate and identify the most significant causes of variation orders in different sectors of construction in Erbil Governorate, and their effects on the projects in order to manage them and find the solutions that can eliminate them by putting some control measures. This research was conducted by questionnaire survey to elicit 30 causes of variation orders from the point of view of owners, consultant engineers, and contractors. A questionnaire submitted to a sample of 140 persons specialized in construction sector in Erbil Governorate. Out of 140 questionnaires 120 were returned forming 18 of owners, 62 of consultant engineers, and 40 of contractors. Then the questionnaire was analyzed statistically. Also a case study adopted for 3٠ projects of different construction sectors that constructed during 2010-2013 to calculate the percentage of cost and time overrun due to variation orders. Also a comparison study had made among the results obtained from this study and some countries for the major causes of variation orders in construction projects. The results of the questionnaire indicate that Owner and consultant engineer are the most responsible parties causing changes. The most important causes of variation orders in construction projects in Erbil Governorate are change in bill of quantities, change of plans or schedule by Owner, inadequate contractor experience, lack of consultant's experience about availability of materials or equipment, errors and omissions in design, and Owner's financial problems. However no matter what is the reason of variation order, respondents agreed that their occurrences often resulted in dispute and dissatisfaction among the parties involved in the project with regard to their resolution. Apart from that variation order also resulted in project delay and difficult to manage as they often involved in new sum of additional or deduction of contract price. To control variation orders the respondents agreed that contract document should be checked and reviewed, a revue for design should be made before change approval, the scope of variation orders should be made clear, variation order should be negotiated by knowledgeable persons, registration of the consultant company should be reviewed to reflect its capabilities, owner should make adequate financial planning during planning stage to avoid changing plans later or during construction, and ensure the availability of materials during the study phase and before starting the design to specify them in order to minimize changing orders of specifications, material, and equipment used.

Keywords: *Construction projects, Variation orders, Causes of variation order, Effect of variation order, Control of variation order, Project performance, Disputes.*

دراسة اسباب اوامر التغيير في مختلف قطاعات الانشاء في محافظة اربيل من وجهة نظر اصحاب العلاقة بالمشاريع الانشائية

**Corresponding Author* az_ijkl@yahoo.com

الخلاصة: امر التغيير هو ظاهرة شائعة في أي مشروع، فهناك العديد من الأسباب التي قد تؤدي إلى اوامر التغيير في المشروع الانشائي. يهدف البحث إلى دراسة و تحديد أسباب اوامر التغيير في قطاعات الانشاء المختلفة في محافظة أربيل، وآثارها على تنفيذ المشاريع من أجل إدارتها وإيجاد الحلول التي يمكن ان تسهم في القضاء عليها او تحد من حدوثها و ذلك عن طريق وضع بعض المعايير لضبطها. و تم اجراء البحث عن طريق الاستبيان ل ٣٠ سبب من الاسباب المحتملة لاوامر التغيير من وجهة نظر أصحاب العمل والمهندسين الاستشاريين والمقاولين. و هؤلاء هم اصحاب العلاقة الذين يعملون في قطاع الانشاء في محافظة أربيل. حيث تم توزيع ١٤٠ استمارة استبيان لاصحاب العلاقة في قطاعات الانشاء في محافظة أربيل. و من أصل ١٤٠ استبيان تم الحصول على ١٢٠ استبيان ليشكل ١٨ من اصحاب العمل و ٦٢ من المهندسين الاستشاريين و ٤٠ من المقاولين. و من ثم تم تحليل الاستبيان احصائيا. كما و تم اعتماد دراسة عملية ل ٣٠ مشروع من قطاعات الانشاء المختلفة التي شييدت في اربيل في الفترة ٢٠١٠-٢٠١٣ و ذلك لحساب النسبة المئوية لتجاوز الكلفة والوقت بسبب اوامر التغيير. أيضا فقد تم اجراء دراسة مقارنة لبعض النتائج التي تم الحصول عليها من هذه الدراسة ونتائج دراسات بعض الدول للاسباب الرئيسية لاوامر التغيير في المشاريع الإنشائية. نتائج الاستبيان بينت أن صاحب العمل و الاستشاري هم الأكثر مسؤولية في التسبب في اجراء التغييرات. و ان أهم أسباب أوامر التغيير في مشاريع البناء في محافظة أربيل هي التغيير في جدول الكميات، وتغيير الخطط أو الجدول الزمني من قبل صاحب العمل و قلة خبرة المقاول وقلة خبرة الاستشاري بالنسبة لتوفر المواد أو المعدات، والسهو اوالخطأ في التصميم، و مشاكل صاحب العمل المالية. و بغض النظر عن سبب حدوث اوامر التغيير، فقد اتفق المستبينون انها تؤدي في كثير من الأحيان إلى الخلافات وعدم الرضا بين الأطراف المشاركة في المشروع فيما يتعلق بحلها. و تؤدي أيضا إلى تأخر المشروع وصعوبة ادارته لأنها غالبا ما تنتج عن اضافة مبالغ جديدة للعقد او خصم من قيمته. و من اجل السيطرة على اوامر التغيير او الحد من حدوثها، فقد اتفق المستبينون الذين استطلعت ارائهم بالنسبة لبعض الحلول المقترحة على وجوب مراجعة وفحص وثائق العقد قبل تقديمها، وكذلك وجوب مراجعة التصاميم قبل اعطاء الموافقة باجراء التغييرات، ووجوب تحديد نطاق امر التغيير بشكل واضح ، و كذلك اجراء دراسة و تدقيق لاوامر التغيير بواسطة شخص متخصص له الدراية الكافية حول اوامر التغيير، و وجوب اجراء فحص دقيق للشركات الاستشارية للتاكد من كفائتها و امكانياتها، و يجب على صاحب العمل اجراء تخطيط جيد للموارد المالية خلال مرحلة التخطيط و ذلك لتجنب اجراء التغييرات في الخطط خلال مرحلة التنفيذ، والتاكد من توفر المواد الانشائية خلال مرحلة دراسة المشروع و قبل البدء بالتصميم للتحقق من المواد و الاليات المتوفرة في الاسواق و ذلك للحد من اوامر التغيير بالنسبة للمواصفات والمواد الانشائية و المكائن المستخدمة.

1. Introduction

One of the major problems faced by the construction project is the issue of the variation order occurring during the construction phase which results in delaying projects, overruns the cost and causes other negative effects [1]. Hence it is very important to control variation orders. There is no single definition of what constitutes a variation [2]. Variation order may be defines as any change that can occur to the basis that is different from the agreed and signed contract [3]. In literature variation order is defined as any deviation from an agreed upon well- defined scope and schedule. Stated differently a variation is any modification to the contractual guidance provided to the contractor by the owner or owner's representative [1]. A change order may fork a new project to handle significant changes to the current project [4]. Variations were common in all types of construction projects [1]. It is almost becoming a rare thing a project not to have variation, thus becoming a normal occurrence in all construction projects. Most contracts these days must make provisions for possible variations given the nature of building construction project [5]. Most of change order issued during construction has significant impact on cost and time of project and in worst case could lead to delay, abandonment of project and disputes which are common in developing countries [6].

These changes however occur after the award of the initial contract or after work might have commenced at the construction sites. Change orders are the reasons why most contractors don't meet up with the time specified for completion of most contract works [7]. 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 [8]. When the owner is responsible for a change, the cost and schedule impacts of change are incorporated into the original contract by way of change orders [9]. 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 [10].

2. Literature Review

Homaid [11], 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 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 projects. The nature and impact of variation orders on overall project performance were investigated by Ndihokubwayo and Haupt [12]. Clients were identified as the most predominant sources of variation orders due to unclear briefing and changing requirement Al-jishi and Marzoug [13], also concluded that the owner is the major source of changes and that most changes are architectural, changing of plans and materials substitution were the first causes of change in large buildings.

Zawawi [14], reviewed different literatures and case studies on causes, effects and controls of change orders. Based on the review, changing plans by the owners through generating conflicting design documents or through change in design afterwards are the main causes of change orders. Adnan Enshassi1, Faisal Arain, and Sadi Al-Raee [15], analyze the causes of variation orders in construction projects in Gaza Strip. The results indicated that consultant is the most important group of causes of variation orders in construction projects. Murlidhar A. Lokhandeand Farouk Saif Yahya Ahmed [16] discussed 21 causes of variation order and found that the Owner is the main cause of variation order in Yemen. Alia Alaryan, Emadelbeltagi, Ashraf Elshahat and Mahmoud Dawood, [17], are 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. They found 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. Apolot [18]. studied the causes of delays and cost overruns in Uganda's public construction projects and found out that change of work scope was the major causes of delay and cost overruns.

Ayodeleand and Alabi [19], have identified variation of project scope as one of the causes of abandonment of construction project in Nigeria. Alnuami, [20], provided an in- depth analysis of the potential effect of variations in building projects. investigated the causes, effects, benefits and remedies of change orders on public construction projects in Oman, he divided the causes of change order into client related, consultant related, contractor related and others. He concluded that client's additional works and modification to design were the most important factors causing change orders, followed by non-availability of construction manuals and procedures. Also he concluded that change of the project scope due to additional diminution or enhancement in client requirement was the most frequent, important and severe causes of change orders. Haseeb [21], also investigated the causes and effects of delay in large construction

projects in Pakistan, among the five causes identified, client change in specification. Keane [22], 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. Olsen [23], 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.

3. Methods and Materials

3.1. Data Collecting and Analyzing

Stratified random sampling was adopted for this study. According to Kothari [24], this method of sampling is used where the population embraces a number of distinct categories, the frame can be organized by these categories into separate "strata." Each stratum is then sampled as an independent sub-population, out of which individual elements are randomly selected. Selection of respondents from each stratum was based on simple random sampling. In assessing construction risk the research targeted owners, consultant engineers, and contractors as the sample units.

Data were gathered through a questionnaire. The questionnaire was distributed to a sample of 140 person specialized in construction industry. The target groups in this study are owners, consultant engineers and contractors whom working in different sectors of construction industry, were further requested to answer questions pertaining to their experience in the construction industry and their opinions about variation orders. 25 questionnaire were distributed to owners, 75 to engineers, and 40 to contractors. Out of 140 question naire 120 questionnaire were returned forming 18 of owners 15%, 62 of engineers 51.66% and 40 of contractors 33.33% as shown in profile table 1.

Table 1. Respondents Profile

Type	Construction sector	Number of responses received	Percent	Total response received	Percent
Owner	building	10	55.55%	18	15%
	Bridges and highways	5	27.77%		
	Sanitary	3	16.66%		
Engineer	building	28	45.16%	62	51.66%
	Bridges and highways	22	35.48%		
	Sanitary	12	19.35%		
Contractor	building	23	57.50%	40	33.33%
	Bridges and highways	12	30%		
	Sanitary	5	12.50%		
Total		120		120	100%

The target group of a different year experience as shown in table 2.

Table 2. Respondents Experience in Performing Projects

Number of working years of experience	Number of response received			Total	Percent
	Owner	Engineer	Contractor		
1 - 5	—	3	—	3	2.50%
6 - 10	1	8	2	11	9.16%
11 -15	3	14	11	28	23.33%
16 -20	10	19	22	51	42.50%
More than 20	4	18	5	27	22.50%
Total number	18	62	40	120	100%

The questionnaire is divided into four main parts. Part 1 is related to general information for respondent. As for the part 2 the respondents were requested to answer questions pertaining to their experience in the construction industry and their opinions about a list of identified 30 causes of variation orders in different sectors of construction projects. These causes are classified into four groups according to the sources of variation order: Factors related to project, owner, contractor, engineer, and external factors as shown in table 3.

Table 3. Questionnaire Form (a)

No	Cause factors	Frequency	Severity
	causes of variation order by contractor		
1	The contractor's financial difficulties		
2	Existence of complications in the design for the contractor		
3	Inadequate contractor experience		
4	The lack of required equipment and tools		
5	The lack of required labor skills		
6	Differing site conditions		
	Causes of variation order by owner		
7	Lack in information given to the contractor		
8	Change of plans or schedule by owner		
9	Change in bill of quantities		
10	Owner's financial problem		
11	Changes in materials used or methods of performance		
12	Change in specifications		
13	Acceleration of work by owner		
١4	Additional works		
	Causes of variation order by engineer		
15	Change in design by consultant		
16	Conflict between contract documents		
17	The lack of clarity in the drawings or specifications		
18	Non-complete drawing or specifications		
19	Errors and omissions in design		

20	Lack of consultant's experience in design
21	Non-conformity of designs with governmental regulations and laws
22	Non-conformity of designs with the requirements of the employer
23	Lack of information given to designer Engineer
24	Lack of consultant's experience about availability of materials or
25	Changes in techniques of performance
	External causes of variation order
٢6	Weather condition
27	Unforeseen site condition
28	Accident during construction
29	Changes in in the country's economic conditions
30	Changes in government regulations and laws

Part 3 lists 12 effects of variation orders and part 4 suggested 12 control measures to minimize the impact of variation orders on the projects as shown in table 4.

Table 4. Questionnaire Form (b)

No	Effects of variation orders	Controls of variation orders
1	Hold on work in other areas	Variation order is negotiated by knowledgeable persons
2	Delay in completion date of project	Contract document are checked and reviewed
3	Delay in payment	The scope of variation orders is made clear
4	Demolition and re – work	Registration of the consultant company should be reviewed to reflect its capabilities
5	Decrease in productivity of workers	Justification of change
6	Decrease in quality of work	Freeze the design after a certain stage
7	Increase in overhead expenses	Areas of concern [monthly reports and meetings]
8	Additional money for contractor	Reviewed for design before change approval
9	Increase the cost of the projects	Changes are not made without appropriate approval in writing
10	Delay of materials and tools	Gray areas of contract documents are highlighted and reviewed before contract award
11	Increase in duration of individual activities	A common learning database system should be shared among all government units
12	Claims and disputes between owners and contractor	A specialized quantity surveyor/ cost controller and project manager should be assigned to large construction projects

For Part 2, the respondents were requested to answer both frequency of occurrence and severity of the causes. A four-point scale of 1 to 4 is adopted for evaluating the effect of each factor. These numerical values are assigned to the respondents' rating: 1 = rarely; 2 = sometimes; 3 = often; 4 = always for frequency, and 1 = little; 2 = moderate; 3 = great; 4 = extreme for severity.

The data are processed through three types of indices:-

Frequency index: This index expresses occurrence frequency of factor responsible for variation order. It is computed as per following formula [25]:-

$$\text{Frequency Index F.I} = \frac{\sum_1^4 an}{4N} \qquad (1)$$

Where: *a* = constant expressing the weight assigned to each responses ranges from 1 for rarely happen to 4 for always happen, *n* = frequency of each response, *N* = total number of responses. Severity index: A formula is used to rank causes of variation orders based on severity as indicated by the participants. This index expresses severity of factor that caused variation order. It is computed as per following formula [25]:-

$$\text{Severity Index S.I.} = \frac{\sum_1^4 an}{4N} \qquad (2)$$

Where: *a* = constant expressing the weight assigned to each responses ranges from 1 for little severe to 4 for extremely severe, *n* = frequency of each response, *N* = total number of responses.

The importance index of each cause is calculated as a function of both frequency and severity Indexes, as follows [25] :-

$$\text{Importance Index IMP.I.} = \text{F.I.} \times \text{S.I.} \qquad (3)$$

By using Microsoft Excel program the data of responses were analyzed in order to calculate the values of F.I, S.I. and IMP.I.. These indexes were used to determine the rank of each cause of variation order. These rankings made it possible to cross compare the importance of the items as perceived by the three groups of respondents Owners, engineers and contractors. This method is used for similar studies to determine the importance of various factors [25].

For part 3 and 4, the Importance index is used to get the weightage average to rank the, effects and control measures. 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). 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 effects and control measures. The basis of calculating Importance Index is the same as follows: Zaneldin [26], calculated the Importance Index of each cause as follows:-

$$\text{Importance index} = \text{Weighted average} * \frac{100}{4} \qquad (4)$$

$$\text{Importance Index} = \frac{\sum W_i * X_i}{N} * \frac{100}{4} \qquad (5)$$

Where *Wi* the weight is assigned to the *ith* option of cause; *Xi* is the number of respondents who selected the *ith* option of cause; and *N* is the total number of respondents.

In this research the Spearman's rank correlation r_s was used to measure and compare the association between the rankings of two parties for a single cause of variation order, while ignoring the rankling of the third par. And it is calculated by using the following formula [27]:-

$$r_s = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \quad (6)$$

Spearman's rank correlation is used for similar studies [15].

Where: r_s is the Spearman rank correlation coefficient between two parties, d_i is the difference between ranks assigned to variables for each cause, and n is the number of pairs of rank.

Spearman's rank correlation is a non-parametric test. Correlation is a relationship measure among different parties or factors and the strength and direction of the relationship. Non-parametric tests are also referred to as distribution free tests. These tests have the obvious advantage of not requiring the assumption of normality or the assumption of homogeneity of variance. They compare medians rather than means and, as a result, if the data have one or two outliers, their influence is neglected. In this research it is used to show the degree of agreement between the different parties. The correlation coefficient varies between +1 and -1, where +1 implies a perfect positive relationship agreement, while -1 results from a perfect negative relationship disagreement. It might be said then that sample estimates of correlation close to unity in magnitude imply good correlation, while values near zero indicate little or no correlation.

To ensure the reliability of each factor, Cronbach's alpha, Cα coefficient of reliability test was used to determine the consistency of the data obtained. It was calculated using SPSS. The value of Cα should be between 0 and 1 where lower values demonstrate lower internal consistency and higher values illustrate greater internal consistency. In fact, there is no set standard or pre-defined acceptable limit of Cα value. Nevertheless, the following criteria explained by Nunally [28], for the interpretation of Cronbach's alpha values was carefully undertaken as a rule of thumb: Cα > 0.8 'Excellent'; 0.8 > Cα > 0.7 'Good'; 0.7 > Cα > 0.5 'Satisfactory'; and Cα < 0.5 'Poor'. Table 14, shows the value of Cronbach's alpha Cα for all attributes are computed as 0.929, which is considered to be excellent.

For construct validity, Nunnally [28], has suggested the unifactorial determination method. Unifactoriality is achieved when a single factor is extracted for each test and shown to be valid as a construct. In order to check the construct validity, KMO test was performed on each factor group. The values for the average variance extracted should exceed the 0.5 threshold, which is accepted as an indication of the validity of a construct's measure, [29].

3.2. Case Study

In order to determine the cost and time overrun due to variation order causes. A case study was adopted for 30 projects of different construction sectors which constructed during 2010-2013 in Erbil Governorate. To calculate the cost and time overrun as percentage of original contract cost and duration, which will be discussed in results and discussion.

3.3. Comparison of Variation Orders For Some Countries

The objective of this comparison is to get a general view about the causes of variation orders among some countries through an examination for different selected previous studies of some countries, which will be discussed in results and discussion.

4. Results and Discussion

By administering and analyzing a questionnaire survey, this research has identified problems related to variation orders during construction phase and then ranked them from different viewpoints of parties with respect to three types of indexes as follows:-

4.1. Top Ten Most Frequent Factors of Variation Orders

Table 5 shows that in overall context, the top10 most frequent factors of the causes of variation orders are change in bill of quantities rank (1), change of plans or schedule by owner rank (2), lack of consultant's experience about availability of materials or equipment rank (3), inadequate contractor experience rank (4), the lack of required labor skills rank (5), owner's financial problem rank (6), differing site conditions rank (7), errors and omissions in design rank (8), conflict between contract documents rank (9) and change in design by consultant rank (10).

Table5. F.I. and Ranks of A Top Ten Most Frequent Factors

Cause	Owner		Engineer		Contractor		Average	
	F.I.	Rank	F.I.	Rank	F.I.	Rank	F.I.	Rank
Change in bill of quantities	0.805	1	0.693	1	0.762	1	0.753	1
Change of plans or schedule by owner	0.750	2	0.604	2	0.637	2	0.677	2
Lack of consultant's experience about availability of materials or equipment	0.722	2	0.620	4	0.600	5	0.651	3
Inadequate contractor experience	0.722	3	0.620	3	0.600	5	0.647	4
The lack of required labor skills	0.694	4	0.620	3	0.550	8	0.621	5
Owner's financial problem	0.750	2	0.483	10	0.575	6	0.602	6
Differing site conditions	0.611	6	0.532	6	0.600	5	0.581	7
Errors and omissions in design	0.527	4	0.475	13	0.525	6	0.509	8
Conflict between contract documents	0.583	7	0.580	5	0.525	10	0.562	9
Change in design by consultant	0.583	7	0.532	6	0.550	8	0.555	10

4.2. Top Ten Most Severe Factors of Variation Orders

Table 6 shows that in overall context, the ten most severe causes of variation orders are change in bill of quantities rank (1), inadequate contractor experience rank (2), change of plans or schedule by owner rank (3), errors and omissions in design rank (4), contractor's financial difficulties rank (5), change in design by consultant rank (6), lack of consultant's experience in design rank (7), conflict between contract documents rank (8), lack of consultant's experience about availability of materials or equipment rank (9) and Owner's financial problem rank (10).

Table 6. S.I. and Ranks of a Top Ten Most Severe Factors

Cause	Owner		Engineer		Contractor		Average	
	S.I.	Rank	S.I.	Rank	S.I.	Rank	S.I.	Rank
Change in bill of quantities	0.861	1	0.685	2	0.712	1	0.752	1
Inadequate contractor experience	0.750	3	0.693	1	0.700	2	0.714	2
Change of plans or schedule by owner	0.777	2	0.661	3	0.675	4	0.704	3
Errors and omissions in design	0.777	2	0.572	10	0.662	5	0.670	4
The contractor's financial difficulties	0.722	4	0.580	9	0.687	3	0.663	5
Change in design by consultant	0.722	4	0.588	8	0.662	5	0.657	6
Lack of consultant's experience in design	0.722	4	0.548	13	0.700	2	0.656	7
Conflict between contract documents	0.750	3	0.612	5	0.600	8	0.654	8
Lack of consultant's experience about availability of materials or equipment	0.638	6	0.637	4	0.662	5	0.645	9
Owner's financial problem	0.722	4	0.596	7	0.612	7	0.643	10

4.3. Top Ten Most Important Factors of Variation Orders

The most ten important causes of variation orders according to overall respondents as shown in table 7 are change in bill of quantities rank (1), change of plans or schedule by owner rank (2), inadequate contractor experience rank (3), lack of consultant's experience about availability of materials or equipment rank (4), errors and omissions in design rank (5), owner's financial problem rank (6), the lack of required labor skills rank (7), lack of consultant's experience in design, and conflict between contract documents, rank (8), change in design by consultant rank (9) differing site conditions rank (10).

Table7. I.MP.I. and Ranks of a Top Ten Most Important Factors

Cause	Owner		Engineer		Contractor		Average	
	IMP.I.	Rank	IMP.I.	Rank	IMP.I.	Rank	IMP.I.	Rank
Change in bill of quantities	0.693	1	0.474	1	0.542	1	0.569	1
Change of plans or schedule by owner	0.582	2	0.426	3	0.429	2	0.479	2
Inadequate contractor experience	0.541	3	0.429	2	0.420	3	0.463	3
Lack of consultant's experience about availability of materials or equipment	0.478	6	0.384	4	0.397	4	0.419	4
Errors and omissions in design	0.539	4	0.262	16	0.380	9	0.393	5
Owner's financial problem	0.499	5	0.268	15	0.395	5	0.387	6
The lack of required labor skills	0.462	7	0.364	5	0.322	15	0.382	7
Lack of consultant's experience in design	0.460	8	0.260	17	0.385	7	0.368	8
Change in design by consultant	0.420	11	0.312	7	0.364	11	0.365	9
Differing site conditions	0.441	9	0.300	9	0.345	12	0.362	10

4.4. Top Five Least Important Factors of Variation Orders

The least five important causes of variation orders according to overall respondents as shown in table 8 are, changes in government regulations and laws, rank (28), accident during construction rank (27), change in specifications rank (26), non-conformity of designs with governmental regulations and laws rank (25), changes in in the country's economic conditions rank (24).

Table8. I.MP.I and Ranks of A five Least Important Factors

Cause	Owner		Engineer		Contractor		Average	
	IMP.I.	Rank	IMP.I.	Rank	IMP.I.	Rank	IMP.I.	Rank
Changes in government regulations and laws	0.157	25	0.156	28	0.183	28	0.165	28
Accident during construction	0.166	24	0.149	29	0.192	27	0.169	27
Change in specifications	0.242	21	0.185	26	0.236	25	0.221	26
Non-conformity of designs with governmental regulations and laws	0.263	19	0.170	27	0.251	22	0.228	25
Changes in in the country's economic conditions	0.230	22	0.275	14	0.234	26	0.246	24

4.5. Group Causes of Variation Orders

The results in table 9 show the rank of the groups of cause for the variation order.

4.5.1. Owner' related group

This group of factors was ranked by overall respondents in the most important group. The contractor ranked this group in the second position, the engineer ranked it in the first position, while the owner ranked it in the third position. The overall ranking of this group reflects the importance of owner in occurrence of variation orders where the owner plays a major role in causing variations. Any changes in owner's requirements or any financial problems of owner will reflect directly on the project at every phase and may cause variation orders. The differences in parties' perceptions toward the importance of this group are not unexpected. The contractor in many cases is not directly in touch with owner that endorses the perception from the contractor side. The engineer considered that the owner is the major originator of variation orders.

4.5.2. Engineer related group

This group was ranked by all respondents as the second position. The contractor and owner ranked it in the first position, while the engineer ranked it in the second position.

4.5.3.Contractor related group

This group was ranked in third position, according to overall respondents. It was ranked in the fourth position by contractor, in the third position by engineer, and in the

second position by owner. This result reflects that the contribution of contractor in causing variation orders is minimal as the initiative of any variation is directly related to causing changes needed by the owner or problems in the design documents.

4.5.4. External factors

This group was ranked in the fourth position, according to overall respondents. There is agreement of two parties in the ranking of this group. The contractor ranked this group in the third position, while engineer and owner ranked it in fourth position.

Table9. I.MP.I. and Ranks of The Group of Causes of Variation Orders

Group	Owner		Engineer		Contractor		Over all	
	I.MP.I.	Rank	I.MP.I.	Rank	I.MP.I.	Rank	I.MP.I.	Rank
Owner related factors	0.447	3	0.339	1	0.339	2	0.352	1
Engineer related factors	0.480	1	0.315	2	0.378	1	0.339	2
Contractor related factors	0.466	2	0.275	3	0.318	4	0.296	3
External related factors	0.337	4	0.249	4	0.336	3	0.259	4

4.6. Top Five Most Important Contractor Related factors

Table 10 shows contractor related factors, the rank and the relative importance index for the most five importance factors in contractor related factors group. Inadequate contractor experience was ranked according to overall respondents in the first position. Almost all parties agreed that this factor is the most important as shown in the table. The lack of required labor skills was ranked as the most second most important factor.

Differing site conditions was ranked according to overall respondents in the third position. The variation orders may be suggested by the contractor due to differing site condition. This is because differing in site conditions may affect the cost estimation and schedule adversely. The results show an agreement between contractor and engineer, however, the owner ranked it in fourth position.

Table 10. I.MP.I. and Ranks of The most Five Important Factors in Contractor Related Factors

Contractor related factors	Owner		Engineer		Contractor		Over all	
	I.MP.I.	Rank	I.MP.I.	Rank	I.MP.I.	Rank	I.MP.I.	Rank
The contractor's financial difficulties	0.460	3	0.224	5	0.343	4	0.342	4
Existence of complications in the design for the contractor	0.321	5	0.276	4	0.309	6	0.302	5
Inadequate contractor experience	0.541	1	0.429	1	0.42	1	0.463	1
The lack of required labor skills	0.462	2	0.364	2	0.322	5	0.382	2
Differing site conditions	0.441	4	0.300	3	0.345	3	0.362	3

The contractor's financial difficulties was ranked in the fourth position, however owner decided that it is third position. Existence of complications in the design for the contractor was ranked in the fifth position according to overall parties. There was a conflict about this factor among the parties. Engineer party announced that it is in fourth position while contractor decided it is in the sixth position. Any complication in design may lead to design changes in addition to delay in work.

4.7. Top Five Most Important Owner Related Factors

Table 11 shows the relative important index and the rank of owner related factors according to each party and to overall respondents. Change in bill of quantities is ranked as the most important factor according to overall respondents. The contractor, engineer, and owner ranked it in the first position. Change of plans or schedule by owner was ranked in the second position. The results show the agreement among all parties on the importance of this cause as rank2. In multiplayer environment like construction, change in specifications by owner during the construction phase may need major variations and adjustments in project planning and procurement activities. Owner's financial problem is ranked as the third most important factor according to overall respondents. Agreement among all parties reflects the importance of this factor as the financial problems for owner has direct effects on the project. This may lead to initiate some major variations to the project in order to reduce the cost to make the project feasible. Changes in materials used or methods of performance i ranked in the fourth position according to overall respondents.

The contractor ranked it also in fourth position whereas, the engineer and the owner ranked it in fifth position. The ranking by contractor is not unexpected as because the contractor may perceive that change in project purpose and scope by owner can affect the scope of contractor's involvement directly limiting the potential opportunities for profits for the contractor. Additional works is ranked as the fifth most important factor. Owner and engineer agreed that it is in the fourth position, while the contractor ranked it in the sixth position. In Erbil the major causes are change in bill of quantities, change of plans or schedule by owner and Inadequate contractor experience. The most common causes are changes scope of project by owners, errors & omissions in design, owner change of schedule, conflicts between contract documents, and lack of consultant's experience about availability of materials or equipment.

Table 11. I.MP. I. and Ranks of the Most Five Important Factors in Owner Related Factors

Owner related factors	Owner		Engineer		Contractor		Over all	
	I.MP.I>	Rank	I.MP>I.	Rank	I.MP.I.	Rank	I.MP.I.	Rank
Change of plans or schedule by owner	0.582	2	0.426	2	0.429	2	0.479	2
Change in bill of quantities	0.693	1	0.474	1	0.542	1	0.569	1
Owner's financial problem	0.499	3	0.291	3	0.395	3	0.387	3
Changes in materials used or methods of performance	0.336	5	0.268	5	0.321	4	0.316	4
Additional works	0.350	4	0.279	4	0.301	6	0.310	5

4.8. Top Five Most Important Engineer Related Factors

Table 12 shows the rank and the relative importance index for the importance factors in engineer related factors group. Lack of consultant's experience about availability of materials or equipment was ranked according to overall as the most important factor. There is agreement among all parties that this factor is the most important one. The utilization of junior staff and/or unqualified part time engineers, who do not have the required experiences regarding the available materials or equipment in local market, increased the importance of this factor. Errors and omissions in design, was ranked as the second most important factor. The results show differing perceptions between engineer and other parties. The engineer ranked this factor in sixth position, while contractor in the fourth position, and owner ranked it in the second position. Conflict between contract documents was ranked according to overall as third important factor.

The owner differs with engineer and contractor towards the importance of this factor, the contractor ranked it in the eighth position, the engineer ranked it in the second position, but the owner ranked it in fourth position. The conflict in tender documents does not happen frequently. However, the owner and consultant perceived it as a frequent cause of variations and that the contractor may consider this as an opportunity to suggest variations to omit the low priced activities. Lack of consultant's experience in design, also was ranked according to overall as third important factor. Engineer ranked it as seventh position. While, the contractor and owner agreed that it is in third position, Lack of consultant's experience leads to design changes and variation orders due to errors and omissions during performance. Change in design by consultant was ranked according to overall as the most fourth important factor. The reason for frequent change in design, and the variations that follow it, is that the design process is not given the enough time to finalize it in proper way and unresponsive to civilian complaints before starting the construction phase so the engineer have to solve that by changing design during construction phase. Lack of information given to designer engineer was ranked as the fifth important factor. There is nearly agreement among all parties about the importance of this factor.

Table12. I.MP.I. and Ranks of The Most Five Important Factors in Engineer Related Factors

Engineer related factors	Owner		Engineer		Contractor		Over all	
	I.MP.I.	Rank	I.MP.I.	Rank	I.MP.I.	Rank	I.MP.I.	Rank
Change in design by consultant	0.420	5	0.312	3	0.364	5	0.365	4
Conflict between contract documents	0.437	4	0.354	2	0.315	8	0.368	3
Errors and omissions in design	0.478	2	0.262	6	0.380	4	0.393	2
Lack of consultant's experience in design	0.460	3	0.260	7	0.385	3	0.368	3
Lack of information given to designer Engineer	0.420	5	0.278	5	0.343	6	0.347	5
Lack of consultant's experience about availability of materials or equipment	0.539	1	0.384	1	0.397	1	0.419	1

4.9. Top Five Most Important External Related Factors

Table 13 shows the relative important index and the rank of external related factors according to each party and to overall respondents. Weather condition was ranked as the most important cause. This shows an agreement among all parties towards the importance of this factor. Unforeseen site condition was ranked in second position. Changes in the country's economic conditions were ranked in the third position by over all respondents. Accident during construction was ranked in the fourth position. Changes in government regulations and laws were ranked in the fifth position. There is nearly agreement among all parties about ranking external group factors.

Table13. I.MP.I. and Ranks of The Most Five Important Factors in External Related Factors

External related factors	Owner		Engineer		Contractor		Over all	
	I.MP.I.	Rank	I.MP.I.	Rank	I.MP.I.	Rank	I.MP.I.I	Rank
Weather condition	0.305	1	0.302	1	0.375	1	0.327	1
Unforeseen site condition	0.283	2	0.257	3	0.297	2	0.279	2
Accident during construction	0.166	4	0.149	5	0.192	4	0.169	4
Changes in in the country's economic conditions	0.230	3	0.275	2	0.234	3	0.246	3
Changes in government regulations and laws	0.157	5	0.156	4	0.183	5	0.165	5

4. 10. Effects of Variation Orders

Figure 1 summarizes the results of owners in the survey on the effects of variation orders. From Owner's point of view, the top five effects of variation orders listed as: Increase the cost of the projects, delay in completion date of project, Increase in duration of individual activities, hold on work in other areas, and claims and disputes between owners and contractor.

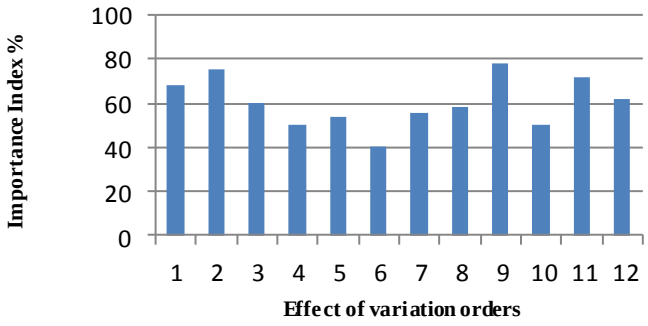

Figure 1. Effects - Owners

Figure 2 shows the top five effects of variation orders of the project from the point of view of contractor are: delay in completion the date of the project, Increase the cost of the projects, delay in payment, additional money for contractor, and claims and disputes between owners and contractor.

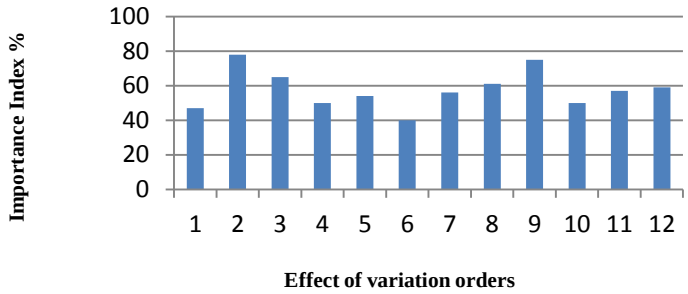

Figure 2. Effects-Contractors

Figure 3 shows the similar results of Engineers with the five most effects as: Increase in cost of the project, delay in completion date of project, additional money for contractor, hold on work on another areas, and disputes between owners and contractor.

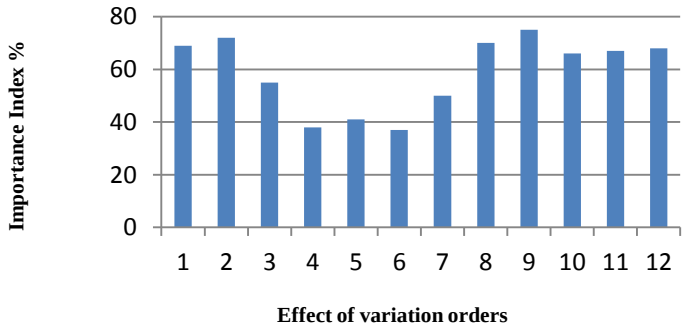

Figure 3. Effects - Engineers

Figure 4 shows the five effects of variation order among all responses as follows: Increase in the cost of the project, delay in completion date of project, Increase in duration of individual activities, additional money for contractor, and claims and disputes between owners and contractor.

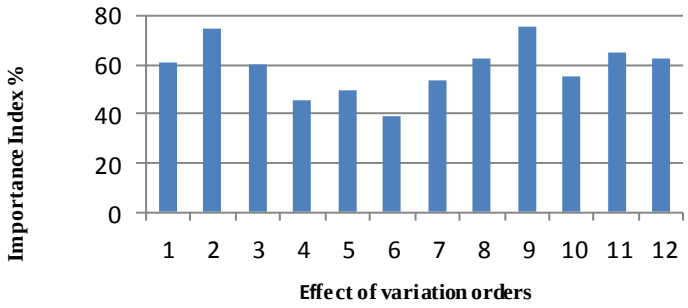

Figure 4. Effects - overall

4.11. Controls of Variation Orders

Figure 5 shows the results of owners on items of variation orders. Out of them, the five most controls to minimize their impacts: Contract document are checked and reviewed, the scope of variation orders is made clear, reviewed for design before change approval, justification of change, and variation order is negotiated by knowledgeable persons.

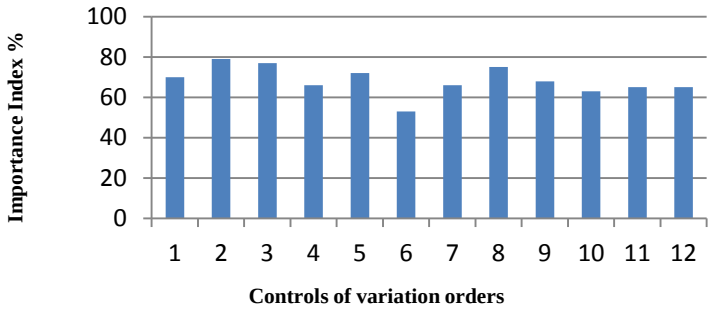

Figure5. Controls - Owners

The most five important controls from contractor's the point view as show in Figure 6 are: Contract document are checked and reviewed, reviewed for design before change approval, a common learning database system should be shared among all government units, variation order is negotiated by knowledgeable persons and changes are not made without appropriate approval in writing

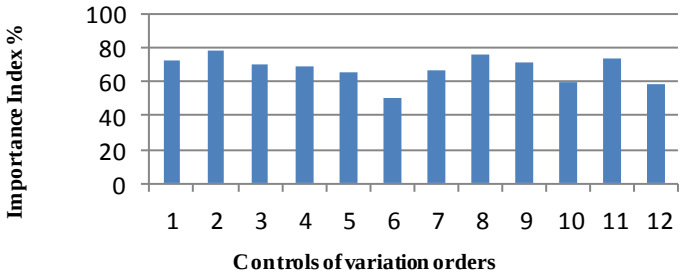

Figure 6. Controls - Contractors

Similarly, the responses from engineers are shown in Figure 7 with the five most controls as follow: Reviewed for design before change approval, contract document are checked and reviewed, registration of the consultant company should be reviewed to reflect its capabilities, justification of change, and variation order is negotiated by knowledgeable persons.

Figure 8 shows the results of the survey for responses and the top five controls of variation order among all responses is as follows: Contract document are checked and reviewed, reviewed for design before change approval, The scope of variation orders is made clear, variation order is negotiated by knowledgeable persons, approval, and registration of the consultant company should be reviewed to reflect its capabilities.

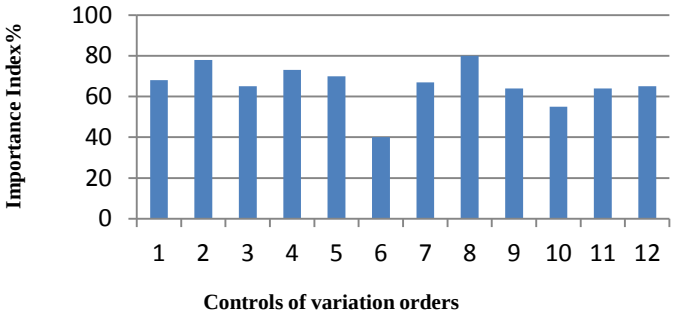

Figure 7. Controls – Engineers

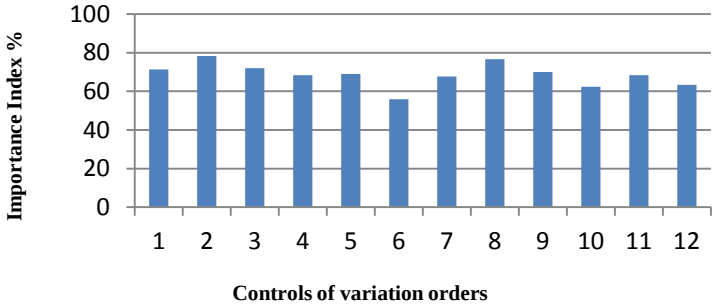

Figure8. Controls - Overall

4.12. Spearman Rank Correlation

The results in table 14 show that there is relatively good agreement between each two groups of pairs in ranking variation order causes for frequency, severity and importance indexes. The highest degree of agreement for frequency index is between owner and contractor 93.6%, also the highest agreement for severity index is between owner and contractor, 93.7.٧%. For importance index the highest degree of agreement is between owner and contractor 84.6%. The lowest degree of agreement for frequency index appears between engineer and contractor about 73.3%. For severity index the lowest degree of agreement is between owner and engineer 69.3%, while the lowest degree of agreement for importance index is between engineer and contractor about 63.5% Due to good agreements between each group of pairs in ranking causes of variation orders, the results of this study can be dependable.

Table14. Spearman Rank Correlation

Pairs	Frequency index		Severity index		Importance index	
	Spearman rank correlation coefficient	Significance level	Spearman rank correlation coefficient	Significance level	Spearman rank correlation coefficient	Significance level
Owner and Engineer	0.812	0.05	O.693	0.05	0.716	0.05
Owner and Contractor	0.936	0.05	0.937	0.05	0.846	0.05
Engineer and Contractor	0/733	0.05	0.755	0.05	0.635	0.05

4.13. Reliability test results

Table 15 shows that the value of Cronbach's alpha Cα for all attributes are computed as 0.923, which is considered to be excellent. Table 15, shows the values for the final four factors ranged from 0.730 to 0.800. These values were at an acceptable level, making all factors reliable.

The percentage of variance explained by each factor in the present study is shown in Table 15. The average variance extracted for each factor ranged from 63.006 to 74.412 for the four constructs. Therefore, four factors were demonstrated to be unifactorial, and this suggests that only a relatively small amount of total variance for each group of variables is associated with causes other than the factor itself. Moreover, the KMO test assessed the suitability of the sample for each unifactorial determination and indicated that all factors were acceptable within the range from 0.508 to 0.716.

Table15. Internal Consistency Analysis, KMO and Variance Explained of Critical Risk Factors in Unifactorial Test

No.	Factor	Cronbach's a reliability	Variance explained % unifactorial	KMO unifactorial
1	causes of variation order by contractor	0.730 Good	63.006	0.508
2	causes of variation order by owner	0.800 Excellent	70.734	0.701
3	causes of variation order by engineer	0.798 Good	63.118	0.716
4	External causes of variation order	0.789 Good	74.412	0.678
	all	0.929 Excellent		

4.14. Case Study results

Table 16 shows that the time overrun due to variation orders causes in building construction sector varies between 8% and 60%. While the time overrun for roads and highways sector varied between 0% and 73.88%. In sewerage sector the time overrun varies between 6.666% and 22.222%. Cost overrun in building construction sector varies between 14.547% and 58.817% increasing cost. While in roads and bridges sector the cost overrun is between 1.59% and 10.3% increasing cost, and between -0.008% and - 7.29% decreasing cost. In sewerage sector the cost overrun varies between -0.054% and -9.123% decreasing cost. According to the results in table 16 it is obvious that the time and cost overrun are depending on the type of the project. In building sector most of cost overrun is increasing contract cost, while most cost overrun in sewerage sector is decreasing cost. According to the project manager of sewerage directory that is due to deletion and omission of works because of the exaggeration or speculation of bill of quantities for the sewerage works to avoid future additional cost during performance in order not to exceed the project budget.

Table16. The Percent of Variation Cost and Time Extension

No	Name of project	Contract cost / Iraqi Dinars	Contract duration / Days	Variation Cost / Iraqi Dinars	Extended Time / Days	Percent of variation cost	Percent of time extension
	Building sector						
1	Constructing 9 houses in berkra	372,994,000	180	180,845,000	96	48.484%	53.33%
2	Constructing a school in melbendey 20 qarachokh	289,557,000	180	45,765,000	75	15.805%	41.66%
3	Construction of sport and youth center unite	149,768,000	360	25,000,000	152	16.692%	42.22
4	Construction of youth and sport directory	105,409,000	360	22,645,000	90	21.482%	30%
5	Construction of sport and youth center unite in kushtepe	987,890,000	360	138,614,000	76	14.031%	21.11%
6	Construction of sport and youth center unite in Erbil	994,326,000	360	144,654,000	89	14.547%	24.72%
7	Construction of electricity hall in Erbil	142,645,000	200	83,900,000	120	58.817%	60%
8	Constructing a school in Kushtape	914,173,000	500	350,450,000	40	38.335%	8%
9	Construction of sport and youth center unite in Hareer	235,907,630	360	135,000,000	68	57.225%	18.88%
10	Constructing a school of 18 class in Erbil	950,370,000	500	250,500,000	49	26.358	9.8%
	Roads and high ways sector						
1	Constructing road in Dushiwan mentik village	134,625,000	75	13,860,000	25	10.3%	33.33%
2	Constructing road in Plinga kona mawaran village	457,750,000	210	-37,500	0	-0.008%	0%
3	Constructing a road in Tutma village	593,185,000	240	33,821,200	103	5.70%%	42.91%
4	Constructing a road in Sinawa village	220,600,000	60	-16,020,000	0	-7.26%	0%
5	Paving the road of Kalacheen village	90,270,000	60	-90,000	0	-0.10%	0%
6	Constructing a road in Girdachal	171,690,000	75	-1,300,000	0	-0.75%	0%
7	Constructing a box culvert in Warti	169,290,000	75	2,700,000	30	1.5 9%	40%
8	Constructing a road in Zhazhuk village	626,995,000	180	282,340,000	133	45.038%	73.88%
9	Constructing a road in shawez	940,235,000	300	570,667,000	200	60.69%	60.66%
10	Constructing a road in Ashi Bragowez Bendaizan village	2,168,570,000	240	-987,990	75	-0.045%	31.25%
	Sewerage sector						
1	Constructing spiral sewerage in Rewandooz	٩٠٧,٩٥٠,٠٠٠	70	-2,950,000	10	-0.324%	14.28%
2	Constructing spiral sewerage in Kownagurg	817,462,500	180	-5,077,500	30	-0.621%	16.66%
3	Constructing spiral sewerage in Koye	794,430,000	200	-430,000	25	-0.054%	12.5%
4	Constructing spiral sewerage in Gishtygal	196,790,000	75	-5,785,000	5	-2.939%	6.66%
5	Constructing spiral sewerage in Khelifan	225,200,000	90	-2,700,000	20	-1.123%	22.22%
6	Constructing spiral sewerage in Azadi	119,900,000	50	-10,939,000	10	-9.123%	20%
7	Constructing sewerage in Khaneqah quarter	430,516,000	95	-3,510,000	15	-0.815%	12.63%
8	Constructing spiral sewerage in Kawnagurg	369,052,000	75	-7,802,000	14	-2.114%	18.66%
9	Constructing sewerage in Khaneqah and changing a water pipe	54,486,5000	150	-4,825,000	30	-0.885%	20%
10	Constructing spiral sewerage in Khanzad	442,900,000	90	-1,000,000	10	-0.225%	11.11%

4.15. Comparing Results of Some Countries of Variation Orders for Some Countries

Table 17 shows that the causes of variation orders in construction projects are differ from one country to another. In Gazza Strip the major causes of variation orders are lack of construction materials and equipment spare parts due to closure and siege, change in design by consultant and lack of consultant's knowledge of available materials and equipment [15]. Yemen major causes are, change of plans or scope by owner, owner's financial problems and change of schedule by the owner [16]. In Malaysia the major causes of variation orders are, poor workmanship, impediment to prompt decision making process and change of schedule by the owner [1]. In Iran the major causes of

variation orders are change of plans or scope by employer, errors and omissions in design and differing site conditions& contractor's financial difficulties [7]. In Kuwait change of plans by owner, change of project scope by owner and Problems on site are the major causes of variation orders [17]. In Egbu the major causes are inadequate working drawing details, conflicts between contract documents and changes scope of project by owners [5]. India major causes are, owner instructs additional works, owner instructs modification to design, and owner's change of schedule due to financial problem [4]. In this study the major causes of variation orders are, change in bill of quantities, change of plans or schedule by owner, and inadequate contractor experience. The most common causes among countries are change of plans or scope by owners, errors & omissions in design, owner change of schedule, conflicts between contract documents, owners financial problems, and lack of consultant's experience about availability of materials or equipment.

Table17. Comparing the Results With Some Countries

Country	**Major Cause1**	**Major Cause2**	**Major Cause3**	**Major Cause4**	**Major Cause5**
Gazza strip, 2010, [15]	Lack of construction materials& equipment spare parts due to closure and siege	Change in design by consultant	Lack of consultant's knowledge about available materials &equipment	Errors & omissions in design	Conflicts between contract documents
Yemen, 2015, [16]	Change of plans or scope by owner	Owner's financial problems	Change of schedule by the owner	Limitations to define the projects objective	Changes in material or procedures
Malaysia, 2014, [1]	Poor workmanship	Impediment to prompt decision making process	Unavailability of equipment	Obstinate nature of owner	Design complexity
Iran, 2012,[7]	Change of plans or scope by employer	Errors and omissions in design	Differing site conditions&	Contractor's financial difficulties	Employer's financial problems
Kuwait, 2014, [17]	Change of plans by owner	Change of project scope by owner	Problems on site	Owners financial problems	Owner change of schedule
Egbu, 2010, [5]	inadequate working drawing details	conflicts between contract documents	Changes scope of project by owners	In contractor side lack of experience	Poor planning by contractor Conflict between contract documents
India, 2015,[4]	Owner instructs additional works	Owner instructs modification to design	Owner's change of schedule due to financial problem.	Unrealistic design periods & Design errors.	Owner fails to make decisions
Erbil, this study, 2015	Change in bill of quantities	Change of plans or schedule by owner	Inadequate contractor experience	Lack of consultant's experience about availability of materials or equipment	Errors & omissions in design

5. Conclusion

In this paper, the findings of the questionnaire survey is presented and discussed. This study investigated the causes, effect, controls of variation order in Erbil Governorate, and compared the main causes of variation orders with some other countries that adopted such studies.

1- From literature review and research it was revealed that the variation orders cannot be avoided completely since construction works involve complex operations that cannot be accurately determined in advance. It was argued that whenever a variation order is issued, unnecessary costs are likely to occur and these constitute a waste of resources and as a result, they contribute to higher construction delivery cost. Variation order can be controlled by putting some standards and restrictions specially, for the consultant.

2- The results of the questionnaire indicate that the owner and engineer are the most responsible parties causing changes. Owner often make changes in the bill of quantities, and make changing in plans or schedule. Owners' financial problems were the critical factors that cause the existence variation orders. The engineer has a lack of experience about the availability of materials or equipment, also making errors and omissions in design because of the lack of experience in design.

3- The results of this study states that effects of variations are increase in project cost, and cause delay in completion date of project, also increase in duration of individual activities. The variation increases disputes and claims in the work which will obstruct the continuousness in the work.

4- To control variation orders the respondents agreed about the suggested controls, that contract document are checked and reviewed, a revue for design should be made before change approval, the scope of variation orders should be made clear, variation order should be negotiated by knowledgeable persons, and registration of the consultant company should be reviewed to reflect its capabilities.

5-The time and cost overrun are depending on the type of the project. In building sector the variation orders increase cost, while most of the variation orders in sewerage sector decrease cost. This is due to wrong estimation or work omission.

6-It is clear from the comparison study that there are many common causes for the major five causes of variation orders among countries such as change of plans or scope by owner, errors and omissions in design, lack of consultant's experience about availability of materials or equipment, and change in design. That means a special attention and care should be taken to control these potential factors of variation orders to eliminate them in their present and future projects.

The findings could help the practitioners to gain better understanding about the problems influencing on budget and time of large projects during construction stage. By taking care of these potential factors

6. Recommendations

1- Emphases the estimation of the bill of quantities by a third party to be in conformity with the design in order to decrease the addition or omission items of bill of quantities.
2- Ensure the availability of materials during the study phase and before starting the design to specify them in order to minimize changing orders of specifications, material, and equipment used.
3- Sufficient time should be given for planning and design phase, this will assist in minimizing errors in design, conflicts between tender documents.
4- Ensure contractors experience before awarding the contract to the bidder.
5- It is recommended that owners make adequate financial planning during planning stage to avoid changing plans later or during construction.
6- Variation order should be negotiated by knowledgeable persons with a sufficient experience in dealing with variation orders.

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