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Evaluating the Causes and Impacts of Change Orders on the Construction Projects Performance in Oman

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Abstract

Purpose: The purpose of the study was to investigate the factors causing the change orders in construction projects and to assess their impact on the projects' performance in Oman.

Design/methodology/approach: The study was conducted using a random sampling technique. The questionnaire was used to collect data from 215 contracting companies located in Muscat Governorate, Oman. Statistical analyses such as the chi-square test, Kolmogorov-Smirnov, and linear regression tests were used.

Findings: The result of the study showed that the variations have more impacts on the project and the change orders harm the project most. It was also revealed that 'Change in specifications', 'Alterations in design and drawing' and 'Time lag in the project implementation' were considered to be the primary causes of change orders, and 'Change of scope', 'Errors and omissions in design' and 'Insufficient Logistics' were the primary causes of variations affecting the construction projects in Oman.

Research Implications: It was suggested to plan for a strategy to avoid the time lag and to take up adequate financial pre-planning to maximize the profit.

Social implications: The findings of the study help the companies to take proactive measures to eliminate or reduce unnecessary variations and change orders to accomplish the prime objectives of such projects.

Originality / Value: This is the first study of its kind in bringing out the issues related to change orders and variations in the construction projects of Muscat Governorate, Oman.

Keywords: Change Orders, Variations, Causes and Impacts on the Construction Projects, Construction Projects in Oman, Clients, Contractors, and Consultants.

Introduction

Since the advent of oil, Oman has witnessed unparalleled growth and prosperity. This growth included the growth of the construction sector, both on the public and private levels. Also, the projects related to this construction sector extend for long periods some times more than months and years, depending on the size of the project and other related factors. The construction period is usually longer compared to other sectorial projects as changes emerge in the project which emerges with the involvement of consultant, owner, and contractor (Ezeldin & El-Sadek, 2016). Change is considered a must if the project warrants it as per the requirement of the owner. The change is represented in the change of delivery time or the cost of work and is possible due to the uniqueness of the task and the time restriction and money that can be accessed. The term 'change order' means approved change in a specification or a project. In any project, the change could occur due to modification of costs, methods, scope, and schedule (Ssegawa et al. 2002; Oladapo, 2007; Turner, 2002).

A change order, which is often called a change request, contains a set of directives that allow modifications, increases, or deletions to the supplier contract arrangement regarding the size and scope of work or the idea of the task to be performed (Khalafallah & Shalaby, 2019). Change in drawings, plans, and agreement reports during the implementation of development projects usually lead to a modification in the mission plan and can result in increased activity and expenditure, which might be a waste of cost, asset, and time.

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Bolin (2018) stated that the change order is a document that contractually modifies the original agreements among signed bodies. It could happen by either the owner or the contractor. Mohammad & Hamzah (2019) defined change order as the work, which is added or deleted from the actual work scope of the contract that modifies the actual completion date or contract amount. Change orders are important to address the unexpected demands and other unavoidable or unforeseen events that adversely affect the progress of a construction project. In most projects, change orders are the main purpose behind deferring development and cost overrun (Karim et. al., 2020). Common contextual investigations carried out by the Government of Oman in the construction projects of the past are shown in Table.1.

Table.1 Details of the Projects Delay Due to Change Orders

#	Original time (days)	Extra time (days)	Delay in %	Aim of the project	Change order details / Impact
1	607	52	8.57	Water Transmission Project– Construction & Commissioning	1. Pipeline rerouting 2. Levelling reservoirs/desalination plants 3. Cover delay 4. Rerouting of pipelines
2	365	365	100	Construction of Classroom buildings	1. Rework of the design 2. Reduce the project scope 3. Adding extra offices – Time overrun 4. Budget mismatch
3	730	153	21	Construction of an asphalt road of 74 km	1. Construction of temporary earth road for turn away traffic 2. Execution of previous change order (10% increase in cost) 3. Revision of new rates
4	825	273	33.1	Construction of 4.2 Km backwater	

Source: Alnuaimi et al. (2010)

Change orders also lead to a decrease in labour productivity and lost man-hours. It is essential to understand the impact of change orders since change orders affect the relationship between the contracting parties. Therefore, those involved in the amendments/modifications must know the need and the purpose, which necessitates such changes, and therefore any such change request must be appropriately taken care of. An agreed and approved project contract is purely based on trust and honesty. A change order might create mitigation against the agreed terms and conditions as per the contract (Nahod, 2012). However, the agreement must be amended by the issuance of a change request. Disagreement to the change request might result in conflicts, the time lag in completion, cost overrun, financial crunch, etc.

The change order is usually an unwelcoming factor in the construction industry, especially in Oman. Also, to expand the profitability of the construction sector of the organizations located in the Governorate of Muscat, there is a need to learn the basic reasons behind the change orders and to formulate a system, through outlining a structure to implement, which might stimulate in reducing the constraints and create opportunities to improve the overall performance of projects in the Governorate of Muscat. This study reflects the effects of change orders in street development projects and other related construction projects in Oman.
The study aimed to examine the effect of change orders on project implementation in construction companies in Oman, which in turn will guide and help the companies to take proactive measures to eliminate or reduce such changes and change orders to accomplish the prime objectives of such projects. It was also aimed to investigate and disclose the causes of change orders in order to analyse the important measures to control such change orders and their occurrences.

Review of Literature

Change orders play a key role in not meeting up the project deadlines (Pourrostam & Ismail, 2012). Hanna et al. (2002a) addressed other factors causing the change orders as design, weather condition, funding, and geological factors. Charoenngam et al. (2003) declared that change order needs to be managed effectively to avoid conflict arising among those who were all involved in a project. Khalifa & Mahamid (2019) declared

that the owner's additional works, errors and omissions in design, financial difficulties, defective workmanship, and poor coordination among construction bodies were the main causes of the change orders. The action of stakeholders – owner, contractor, consultant, etc. of a project could be the direct cause of change order in the construction industry (Ssegawa et al., 2002; Oladapo, 2007). Arain & Pheng (2005) sorted change order causes into five main categories viz. client-related variations, consultant-related variations, contractor-related variations, other variations, and combinations of causes. Gbeleyi (2002) listed out the all possible causes of the change order and their occurrence in the construction projects.

Koushki et al. (2005) addressed that variations and modifications in the construction cause both costs as well as time overrun. But, Ndihokubwayo & Haupt (2009) argued that there is a need to devote more time to the design stage to reduce changes. Changes can be internal and external (Arefazar et al. 2019; Chua & Hossain 2012). The internal changes could be because of uncertainty, which towards construction process (Motawa et al., 2007; Tombesi, 2000), change in methods of construction and future needs of customer that change the scope and plan of the work (Chua & Hossain, 2012; Gil et al., 2006; Perkins, 2009).

The external changes could be because of unexpected events that could contain the wrong assumption in market condition, innovation of materials and technology (Liao & Teo, 2018; Sun & Meng, 2009; Wu et al., 2004), Changes in regulations due to the direct cause of variation (Prasad et al., 2018; Sanni-Anibire et al., 2020; Yap et al., 2019) and unpredictable climate conditions that uncontrolled by construction parties (Yogeswaran et al., 1998; Hsieh et al., 2004). Others argued that design errors, omissions, and client-related changes are the main causes for a change order in a project (Mahamid, 2017; Manavazhi & Xunzhi, 2001; Sun et al., 2006).

Alnuaimi et al. (2010) studied the public construction projects of Oman, reported that client-initiated changes, lack of national information, the soil conditions, and services were the causes for change orders. Additionally, poor workmanship, poor supervision, and site management, and inadequate contractor experience are the prime causes triggering change orders in construction projects (Hsieh et al., 2004; Love et al., 2004). The change orders occurs due to lack of stakeholder engagement, rise complexity, management perspective, and uncertainty, ineffective communication, and a dynamic environment (Butt et al., 2016; Yap & Skitmore, 2017). Al Maktoumi et al., (2020) investigated the factors causing delay ibn construction delay in Oman due to materials, equipment or clients.

Lu & Issa (2005) claimed that design changes are the most frequent and expensive. It includes the lack of briefing practices, client need change, and design errors and omission (Douglas, 2000; Hsieh et al., 2004; Yap & Skitmore, 2017). The impact of change in time and cost results in the redesign and rework as well. Ahmed & Arocho (2021) claimed that the change orders occurs because of the changes in work scope, design errors, and changes in unit rate. Errors by the engineer may cause changes from up-level activities transmitting it to down-level activities (Lee et al., 2005). Design change obtain a positive influence on the goals of the clients (Isaac & Navon, 2013; Yap et al., 2019).

Sun & Meng (2009) claimed that the rework because of changes may increase 10 to 15% of the value of the contract. Cox et al. (1999) reported that change in design has affected the whole cost of the project. Love (2002) claimed that the changes might account for around 50% of the total project value, in term of labor productivity that argued by (Al-Kofahi et al., 2020; Moselhi et al., 2005; Shrestha & Fathi, 2019). Another effect is on workmanship, quality, and staff morale (Hanna et al., 1999; Hanna et al., 2002b; Hanna et al., 2004). Al-Sadi and Khan (2018) revealed that the workers prefer to work with freedom, clearly defined tasks with proper guidance, and without repetition of work like repeated changes, etc. Further, the impact is also on the stakeholders' relationships which shows negative human activities and poor decisions that reflecting poor scope and target (Goodacre and Hunter, 1987),

After thoroughly going through the review literature, the variables – variations, change orders have been identified as the dependent variables which might have an impact on the projects. The statistical analysis was carried on this assumption and performed.

Research Methodology

The sample size was calculated using the following for a population of 500:

$$\text{Sample Size} = \frac{\frac{Z^2 \times p(1-p)}{e^2}}{1+(\frac{Z^2 \times p(1-p)}{e^2 N})}$$

Where N is the population size, e is the confidence interval – margin of error – the permissible rate is 5%), Z is the Z value at 95% (1.96) and p is the likely sample proportion (– permissible is 50%).

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Hence, the needed size of sample $=\frac{\frac{1.96^2 \times 0.5(1-0.5)}{0.05^2}}{1+(\frac{1.96^2 \times 0.5(1-0.5)}{0.05^2 X480})}$ ~214

i.e. the sample taken for this study was 215 which was obtained using the questionnaires from all the stakeholders of the construction industry. The clients, contractors, and consultants were selected on a random sampling basis. SPSS software was utilized to analyse data.

About the conceptual model in this study, there were two independent variables, causes of variation and causes of change orders. The dependent variable is the impact of variation in the construction projects.

Findings

Table.2 Demographic information

Characteristics		Frequency	Percent
Gender	Male	87	40.5
	Female	128	59.5
Nationality	Omani	207	96.3
	Non-Omani	8	3.7
Age	20-29	41	19.1
	30-39	145	67.4
	40-49	26	12.1
	50-59	3	1.4
Education Level	High School	13	6.0
	University	148	68.8
	Master	51	23.7
	PhD	3	1.4
Work Experience	1-5 Years	68	31.6
	6-10 Years	75	34.9
	11-20 Years	62	28.8
	More than 21 Years	10	4.7
Primary area of work	Design	45	20.9
	Construction	57	26.5
	Operation	49	22.8
	Maintenances	8	3.7
	Other	56	26.0
Work description	Client	127	59.1
	Consultant	56	26.0
	Contractor	32	14.9

Source: Questionnaire

Table.3 Reliability Analysis of the data

	N	%
Valid	215	100.0
Excluded	0	.0

Cronbach's Alpha	N of Items
0.720	30

From Table.3, the reliability of data and internal consistency can be ensured as the value more than 0.70.

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The current study obtained factors that lead to the occurrence of variations, and the factors responsible for causes of the change orders, and thereby the impact on the construction projects.

Table.4 Change Orders

	Frequencies										K-S value	p-value
	SD		D		N		A		SA			
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%		
Alteration in Design/Drawing	84	39.1	94	43.7	26	12.1	7	3.3	4	1.9	.261	.000
Change in specifications	80	37.2	96	44.7	24	11.2	13	6.0	2	0.9	.269	.000
Financial Interim arrangement	68	31.6	58	27.0	53	24.7	27	12.6	9	4.2	.190	.000
Disruption due to Weather conditions	34	15.8	62	28.8	73	34.0	30	14.0	16	7.4	.175	.000
Time lag in the project implementation	61	28.4	84	39.1	44	20.5	24	11.2	2	0.9	.243	.000
Unavailability of raw materials	44	20.5	62	28.8	51	23.7	50	23.3	8	3.7	.194	.000
Poor Workmanship	49	22.8	64	31.2	52	24.2	41	19.1	6	2.8	.205	.000
Change in Government regulations	47	21.9	71	33.0	54	25.1	36	16.7	7	3.3	.212	.000
Change of Technology	47	21.9	59	27.4	70	32.6	33	15.3	6	2.8	.186	.000
Additional need for Equipment / Resource	44	20.5	65	30.2	70	32.6	29	13.5	7	3.3	.184	.000

Table.4 shows the choices of the respondents of the change orders in the construction projects. The p-values of all the factors are less than 0.05, which reflect the validity of the analysis i.e. there is a relationship between the choice of the respondents and the change orders. Therefore, comparing the K.S. values obtained from the Kolmogorov-Smirnov test, the result shows that 'Change in specifications' ranked first (0.269) followed by 'Alteration in design and drawing' (0.261) and 'Time lag in the project implementation' (0.243). 'Poor workmanship' ranked fourth (0.205) followed by 'Change in Government regulations' (0.212) and 'Unavailability of project materials' (0.194) ranking sixth.

Table.5 Variations

	Frequencies								K-S value	p-value
	Client		Consultant		Contractor		Other			
	Freq.	%	Freq.	%	Fre	%	Fre	%		
Change of scope	159	74.0	39	18.1	11	5.1	6	2.8	.437	.000
Errors and omissions in design	35	16.3	151	70.2	24	11.2	5	2.3	.362	.000
Lack of Design clarity	61	28.4	115	53.5	33	15.3	6	2.8	.278	.000
Improper Financial Management	117	54.4	45	20.9	39	18.1	14	6.5	.330	.000
Insufficient Logistics	29	13.5	51	23.7	127	59.1	8	3.7	.356	.000

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Improper completion / incompletion handover	45	20.9	40	18.6	122	56.7	8	3.7	.350	.000
Non-quality materials or procedures	75	34.9	49	22.8	82	38.1	9	4.2	.249	.000
Quantification errors	34	15.8	103	47.9	68	31.6	10	4.7	.264	.000

Table.5 shows the choices of the respondents for the variations in the construction projects. The p-values of all the factors are less than 0.05, which reflect the validity of the analysis i.e. there is a relationship between the choice of the respondents and the variations. Therefore, comparing the K.S. values obtained from the Kolmogorov-Smirnov test, the result shows that 'Change of scope' ranked first (0.437) followed by 'Errors and omissions in design' (0.362) and 'Insufficient Logistics' (0.356). 'Improper completion/incompletion handover' ranked fourth (0.350) followed by 'Improper financial management' (0.330) and 'Lack of Design Clarity' (0.278) ranking sixth.

Table.6 Impacts on the Project

Outcome	**Frequencies**						**K-S value**	**p-value**
	Major Impact		**Slight Impact**		**No Impact**			
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**		
Increase in project cost	143	66.5	67	31.2	5	2.3	.417	.000
Delay in completion schedule	113	52.6	89	41.4	13	6.0	.336	.000
Disputes between parties to the contract	83	38.6	122	56.7	10	4.7	.340	.000
Quality standards enhancement	99	46.0	83	38.6	33	15.3	.292	.000
Reputation of one or more parties got adversely affected	84	39.1	106	49.3	25	11.6	.271	.000

Table.6 shows the choices of the respondents of the impacts on the construction project. The p-values of all the factors are less than 0.05, which reflect the validity of the analysis i.e. there is a relationship between the choice of the respondents and the impacts on the projects. Therefore, comparing the K.S. values obtained from the Kolmogorov-Smirnov test, the result shows that 'Increase in project cost' ranked first (0.417) followed by 'Disputes between parties to the contract' (0.340) and 'Delay in completion schedule' (0.336). 'Quality standards enhancement' ranked fourth (0.292) followed by 'Reputation of one or more parties got adversely affected' (0.271).

Table.7 (a), (b), (c) & (d) Regression Analysis

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Variations, Change orders[b]	….	Enter

[a] Dependent Variable: Impacts on the Project
[b] All requested variables entered

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the estimate
1	.321[a]	.103	.094	1.69622

ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	69.872	2	34.936	12.142	.000[b]
Residual	609.961	212	2.877		
Total	679.833	214			

[a] Dependent Variable: Impacts on the Project
[b] All requested variables entered

Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	8.339	.674		12.379	.000
Variations	.064	.016	.256	3.918	.000
Change orders	-0.124	.038	-0.213	-3.261	.001

[a] Dependent Variable: Impacts on the Project

From the above table, it was seen that the p-value of F-table < 0.05. It was also seen that the p-values of the independent variables < 0.05. Thus, it was confirmed that there existed a linear combination between the variables Change orders, Variations, and Impacts on the project. i.e, the derived linear regression equation was as follows:

$$d = 0.064\ b - 0.124\ c$$

where d is the impacts on the project, b is variations and c is change orders. From the equation, it was confirmed that the variations have more impacts on the project and the change orders have negatively impacted the project i.e. the change orders harm the projects most.

Conclusion

The impact of variations and change orders on the construction projects are considered to be complex and affected in many intrinsic ways.

Most of the respondents claimed that 'Change in specifications' followed by 'Alterations in design and drawing' and 'Time lag in the project implementation' were considered to be the primary causes of change orders affecting the construction projects in Oman. Most of the respondents confirmed that 'Change of scope' followed by 'Errors and omissions in design' and 'Insufficient Logistics' were the primary causes of variations affecting the construction projects in Oman. Most of the respondents also confirmed that 'Increase in project cost' followed by 'Disputes between parties to the contract' and 'Delay in completion schedule' were the primary impacts on the projects due to the above said reasons.

It was confirmed that the client only responsible for the causes such as change of scope and financial interim arrangement and these causes occur mainly from the client's side. Most of the causes of variations such as errors and omissions in design, lack of design clarity, and errors of quantification were from the consultant's side. Accordingly, the most resulting impacts on the construction projects were the increase in project cost, delay in completion schedule, and disputes between parties to the contract. Overall, the causes show a direct impact on the construction projects. Thus, the main contribution of the study was to develop a proper change order management system to have better control over the change orders.

Recommendations

Based on the above, the following recommendations were suggested:

- In the context of the contractor, the contractor needs to plan a strategy to fix the time lag occurring on the delivery of the project and the logistics facilities. Also, the contractor needs to take up adequate financial pre-planning to avoid alterations or change in work during the implementation phase i.e. during work-in-progress. Also, it is necessary to avoid using change orders to maximize profit.
- In terms of consultant, the consultant should clearly understand the scope of the work to avoid future changes in design. The consultant should ensure that the materials required and the other equipment are readily available in the pre-planning stage. He/she should avoid miscommunication among the team of design draftsmen to minimize the future change orders and cost overruns thereby.
- In terms of client, the client should conduct a deep assessment plan before the initiation of the project to avoid change in project scope during the execution stage. Also, it is a must for the client to do proper financial pre-planning to cover the overall project and to keep provision for the contingency expenses.

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