Global Scientific JOURNALS

GSJ: Volume 8, Issue 9, September 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

TO INVESTIGATE VARIATION ORDER EFFECTS ON BUILDING CONSTRUCTION PROJECTS - REVIEW

Abdul Ghafoor[1], Yaseen Mahmood[2]

[1]*Abdul Ghafoor, Department of Civil Engineering IQRA National University Peshawar, Pakistan. Email: abdulghafoor_94@yahoo.com*
[2] *Yaseen Mahmood, Supervisor, Department of Civil Engineering IQRA National University Peshawar, Pakistan. Email:* Yaseen@inu.edu.pk

ABSTRACT

Throughout the world, in construction industry due to complex nature of projects various are common. Moreover, in construction project most frequently occurring issues which faced by contractors are various orders. Variations are known to impact various aspects of construction projects. Therefore, it is necessary to study about the various order impacts on construction projects to minimize the wastage of resources in construction industry. The main focus of this research is to investigate variation orders effects on Construction projects. In order to achieve our study objective, this study is limited to public buildings. After studding the literature review, as a result 15 numbers of variation orders effects the public buildings are identified. In addition, different tools are used (Questionnaire Survey, desk study and Interview) to determine the effects of variation orders on public buildings. Five numbers of public buildings were selected for desk study and variation orders effects on those buildings are determined. For conducting interviews public building project experience respondents with expert opinions are selected. Questionnaire survey form were given to relevant project parties for obtaining their responses. After receiving responses on the basses of survey forms, relative index method (RI) was used for analysis purpose. In order to find more accurate data from the findings, in this study triangulation method were used on the desk study, survey and the literatures. Based on results it was concluded that main variation orders effects on public buildings were, delay in work schedule, project cost increased, Contactor additional payments, effect on progress, and overhead expenses increase.

Keyword's: Construction Industry, Public Buildings, Questionnaire Survey, Relative Index Method, Triangulation Method, Variation Order.

I. INTRODUCTION:

In the construction industry public projects implementations are expected to provide further thrust. Thus, successful executions of these projects were one of important and significant without causes any major problem to reduce the effect of variation orders on the outcome of any project. In each construction project, it is unavoidable to make changes in original scope of work without issuance of variation orders so if there was any changes occurred to original scope of work, variation orders are issued to accurate or modify the original scope of work. As in project if variation order numbers increase complication created between contacting parties to work on their original work schedule. These complications may occur due to lack of knowledge regarding variation order between parties. The changes in original scope of work included i.e. cost of implementation changes, work delays, conflicts, and construction sequence interruption and original submitted work schedule, and lead directly to effect project coordination badly. Variation order sources and caused were studied by previous researchers. At different stages of the project, construction delays, construction cost overrun, and construction quality defects are caused of variations many times. Overall project performance is badly affected by Variation orders (Ruben, 2008). That is why variations in project can cause substantial adjustment to the duration of contract, total direct and indirect cost, or both. More ever, it is also included alteration, addition, omission, and substitution in terms of quality, quantity, and work schedule. Variation was defined as "any addition, deletion, or revision to objectives of project and work scope" which directly make changes to in the schedule and cost of the project. (Ibbs et al., 1998). Sun and Ming (2004) described variation in construction projects i.e. design changes, building works, programs or project aspects caused by variations of pre-existing situations, norms, or requirements. In building projects variation order occurrence in most countries are usual. More ever, in our daily routine of building construction projects variations and conflicts at work are very common (Arain and Pheng, 2006). Thus, it is important to study the effect of variations on public buildings due to issue in construction industry and especially problem to public building. The aim of this research is to investigate public building projects effected due to variation orders. The steps outlined in this in this study were introduction, literature review, data analysis and conclusion.

II. LITERATURE REVIEW:

As no single definition of variation are there to describe but the term 'variation' defined by various standard forms of contract differs from one another but in principle the definition and/or meaning is more or less same. A definition of a variation with respect to specific actions and activities will contain any standard form of building contract usually. The dictionary of building contract defined variations i.e. alterations, additions or work omission, materials omission, working hours omission, workspace omission, etc. Impact is described in electronic Webster dictionary as "The impression force of one thing on another". No issue how the project planned and scheduled carefully or not but variation must be certain before completion of any project. During construction projects from various bases the variations are very common and likely to occur. Ming et al. (2004) observed variations in projects are of two types i.e. "anticipated" and "emergent". The variation which are planned in advance and Anticipated variations are planned in advance and occurred as per plan called anticipated variations. While emergent variations are opposite to anticipated variation because these variations occurred without planning or suddenly. To view project variation, need/necessity is another way thus classified project variation as "elective" and "required" (Ming et al., 2004). When there is chance of yes/no option for implementing the variation called elective while in required variation there is no chance/option but make variation. Arain & Pheng (2005) classified variation orders in two types, namely: beneficial and detrimental.

The variation order included project quality standard improvement, project cost reduction, improvement of project work schedule or degree of difficulty known as beneficial variation. As a result of this variation unnecessary project cost are eliminated form project which leads client benefit in terms of eliminating unnecessary cost from project against the resource input. This means beneficial variation orders initiated for value analysis purposes and client satisfaction to realize a stability between the cost, functionality, and durability aspects of a project. For the identification and elimination of unnecessary costs, value analysis is an organized approach and defined as "costs which provide neither use, nor life, nor quality, nor appearance, nor customer features" (Kelly & Male, 2002). On the other hand, variation which effect client value or project performance negatively defined as detrimental variation i.e. a substandard cheap material was used instead of quality standard expensive materials when client experiencing financial problems. Perhaps, a detrimental variation order compromises the client's value system i.e. if frames of timber and aluminum were not used in marine construction but used steel window frames which results in steel oxidation.

In construction projects the variation orders effected directly and indirectly some part of project which directly damaged the productivity rate of said project were accepted by many experience/experts professional working in construction industry. In addition, consultants/designers and client/owners are responsible for any type loss occurred due to variation orders as felt by the contactor.

While productivity loss in construction project caused due to poor management of the contractor was claimed by owners. Though, the project productivity will not affect by every variation. Disturbance caused by variation orders when occurred in planned activities and required existing plan review the recent developments. Many researchers noted variation orders occurrence which effected the performance of project negatively. Ruben (2008) concluded overall performance of project was affected by the variation orders while cost overturns, time and conflict between parties are affected very badly. Thomas et al. (2002) observed that variability delays project performance. Ibbs (1997) concluded that variation orders affect project performance as they adversely affect productivity and project costs. According to Arain and Pheng (2005), in any construction project inevitable and unwanted reality are variation orders. Further, Hanna et al. (2002) observed that contactors achieved low productivity as compared to plan in schedule if large numbers of variation orders caused. Success of project was disturbed negatively due to causes of Variation orders in project such as cost overruns, time overruns, quality degradation, health and safety problems and professional relations. Many professional researchers studied to determine the variations impacts ,variation and its impacts relation-ships (Hanna et al., 2002; Hester et al., 1991; Thomas and Napolitan, 1995; Osman et al., 2009; Ibbs, 1997; Arain and Pheng, 2005; Haldun, 1998; CII, 1990; Ibbs, 1998). According to the above authors, the various impacts of variation orders were;

- Project cost increase
- Progress affected without any delay
- Overhead expenses increase
- Payment delay
- Degradation of quality
- Degradation in production
- Delay in procurement
- Re-work and demolition
- Delays in logistics
- Blemish firm's reputation
- Safety conditions (Poor)
- Professional relations (Poor)
- Contractor Additional payments
- Professionals disputes
- Delay in work Schedule

Based on above literature, building projects are affected by various order frequent occurrence i.e. by cost overruns contribution and delays in completion schedule. More ever, conflicts between contract parties occurred if variations are not management carefully.

III. RESEARCH METHODOLOGY

In this study, the data was collected from relevant parties and to select the population a purposive sampling method was used. In this research methodology qualitative and quantitative combine approaches were utilized. Based on direct exposure to project activities of building projects the interviewer and respondents were selected. On public building projects, to determine the variation orders effect desk study, interview and questionnaire survey were conducted. For collecting data in this study above mentioned three units were used to analyze form concerned population. In order to find more accurate data from the findings, in this study triangulation method were used on the desk study, survey and the literatures. Variation orders effects were determined on selected public building project by conducting the desk study. The project payment certificates, and monthly progress reports was used for data extraction to get information on the stated problem which is useful in building projects to know the theories and actual practices relationship. For this study, the importance of topic was found by data collection through desk study. For conducting interviews public building project experience respondents with expert opinions are selected. By using the relative index (RI) technique analysis of questionnaire responses were conducted. to measure variables relative index is the simplest method in a quantitative research. Moreover, the based on qualitative data on variation order impacts which is obtained from public buildings stakeholders in construction industry by their perceptions. To find variation orders impacts most frequently on public buildings project literature review were used for variables identification. The questionnaire survey was developed in such a way to collect information from experts that involved in public building projects. By utilizing scale of Likert's having five measures and arranged in

ascending orders from 1 to 5 for ranking response. Relative index method was used for data analysis. The main approach used for data analysis was the Relative Index (RI) technique.

$$RI = \frac{(5n_5 + 4n_4 + 3n_3 + 2n_2 + n)}{5\,(n_5 + n_4 + n_3 + n_2 + n)} \quad (1)$$

where RI= Relative index and n_5, n_4, $n_{3.....}$ = Responses indices numbers

MS excel software package was used for analysis purposes of responses. The analysis involved factor ranking on bases of degree of effect. For determining the variances in ranking between two groups of respondents Spearman (rho) rank correlation coefficient is used scoring for various factors (i.e. clients versus consultants, clients versus contractors, and consultants versus contractors).

$$Rho\ (\rho_{cal}) = 1 - \frac{6 \text{ x } (\Sigma d_i^2)}{N \text{ x } (N^2 - 1)} \quad (2)$$

Where: *Rho (ρ_{cal})*: Spearman's rank correlation coefficient, d_i: the difference in ranking between each pair of factors; and *N*: number of factors (variables). The Spearman (rho) rank correlation coefficient value varies between *-1* and *+1*. A correlation coefficient of +1,0 and 1 implies perfect positive correlation, no correlation and perfect negative correlation, respectively.

IV. Result Analysis and Discussion:

In this section the collected data was analyzed obtained from three groups i.e. by questionnaire survey, desk study and interviews responses. Questionnaire data were tabulated and analyzed according to their ranking on Relative Index (RI) while results obtained from Interview and desk study were presented combinedly with observations.

The Desk study, interviewers and questionnaire survey results are shown in detail below

Result of Desk Study:

During this study, 5 numbers of public building in completed conditions were selected for desk study in which variation orders were already approved to know the effect of variation orders on these buildings. The details were listed in table1

Table 1. Public Building projects Selected for desk Study

Project Code	Project Name	Contract Amount (Birr)	V.O (Birr)	Percent of V.O (%)
Project A	Sport Commission Building	51,931,227.89	8,284,485.09	15.95
Project B	Education Bureau Building	60,343,438.45	4,091,699.06	6.78
Project C	Police Commission Building	99,444,398.79	8,152,255.70	8.20
Project D	Credit & Savings Institution Building	36,914,578.87	7,234,368.3	19.60
Project E	Fire and Emergency Service Building	58,076,253.18	5,150,610.80	8.87

It was clearly observed form table one that Project D having highest increase in cost (19.60%) due to variation orders while project B showed less change in cost percentage. The Summary due to variation order effects from desk study were also shown in table 2.

Table 2. Effects of variation orders from desk study (summary)

Project Code	Impact of V. O
Project A	Project cost increased and Delay in work schedule
Project B	Project cost increased, Delay in work schedule, Disputes among the parties, Delay Payment to the contractor
Project C	Project cost increased, Delay in work schedule
Project D	Project cost increased, Delay in work schedule Delay Payment to the contractor
Project E	Project cost increased, Delay in work schedule

Table 2 showed findings of desk study and effects on variation orders due to desk study results such as

- Project cost increased
- Delay in work schedule
- Disputes among the parties
- Delay Payment to the contractor

Result of interviews:

In this study, interviews were conducted form selected experts having great experience in dealing of variation orders in public building projects. Total of Three persons/participants were selected form client, consultants and contractor i.e. senior project supervisor, senior contractor administrator and Senior project manager, respectively. The responses of all interviewers were noted and shown in table 3

Table 3. Results of interview

Question	Interviewee A	Interviewee B	Interviewee C
What are the various impacts of variation orders on public building projects?	Project cost increased Delay work schedule Quality Degradation	Conflicts among the professionals Project cost increased Delay work schedule Rework and demolition	Contract and overhead costs increased Conflicts among parties Delay work schedule

From table 3 it is clearly observed that in public building projects the mostly occurred effect of variations order was project cost increases. More ever, project cost increased termed as cost/time overturns, conflict among parties and quality degradation results in rework and demolition.

Questionnaire results:

Questionnaire survey forms were distributed among three groups i.e. client, consultants, and contractors. The return rate of questionnaires forms these groups were shown in table 4.

Table 4. Return rate of Questionnaire's

Group	Number of Questionnaires distributed	Number of Questionnaires Returned	Response Rate (%)
Client	12	9	75
Consultant	5	4	80
Contractor	28	19	68
Total	**45**	**32**	**71**

Table 4 clearly showed that out of total 45 forms only 32 were returned i.e. (client =9, Consultants=4 and Contactors =19). Thus, return rate of questionnaire was found 71%.

Variation orders impacts were extracted from literature review having 15 in numbers and shown in table 5.

Table 5. Effects on variation order (Survey Questions)

S.NO	Effects on Variation orders	No -vary High impact (Impact)				
		1	2	3	4	5
1	Project cost Increase					
2	Progress is affected					
3	overhead expenses Increase					
4	Payment Delays					
5	Quality degradation					
6	Productivity degradation					
7	Delay in Procurement					
8	Rework and demolition					
9	Delays in Logistics					
10	Blemish firm's reputation					
11	Safety conditions (Poor)					

12	Professional relations (Poor)					
13	Contractor Additional payments					
14	Conflicts among professionals					
15	Delay in Work Schedule					

Relative index method was used to determine the most important factor for each part. RI values ranges between 0.2 and 1 which showed low and maximum strength. Scale of Likert was used for finding the impact and valued from 1 to 5 showing low to very high impact. Various groups respondents were used for conducting the correlation test which was shown in table 6.

Table 6. Summary of correlation test on the ranking of the impact of variation orders

Respondents	***Rho (ρcal) = 1- $\frac{6 \times (\sum d_i^2)}{N \times (N^2-1)}$***	**Relation of the respondents**
Client Vs Consultant	0.994	strong
Consultant Vs Contractor	0.999	strong
Client Vs Contractor	0.997	strong

Form all respondents combined responses, ranked wise effects of variation orders were shown in table 7.

Table 7 Impact of variation orders Frequency on public building projects

Impact of variation orders	**Relative Index (RI)**	**Ranking**
Delay in Work Schedule	0.794	1
Project cost Increase	0.793	2
Contractor Additional payments	0.742	3
Progress is affected	0.731	4
overhead expenses Increase	0.697	5
Payment Delays	0.694	6
Procurement delay	0.679	7
Delays in Logistics	0.667	8
Conflicts among professionals	0.661	9
Rework and demolition	0.642	10
Productivity degradation	0.594	11
Blemish firm's reputation	0.576	12
Quality degradation	0.566	13
Professional relations (Poor)	0.560	14
Safety conditions (Poor)	0.537	15

V. CONCLUSION AND RECOMMENDATIONS

It was concluded that variation order having negative effects on public building projects. Based on desk study, it was observed that project cost increases with approval of variation orders and badly affected on public building projects. Similarly, project cost increases with variation orders as indicated from result of interviews. From the questionnaire survey form, it was observed that variation orders effects on public building projects were delay in work schedule and cost increase in project. It was also found from study findings that, delay in work schedule, increase in cost of project and overhead expenses, contractor addition payments and effect on progress were main factors that affected public buildings variation orders.

To prepare project detailed brief client should allow sufficient time is recommended which will be helpful to eliminate frequent variations to project original plan due to client change of mind. For minimizing work schedule delay caused due to variation orders complete package of contract and design document should be provided by consultants. More ever, to reduce cost overturns consultants should give enough time for planning and design phase. Also, to lessen contractor extra payments due to variation consultants should prepare completed design and contract document before the tendering stage. Before the activity starts to reduce variations, contractors should identify and inform the varied item of work to the client and to help the client to give work order at minimum variations. Without affecting the project progress, project management and decision-making process by all the parties during project execution stage should be improved.

REFERENCES

[1] Ruben, N. 2008, "An analysis of the impact of variation orders on project performance", Cape Peninsula University of Technology, *Theses & Dissertations,* Paper 33.
[2] Ibbs, C. Williams, Lee, S., and Li, M. (1998). 'Fast-tracking's impact on project change', *Project Management*, Vol. 29. No. 4, 35-41.
[3] Ming, S., Martin, S., & Chimay, A. 2004, '*Managing Changes in Construction Projects'*, Industrial Report, University of the West of England, Bristol, pp 7-10.
[4] Arain, F.M. & Pheng, L.S. 2006, 'Developers' views of potential causes of variation orders for institutional buildings in Singapore', *Architectural Science Review*, vol. 49, no. 1, pp 59-74.
[5] Arain F.M. and Pheng L.S. (2005): The Potential Effects of Variation Orders on Institutional Building Projects, *Journal of Facilities*, Vol 23 No 11/12, 2005, pp 496-510.
[6] Kelly, J. & Male, S. 2002, 'Value Management', *Best Value in Construction,* RICS Foundation, Oxford: Blackwell Publishing.
[7] Thomas, R., Horman, J., De Souza, L. & Zavřski, I. 2002, 'Reducing Variability to Improve Performance as a Lean Construction Principle', *Journal of Construction Engineering and Management,* vol. 128, no. 2, pp 144-154.
[8] Ibbs, C.W. 1997, 'Quantitative Impacts of Project Change: Size Issues', *Journal of Construction Engineering and Management,* vol. 123, no. 3, pp 308-311.
[11] Thomas, R. and Napolitan, L. 1995, 'Quantitative effects of construction changes on labor productivity', *Journal of Construction Engineering and Management*, vol. 121, no.3, pp 292-294.
[12] Osman, Z., Omran, A., FOO, C. 2009, 'The potential effects of variation orders in construction projects', *Journal of Engineering annals of Faculty of Engineering, Hunedoara*, pp 8-10.
[13] Haldun, C. 1998, 'Using Simulation to Quantify the Impacts of Changes in Construction Work', *Thesis*, Virginia Polytechnic Institute and State University.
[14] CII. 1990, 'The Impact of Changes on Construction Cost and Schedule', *Construction Industry Institute*, University of Texas, Austin.