Investigation of Effect of ICTAD Price Fluctuation Formula Procedure to Recover the Actual Materials Cost of Contract

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Abstract: *The cost estimation prepared during the bidding stage may not same as the cost calculated at the time of actual work done. This is because open market escalation of construction inputs. To address this problem ICTAD has introduced a country specific documents "ICTAD formula method for adjustments to contract price due to fluctuation in prices". Price Fluctuation Formula mainly considers several parts; value of work done for a particular period, non-adjustable work elements, cost of materials at site, percentage input contribution from each construction inputs and price indices variation compared to the start of the project. Therefore careful identification, selection and calculation in relation to each and every factors used in the formula are very important to recover the actual cost variation to the contractor.*

This research mainly focused on effect of ICTAD price adjustment formula to recover the actual material cost of contract. To fulfil this, research aimed at finding the relationship between ICTAD price adjustment and true price adjustments through the data analysis and estimating accuracy and effect of the ICTAD price fluctuation formula procedure. Finally some suggestions were made to modify the formula to increase the accuracy of ICTAD price fluctuation formula. To fulfil above objectives, analysis were carried out under four sections for the data gathered from 11 actual projects which are already completed. Those four sections are Effect of Non- adjustable elements, Effect of current indices related to the materials which are not used during a particular valuation period, Effect of selecting Input percentage and Cost of Materials at the site.

Base on the results it was identified that excluding non-adjustable elements in the formula does not affect to the actual cost recovery. But careful identification is very essential. Use of material cost at site which is not still used for the construction is having some effects. It may lead to get higher price adjustment to the contractor which may unfair to the client. Also use of same input percentages throughout the project may lead to get higher price adjustment. Dividing the input percentages based on the interim bills and not for the entire project may have fair decision to both contractor and the client, but further research is suggested on this.

Keywords: *Price fluctuation, Price indices, Input percentage, Construction materials, non- adjustable element.*

1. INTRODUCTION

It is obvious that, many construction projects last for a long duration. Also the time of preparation of the tender, time of awarding the tender and the time of completion of the project has significant difference. Due to the price fluctuation of materials, equipment, labours etc., bid amount for a particular project can be varied from the actual construction cost. To address this problem Institute for Construction Training and Development (ICTAD) (Now it is called as CIDA) has introduced a procedure for price adjustment due to price variations of materials, equipment, labour hours etc. To address this problem it is necessary to use price fluctuation adjustment formula for construction field. Application of the price fluctuation to the contract cost, largely depend on the category of construction. So to satisfy both of client and contractor, it is necessary to use some simple mechanism to compute the price adjustment to fair fluctuation formula (Jayasinghe et al. 2015). The purpose of the Price fluctuation formula system is for equitable risk sharing between the client and the contractor in terms of materials, labour and plant & equipment cost fluctuation.

ICTAD is the responsible authority for the construction works related activities in Sri Lanka. So they have developed a general formula for adjustments to contract price due to fluctuation in prices. In this research, it is expected to study about the effect of ICTAD price fluctuation formula procedure to recover the actual materials cost of contract. Prices of materials, wages of labours, equipment hiring charges etc. are fluctuated due to many reasons such as changing tax, changing climate, condition of area. So ICTAD Price adjustment formula is a compensation method and not to recover the full actual cost (Jayalath 2014).

This research is aiming to study whether the available ICTAD price adjustment procedure is exactly suitable to use with the present format. This aim was achieved through identifying the relationship between ICTAD price adjustment and true price adjustments through the data analysis, estimating the accuracy and effect of the ICTAD price fluctuation formula procedure and suggesting modifications to increase of accuracy of ICTAD price fluctuation formula.

1.1. Literature Review

ICTAD formula is a "country specific" approach with the aim to provide a reasonable basis for calculating price adjustments due to open market escalation in specified construction inputs such as major building materials, hire charges of plants and wages for the labour. The choice of those inputs largely depends on the principle of cost significance in the overall share for the quoted tender price. Adjustments to the contract price shall be made in respect of not only in rise but also in fall in the cost of materials and other inputs affecting the cost of execution of works (Jayalath 2014).

Price Adjustment clauses for a particular contract allow the contractor to submit a more realistic bid without adding an arbitrary mark-up for escalation. Price escalation is the change in cost or price of specific goods or services in a given economy over a period. The escalation in price of units reflects the inflationary trends in the economy (Chaphalkaretal & Sandbhor 2012, cited in Jayasinghe et al. 2015). A brief overview of the practice of fluctuation adjustment in other countries, confirms that there is no single fluctuation formula that suits all jurisdictions, nor a single formula to satisfy all employers and contractors (Construction industry council 2011, cited in Jayasinghe et al. 2015).

The ICTAD Formula method for reimbursement of price fluctuation of materials, labour and equipment in construction project was introduced in January 1993. ICTAD Price fluctuation formula can be divided in to two parts. Those two parts are contracts exceeding Rs.10 million and contracts not exceeding Rs.10 million. The price indices for materials, labour, machineries and fuel are published by the ICTAD every month.

The Formula method for contracts exceeding Rs.10 million.

$$F = \frac{0.966(V - V_{na})}{100} \sum_{all\ inputs} P_x \frac{(I_{xc} - I_{xb})}{I_{xb}}$$

The Formula method for contracts not exceeding Rs.10 million

$$F = 0.869(V - V_{na}) * \frac{(I_{tc} - I_{tb})}{I_{tb}}$$

F   = Price adjustment for the period
I_{xb} = Base index for input X, published by ICTAD
I_{xc} = Current index for input X
P_x = Percentage cost contribution of input X
V = Valuation of work done during the period concerned including 80% of cost of materials at site
V_{na} = Value of net non-adjustable element
I_{tc} = Current composite index for the type of work published by ICTAD
I_{tb} = Base composite index for the type of work published by ICTAD

2. METHODOLOGY

Mainly methodology was divided in to different stages. Those are preliminary survey using interviews and questionnaire, collection of cost data related to different interim bills of 11 projects and data analysis.

Analysing of the data is to be done by comparison with indices variation and cost recovery calculated based on the ICTAD formula method for selected projects. For a particular project indices variation throughout the project duration and calculated cost recovery were plotted. In addition, indices variation was compared with cost recovery by eliminating non-adjustable part for the concerned period.

Using the Cost recovery data for eleven (11) projects, percentage of current indices variation to the base indices and percentage of Price adjustment to actual cost for each bill number were considered. For this price escalation, summary sheets for various projects were collected as the data collection task and then those were analysed calculating below mentioned parameters.

$$\text{Percentage variation of current indices} = \frac{(CurrentIndices - BaseIndices)}{BaseIndices} * 100\%$$

All the indices are published by the ICTAD in their monthly bulletins. With this calculation it is expected to see the indices variation theoretically.

Percentage of price adjustment (Including non − adjustable elements)
$$= \frac{\text{Price A djustment}}{\text{Work done in period(v)}} * 100\%$$

With this, it is expected to see the variation of price adjustments that the contractor received based on the work done during the concerned period.

Percentage of price adjustment (without non − adjustable elements)
$$= \frac{\text{Price A djustment}}{\text{Computation of V − Vna}} * 100\%$$

Usually price adjustments are done by eliminating value for non-adjustable work. So it is expected to see the relationship of price adjustments without the value for non-adjustable works.

Calculations of above three parameters were explained using data gathered from a selected project and those are in Table 1 and Table 2.

Table 1 Base indices and current indices for each invoice number

Indices	Base indices	Bill No 01	Bill No 02	Bill No 03	Bill No 04	Bill No 05	Bill No 06	Bill No 07
Machinery	313.7	318.6	346.4	346.4	346.4	346.4	346.4	346.4
Unsk labour	407.4	420.3	433.2	433.2	433.2	457.1	457.1	469.8
Small plant	336.7	336.7	400.8	400.8	400.8	400.8	400.8	400.8
R/F steel	516.1	528.2	558.0	558.0	558.0	558.0	558.0	558.0
Fuel	747.6	820.8	1123.8	1123.8	1126.7	1140.7	1182.4	1182.4
Skilled labour	363.5	374.0	395.8	395.8	395.8	414.8	414.8	427.7
Cement	416.3	416.3	462.1	462.1	508.6	508.6	508.6	508.6
Formwork	778.7	806.7	819.2	819.2	819.2	847.4	847.4	867.6
Sand	1797.0	1914.4	2068.8	2160.9	2251.0	2262.4	2308.7	2356.4

The data in the Table 1 is based on the ICTAD published indices in their monthly bulletin

Table 2 Percentage variation of current indices and price adjustment variations

	1	2	3	4	5	6	7
Machinary (%)	1.56	10.42	10.42	10.42	10.42	10.42	10.42
Unskilled labour(%)	3.16	6.33	6.33	6.33	12.19	12.19	15.32
Small plant (%)	0	19.04	19.04	19.04	19.04	19.04	19.04
R/F steel (%)	2.34	8.11	8.11	8.11	8.11	8.11	8.11
Fuel (%)	9.79	50.32	50.32	50.71	52.58	58.16	58.16
Skilled labour (%)	2.88	8.88	8.88	8.88	14.11	14.11	17.66
Cement (%)	0	11.05	11.05	22.17	22.17	22.17	22.17
Formwork (%)	3.59	5.2	5.2	5.2	8.82	8.82	11.42
Sand (%)	6.88	15.56	20.65	25.68	26.32	28.91	31.57
Price Adj (Rs)	46,698.17	251,405.39	386,263.30	236,611.47	679,065.64	282,454.42	628,360.36
Value of work (Rs)	2,813,548.06	2,782,620	4,476,970	2,655,555.84	5,945,205.50	2,523,285	4,949,000
%of price adj to work	1.659	9.035	8.628	8.91	11.42	11.19	12.697
V-Vna (Rs)	2,295,495	2,626,620.00	4,014,970.00	2,390,928.50	5,789,205.50	2,370,285.00	4,866,000.00
	2.03	9.57	9.62	9.90	11.73	11.92	12.91

Percentage variations of current indices for machinery, labour, plant and other materials in the Table 2 were calculated based on the data in Table 1. Price adjustments, value of work done and value of work done without non-adjustable work (V-Vna) are gathered data for that particular project. Then percentage price adjustments were calculated.

3. RESULTS AND DISCUSSION

The collected data were analyzed considering following four different points which were identified during the preliminary surveying and literature review as having effects to recover the actual construction cost.

3.1. Effect of Non- Adjustable Elements

Usually non-adjustable elements are identified at the tender documents preparation stage and those non-adjustable elements are entered as contract data. Also non-adjustable elements are considered as not liable to price variation throughout the project period. Therefore careful selection of non-adjustable elements will not affect to the contractor's price fluctuations. This statements was proved using data taken from all the projects and data for project 1 is plotted in Figure 1.

Figure 1 shows the percentage variation of price indices for the months of interim bills (current indices) and percentage variation of price adjustments for those interim bills for values obtained for project number 1.

Price indices are published by ICTAD for every month in their monthly bulletin. Variations of price indices were calculated considering the base indices which are relevant to one month prior to the bid closing month of that particular project.
In Figure 1, percentage variation of price adjustment to work done and percentage price adjustment to work done without non-adjustable elements are marked. All the other lines represents percentage variation of indices for different construction inputs.
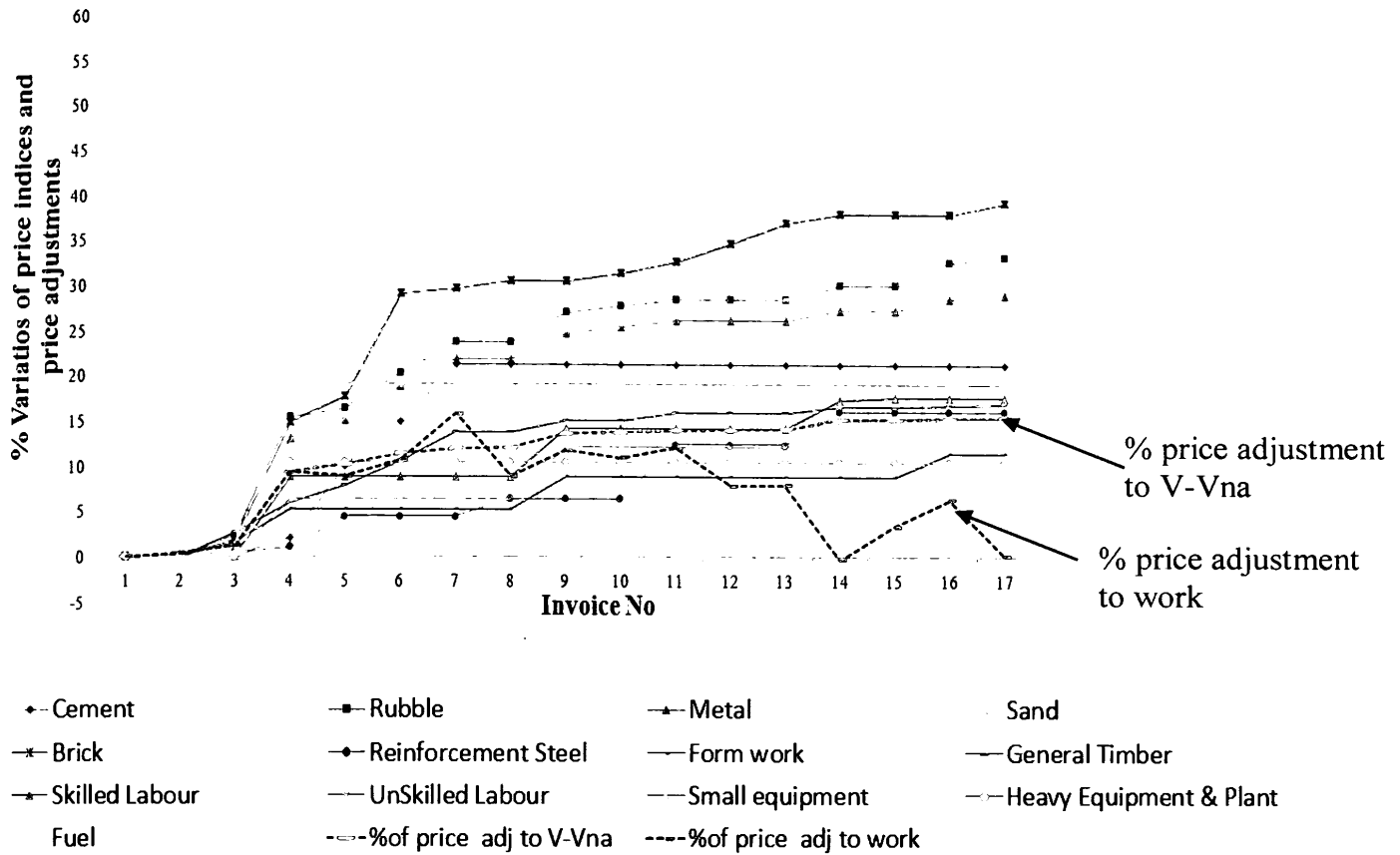
Legend:
- ← Cement
- ← Brick
- ← Skilled Labour
- Fuel
- ← Rubble
- ← Reinforcement Steel
- — UnSkilled Labour
- -○-%of price adj to V-Vna
- ← Metal
- — Form work
- — Small equipment
- ----%of price adj to work
- Sand
- — General Timber
- — Heavy Equipment & Plant

Figure 1 Relationship between current indices and price adjustment for Project 1

In here it can be seen that the price adjustment variation without considering non-adjustable elements and variation of current indices are with the same pattern. But price adjustment to the work done and variation of current indices are not in same pattern.

To calculate price adjustment, value of (V-Vna.) is used. According to the graph current indices increase throughout the project. As same, percentage of price adjustment to the value of (V-Vna) graph increases throughout the project. But, graph of percentage of price adjustment to the value of work done does not increase throughout the project. Price adjustment values decrease in some bill numbers. Invoice numbers 8,10,12,14 and 17 shows the decrease in price adjustments. Increase the non-adjustable value in valuation period is the reason to decrease the price adjustment.

3.2. Effect of Current Indices Related to the Materials which are not Used during a Particular Valuation Period

Valuation data analysis graph of selected project is shown in Figure 2. Similar to Figure 1, in the Figure 2 also price adjustments variations are labelled. Other lines indicate the percentage variations of indices.

In this plot price adjustment percentage in some bill numbers are high. Same as the previous graph, the price indices variations and price adjustment variations to the work done value without considering non-adjustable elements are with the same pattern.
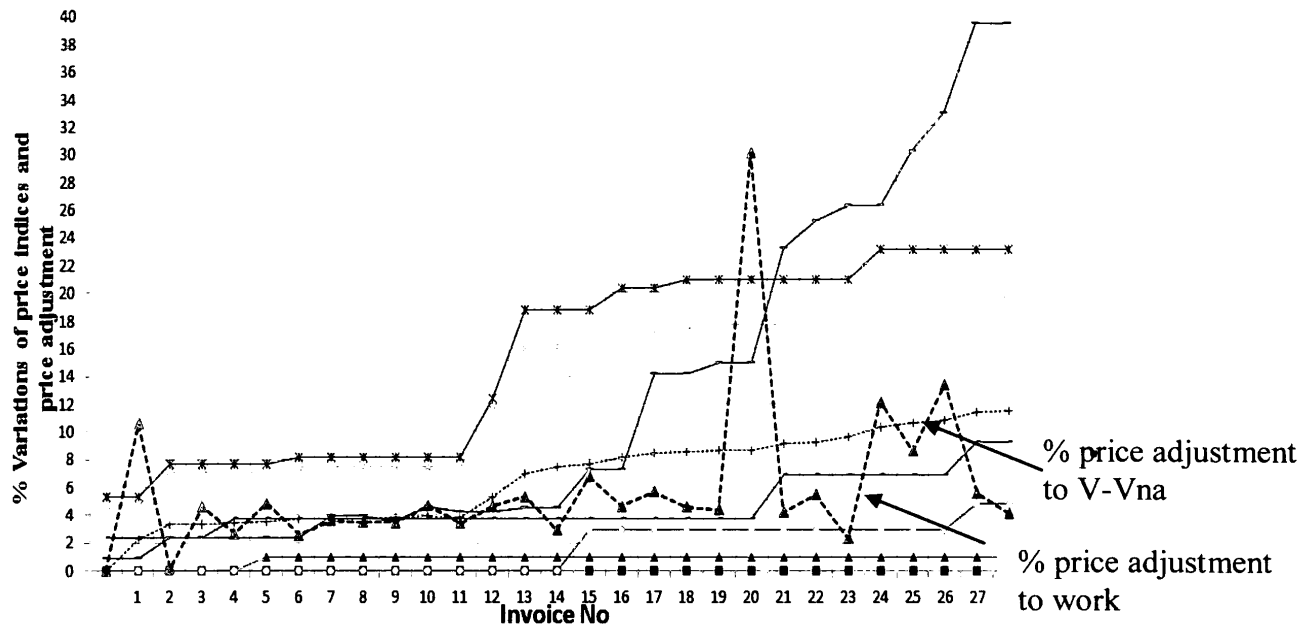
Figure 2 Relationship between current indices and price adjustment for Project 2

In this project also, current indices' variation increase throughout the project. When considering the invoice numbers 2, 20 and 24, price adjustment percentage are high. By considering the project details it can be identified that some current indices are not used at the valuation period but those current indices are used for the price adjustment calculation. Because of that Factor sum [Px (Ixc-Ixb)/Ixb] increases for low work done value for the valuation period. Because of this reason client has to pay extra price adjustment value for the contractor for less work done. So in here another shortcoming of the ICTAD price fluctuation formula is, current indices which are not used at the time of valuation are considered for price fluctuation calculation.

3.3. Effect of Selecting Input Percentage

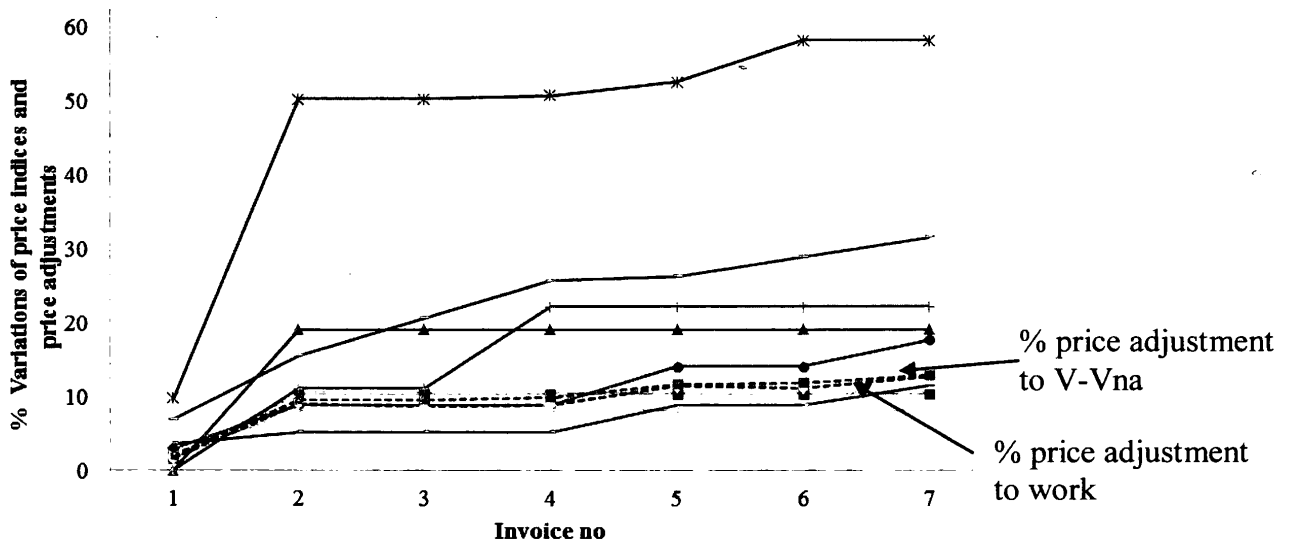Valuation data analysis graph of project No 3 is shown in Figure 3.

Figure 3 Relationship between current indices and price adjustment for Project 3

Current indices and price adjustments increased throughout the project. After data analysing and plotting project valuation data some relationship between current indices variation and price adjustment variation were identified. Below Table 3 shows the input percentage and current indices variation for machinery and fuel. Although the machinery has lower value in percentage of current indices variation, it contribution to price adjustment is high as its input percentage is high.

Table 3 Price adjustment data of Bill No 2 under Figure 3

Input name	Input %	Current index variation	Factor of sum
Fuel	3%	50.32%	1.51
Machinery	41%	10.41%	4.57

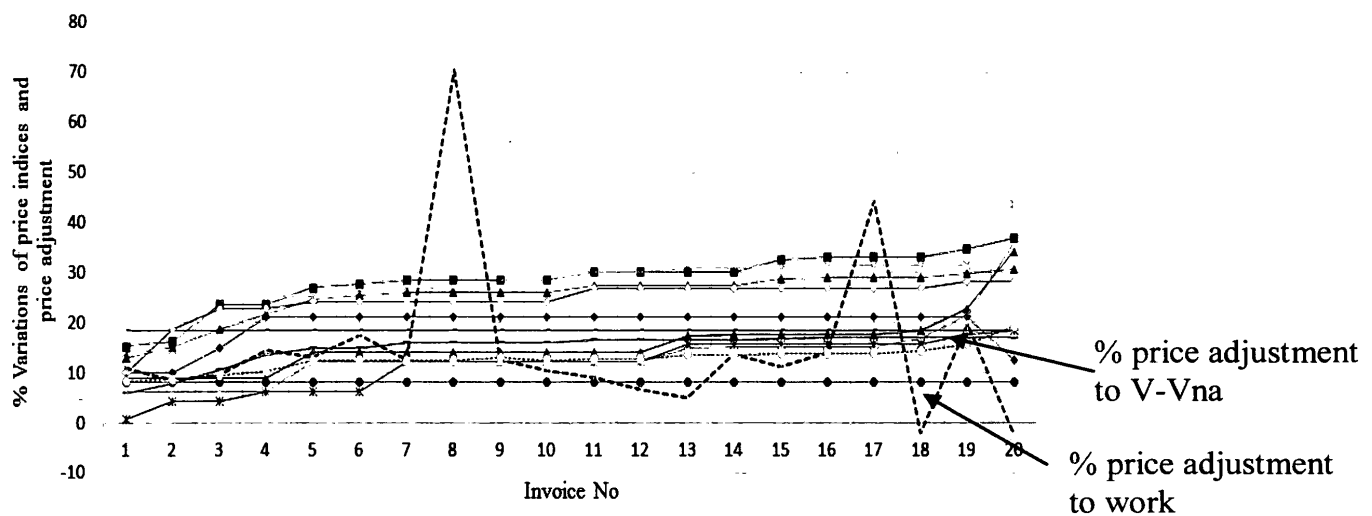## 3.4. Cost of Materials at the Site

Figure 4 Relationship between current indices and price adjustment for Project 4

According to the Figure 4, for invoice numbers 8 and 17, price adjustment is relatively high. This is because the cost of materials at site. Those information are shown in Table 4

Table 4 Cost of Material for project under Figure 4

Bill No	7	8	17	18
Cost of Materials (Rs.)	8,128,740	21,912,262	24,265,415	8,423,358

This shows the cost of materials at the site effects to price adjustments.

4. CONÇLUSION

Based on the above explained results, price adjustment calculation without non-adjustable elements is fair. Use of current indices & their input percentages defined at the beginning, for all the valuation period is not fair. Suggestion for that effect is check the price adjustment using indices which are related to the materials used during the valuation period. Similarly, use of same input percentage values is not fair. Suggestion for that effect is Input percentages can be calculated considering the materials used during the valuation period and not the entire project. Also, adding the cost of materials at site to work done leads to higher price adjustment. So eliminating that part that effect can be minimized.

Research can be further carried out considering the use of input percentages for different valuation period rather than using the same set of input percentages throughout the project. Also effect of material cost at site can be considered as one main criteria and it can be analysed its effect.

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