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Impacts of Variation Order in the Government Building Projects of Nepal

SHASHANKA KARKI[1*], ASHISH BANSTOLA[2], GOPAL BHATTARAI[3]

ABSTRACT. Variation order is the major hurdle in the construction of government building projects in Nepal. This study investigates the impacts of variation order in the government building project of Nepal. For this, using Likert scale, 415 responses were collected from the professionals involved in construction of government buildings in Nepal. Results showed that cost fluctuation, difficulty in project management, complexity to beneficiaries, delay in project progress, difficulty in fixation of new rate, and erosion of professional integrity are the impacts of variation order in government building projects of Nepal. It is recommended that experts should be hired for design and supervision by involving contractors in the design phase. Proper verification of design and documentation should be ensured before soliciting tender. Also, in-depth exploration of site condition should be done, and good communication and coordination between stakeholders should be maintained to reduce variation order.

Keywords: Variation Order,Government Projects,Procurement.

[1] School of Engineering, Edith Cowan University, Perth, WA, Australia
E-mail: shashanka.karki@gmail.com
[2],[3] Department of Urban Development and Building Construction, Nepal
E-mail: 076mstre003.ashish@pcampus.edu.np
E-mail: engbhatt@gmail.com
* Corresponding author

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1. Introduction

Construction industry is a major contributor to Nepal's economy as it contributes 5.5% to GDP of Nepal[1]. Nepal government allocated 19% of total budget for capital expenditure for fiscal year (F/Y) 2024/25[2]. However, the construction industry is facing many difficulties and Variation Order is one of them. Variation orders consist of the additions, subtraction and modification in terms of quantity, plan, scope and time of works [3]. Building construction projects involve complex works and varieties of materials and monuments building consist of various traditional materials which cannot be accurately determined in advance due to which variation orders occur. Variation orders cannot be avoided completely and inclusion of variation clauses in contracts is the proof that a project can't be finished without alteration[4].

Variation orders are causing various impacts in the projects like increase in project completion time, cost rise, increase in overhead expenses, difficulty in project management, increase in disputes etc.[5]. Although, variation is causing various threats to the building project of Nepal, few research is carried out in the perspective of Nepal. So, this study investigates the impacts of variation order in governmental building projects of Nepal.

2. Literature Review

Variation order which is also called change order is the deviation from original plan and scope of projects with change in term and conditions. Variation can be addictive; which prolongs time of contract with incline in materials and cost of the project, and deductive; which reduces project time, cost and quantity of the materials [6]. According to Tunde et al. (2015), the impacts of variation order in construction projects of Nigeria are: rise in project cost, difficulty to maintain work cash flow, decrease in contractor's profit, abandonment of project, degradation in quality of works, logistics delay, demolition and reworks[7]. Variation can affect project time and cost but if managed properly the contractor could experience profit with variation order [8].

Variation primarily impacts project cost and time. Variation increased project cost by 30.1% and project time surged by 30%. However, it also has a positive aspect as due to variation, quality of construction works improved by 24% [9]. Variation order is imminent in building construction projects and affected most of building construction projects of Lagos, Nigeria. Dosumu and Aigbavboa (2017) studied and found that 12.5% of building projects faced 1–5% variation, 43.7% of projects faced 5–10% variation, 12.5% of building subjected to 10–15% variation and 31.3% of buildings projects suffered 15% variation in Lagos, Nigeria[10].

Mohamed (2013) studied impacts of variation order in public works of Malaysia and found impacts are: decline in professional relations, late payment, surge in overhead expenses, delay in procurement of materials, additional payment for contractor, effect on progress of project, lack of proper safety condition, rise in claim dispute and delay in schedule of works[11]. Also, variation order is reducing labor productivity and surge in disputes between contracted parties [12].

3. Methodology

In order to identify impacts of variation order in government building projects of Nepal, quantitative research methods are utilized. The study population comprised of client, contractor and consultant who were working in government building projects of Nepal at the time of study. Questionnaires were prepared by detailed study of literatures and consisted of a 5-point Likert scale (where, 1=Strongly Disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly Agree). A total of 415 responses were received which were analyzed by Principal Component Analysis (PCA) with the use of SPSS software.

4. Result and discussions

4.1. **Information of Respondents.** Variables after data extraction are presented below in the table:

TABLE 1. Respondents Data Summary ($n = 415$)

Variable	Frequency	Percent	Variable	Frequency	Percent
Respondent Type			**Respondent Position**		
Client	170	40.96	Office/Site Engineer	145	34.93
Contractor	195	46.98	Site Supervisor	180	43.37
Consultant	50	12.04	Others	90	21.68
Education level			**Work experience (years)**		
Diploma	130	31.32	1–4	220	53.01
Bachelor's	170	40.96	4–8	125	30.12
Master's	40	9.63	8–12	50	12.04
Others	75	18.07	>12	20	4.81

4.2. **Kaiser–Meyer–Olkin (KMO) and Bartlett's tests.** In order to test the suitability of data for PCA, Kaiser–Meyer–Olkin (KMO) and Bartlett's tests were carried out.

TABLE 2. KMO and Bartlett's Test Results

Test	Statistic	Value
Kaiser–Meyer–Olkin Measure of Sampling Adequacy		0.810
Bartlett's Test of Sphericity	Approx. Chi-Square	1780.981
	Degrees of Freedom (df)	378
	Significance (p-value)	< 0.001

From Table 2, the value of the KMO sampling adequacy was 0.810 which is higher than 0.7 and lies on a suitable range [13]. Furthermore, Bartlett's test was significant ($\chi^2 = 1780.981$, df $= 378$, Sig. $= 0.000$) which shows significant correlation exists between the variables due to which it is suitable for factor analysis [14].

4.3. **Factor Extraction for Safety Measure Barriers.** Principal component analysis (PCA) with Varimax rotation was performed to identify the underlying components of the safety measure barriers. The number of components retained was determined using Kaiser's criterion (eigenvalue > 1) and the scree plot. As shown in Fig. 1, a clear inflection point was observed after the sixth component, indicating that six components should be retained for further analysis.

The eigenvalues and the percentage of variance explained by the retained components are presented in Table 3.

As presented in Table 3, the first six components had eigenvalues greater than 1.0 and were therefore retained based on Kaiser's criterion. The first, second, third, fourth, fifth, and sixth components had eigenvalues of 7.025, 5.684, 2.755, 1.915, 1.647, and 1.209, respectively, explaining 25.088%, 20.301%, 9.841%, 6.840%, 5.883%, and 4.318% of the total variance. Collectively, these six components explained 72.271% of the total variance, exceeding the recommended minimum threshold of 50% (Sarstedt and Mooi, 2014). Therefore, the extracted components adequately represent the underlying structure of the dataset and were considered suitable for subsequent analysis.

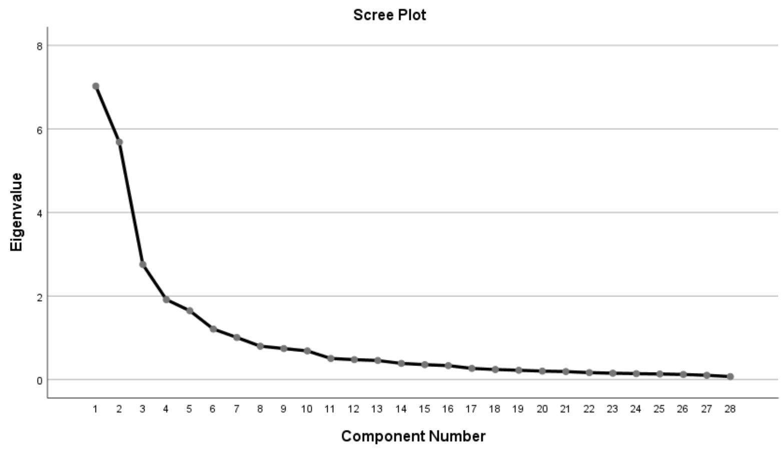

FIGURE 1. Scree plot obtained from principal component analysis.

TABLE 3. Eigenvalues and total variance explained (Extraction method: Principal Component Analysis)

Component	Initial Eigenvalues			Extraction Loadings			Rotation Loadings		
	Total	**% Var.**	**Cum. %**	**Total**	**% Var.**	**Cum. %**	**Total**	**% Var.**	**Cum. %**
1	7.025	25.088	25.088	7.025	25.088	25.088	7.025	25.088	25.088
2	5.684	20.301	45.389	5.684	20.301	45.389	5.684	20.301	45.389
3	2.755	9.841	55.230	2.755	9.841	55.230	2.755	9.841	55.230
4	1.915	6.840	62.069	1.915	6.840	62.069	1.915	6.840	62.069
5	1.647	5.883	67.953	1.647	5.883	67.953	1.647	5.883	67.953
6	1.209	4.318	72.271	1.209	4.318	72.271	1.209	4.318	72.271
7	0.908	3.601	75.872						
8	0.799	2.853	78.725						
9	0.742	2.651	81.376						
10	0.686	2.450	83.826						
11	0.505	1.803	85.629						
12	0.476	1.702	87.331						
13	0.456	1.630	88.960						
14	0.387	1.382	90.343						
15	0.357	1.274	91.617						
16	0.334	1.195	92.812						
17	0.267	0.954	93.765						
18	0.240	0.859	94.624						
19	0.223	0.796	95.420						
20	0.202	0.721	96.142						
21	0.191	0.683	96.824						
22	0.166	0.593	97.417						
23	0.153	0.547	97.963						
24	0.141	0.505	98.468						
25	0.133	0.476	98.944						
26	0.122	0.436	99.380						
27	0.103	0.367	99.747						
28	0.071	0.253	100.000						

4.4. **Factor Rotation and Interpretation of the Impacts of Variation Orders.** The rotated component matrix obtained from principal component analysis is presented in Table 4. A loading threshold of 0.60 was adopted to identify significant factor loadings (Kline, 2014). Variables with factor loadings below 0.60 were excluded from further interpretation.

As shown in Table 4, 19 out of the 28 impact variables were identified as significant and grouped into six components. A factor loading threshold of 0.60 was adopted based on the recommendation of Kline (2014). Accordingly, only variables with factor loadings greater than 0.60 were retained for interpretation, while the remaining nine variables with lower factor loadings were excluded from further analysis.

TABLE 4. Rotated component matrix of the impacts of variation orders in government building projects in Nepal

Impact of Variation Orders	Cost Fluctuation	Difficulty in Project Management	Complexity to Beneficiaries	Delay in Project Progress	Difficulty in Fixation of New Rates	Erosion of Professional Integrity
Increase in project cost	0.891					
Increase in overhead expenses	0.882					
Additional payments for contractors	0.879					
Additional material costs	0.877					
Cost for redesign	0.861					
Inflation costs	0.857					
Decrease in project cost	0.854					
Difficulty in manpower management		0.786				
Delay in decision-making process due to disputes		0.749				
Difficulty for beneficiaries to perform daily work			0.863			
Rework and demolition			0.835			
Increase in project completion time				0.810		
Procurement delay				0.787		
Slower project progress and schedule hampering				0.763		
Difficulty in rate negotiation					0.893	
Disputes regarding variation orders of provisional sum items					0.884	
Difficulty in balancing the contract with respect to the original contract					0.859	
Degradation of professional relations						0.776
Damage to the reputation of clients and contractors						0.770

Component 1: Cost Fluctuation. The first component, *Cost Fluctuation*, comprises seven variables: increase in project cost, increase in overhead expenses, additional payments to contractors, additional material costs, redesign costs, inflation costs, and decrease in project cost. These variables exhibited factor loadings of 0.891, 0.882, 0.879, 0.877, 0.861, 0.857, and 0.854, respectively. This component had an eigenvalue of 7.025 and explained 25.088% of the total variance. The results indicate that variation orders have a substantial impact on the financial performance of government building projects in Nepal.
These findings are consistent with Koirala et al. (2022), who reported that variation orders increased the overall project cost by 9.85% to 21.02% in government building projects in Nepal[15]. In contrast, Tuloli et al. (2021) observed that a reduction in the scope of work in an educational building project resulted in a decrease in the overall project cost[16].

Component 2: Difficulty in Project Management. The second component, *Difficulty in Project Management*, consists of two variables: difficulty in manpower management and delays in the decision-making process due to disputes. These variables had factor loadings of 0.786 and 0.749, respectively. The component had an eigenvalue of 5.684 and explained 20.301% of the total variance, indicating that variation orders significantly complicate project management activities.
This finding is consistent with Dansoh et al. (2017), who reported that managing variation orders in construction projects is challenging because of weak management practices, conflicting stakeholder interests, coordination difficulties, communication barriers, trust issues, and bureaucratic procedures[17].

Component 3: Complexity to Beneficiaries. The third component, *Complexity to Beneficiaries*, comprises two variables: difficulty for beneficiaries to carry out their daily activities and rework and demolition. These variables exhibited factor loadings of 0.863 and 0.835, respectively. This component had an eigenvalue of 2.755 and explained 9.841% of the total variance. The findings suggest that variation orders adversely affect project beneficiaries by disrupting normal activities and increasing rework.

Component 4: Delay in Project Progress. The fourth component, *Delay in Project Progress*, consists of three variables: increase in project completion time, procurement delay, and slower project

progress due to schedule disruption. These variables had factor loadings of 0.810, 0.787, and 0.763, respectively. This component had an eigenvalue of 1.915 and explained 6.840% of the total variance.
These findings are supported by Yadeta (2016), who identified delays in project completion as the most significant impact of variation orders in public building projects in Ethiopia[18]. Similarly, Hanif et al. (2016) reported that variation orders contributed to substantial project delays and cost overruns in hydropower projects in Pakistan[19].

Component 5: Difficulty in Fixation of New Rate. The fifth component, *Difficulty in Fixation of New Rate*, comprises three variables: difficulty in rate negotiation, disputes regarding variation orders for provisional sum items, and difficulty in balancing the revised contract with the original contract. These variables exhibited factor loadings of 0.893, 0.884, and 0.859, respectively. This component had an eigenvalue of 1.647 and explained 5.883% of the total variance, indicating that variation orders create significant challenges in determining equitable rates for additional or modified works.

Component 6: Erosion of Professional Integrity. The sixth component, *Erosion of Professional Integrity*, consists of two variables: degradation of professional relationships and damage to the reputation of clients and contractors. These variables had factor loadings of 0.776 and 0.770, respectively. This component had an eigenvalue of 1.209 and explained 4.318% of the total variance. The findings indicate that variation orders may weaken professional relationships and negatively affect the reputation of project stakeholders.
This finding is consistent with Donold (2014), who reported that disagreements regarding contract terms, additional costs, and the implementation of variation orders often lead to disputes, thereby damaging professional relationships among project participants[20].

4.5. **Reliability of Retained Components.** The internal consistency of the six retained components was evaluated using Cronbach's alpha (α). As presented in Table 5, the Cronbach's alpha values ranged from 0.702 to 0.952, exceeding the recommended threshold of 0.70 (Taber, 2018). These results indicate that all retained components possess satisfactory internal consistency and are therefore considered reliable for subsequent analysis.

Table 5. Cronbach's alpha values of the retained components

Component	**Cronbach's Alpha (α)**
Cost Fluctuation	0.952
Difficulty in Project Management	0.739
Complexity to Beneficiaries	0.866
Delay in Project Progress	0.796
Difficulty in Fixation of New Rate	0.903
Erosion of Professional Integrity	0.702

5. Conclusion and Recommendations

This study investigated the impacts of variation orders in government building projects in Nepal using principal component analysis. Six major components were identified: *Cost Fluctuation*, *Difficulty in Project Management*, *Complexity to Beneficiaries*, *Delay in Project Progress*, *Difficulty in Fixation of New Rate*, and *Erosion of Professional Integrity*. Among these, *Cost Fluctuation* was the most influential component, explaining the highest proportion of the total variance.
The findings indicate that variation orders significantly affect project cost, schedule, project management, beneficiary convenience, contractual negotiations, and professional relationships among project stakeholders. Therefore, minimizing unnecessary variation orders is essential for improving the performance of government building projects in Nepal.

Based on the findings, it is recommended that project objectives and design requirements be clearly defined before project commencement. Contractors should be involved during the design stage to enhance constructability and reduce design-related changes. In addition, effective coordination and communication among clients, consultants, and contractors should be maintained throughout the project lifecycle. Employing experienced professionals during the design and supervision phases, conducting comprehensive site investigations, and assessing material availability before finalizing the design can further reduce the occurrence of variation orders and their associated impacts.

6. Research Implications

Variation orders continue to pose significant challenges to the successful delivery of government building projects in Nepal. The findings of this study provide empirical evidence on the major impacts of variation orders and their underlying dimensions, which can support evidence-based decision-making by government agencies, project owners, consultants, and contractors.
The identified components may assist policymakers in formulating strategies and guidelines to minimize unnecessary variation orders and improve project performance. Furthermore, the results provide a useful reference for construction professionals in implementing effective project planning, design management, and contract administration practices. This study also establishes a foundation for future research on variation orders in different types of construction projects and geographical contexts, allowing researchers to compare findings and develop appropriate mitigation strategies.

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