International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

Causes and Effects of Variation Orders on Building Construction Projects in Kingdom of Bahrain

Noora Al mannai[1], Saad M. A.Suliman[2]

Mechanical Engineering Department, University of Bahrain, Bahrain
*Corresponding author e-mail: *almannai505[at]gmail.com*

Abstract: ***Variation orders (VO) of construction projects lead to delay, increase in cost, quality defects and other negative effects. Through this research, we can study this dilemma throughout the Kingdom of Bahrain. The study identifies the most important reasons for variation orders in construction projects in the Kingdom of Bahrain. The study tried to clarify the effect of variation orders on the performance of these projects. The study depended on questionnaire and an interview survey. The population sample of this research consisted of clients, consultants and contractors of working construction companies involved in building construction projects in the Kingdom of Bahrain.***

Keywords: Variation orders, construction projects, schedule and cost overrun

1. Introduction

The success of many construction projects depends on a lot of influential factors that are responsible about improving the projects' effectiveness and efficiency. These factors mainly are time, cost, and quality. Projects can be evaluated as successful, if they are handed over to the client/owner within the approved scheduled time without any delay, within the approved budget excluding all the extra cost, and with a high quality outcome. However, with the appearance of VOs, these objectives cannot be achieved properly and successfully.

While carrying out any building construction projects, there is always a desire and a need to avoid waste and inefficient use of resources in order to reduce unnecessary activities and any possible non value-adding activities. Due to many factors, the overall cost of a project can change drastically from the initial agreed cost. These factors could be amendments in the scope of work specifications, or in the agreed contract. In this project, variation orders occur when the project deviates from the project scope or schedule.

Commonly in building projects, Variation Orders (VO) occur when there is any alteration in the initial plan and agreed upon by a written contract. In fact, variation orders represent all changes to the aim and objectives of work that may have a negative effect on cost and time. In light of this problematic issue, this research intends to examine the prevalence of VOs on construction projects in Kingdom of Bahrain. It also aims to highlight the sources that lead to VOs and their causes in building projects in Kingdom of Bahrain. It further aims to test to what degree the VOs can affect the overall performance and achievement of these projects.

In the Kingdom of Bahrain, the construction projects' contractors face challenges in handing over their projects within the approved time, cost and quality. These obstacles are caused by VOs requested by their clients and owners. Unfortunately, VOs are unavoidable in most construction projects. The current study aims to answer the following questions:

- What is the extent of occurrence of VOs in building construction projects?
- What are the predominant sources and causes of VOs in the building construction projects?
- What are the effects of VOs on the overall performance of building construction projects?

To answer these questions, the following objectives are set:

- To examine the common occurrence of VOs in building construction projects.
- To highlight and identify the main sources that lead to VOs, their causes and effects in building construction projects.

This study will contribute to the literature of causes and effects of VOs. The study will highlight the most common causes and effects of VOs in building construction projects, that will assist to minimize and prevent the VOs causes in Kingdom of Bahrain.

2. Literature Review

Changing is taken for granted in engineering projects. A contractor or owner can request engineering design changes to suit the current conditions and be better than the agreed design. But the changes have many disadvantages, such as higher costs and a long period of time to complete the project. The condition of changes must be added to the written contract between the engineer and the contractor or owner. The changes include adding or removing part of the engineering design to match the requirements of the owner or contractor or in line with the real estate market or environmental conditions. VOs are seen as a deviation in the engineering project agenda and may involve adding, deleting or modifying the project agenda. The change may be due to the owner, market demands, or technology development. Ubani, et al; (2010), Alhams, (2010) and Al-suliman, et al; (2014) reported that the VOs are also defined as procedures for changing or modifying a project contract between the owner and the engineer or contractor. VOs affect the project delivery date or final cost of the building or both to gather. There are a lot of reasons leading to VOs,

such as, the financial problems faced by the owner which has the ability to effect the process of work, and the quality of the construction projects in a way that it leads to changing the specifications and the schedule of the work can cause VOs ,Clough and Sears, 1994). As stated by Assaf, et al; (2006), Crewell, et al;(2006, Arian, et al;(2006) and Arian, et al;(2004), the most source of VOs is the consultant and client related causes due to the design errors and omission, design changes, and other conditions. Other significant and important causes of VOs are summarized below as suggested by Mohammad et al., (2015); Keane, et al; (2010) and Mohmed, et al; (2016) i) Client related causes includes inadequate project objectives, change of scope, substitution of materials, financial problem and aesthetic. ii) Consultant related causes includes error and omission, insufficient scope of work, design complexity, change in design, conflicting contract document and insufficient drawing details. iii) External related causes includes different in site condition, new government regulation and weather. In other sight, as stated by, Ndihokubwago et al; (2008, Rubem et al; (2008), Oladapo (2007) and (Osman, et al (2009), the VOs have an effect on overall project performance and the major adverse effects of VOs are time and cost overruns, health and safety issues and quality degradation. VOs also affects the project performance as it leads the contractor to achieve and obtain lower productivity levels than its approved and planned.

3. Methodology

To achieve the objectives of the study, a mixed method research design which relies on grouping quantitative and qualitative methodologies into one research in order to provide a wider overview. Besides, the research design of the current study will consist of several stages including: reviewing the literature, designing expert's questionnaire, analyzing the questionnaire, designing main questionnaire, analyzing results, reviewing the case studies, interviews and deriving conclusion and recommendations. Two questionnaires were designed, the first questionnaire is the experts questionnaire; it is distributed to 09 experts; 03 clients, 03 consultants and 03 contractors, which includes all the 64 causes and 15 effects identified from the literature reviews. Expert's questionnaires were analyzed with the most causes and effects of variation of orders in building construction projects in Kingdom of Bahrain as shown in Appendix (A). The second questionnaire is the main questionnaire includes 49 causes and 11 effects, that filtered from the expert questionnaire. It aims to assess the variation orders causes and effects. Furthermore, it includes two extra parts; one part is general information about the respondant: the respondent years of experience; entity; and job title. The other part is information about projects managed, which consist of: the size of projects that had a director; percentage of projects include VOs that had obstructing work; the rate of delays on time in building construction projects caused by VOs; projects that exceeded the value of the contract due to VOs; and to what extent VOs cause obstruction in building construction projects.

Population of the study consisted of authorized consultants in building construction projects, authorized contractors, clients and owners of projects in the Kingdom of Bahrain. According to The Council for Regulating the Practice of Engineering Professions (CRPEP)approved contractors list, there are 67 contracting companies in Bahrain classified as (A and B) classes, which were considered in this study.

Using Cochran (1963) equation for calculating the sample size for infinite population (assuming p = 0.5 maximum variability, e = ±5%), with 95% confidence level, for 67 contracting companies, the sample size for the contractors was 58. Eighteen approved consultants working in building construction projects, beside, 40 clients of various building projects were selected all as samples for these two categories. Table (1) shows the distribution of the sample used in the study.

Table 1: The Distribution of the Sample of the Study

No.	Project Parties	Distributed	Received
1.	Client	40	35
2.	Consultant	18	17
3.	Contractor	58	30
Total		115	82

4. Results and Analysis

This section reports the results derived from the analysis of the data generated from the three research instruments that were employed in the study, i.e. the questionnaire collected from (82) respondents, eight case studies and interviews of nine experts. It is worth mentioning that the data collected from the questionnaire were analyzed using the Statistical Package for Social Sciences (SPSS). To verify the validity of the study tool, the researcher calculated the Spearman's Coefficient of Correlation between the VOs sources and its causes and effects. The calculated Spearman's coefficients of correlation for the sources of the questionnaire show statistically significant relations (p=0.05) between each of the four source and t causes and effects.

4.1 Respondents Information

The respondent's information section of the questionnaire included questions about the respondent's experience, respondent's work entity, size of projects and projects with VOs that caused obstruction of work in construction projects in Kingdom of Bahrain. Table (2), (3) and (4) are demonstrating the findings generated from respondents' answers.

Table 2: Respondent's Work Experience

Experience	Frequency	Percent
Less than 10	6	7.3%
10 to 15	8	9.8%
15 or more	68	82.9%
Total	82	100%

Table 3: Respondent's Entity

Entity	Frequency	Percent
Owner/ Client	35	42.7%
Consultant	17	20.7%
Contractor	30	36.6%
Total	82	100%

Table 4: Size of the Project

Size of the Project	Frequency	Percent
Less than BD 100 thousand	2	2.4%
BD 100-200 thousand	1	1.2%
BD 200-300 thousand	2	2.4%
BD 300 thousand and more	77	94.0%
Total	82	100%

Table 5: Projects with VOs that caused obstruction of work

Percentage of Projects	Frequency	Percent
None	0	0.0%
Less than 20%	46	56.1%
20% to 50%	33	40.2%
More than 50%	3	3.7%
Total	82	100%

4.2 Analysis of the VOs causes

The means and standard division of Vos causes for each group were calculated as shown in Table (6). By ranking these causes for each group; it shows that in; 1) Client related causes; the "Client financial problems" comes in the first position with mean of 4.720 and standard deviation of 0.634 and the smallest ranking is "Impediment in prompt decision making process" with mean of 3.561 and standard deviation of 0.918. 2) Consultant related causes; the "Lack of coordination" is the most dominant cause with mean of 4.695 and standard deviation of 0.885, and the lowest ranking is "Insufficient time for preparation of contract document" with mean of 2.549 and standard deviation of 0.877. 3) Contractor related causes; the "poor scheduling" cause is in the first rank level with mean of 4.049 and standard deviation of 0.800 and the lowest ranking is "contractor desired profitability" with mean 2.293 and standard deviation of 0.745.

Table 6: Means and standard deviations and ranks of causes of VOs

No.	Causes	Means μ	Standard Deviations	Rank
(1) Client related causes				
1	Client financial problems.	4.720	0.634	1
2	Change of schedule.	4.500	0.790	2
3	Changes in clients' interests / requirements.	4.329	0.847	3
4	Change of plans or scope.	3.988	0.711	4
5	Lack of previous Experience in related projects.	3.890	0.930	5
6	Impediment in prompt decision making process.	3.561	0.918	6
Average		**4.165**	**0.805**	
(2) Consultant related causes				
1	Lack of coordination.	4.695	0.885	1
2	Value engineering.	3.890	0.588	2
3	Modifications of the drawings.	3.866	0.438	3
4	Obstinate nature of clients.	3.841	0.867	4
5	Technology change.	3.829	0.625	5
6	Non-compliant design with client requirements.	3.817	0.803	6
7	Inadequate working drawing details.	3.805	0.576	7
8	Non-compliant design with government regulation.	3.573	0.817	8
9	Conflicts between contract documents.	3.549	0.804	9
10	Failure to observe all other parties requirements (water, electricity, etc.).	3.537	0.804	10
11	Lack of knowledge of available materials and equipment.	3.439	0.876	11
12	Inadequate design team experience.	3.317	0.954	12
13	Consultants lack of required data.	2.976	0.943	13
14	Inadequate scope of work for contractor.	2.927	0.913	14
15	Design complexity and difficult to understand.	2.817	0.918	15
16	Consultant's lack of judgment and experience.	2.768	0.865	16
17	Design discrepancies.	2.756	0.869	17
18	Ambiguous design details.	2.683	0.830	18
19	Insufficient time for preparation of contract documents.	2.549	0.877	19
Average		**3.247**	**0.803**	
(3) Contractor related causes				
1	Poor scheduling.	4.049	0.800	1
2	Shortage of skilled manpower.	3.951	0.469	2
3	Lack of strategic planning.	3.939	0.574	3
4	Defective workmanship.	3.854	0.631	4
5	Shortage of materials.	3.841	0.793	5
6	Unavailability of equipment.	3.744	0.734	6
7	Complex design and technology.	3.561	0.771	7
8	Unfamiliarity with local conditions.	3.402	0.914	8
9	Inadequate shop drawing details.	3.378	0.870	9
10	Honest wrong beliefs of contractors.	3.134	0.604	10
11	Unsuitable management structure and style.	3.049	0.955	11
12	Improper control over site resource allocation.	2.951	0.980	12
13	Poor site management and supervision.	2.854	0.957	13
14	Contractors lack of judgment and experience.	2.805	0.895	14

15	Lack of a specialized construction manager.	2.793	0.899	15
16	Different site conditions.	2.622	0.826	16
17	Long procurement lead time.	2.585	0.647	17
18	Contractor financial difficulties.	2.488	0.835	18
19	Poor procurement process.	2.476	0.707	19
20	Changes in construction method.	2.439	0.771	20
21	Contractor desired profitability.	2.293	0.745	21
Average		**3.153**	**0.762**	
(4) External environment causes				
1	Weather conditions.	3.963	0.429	1
2	Unforeseen problems.	3.939	0.454	2
3	Change in government regulations.	3.720	0.742	3
Average		**3.874**	**0.542**	

4.3 Analysis of the VOs sources

By ranking the causes groups "client, consultant contractor and external" as it is shown in Table (7) the most dominant sources of VOs are client related causes with the highest mean85and standard deviation of 4.165 and 0.805, respectively. External environment related causes demonstrate the second ranking with mean of 3.874 and standard deviation of 0.542. In the third level is Consultant related causes with mean of 3.247 and standard deviation of 0.803. Contractorrelated causes has the smallest mean of 3.153 with a standard deviation of 0.762,respectively. These results reflect the main causes of VOs for the differentparties. It should be mentioned that the client related causes include a totalof only six causes of VOs. On other hand, the contractor related causesinclude a total of twenty-one causes of VOs.

Table 7: Summary of the means, standard deviations and ranks of causes of VOs related groups

No.	Subscale	Means	Standard Deviations	Rank
1	Client related causes	4.165	0.805	1
2	Consultant related causes	3.247	0.803	3
3	Contractor related causes	3.153	0.762	4
4	External Environment related causes	3.874	0.542	2

4.4 Analysis of the VOs effects

The means and ranks of the VOs effects in building construction projects are shown in Table (8). The results shows that the most dominant effect of VOs in construction projects in Bahrain is the "Completion schedule delay/Time overrun" with mean of 4.817 and standard deviation of 0.611. The second effects is "cost overrun" with mean of 4.805 and standard deviation of 0.675. Followed by "poor professional relation" in the third level with mean of 4.110 and standard deviation of 0.956. In the forth ranking is "effect on progress" with mean of 3.890 and standard deviation of 0.497, then "logistic delay" is in the fifth level, with mean of 3.805 and standard deviation of 0.532. In the six level "rework and demolition" with mean of 3.744 and standard deviation of 0.584. "health and safety" is in the seventh level with mean 3.293 and standard deviation of 0.728. Then "employment of new professional" with mean of 3.171 and standard deviation of 0.927. In the ninth ranks is "increase in overhead expenses" with mean 2.683 and standard deviation of 0.873.

Table 8: Means and standard deviations and ranks of effects of VOs

No.	Effects	Mean	Standard Deviations	Rank
1	Time overrun	4.817	0.611	1
2	Cost overrun	4.805	0.675	2
3	Poor professional relations	4.110	0.956	3
4	Effect on progress	3.890	0.497	4
5	Logistic delays	3.805	0.532	5
6	Rework and demolition	3.744	0.584	6
7	Health and safety	3.293	0.728	7
8	Employment of new professionals	3.171	0.927	8
9	Increase in overhead expenses	2.683	0.873	9
10	Delay in payment	2.500	0.850	10

4.5 Case studies

The case studies were taken from Durrat Khlaeej AL-Bahrain resort, it is consisting of three sectors private sector, semi private sector and public sector. During the study period, there were a total of 128 residential villas under execution in private sector. From these projects, eight completed projects with approved VOs were selected. The list of selected projects is shown in Table (9).

Table 9: Selected projects on Durrat Khaleej Al-Bahrain as case studies

Project	Project Name	Contract Amount BHD	VO Cost BHD	Percent of VO cost
Project 1	Fishing Deck Petal 1,2,3,4 and 5	105000	5250	5%
Project 2	Toilet Blocks Petal 4 and 5	28000	650.800	2.3%
Project 3	Villa 5367	176000	-2126.14	-1.2%
Project 4	Villa 5343	176000	325	0.184%
Project 5	Villa 4777	176000	363.200	0.2%
Project 6	Petal 5 villas	11246000	8561.400	0.076%
Project 7	Construction of telecommunication building Petal 4 and 5	650000	27991	4.3%
Project 8	Petal 4 Villas	11246000	644645	5.732%

By analyzing and studying the eight projects in Durrat Khaleej Al-bahrain, each project has its causes and effects of variation orders and it is summarized as shown in Table (10).

Table 10: Summary of causes and effects of VOs in Durrat Khaleej Al-Bahrain projects as case studies

Projects	Causes of VOs	Effects of VOs
Project 1	• Change in client interests and requirements. • Change of plans and scope. • Lack of previous experience in related projects.	• Cost overrun. • Completion schedule delay /Time overrun.
Project 2	• Inadequate working drawing details. • Conflict between contract documents. • Lack of coordination between the parties.	• Completion schedule delay /Time overrun • Increase in project cost. • Disputes among parties.
Project 3	• Client financial problems. • Design modification and Design changes.	• Contract cost decreased.
Project 4	• Client interests and requirements. • Change of plans and scope. • Contractor, shortage of skilled manpower. • Poor site management and supervisor.	• Cost overrun. • Completion schedule delay /Time overrun. • Effect on progress.
Project 5	• Client interest and requirements. • Change of plans and scope.	• Completion schedule delay /Time overrun. • Cost overrun.
Project 6	• Consultant, involvement of value engineering. • Contractor, lack of strategic planning. • Unavailability of materials.	• Disputes among parties. • Completion schedule delay /Time overrun. • Cost overrun. • Effect on progress.
Project 7	• Client change of plans and scope. • Financial problems. • Consultant lack of coordination. • Technology changes. • Modification of drawings. • Non - compliant design with Government Regulation TRA. • Failure to observe all other parties. • Value engineering.	• Cost overrun. • Completion schedule delay /Time overrun. • Poor professional relations. • Effects on progress.
Project 8	• Client interest and requirements. • Consultant change of design. • Contractor, Poor scheduling and defective workmanship.	• Completion schedule delay /Time overrun. • Cost overrun. • Poor profession relations. • Effect on progress.

4.6 Comparison of the questionnaire and the case studies

By comparing the outcome from the questionnaire and the case studies, it is obvious that there is similarities and differences between the questionnaire and case studies analyses with respect to the ranking of causes of VOs. The differences between the case studies and questionnaire are mainly because of the limited data obtained from the few case studies considered in comparison with the questionnaire data obtained from the clients, consultants and contractors.

The similarities between the case studies and the questionnaire of the "Client related causes" are: 1) Client financial problems. 2) Change of plans and scope. 3) Lack of previous experience in related to projects. While the similarities with regard to "Consultant related causes" are:1)Lack of coordination. 2) Value engineering. 3) Modification of drawings. 4) Technology change. 5) Non-compliant design with client requirement. 6) Inadequate working drawings details. 7) Non- compliant design with government regulation. 8) Conflict between contract and document. 9) Failure to observe all other parties' requirements.

The common causes between questionnaire and case studies "Contractor related causes" are: 1) Poor scheduling. 2) Shortage of skilled manpower. 3) Lack of strategic planning. 4) Defective workmanship.5) Unavailability of equipment. 6) Complex design and technology. 7) Unfamiliarity with local conditions. 8) Poor site management and supervision.

In addition to the causes, the analysis of the effects of VOs, Table (11) shows the similarities between the questionnaire's results and case studies'. The most potential effects of VOs are accordingly: a) Cost overruns. b) Completion schedule delay / Time overrun. c) Effect on progress and d) Poor professional relations.

Table 11: Comparison between the questionnaire and case studies' results in terms of the VOs' effects

Effects	Questionnaire Ranking	Case study ranking
1. Completion schedule delay / Time overrun	1	1
2. Cost overrun	2	1
3. Poor professional relations	3	3
4. Effect on progress	4	2
5. Logistic delays	5	
6. Rework and demolition	6	
7. Health and safety	7	
8. Employment of new professionals	8	
9. Increase in overhead expenses	9	
10. Delay in payment	10	
11. Procurement delay	11	

5. Conclusions

The study concluded that the causes of variations and their effects on project cost and schedule are complex. The risks associated with project changes and variations make the planning and controlling of these changes a difficult task. The objective and aim of the study was to carry out a literature review and field survey to identify major causes of variations, their effects on projects and control procedures adopted in Kingdom of Bahrain . therefore, the conclusion can be demonstrated the following;The general construction information collected mentions the following facts: contractors participated in large and huge building constructions projects are large in size and most of them reported over 15 years of experience. The working relation between project parties in construction process is generally and usually very good. Results indicated an active participation of clients during design and construction stages. Furthermore, From the data analysis and case studies, it shows that the Client is the main source of changes and variations in construction projects. Change of plans by client is the first cause of variations by the client. There are three possible explanations to this; First, the client was not involved in the design development. Second, the client did not understand or visualize the design. The designer may not have made the design clear or the client just lacked the ability to read the drawings. Third, it is merely a change of mind while not appreciating the negative effects of changes. The results showed that changes and variations may be made by client due to financial issues facing the client.

In addition to the above, Consultant is the second major source contributor to VOs, by generating conflicting design documents or through change in design after award. Another cause is errors and omissions in design. So, Increase in project cost and time overrun are the two main effects being noted for VOs. Quality of work is not affected by variations. Additional revenue for contractors is considered an outcome of variations.

The study has further concluded that contractors and consultants agree to a large extent on the causes of VOs, effects of these causes and the controls adopted. This is in contrary to the common perception that consultants and contractors would not agree. The normally adversarial relation did not affect their evaluation of the problem. This indicates a mature and well-developed contractual relationship in this field of construction. This may not be present in small-scale construction projects.

References

[1] Al-Hams, M. (2010). "*Simulation Model of Change Orders and their Impact on Building Projects Performance in Gaza Strip*". Master's thesis: The Islamic University-Gaza-Palestine. Retrieved from:
[2] https://iugspace.iugaza.edu.ps/bitstream/handle/20.500.12358/19473/file_1.pdf?sequence=1&isAllowed=y
[3] Al-Suliman, J. A. (2014). "*Effective Stakeholder Engagement in Variation Order Management at the Design Stage of Public Sector Construction Projects in Saudi Arabia*". Ph.D. Dissertation: School of the Built Environment. Heriot-Watt University London.
[4] Arain, F. M., Assaf. S and Low, S. P. (2004). "*Causes of Discrepancies Between Design and Construction*". Architectural Science Review. 47(3): 237-249.
[5] Arain, F. M., and Low, S. P. (2006). "*Developers' Views of Potential Causes of Variation Orders for Institutional Buildings in Singapore*". Architectural Science Review49(1): 59–74.
[6] Assaf, S. A.; and Al-Hejji, S. (2006). "*Causes of delay in large construction projects*". International Journal of Project Management 24(4): 349–357. doi:10.1016/j.ijproman.2005.11.010
[7] Clough, R. H. and Sears, G. A. (1994). "*Construction Contracting*". 6th ed. John Wiley and Sons Inc., New York.
[8] *Creswell, J. W., and Plano Clark, V. L. (2006).* "*Designing* and Conducting Mixed Methods Research". Thousand Oaks, CA: Sage.
[9] *Cochran, W.G. (1963) Sampling Techniques, Wiley, New York*
[10] Keane, P., Sertyesilisik, B., and Ross, A. (2010). "*Variations and change orders on construction projects*". J. Legal Affairs Dispute Resolution Eng. Constr., 2: 89-99.
[11] Mohammed, A. (2016). "*A study for the causes of variation orders in different sectors of construction projects in Erbil Governorate form the point of view of the involved parties*". Journal of engineering and sustainable development: Vol. 20, No.05, September 2016. ISSN 2520-0917.
[12] Mohammad, Z., Keyvanfar, A., MuhdZaimi, A., Shafaghat, A., Magana, A., and Dankaka, N. (2015). "*Causes of variation orders in building and civil engineering projects in Nigeria*". JurnalTeknologi (Sciences and Engineering) 77:16 (2015) 91–97.
[13] Ndihokubwayo, R.; and Haupt, T. C. (2008). "*Uncovering the origins of variation orders*". In Proceedings of the 5th Post Graduate Conference on Construction Industry Development, 16–18 March 2008, Bloemfontein, South Africa, 88–96.
[14] Oladapo, A. (2007). "*A quantitative assessment of the cost and time impact of variation orders on construction projects*". Journal of Engineering, Design and Technology, Vol. five No. 1, pp. 35-48. https://doi.org/10.1108/17260530710746597
[15] Osman, Z., Omran A. and Foo, C.K. (2009). "*The Potential Effects of Variation Orders in Construction Projects*". Journal of Engineering. 2: 141-152.
[16] Ruben, N. (2008). "*An analysis of the impact of variation orders on project performance*". Cape Peninsula University of Technology, *Theses and Dissertations*, Paper 33.
[17] Ubani, E., C., Nwachukwu, and Nwokonkwo, O. (2010). "*Variation Factors of Project Plans and Their Contributions to Project Failure in Nigeria*". American Journal of Social and Management Sciences. 1(2): 141-149

Appendix A: Experts questionnaire analysis

No	Variation order Causes	1 (Strongly disagree)	2 (Disagree)	3 (Neither Agree or Disagree)	4 (Agree)	5 (Strongly Agree)	Total	Total Likert – points	Select Score≥4
	Frequencies								
	Client Related Causes								
1	Change in Plan or scope				2	7	(2*4)+ (7*5) = 43	43/09= 4.7	✓
2	Change of Schedule				3	6	42	4.6	✓
3	Change in clients interest			1	5	3	38	4.2	✓
4	The long waiting time to get approval on drawing		1	2	5	1	33	3.6	
5	Inadequate Project objectives		1	7	1		27	3.0	
6	Replacement of materials or procedure		1	6		2	30	3.3	
7	Impediment in Prompt Decision making process			1	3	5	40	4.4	✓
8	Lack of Previous experience in related projects			1	3	5	40	4.4	✓
9	Obstinate nature of client			4	3	2	34	3.7	
10	Change in Specification by client		4	3		2	30	3.3	
11	Client financial problems		1		1	7	41	4.5	✓
	Consultant Related Causes								
1	Change in design by consultant			4	3	2	34	3.7	
2	Error and omissions in design		2	1	3	3	34	3.7	
3	Conflicts Between Contract documents				2	7	43	4.7	✓
4	Inadequate design team experience					9	45	5.0	✓
5	Consultants lack judgment and experience					9	45	5.0	✓
6	Lack of Consultants knowledge of available materials and Equipment				4	5	41	4.5	✓
7	Design complexity and difficulty to understand				5	4	41	4.5	✓
8	Insufficient time for preparation of contract documents			2	3	4	38	4.2	✓
9	Modifications to the drawings				4	5	41	4.5	✓
10	Inadequate working drawing details				3	6	42	4.6	✓
11	Lack of required data				7	2	38	4.2	✓
12	Failure to observe all other parties requirement			1	4	4	39	4.3	✓
13	Client financial problems		2	3	2	2	31	3.4	
14	Obstinate nature of clients			1	5	3	38	4.2	✓
15	Technology Changes				7	2	38	4.2	✓
16	Value engineering				4	5	36	4.0	✓
17	Inadequate scope of work for contractor			2	4	4	42	4.6	✓
18	Lack of coordination				3	6	42	4.6	✓
19	Ambiguous design details				2	7	43	4.7	✓
20	Honest wrong beliefs of consultant		1	4	3	1	31	3.4	
21	Design discrepancies			1	4	4	39	4.3	✓
22	Non-Compliant design with client requirements				6	3	39	4.3	✓
23	Non-compliant design with government regulation				5	4	40	4.4	✓
	Contractor Related Causes								
1	Fast completion of Construction activities			6	3		30	3.3	
2	Lack of strategic planning				7	2	38	4.2	✓
3	Complex design and technology				7	2	38	4.2	✓
4	Lack of contractors involvement in design		1		7	1	35	3.8	
5	Unsuitable management structure and style of contractor				8	1	37	4.1	✓
6	Lack of communication		2	3	3	2	30	3.3	
7	Poor site management and supervision				1	8	44	4.8	✓
8	Lack of specialized construction manager			1		8	43	4.7	✓
9	Contractors lack of required data		3	1	4	1	30	3.3	
10	Shortage of materials			1	6	2	37	4.1	✓
11	Improper control over site resource allocation					9	45	5.0	✓
12	Contractors lack of judgment and experience			1		8	43	4.7	✓
13	Shortage of skilled manpower		1			8	42	4.6	✓
14	Defective workmanship				1	8	44	4.8	✓
15	Change in construction method				2	7	43	4.7	✓
16	Different site conditions				2	7	43	4.7	✓
17	Contractors financial difficulties					9	45	5.0	✓
18	Contractors desired profitability				8	1	37	4.1	✓
19	Poor scheduling		1			8	42	4.6	✓
20	Inadequate shop drawing details			2		7	41	4.5	✓
21	Unavailability of equipment		3			6	36	4.0	✓

22	Unfamiliarity with local conditions			1	1	7	42	4.6	✓
23	Poor procurement process				2	7	43	4.7	✓
24	Long Procurement lead time				8	1	41	4.5	✓
25	Honest wrong beliefs of contractors				8	1	37	4.1	✓
	External Environment Related causes								
1	Weather conditions				1	8	44	4.8	✓
2	Unforeseen problems				8	1	44	4.8	✓
3	Change in government regulations				9		36	4.0	✓
4	Change in economic conditions		1	7		1	28	3.1	
5	Change in the competing market		2	7			25	2.7	
	Effects of Variation Orders								
1	Effect on progress				5	4	40	4.4	✓
2	Cost overrun				2	7	43	4.7	✓
3	Employment of new professionals			1	3	5	40	4.4	✓
4	Increase on overhead expenses				8	1	37	4.1	✓
5	Delay in payment			1	5	3	38	4.2	✓
6	Quality degradation		2	3	3	1	30	3.3	
7	Productivity degradation		2	3	2	2	31	3.4	
8	Procurement delay			2	1	6	40	4.4	✓
9	Rework and demolition			1	4	4	39	4.3	✓
10	Logistic delays			1	5	3	38	4.2	✓
11	Damage to firm's reputation			7	2		29	3.2	
12	Poor safety conditions			2	6	1	35	3.9	
13	Poor professional relations			1	6	2	37	4.1	✓
14	Additional payment for contractor			5	3	1	32	3.5	
15	Completion schedule delay				7	2	38	4.2	✓
16	Health and safety			1	2	6	41	4.5	✓