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Impact of Using Price Fluctuation Related Conditions on Construction Projects

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Abstract: The inherent nature of construction projects is long duration and high cost. Extended project duration leads to escalation of cost. If the project duration is too long, the initial estimation may not be sufficient to recover the actual cost of the contract. To address this problem, Construction Industry Development Authority (CIDA) has introduced a price adjustment method called the "ICTAD formula method for adjustments to contract price due to fluctuation in prices". Contract documents related to construction projects also provide some provisions to address the issues with material price fluctuations. This study investigated the practices of contractors to minimize the effect of price variation and support of price fluctuation clauses to minimize the impact of price variation. A questionnaire survey was conducted among the professionals to represent CS2 to C5 grade construction companies registered at CIDA. The questionnaire consisted of practices of contractors to minimize the effect of price variation and the impact of using price fluctuation clauses in different aspects. Collected responses were converted to a quantitative value using the relative importance index (RII). In addition, SPSS software was used for the critical review of responses. The results revealed that contractors mostly agree with using price fluctuation clauses to recover the increased project cost due to increased construction input prices. Further, results are evident that using price fluctuation clauses helps to fair risk sharing between the contractor and the client.

Keywords: Price Fluctuation, Contract Document, Fluctuation Clause

1. Introduction

One of the primary sectors that has a considerable impact on a nation's socioeconomic development is the construction industry. Additionally, it makes a substantial contribution to creating jobs in the nation. As a result, the country's economy is directly impacted by the success or failure of the construction industry. Any construction project's ability to meet its goals in terms of cost, quality, and duration will determine its success. The cost can be regarded as the most essential component that impacts the project's success because each source that directs the project to its destination ultimately depends on money. Currently, cost overrun is a significant problem faced by many contractors and all the other parties involved in the construction industry. When the project's actual cost exceeds the budgeted cost, there is a cost overrun. A few disadvantages due to cost overrun are reduction in project profit, withdrawal of the project [1] and conflicts between involved parties in a project [2]. The major factors affecting cost overrun are price fluctuation [3], serious project design errors [2], poor site management, and not selecting a qualified project team [1].

From the above factors, price fluctuation of construction inputs significantly causes cost overrun, according to Zainudeen et al. [3].

This study considered examining the contractors' reaction to minimize the effect of price fluctuation on their budget and the impact of fluctuation clauses of the contract to minimize the effect of price fluctuation on the project. A questionnaire survey was conducted among relevant professionals in the construction industry to gather the required data.

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2. Literature Review

Price fluctuations are unavoidable in long-duration construction projects [4]. Cost overrun due to price fluctuation is the main problem in the construction industry. Furthermore, with inflation, cost of the construction inputs get affected resulting in considerable price fluctuation [5], [6], [7]. Hence, to avoid this improper cash flow, a recovery method is needed to minimize the effect of price fluctuation in construction projects [8]. Construction Industry Development Authority (CIDA) (Previously known as the Institute for Construction Training and Development, ICTAD) has introduced a general formula to adjust the contract price due to price fluctuations. ICTAD formula is the primary technique used by most contractors in Sri Lanka. The monthly bulletin of CIDA publishes the price indices for cost fluctuation in each month for construction works [9]. In this method, price variations are adjusted compared to a base index, published by CIDA. Indices published by CIDA are used for every type of construction work at any location in the country [10].

A study done by Ganegoda & Malkanthi [10] has identified that price indices published by ICTAD are based on the available material prices in the Colombo region. Jayasinghe et al. [4] reveal that the ICTAD price formula overestimates the true price adjustment for most cases though the price adjustment is positive or negative. Jayalath [11] has also mentioned that the ICTAD formula method is only a compensation method and does not cover the actual price variation. These are the drawbacks of the ICTAD formula when practicing price adjustment in the construction industry. Hence there is a necessity for accurate price indices to calculate price fluctuation which results in values close to the true fluctuation and overcome these drawbacks.

On the other hand, reduction of the effect of price fluctuation involves identifying the factors, quantifying them, and mitigating them as far as possible. According to several previous researches, some important factors can be used to reduce the effect of price fluctuation. That can be summarized as the use of price fluctuation clauses, bulk material purchases and storing at the beginning of the project, regular cost monitoring throughout the project, enhancing skills and efficiency [12], consider locally available material in design, use of value engineering concept, comprehensive and error-free designs and specifications, reducing site waste, and effective human resource management [1]. Fluctuation provisions provide a mechanism to deal with the effect of inflation. In Sri Lanka, all the projects are bound with Standard Bidding Documents (SBD). Section 4: Contract Data in the SBD provides a clause related to the price adjustment due to input price variation [13]. Also, Section 3 of SBD says price adjustments shall be made considering the current indices and current prices.

3. Research Methodology

A questionnaire survey was carried out to get the view of construction industry professionals regarding the contractors' reaction to minimizing the effect of price fluctuation on their budget and the impact of fluctuation clauses of the contract to minimize the effect of price fluctuation on the project. It consisted of two Sections. In Section 1, nine (9) important factors related to minimize the effect of price fluctuation were included. In Section 2, eight (8) factors associated with the possible impact of using price fluctuation clauses were included. Those factors are shown in Table 1. There are 503 contractors registered with CIDA in 2020 [14] from grades CS2 to C5. 90% of confidence interval and 10% of error margin were considered for the sample size calculation based on the below equations.

$$n_0 = \frac{z^2 pq}{e^2} \qquad n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}} \quad \ldots(1)$$

where,

n_o = Sample size,

n = Adjusted sample size,

z = 1.6449 (90% confidence level),

p = 0.5 (maximum variability),

Hence, q = 0.5 (1-p),

e = 0.1 (10% of error margin),

$$n_0 = \frac{1.6449^2 * 0.5 * 0.5}{0.1^2} = 68$$

N = 503 (Population)

Then,

$$n = \frac{68}{1 + \frac{(68 - 1)}{503}} = 60$$

The minimum required sample size is 60. 68 responses were received covering grades CS2 to C5 contractors. Therefore, the collected data is sufficient for the analysis. Responses were rated using five-point Likert scale. These responses were analyzed by calculating the Relative Importance Index (RII). Further, SPSS software was used to find the relationship between the factors.

Table 1 - Factors Considered for the Questionnaire

Section 1(S1): Importance factors to minimize the effect of price fluctuation	Section 2(S2): Possible impact of using price fluctuation clauses
1. Consider price fluctuation clauses 2. Bulk material purchases and storing at the beginning of the project 3. Consider locally available material in design 4. Regular cost monitoring throughout the project 5. Enhancing skills and efficiency 6. Use of value engineering concepts 7. Comprehensive and error free designs and specifications 8. Reducing site wastes 9. Effective human resource management	1. Fluctuation clauses can minimize disputes 2. Fluctuation clauses help to recover the construction cost increase due to material and other resource price increment 3. Fluctuation clauses help the client to get the advantages with the reduction of material prices 4. Fluctuation clauses can help contractors to minimize financial difficulties 5. Fluctuation clauses can minimize the risk of bankruptcy of the contractors 6. Fluctuation clauses can minimize cost overrun of the project 7. Fluctuation clauses provide fair risk sharing between the contractor and client 8. Fluctuation clauses can minimize the abandon rate in construction industry

4. Results and Discussion

When a questionnaire survey is used as a research data collection tool, the selected factors in the questionnaire should be consistent and reliable. SPSS software gives a mathematical interpretation called Cronbach Alpha to check the reliability. According to the statistical inferences [15], Cronbach Alpha should be greater than 0.7 for high internal consistency and reliability of the questionnaire. Table 2 gives Cronbach Alpha values, higher than 0.7, for the two sections of the questionnaire used in this research.

So, the use of a questionnaire survey for this research is acceptable.

Table 2 - Reliability Statistics for the Questionnaire

Section	No. of items	Cronbach Alpha
Section 1	9	0.809
Section 2	8	0.810

4.1 Significance of Factors

Based on the level of significance marked by the respondents, the Relative Importance Index (RII) was calculated based on the following equation.

$$RII = (\Sigma a * n) / N \quad \ldots(2)$$

where,

a = constant expression weight (5 for strongly agree, 4 for agree, 3 for neutral, 2 for disagree and 1 for strongly disagree)

n = frequency of response

N = total number of responses

Figure 1 and Figure 2 represent the importance level of factors based on RII values. As per the results in Figure 1, most respondents agreed that using price fluctuation clauses is more significant to minimize the effect of price fluctuation. Also, Figure 2 says that using price fluctuation clauses helps minimize the disputes. These RII values alone are not sufficient to give a clear conclusion. Therefore, to elaborate the results in a more meaningful manner, analysis was done using SPSS statistical software too.

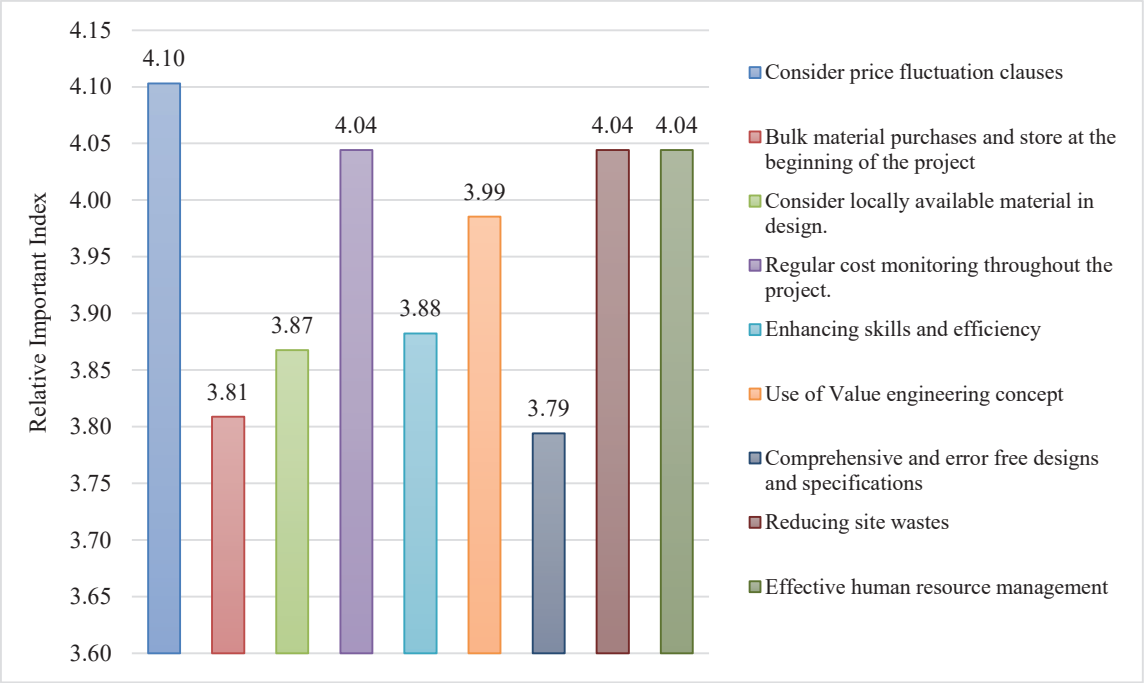

Figure 1 - RII for Factors Affecting to Reduce the Effect of Price Fluctuation

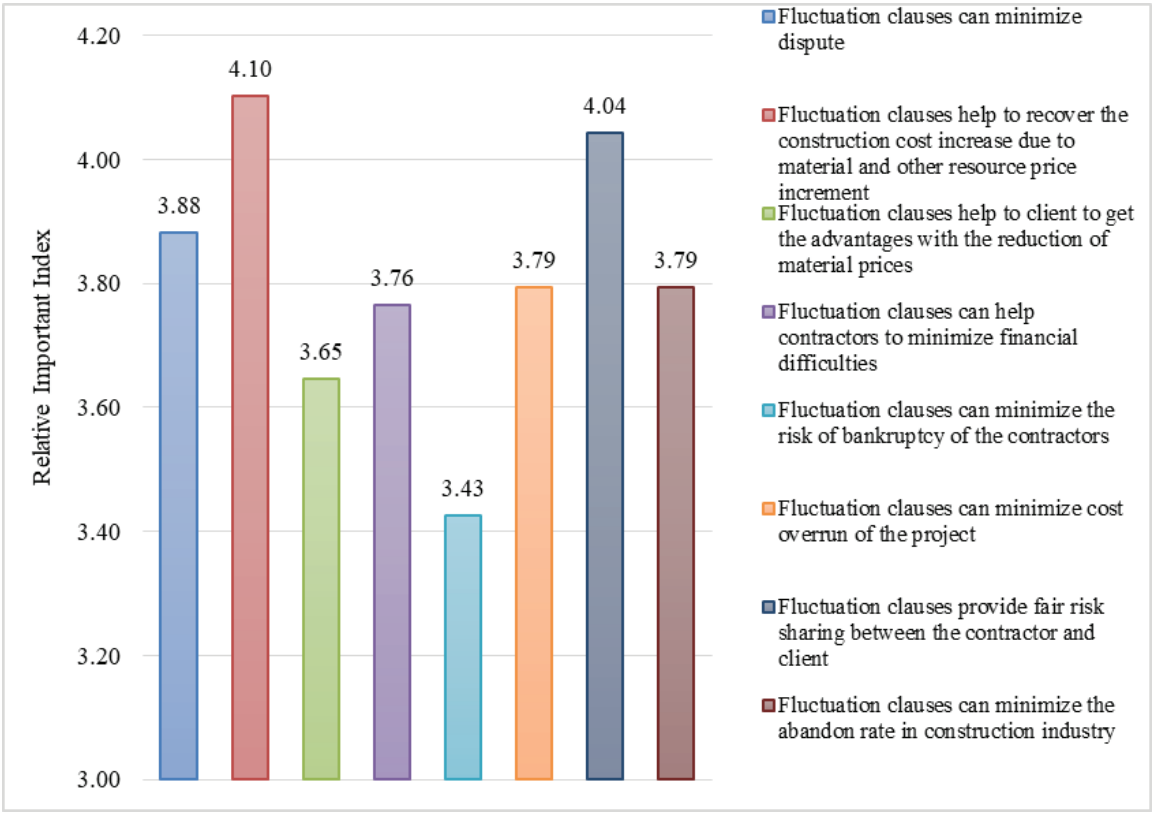

Figure 2 - RII for Impact of Using Price Fluctuation Clause to Minimize Effect of Price Fluctuation

4.2 Correlation between Factors

Table 3 shows the correlation coefficient obtained using SPSS statistical software for section 1 (S1) of the questionnaire while Table 4 is for section 2 (S2) of the questionnaire.

According to the correlation coefficient in Table 3, S1-4 displays a strong relationship with S1-3. Also, it moderately correlated with S1-5, S1-8 and S1-9 at the significance level of 0.01. These results say that if the "regular cost monitoring (S1-4)" can be done, it leads to minimizing the effect of the price fluctuation and, at the same time, reducing the effect of price fluctuation due to the factors S1-3, S1-5, S1-8 and S1-9. A similar conclusion can be

made using the other correlation coefficient too. According to the correlation coefficients in Table 4, S2-8 is strongly correlated with S2-7. Also, it moderately correlated with S1-2, S1-5 and S1-6. These results say that if the "Fluctuation clauses can minimize the abandon rate in the construction industry (S2-8)"; simultaneously, it is possible to reduce the effect due to factors S2-2, S2-5, S2-6 and S2-7.

Table 3 - Pearson Correlation Results for Section 1 of the Questionnaire

Factors	S1-1	S1-2	S1-3	S1-4	S1-5	S1-6	S1-7	S1-8	S1-9
S1-1	1	.001	.285*	.291*	.128	.545**	.284*	-.043	.106
S1-2	.001	1	.276*	.198	.338**	.193	.260*	.343**	.382**
S1-3	.285*	.276*	1	.643**	.430**	.176	.285*	.242*	.310*
S1-4	.291*	.198	.643**	1	.532**	.285*	.238	.465**	.405**
S1-5	.128	.338**	.430**	.532**	1	.179	.513**	.566**	.573**
S1-6	.545**	.193	.176	.285*	.179	1	.432**	.106	.206
S1-7	.284*	.260*	.285*	.238	.513**	.432**	1	.419**	.409**
S1-8	-.043	.343**	.242*	.465**	.566**	.106	.419**	1	.546**
S1-9	.106	.382**	.310*	.405**	.573**	.206	.409**	.546**	1

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

Table 4 - Pearson Correlation Results for Section 2 of the Questionnaire

Factors	S2-1	S2-2	S2-3	S2-4	S2-5	S2-6	S2-7	S2-8
S2-1	1	.304*	.059	.179	.412**	.390**	.240*	.286*
S2-2	.304*	1	.237	.397**	.351**	.284*	.233	.531**
S2-3	.059	.237	1	.431**	.371**	.213	.139	.187
S2-4	.179	.397**	.431**	1	.528**	.307*	.282*	.355**
S2-5	.412**	.351**	.371**	.528**	1	.451**	.512**	.530**
S2-6	.390**	.284*	.213	.307*	.451**	1	.393**	.543**
S2-7	.240*	.233	.139	.282*	.512**	.393**	1	.681**
S2-8	.286*	.531**	.187	.355**	.530**	.543**	.681**	1

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

4.3 Principal Component Analysis

Further to the above analysis, principal component analysis was also carried out, and its results are shown in Table 5. Principal component analysis is a variable-reduction technique that shares many similarities to exploratory factor analysis. It aims to reduce a more extensive set of variables into a smaller group of 'artificial' variables, called "principal components". Based on the analysis, factors in section 1 can be divided into three groups, while factors in section 2 can be divided into two groups. According to the results, S1-2, S1-5, S1-7, S1-8 and S1-9 are in one group, while S1-3 and S1-4 are in another group. S1-1 and S1-6 are in the third group. These results say that grouped factors can be addressed and treated simultaneously. In Section 2, S2-1, S2-2, S2-5, S2-6, S2-7and S2-8 are in one group while S2-3 and S2-4 are in another group.

Table 5- Principal Component analysis results

Section 1				Section 2		
Factor	Component			Factor	Component	
	1	2	3		1	2
S1-1	-.130	.302	.821	S2-1	.626	.007
S1-2	.628	.038	.058	S2-2	.469	.425
S1-3	.174	.847	.144	S2-3	-.027	.854
S1-4	.286	.848	.148	S2-4	.259	.782
S1-5	.706	.430	.082	S2-5	.619	.517
S1-6	.181	.040	.863	S2-6	.701	.190
S1-7	.632	.010	.520	S2-7	.754	.111
S1-8	.785	.241	-.088	S2-8	.823	.231
S1-9	.751	.238	.086			

5. Conclusions

Variation of prices of construction inputs during a contract period is not avoidable. If the contract period is considerably long, price differences between the stage of preparation of Bills of Quantities (BOQ) and the actual construction stage may increase substantially. CIDA has introduced a price adjustment formula procedure to overcome this problem in Sri Lanka. This formula method considers a

unique set of price adjustment factors published by CIDA as price indices on a monthly basis for the whole country. Based on past research, CIDA price adjustment formula and price indices are insufficient to recover the effect of price fluctuation of construction inputs. Therefore, the present study focused on using price fluctuation-related clauses and their impacts to reduce the effect of price fluctuation on construction inputs.

Views of construction industry professionals were gathered regarding the importance of identified factors to minimize price fluctuation through a questionnaire survey. However, this questionnaire was limited to grade CS2 to C5 CIDA registered companies. Sixty-eight (68) responses were collected and analyzed using SPSS software. According to the analysis results, it can be concluded that Consideration of price fluctuation clauses, Regular cost monitoring throughout the project, Reduction of site wastes, and Effective human resource management are the most significant factors to minimize the effect of price fluctuation of construction inputs in construction projects. However, bulk material purchases and stores at the beginning of the project, and comprehensive and error-free designs and specifications do not significantly minimize the effect of price fluctuation in the construction industry. But all factors are correlated with each other and the RII value is nearly 4, so all factors in section 1 can be considered to minimize the effect of price fluctuation of construction inputs in construction projects. Fluctuation clauses can minimize the project's cost overrun and help contractors minimize financial difficulties. But it is not a suitable tool for use to minimize the risk of bankruptcy of the contractors.

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