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Time and Cost Variations in Public Building Projects: A Case Study of CLPIU (BH) Projects in Kathmandu, Nepal

Er. Brajendra Kumar Deo

PhD Scholar, Sikkim Professional University, Gangtok, India

Abstract

Nepal's Public construction sector is facing problems of time and cost overruns. Several projects executed in Kathmandu by CLPIU(BH) are facing the same problems. It has eleven projects taken for this study, and the causes for variations, their impact, and preventive measures are analyzed. Data were collected from 110 respondents by survey tools like observations, a questionnaire, and interviews. Data were collected by different stakeholders like client, contractor and consultant. Generally, respondents had having technical background like an engineer, an architect, a project manager, a resident engineer, etc. The main factors for variation are found that administrative inefficiencies, changes in design, and unforeseen conditions. It has been recommended to improve proper planning, stakeholder communication, and adherence to legal procedure to minimize negative impact on project performance.

Keywords: Variation Order, Time Overrun, Cost Overrun, CLPIU(BH), Public Construction, Nepal

1. Introduction

Public infrastructure in Nepal sustained major destruction from the 2015 Gorkha earthquake [1] [2]. The National Reconstruction Authority (NRA) was established by the government to manage reconstruction while CLPIU(BH) became the main agency for rebuilding activities according to [3]. CLPIU(BH) controls numerous public buildings under construction which currently experience significant delays combined with increased costs. Building projects maintain complexity because they require proper management of their temporal aspects as well as financial resources and performance levels. Despite existing in Nepal the Public Procurement Act (2007) does not adequately solve the concrete project obstacles that arise during implementation. The implementation of variation orders together with provisional sums both impact project time and cost according to [4] and [5].

Construction projects face persistent challenges related to performance, including delays, cost overruns, time overruns and quality issues. These issues are intensified by political, economic, and cultural factors, leading to financial losses, project delays, and decreased stakeholder satisfaction. However, completing projects within the allocated time and budget proves challenging due to unexpected problems and design changes during construction [6].

Time and cost overruns are prevalent in nearly all construction projects, often stemming from unexpected problems and design changes during the construction phase [7].

Most of the building construction projects are facing the problem of time and cost overruns. The major factors that impact cost of construction are material, labour, equipment, overhead and profit [8]. Delay in

the intended completion date causes substantial financial burden to the stakeholders of this industry. In this context, Nepalese construction industry is also not an exception [9].

Time and cost overruns remain persistent challenges in Nepal's public construction projects, particularly those managed by CLPIU(BH) after the 2015 earthquake. Variation orders significantly contribute to these overruns. some studies have explored their causes, impacts, and possible solutions, there is still a need for a more systematic and focused investigation into how variation orders specifically affect project performance under CLPIU(BH) projects

Objective

The main aim of this study is to find out the causes, effects, and ways to prevent time and cost changes caused by variation orders in public building projects managed by CLPIU(BH) in Kathmandu, Nepal. Specific objectives are:

- To find out time and cost overrun.
- To know the reasons behind variation orders.
- To see the impact on the progress and performance of projects.
- To suggest preventive measures.

2. Literature Review

CLPIU(BH) was established to rebuild public buildings and heritage sites damaged by the earthquake. After the dissolution of NRA, CLPIU(BH) came under DUDBC to complete reconstruction [3].

Due to design adjustments, unexpected issues, or any technological development, there may changes happens by officials [10].

Beneficial and detrimental variations exist. Beneficial improvements improve outcomes, while detrimental ones negatively impact the client's value [11].

Public Procurement Act (PPA, 2063) and Public Procurement Regulations (PPR, 2064) define the processes for approving variation orders, aligned with FIDIC standards [4].

Major causes include poor initial investigation, client-induced changes, design errors, material shortages, and unforeseen conditions [12]; [13]; [14].

Variation orders impact project cost, time, quality, and lead to disputes between stakeholders [15]; [16]., 2016; [17].

Proper planning, accurate design, effective communication, site investigation, and using modern project management tools are preventive tools [18]; [19]; [20].

3. Methodology

The study was based on primary and secondary data where primary data was taken from survey tools like field observation, interviews and questionnaire survey from 110 respondents associated with these projects and secondary data was taken from final report of project Total number of projects taken was eleven and respondents were from client, consultant and contractor's representatives.

Several analytical statistical tools were used to draw the results from this study. The study used descriptive analysis, the Chi-Square test, the One-Way Anova test, RII, Ranking and the Spearman Correlation test.

4. Results and Analysis

4.1 Gender Distribution of Respondents

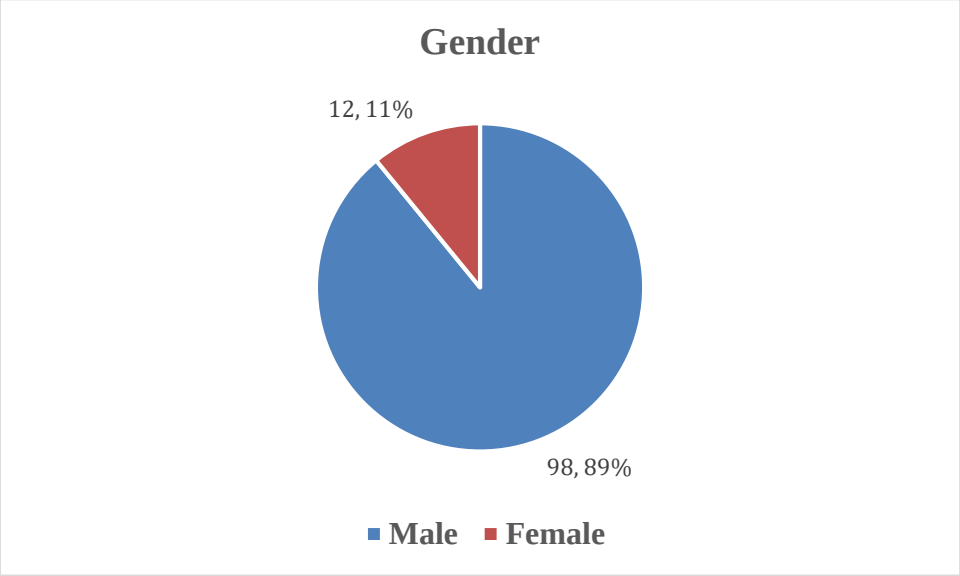

Figure 1: Gender Distribution of Respondents

There were 110 respondents, among them. 89% were male (n=98) and 11% were female (n=12), indicating male dominance in the construction sector respondents.

4.2 Objective 1: Time and Cost Variations

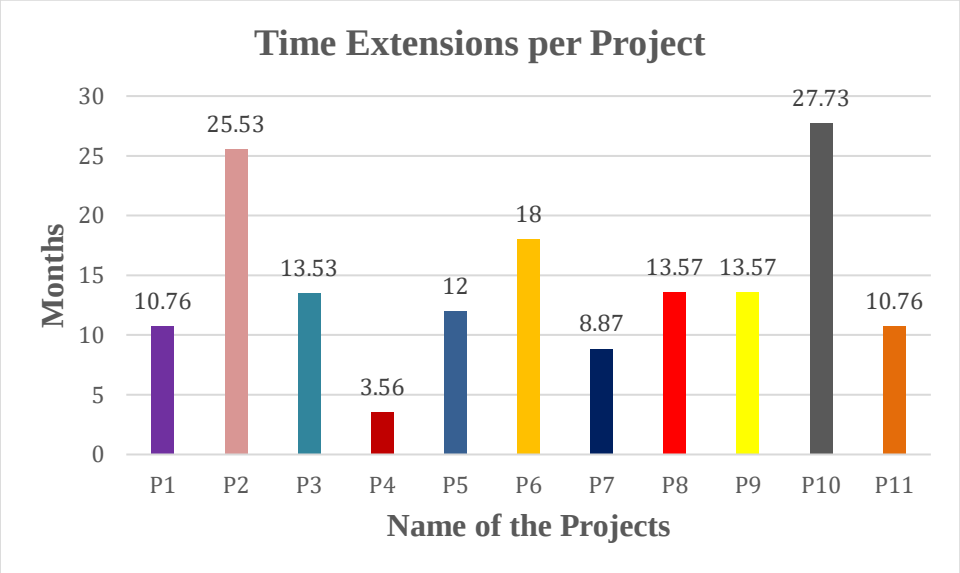

Figure 2: Time Extensions per Project

The majority of CLPIU(BH) projects experienced delays ranging between three months to more than twelve months as illustrated in Figure 1. Project delays lengthened to more than 12 months when major design changes and slow approvals and site issues were combined however small variations resulted in faster completion times. The majority of time delays occurred because of variation orders combined with inadequate stakeholder coordination.

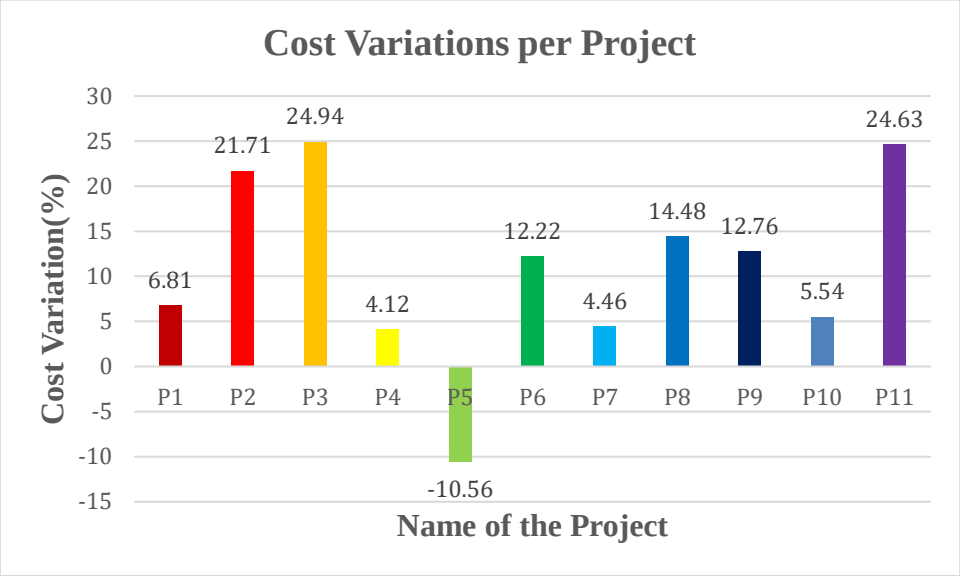

Figure 3: Cost Variations per Project

Cost overruns between 5% and 25% affected most CLPIU(BH) projects as revealed in Figure 2 while design changes, unforeseen conditions, and procurement delays served as primary cost increase factors. Better project planning techniques resulted in reduced cost variations for projects. External disruptions, together with scope modification served as fundamental factors that translated into higher costs throughout the public building projects.

4.3 Objective 2: Causes of Variation Orders

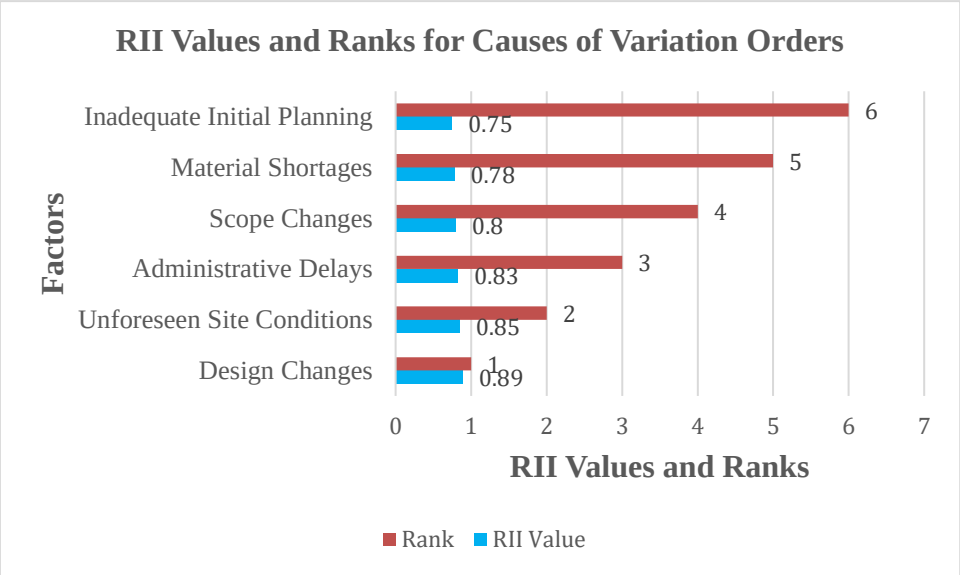

Figure 4: Causes of Variation Orders (RII Ranking)

The RII analysis revealed the principal factors that drove variation orders to occur. The major contributors to variation orders consisted of design modifications, unknown site conditions and insufficient project documentation. The combination of client-caused changes together with inadequate coordination substantially contributed to the situation. The study findings verified information obtained from both interviews and reports. The main reasons behind variation orders stem from technical difficulties combined with management problems.

4.4 Objective 3: Impact on Progress and Performance

The respondent's data taken from questionnaire survey were analyzed using the Relative Importance Index (RII) to prioritize the most significant impacts.

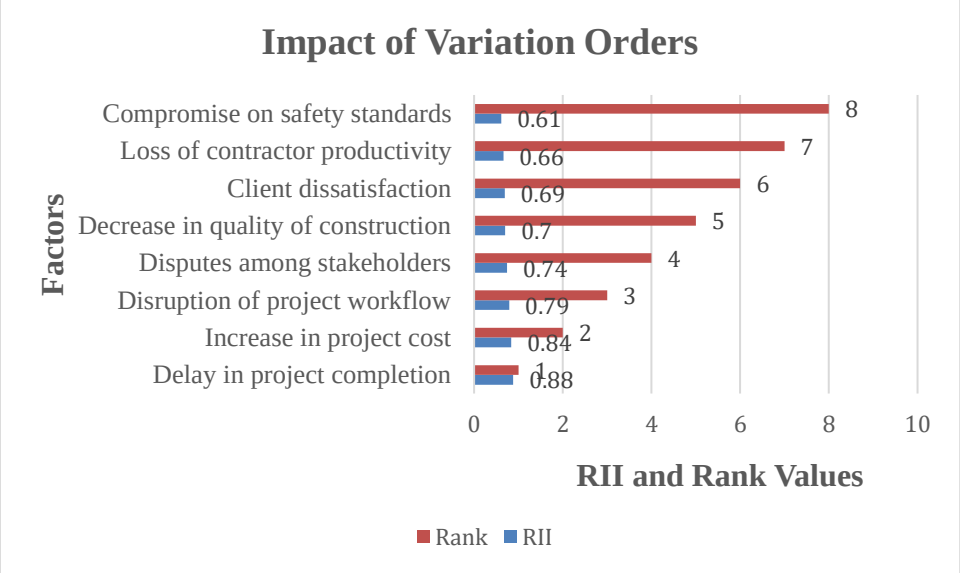

Figure 5: Impact of Variation Orders on Project Progress and Performance

The highest-ranked impact was delay in project completion (RII = 0.88), indicating that time overrun is perceived as the most significant issue arising from variation orders. This is followed by increased cost (RII = 0.84) and workflow disruption (RII = 0.79). Issues such as disputes, quality reduction, and safety concerns also received notable importance, reflecting the multidimensional impact of variation orders on project performance.

4.5 Objective 4: Preventive Measures

Preventive measures are analyzed as per the responses taken from stakeholders to minimize cost overrun and extension of time in public building projects. RII was used to evaluate the rank of the responses given by stakeholders.

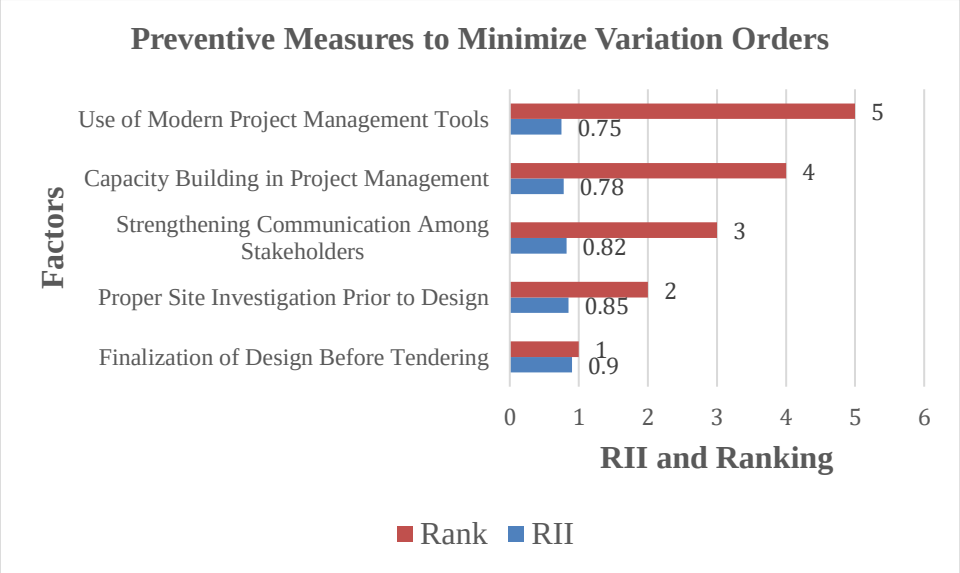

Figure 6: Preventive Measures to Minimize Variation Orders (RII & Rank)

The most important preventive step was finalizing the design before tendering (RII = 0.90). This was followed by proper site investigation (RII = 0.85) and strong communication (RII = 0.82). Other useful strategies included building project management capacity and using modern tools like BIM. Together, these steps help reduce the chances and effects of variation orders in public building projects.

4.6 Spearman Correlation Test

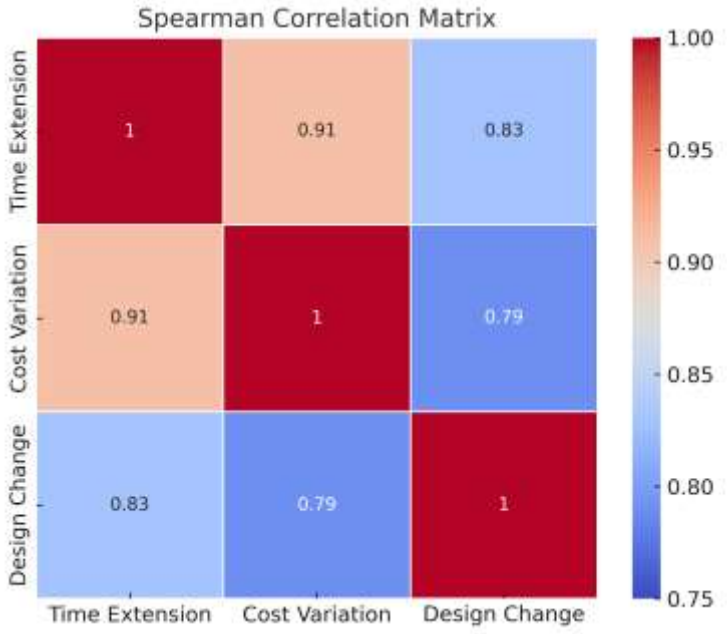

Figure 7: Spearman Correlation Matrix

To check how time extension, cost variation, and design changes are related, Spearman correlation analysis was performed. The following are the results:

- Time extension and cost variation: $\rho = 0.91$ (very strong)
- Time extension and design changes: $\rho = 0.83$ (strong)
- Cost variation and design changes: $\rho = 0.79$ (strong)

From the above result, it has been confirmed that projects are facing the problem of cost overruns and delays due to more design changes. To solve this problem, the design changes should be fewer.

4.7 Chi-Square Test: Association between Stakeholder Role and Observed Project Impacts

This research used a Chi-square test to determine if stakeholder category (Client, Contractor, Consultant) shaped their detection of major project alterations caused by variation orders.

Result: $\chi^2(2) = 3.34$, $p = 0.188$.

The result showed that no statistically significant association between the stakeholders role and observed impacts on the p-value of 0.188 when testing at a 5% significance level.

4.8 One-Way ANOVA: Differences in Perceived Time Extensions among Stakeholder Groups

A One-Way ANOVA was performed to compare the mean perceived time extensions (in months) among Clients, Contractors, and Consultants.

Result: $F(2, 107) = 24.46$, $p = 0.000$.

The p-value of 0.000 indicates a statistically significant difference in perceived time extensions between the stakeholder groups at the 5% significance level.

6. Conclusion

The research showed that changes made during construction, known as variation orders, often lead to delays and extra costs. Most of these were caused by design issues and administrative delays. To prevent time and cost overruns, proper planning and timely action are essential. Taking proactive steps can reduce similar problems in future projects.

7. Recommendations

a. Conduct thorough site investigations
b. Finalize design before tendering
c. Improve communication among stakeholders
d. Build capacity in project management
e. Adopt project management software

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