TECHNICAL SESSION: Energy management and quantity surveying best practices for resilient industries **449**

Impact of Unexpected Rapid Price Fluctuations on Medium-Scale Building Construction Projects in Sri Lanka: A Case Study

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Abstract—The construction industry is facing a severe recession. This scenario spreads throughout the country, and contractors related to the construction industry are critically affected. The general objective of this research is to investigate the variation in material prices in the construction industry and its impact on medium-scale building construction projects. This research investigates the effects of unexpected rapid price fluctuations on the capacity of local contractors. The study concepts are developed through a literature survey to identify relevant variables, and project case studies are used to assess the problem. According to the research; market survey details show that the material price increased dramatically after June of 2021, and these followed a steep upward trajectory until June of 2022. When considering other materials, the price of cement is reduced. Figure 2. Most of the material prices increased above 200% compared to the year 2019. The highest increase in the price of the material is cement and increased to 268% in June 2022 compared to 2019. Not only the material but also the labour daily charges have been escalated, as an example, Blacksmith, Plumber, Specials sk labour and Tinker prices are inflated up to 90% in December of 2022 compared to the year 2019. The results presented by the case studies, collectively demonstrate a pattern of price fluctuation across multiple projects and all the projects which are selected for the case study work, suffered from the price escalation. The project which completion date is falling under the month October in year 2022 (3rd part of 2022), shows the significant price increase.The actual completion dates of projects are significantly delayed compared to their scheduled completion dates and it is the major reason for the price increment.

Index Terms—Price escalation, price indices, construction inputs, price fluctuation

I. Introduction

Sri Lankan Construction Industry continues to play an important role in the country's economy. Construction industry is one of the most significant industries that contributes to socioeconomic growth, especially in developing countries. The construction sector produces a wide range of products, from individual houses to major infrastructure such as roads, power plants, petrochemical complexes, etc. [1].

The construction industry in Sri Lanka has been growing rapidly for years. According to the Central Bank Report (2016), [2] 'The Sri Lankan Construction Industry contributes 7. 6% to the Gross Domestic Product (GDP), and the value added of construction activities rebounded during the year, recording a substantial growth of 14. 9% in 2016 [3].

But unfortunately, since the end of 2019, it has been shrinking; due to the Covid-19 pandemic situation and the current economic crisis in the country, [4]. According to data from the international trade Administration; "This industry is one of the largest contributors to GDP and the source of employment in Sri Lanka and the construction industry contributed 6.2% of GDP in 2020, [5] from the previous year's contribution of 7.6%, employing around 600,000 workers.

Although GDP decreased by an unexpected 8. 4% in the April-June period in year 2022 compared to the same period last year, acute shortages in fuel and other commodities and prolonged power cuts, which began around February, became more pronounced and brought the economy to a near standstill in June. However, many professionals have lost their jobs as a result of this collapse. Marginal workers were the hardest affected, and their daily activities were hampered by the loss of jobs.

According to the National Construction Association of Sri Lanka;"Sri Lanka's construction sector has collapsed, with approximately 90% of its work stalled in the country, resulting in the loss of around 75% of the workforce, mainly due to the shortage of cement, iron and other raw materials and the high prices of the economic crisis. The construction industry has faced various difficulties, which have hindered the growth of the industry [6]. There are several basic problems in the construction sector, which can be classified into two main categories. The first is related to the consequences of joint planning and execution capability (Mishra and Magar, 2017) [7]. The second problem is the shortage of inputs required for construction and fluctuating market prices.

The deficiencies and fluctuation of the market price of the inputs required for construction greatly affected the growth of the construction industry [8]. Enormous price increases affected to completion of the projects; the contractors couldn't complete their projects within an acceptable margin of time and quality and failed to complete within the planned cost

margin, leading contractors to failure.

As a result of this situation, contractors have to suffer significant losses. Due to the losses, construction contractors are facing difficulties building their capacity.

Fluctuations in the price of material pose many challenges and consequences to the construction industry [9]. This phenomenon allows high-end contractors to bid in the non-competitive construction industry. As their economic capacity is greater than that of small-scale contractors, they are able to submit reasonably high bids subject to the prevailing price fluctuations [10].

ICTAD introduced a bulletin of price and cost indices in year 1990 and capitalized it as the base year. Indices can be defined as indicators of inflation in construction inputs such as materials, labour, and fuel [11]. Currently, price indices of 61 items are published including 55 materials (M- indices), 03 labour (L- indices), and 03 Dry Hire Rates for Plant & Equipment (P- indices).

The ICTAD Formula Method for reimbursement of price fluctuation of materials, labour, and equipment in construction projects was introduced in January 1993.The publication is divided into two sections, and Section 1 covers the formula applicable to contracts exceeding Rs.10 million. Section 2 describes the specified method of the Formula Method for contracts not exceeding Rs.10 million. The formula was developed by ICTAD and is the most commonly used method in Sri Lanka, which has been designed to protect both the borrower and contractor from price fluctuations; by allowing the contractors to offer more realistic prices during bidding.

The procurement guidelines (2006) state that a price fluctuation formula should be included in the bidding documents and contract agreements of all Sri Lankan construction projects that are more than three months in duration.The cabinet has granted its approval for the CIDA formula. Due to its inherent characteristics, the government has recommended using the formula as a standard approach in calculating price fluctuations in civil engineering projects [12].

II. OBJECTIVES

Price fluctuation in construction input normally occurs in the construction industry, but after the third quarter of 2021,

it was highly affected by the industry. The following factors mainly affected to this issue;

- Increase in taxes
- Lack of raw materials due to restrictions on import of
  goods.
- A sharp rise in good prices due to the depreciation of the rupee against the dollar.
- Increase in transport charges due to the increase in fuel prices.

The government increases the VAT rate for the import and / or supply of goods or supply of services from 8% to 15% on the 1st of September 2022. Due to this, the prices of goods and services are rocketed. Additionally, the government has temporarily suspended the import of goods related to the construction industry. To remedy this situation, the Cabinet

decided to allow the Institute of Construction Training and Development (CIDA) price escalation formula to be applied up to an upper limit of 20% of the contract amount, for contracts beyond 3 months where the price escalation clause has been excluded.

The purpose of this research is to analyze the impact of rapid price variation on medium-scale building construction projects. Projects with a project cost between 10-100 million rupees were selected for the case studies.

According to CIDA notice Gov/CIDA/Directive/110/2022, which was published on November 30, 2021, it discussed the importance of applying price escalation provisions in the construction industry in accordance with the Construction Industry Development (CID) Act 33 of 2014. The Construction Industry Development Authority (CIDA) emphasized the need for including these provisions in contract documents for all Identified Construction Works (ICWs), regardless of the contract duration. This notice clarified that, according to the CID Act, ICW refers to construction work for public use exceeding a value of Rupees Ten Million (Rs. 10,000,000.00), or a higher value set by the Minister. So that, this research is based on the medium scale building construction projects which falling under 10-100 million rupees category.

The main objective of this study is to investigate the significant challenges arising from unpredictable price variations in the construction industry and their impact on project costs.

III. METHODOLOGY

This research aims to explore how the capacity of local contractors is affected by unexpected price fluctuations, and it is more detailed and exploratory. Research is based on case studies that help investigate problems and provide knowledge mainly to contractors and other stakeholders in the construction industry. According to the methodology, a flow chart research was done. (Refer to Fig.1)

According to the ICTAD Formula method for adjustments to contract price due to fluctuation in prices; the formula for contracts greater than 10 million is given in Equation (1). The calculation of price escalation for all six case studies was performed using the following formula

$$F = 0.966 \ \frac{V - V_{na}}{100} \ \sum_{x} P \ \frac{I_{xc} - I_{xb}}{I_{xb}} \qquad (1)$$

Where:

F : Price adjustment for the period

V : Valuation of work done during the period concerned

V_{na} : Value of net non-adjustable element

P_x : Percentage cost contribution of input x

I_{xc} : Current index for input x

I_{xb} : Base index for input x

According to this equation, six parameters need to be found to solve it or find the "F" value.

Step 1: Valuation of the work done during period (V)

Valuation of the cumulative work done including 80% of the cost of material delivered to the site but not incorporated in permanent works and deducting the certified cumulative payment up to the previous bill. Equation (2)

$$V = (V_c + M_c) - (V_p + M_p) \qquad (2)$$

where,

V_c : Cumulative value of work done during the period in question.
M_c : 80% of the invoiced value of material used for permanent works in the current valuation.
V_p : Cumulative value of work done up to the previous claim.
M_p : 80% of the invoiced value of material used for permanent works on the previous valuation.

Step 2: Excluding the non-adjustable element (V_{na})

The net Non- adjustable element for the current valuation is computed by deducting the cumulative non adjustable element of the previous bill from the current cumulative non adjustable element.Equation (3)

$$V_{na} = V_{nac} - V_{nap} \qquad (3)$$

Where V_{nac} is the Cumulative Value of work certified under

items specified as nonadjustable element up to current claim, and V_{nap} is the Cumulative Value of work certified under items specified as nonadjustable element up to previous claim.

Step 3: Computation of first part of the Formula

$$0.966 \; \frac{V - V_{na}}{100} \qquad (4)$$

Calculate the next part of the equation.

Step 4: P_x – Input Percentages

Input proportion of a particular input was calculated as the ratio between the cost of the input and the cost of all inputs. The contractor provides these input percentage values for the contract.

Step 5: I_{xb} – Base Indices

'Base Indices' shall be the indices for the input, prevailing for the calendar month, one month before the date set for the submission of the bid. These values are taken from the CIDA statistics bulletin publication.

Step 6: I_{xc} – Current Indices

The current index of a particular input shall be the index published by CIDA for that input for the month applicable. The contractor is supposed to submit the monthly statement for the payment.

For the first interim bill, the current indices shall be taken as the indices that prevail on the first month after the commencement of the contract.

For any other interim claim or the final claim, the current indices shall be taken as indices prevailing for the calendar month, one month after the previous valuation was done.These values were taken from CIDA statistics bulletin publication

Step 7: Computation of second part of the Formula

$$\Sigma \; P_x \; \frac{I_{xc} - I_{xb}}{I_{xb}} \qquad (5)$$

Step 8: Computation of the total price fluctuation

Multiplying the total obtained in Step 3, Equation (4) and Step 7, Equation (5); and as in the case of any other payment made to the contractor, the amount computed as price adjustment shall be subject to VAT.

A. Data Collection

The target population for this research is local construction

contractors. Although price fluctuations are constant, no proper studies have been done on their relationship and impact

on the construction industry and especially on construction contractors.

Six case studies of construction projects are used as the research instrument in this investigation. These six case studies are taken from the North Western Provincial Engineering Department-Kuliyapitiya Division. This research work is designed in such a way that it has two parts. The first part deals with market price fluctuation and pricing issues, and the second part deals with compensation-related issues.

Unexpected price fluctuation is a problem that affects contractors of different grades and categories. But because higher-grade contractors take on larger projects, they are more vulnerable to the adverse effects of price fluctuation. Therefore, the study population included in this research work is local contractors of grade C2-C7.

IV. DATA ANALYSIS AND DISCUSSION

A. Market price Fluctuation Trend

Price fluctuation of construction inputs is unpredictable due to sociogeographical complexity. The price of construction materials fluctuates for a short period of time, but on a quarterly basis, it can be seen that it is consistently increasing at a lower rate. since most construction materials and raw materials are imported; The chain of continuous price changes was found to extend between these quarters. Meanwhile, the labourers have had to grow with the industry, because they have no opportunity to increase their demand.
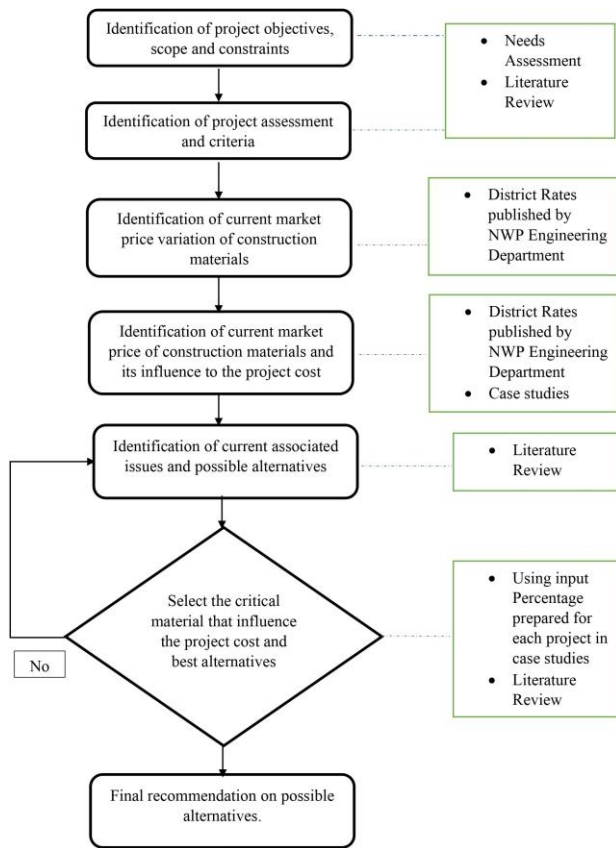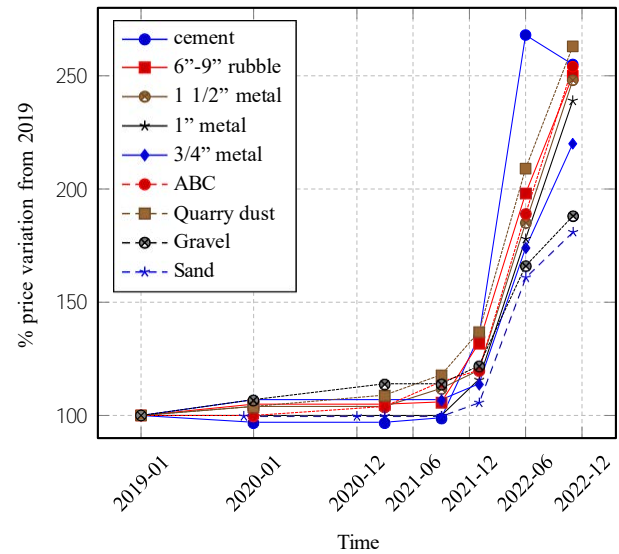
Fig. 1. Flow chart of Research Methodology

Fig. 2. % Price variation common construction materials compared to 2019
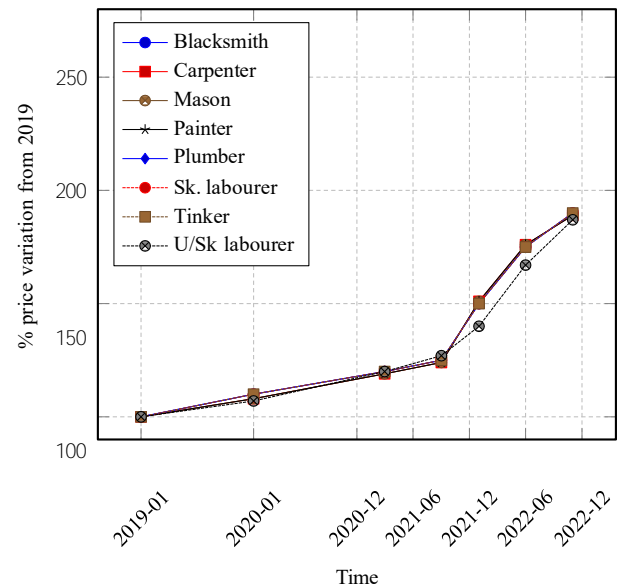
Fig. 3. Price variation graph of common construction materials in comparison to 2019

Since construction is a risky business, contractors must be careful in their bids. i.e., the contractor requires a detailed market survey of the construction inputs, to the preparation of the bid price. Pricing requires not only the market study, but also consideration of all other factors affecting prices such as price fluctuation and contingencies.

According to market surveys, the price variation of the labour from 2019 to 2022 is shown in TABLE I and Fig. 3, the price variation of materials such as Cement, 6"-9" rubble, 1 1/2" metal, 1" metal, 1" metal, ABC, Quarry dust, Gravel and Sand which are directly linked with the construction is shown in TABLE II and Fig. 2. These Tables and Figures are merely used as an example to show the results of the market survey.

B. Case Studies

Six case studies were selected to illustrate the level and impact of price fluctuation on the six projects and the construction contractors. All the projects considered for the case study are building construction projects, and the contract amount is within 10-100million.

The study is conducted by collecting data from the projects contract amount, bid date, commencement date, details of the contractor, project basic price indices (input percentage), material requirements, progress reports, material delivery reports and causes of project time extensions. The study focusses on the planned and actual costs of the main inputs in construction projects, which are selected for the study. For building projects, the main inputs are material and labour. Therefore, data is collected from these documents to view the planned and actual cost of the projects for the main inputs of construction of the respective projects.

1) Case study framework: The framework of the case study is organized in four main steps.

- List all the main materials required for the project by input percentage, along with their base prices in pricing.
- Provide the actual purchase price of the materials.
- Analyse the compensation for the project.
- Study the price difference and how it contributes to the contractor's capacity and project performance.

TABLE I
PRICE VARIATION OF LABOUR IN COMPARISON WITH 2019

No	Item	Unit	2022 (3rd part)	2022 (2nd part)	2022 (1st part)	2021 (2nd part)	2021 (1st part)	2020	2019
1	Blacksmith	Day	3,800.00	3,500.00	3,000.00	2,500.00	2,400.00	2,200.00	2,000.00
2	Carpenter	Day	3,500.00	3,250.00	2,800.00	2,300.00	2,200.00	2,000.00	1,850.00
3	Mason	Day	3,500.00	3,250.00	2,800.00	2,300.00	2,200.00	2,000.00	1,850.00
4	Painter	Day	3,500.00	3,250.00	2,800.00	2,300.00	2,200.00	2,000.00	1,850.00
5	Plumber	Day	3,800.00	3,500.00	3,000.00	2,500.00	2,400.00	2,200.00	2,000.00
6	Specials sk labourer	Day	3,800.00	3,500.00	3,000.00	2,500.00	2,400.00	2,200.00	2,000.00
7	Tinker	Day	3,800.00	3,500.00	3,000.00	2,500.00	2,400.00	2,200.00	2,000.00
8	U/Sk labourer	Day	2,800.00	2,500.00	2,100.00	1,900.00	1,800.00	1,600.00	1,500.00

TABLE II
PRICE VARIATION OF MATERIAL IN COMPARISON WITH 2019

No	Item	Unit	2022 (3rd part)	2022 (2nd part)	2022 (1st part)	2021 (2nd part)	2021 (1st part)	2020	2019
1	Cement	Cwt	2,462.36	2,588.66	1,300.00	956.00	933.00	933.00	965.00
2	6"-9" rubble	Cu	9,779.00	7,742.00	5,165.00	4,138.00	4,114.00	4,114.00	3,914.00
3	1 1/2" metal	Cu	15,779.00	11,742.00	7,665.00	7,138.00	6,614.00	6,614.00	6,364.00
4	1" metal	Cu	15,779.00	11,742.00	7,665.00	6,638.00	6,614.00	6,614.00	6,614.00
5	3/4" metal	Cu	16,779.00	13,242.00	8,665.00	8,138.00	8,114.00	8,114.00	7,614.00
6	ABC	Cu	16,779.00	12,490.00	7,915.00	7,638.00	6,864.00	6,614.00	6,614.00
7	Quarry dust	Cu	14,779.00	11,742.00	7,665.00	6,638.00	6,114.00	5,864.00	5,614.00
8	Gravel	Cu	6,779.00	5,992.00	4,415.00	4,133.00	4,114.00	3,864.00	3,614.00
9	Sand	Cu	28,000.00	25,000.00	16,500.00	15,500.00	15,500.00	15,500.00	15,500.00

a) Case study -01: Construction of a three-story building with the primary Learning Resource Center & Junior Secondary Laboratory at Holy Angel's Girls' College, Kuliyapitiya.

b) Case study -02: Construction of a 70 x 25 'two-story classroom building in Yayawaththa Mus K.V.

c) Case study -03: Construction of a three-storey 29.25x10.15m classroom building with ordinary-level science laboratory (FF) & library (SF) at Giri / Wildramashila Madya Maha Vidyalaya.

d) Case study -04: Repair of the building at the Giri / Wickramashila National School.

e) Case study -05: Construction of the new laboratory in the Bingiriya Divisional Hospital Bingiriya.

f) Case study -06: Construction of the Katupotha office building of MOH (Bihalpola).

According to TABLE III, it shows the result of case studies. Both contracts (case studies 1 and 2), which had a start date of 2019, have been extended to 2021. Additionally, the contract that started in 2020 must be completed in 2022. The Covid-19 pandemic situation, the lack of contract inputs and the increase in the price of contract inputs can be identified as the reason. Contractors have requested extensions for those projects and the reasons for them are,

- Scarcity of material due to COVID-19 pandemic
- Suspension of the site work due to Covid-19 pandemic
- Due to the difficulty of finding materials
- Due to the difficulty of finding materials
- Scarcity of tiles in the market
- Shortage of fuel
- Material cost increase

contracts concluded in the last months of 2022 (i.e. case study 4,5 and 6) have higher price fluctuations. It is up to 18%-26% compared to the contract amount. Although all the case studies are taken from the kuliyapitiya area, entire country significantly suffered from the price escalation of the construction inputs between year 2019-2022.

With the free float of the rupee, the exchange rate of 1 US $ is Rs.367.00 in December 2022. In December 2020 and December 2021, this was Rs.186.40 and Rs.203.00, respectively. As almost 70% of the construction materials in buildings and other engineering constructions are imported on an import basis, the impact of this would be at least another 60% increase in construction costs.

So this case studies could be applied for all over the country.

TABLE III
SUMMARY OF THE CASE STUDIES

Case study	Contact Duration	Commencement Date	Scheduled Completion Date	Actual Completion Date	Contract Amount (Rs.)	Total project cost (Rs.)	Price Increase (%)
1	365 days	11-Jun-2019	11-Jun-2020	25-Sep-2022	41,613,968.62	44,563,340.21	7.09%
2	365 days	2-Nov-2019	30-Apr-2020	20-Jun-2022	14,000,885.33	14,302,974.72	2.16%
3	365 days	22-Jan-2020	21-Jan-2021	21-Oct-2022	29,127,945.07	30,353,437.80	4.21%
4	365 days	26-Aug-2021	9-Dec-2021	21-Dec-2022	12,001,686.24	14,206,242.71	18.37%
5	365 days	18-Oct-2021	18-Apr-2022	18-Dec-2022	30,330,228.50	35,698,863.73	17.70%
6	365 days	14-Oct-2021	14-Apr-2022	25-Oct-2022	21,472,169.76	27,036,870.10	25.92%

V. CONCLUSIONS

According to this research it shows that price variation can occur at any time; but it is very difficult to predict the magnitude of the price fluctuation, the duration of the fluctuation, or whether it is an increase or decrease in price. Sometimes, even during a period of high price fluctuation, it is often difficult to predict whether the prevailing prices will rise or fall or remain fairly stable.

Price variation means increase or decrease in prices, but in this study it shows that almost all building materials show an increase in price and the prices of some construction inputs are rocketed; due to the contractor's planned construction cost, it will vary at the finishing stage of the project.

Although the construction inputs for civil engineering are quite large in number and type, the Sri Lankan government has allowed compensation for only a few types of materials. According to the ICTAD Bulletin of Statistics, only 55 items are mentioned.

These case studies revealed that contractors were unable to make as much profit as they expected from the projects. Due to insufficient profits, they have not been able to take steps to increase the capacity of the company.

This research shows that project delays are common as a result of material shortages, delaying receiving orders, and loss of working capital. Therefore, contractors try to reduce the quality of the project and materials to minimise their losses; and they try to use materials sparingly by minimising the materials they use.

VI. RECOMMENDATION

To address the challenges arising from unpredictable price fluctuations in the construction industry, it is recommended to enhance price fluctuation forecasting, diversify the compensation system, incorporate risk management strategies, allow flexible bidding mechanisms, promote contractual flexibility, foster collaborative supplier relationships, build contractors' capacity for financial resilience, streamline payment processes, prioritise quality over cost cutting, and advocate for regulatory reform to enable dynamic responses to price fluctuations.

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