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Exploring Relationship between Price Escalation Components using Regression Analysis – A Case Study of Pakistan Construction Sector

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ABSTRACT

Keeping in view the present unprecedented price fluctuation, it has become a critical aspect to explore the relationship of elements being evaluated during contractual escalation mechanism. The current study investigated the components of the escalation provisions being practiced in local construction industry to understand their relationship with components admissible for compensations. The research is based upon the price adjustment mechanism under FIDIC scheme. As a case study, available escalation bills of an actual construction project have been evaluated and the period of billing ranged from July 2011 to May 2018. Multiple regression analysis was implemented at this stage to explore the relation of escalation paid with its four (04) components considered in provisions. This included cement, labour, reinforcement and fuel. The co-efficient of determination (R^2) achieved a value of 0.90, 0.93, 0.88 and 0.89 respectively, The results have shown a strong relationship of components with the escalation provision which was linear in nature.

KEYWORDS:

Price Escalation, Adjustment Formula, Regression Analysis

1 INTRODUCTION

The role of construction industry in development of every economy is pivotal [1]. It not only contributes in development of basic infrastructure but also uplift the social standards of comfort living. Infrastructure like energy, residence, education, health care, defence, transportation, communication system, water bodies management etc are the prime focus area of any nation economy and construction industry remain one of the key pillars to achieve them. However, the multi-level involvement of human, material and financial resources makes the structure of this industry a very complex one and challenging to manage. One of basic and prime challenge of any construction endeavour lies in its cost management [2, 3]. The expenditures related to the procurement of skilled and un-skilled human resource, material procumbent and machinery involved in the process present the key barriers to be managed to meet the objectives of any construction activity. Besides many other factors, the price escalation is a major factor in cost fluctuation of any project[4, 5]. Although, it is heavily dependent on the local market environment but needs a serious consideration during the project life cycle as construction activity depends upon the economy of region and vice versa. Interestingly, in case of developing or under developed

nations, this variation may observe serious fluctuations as economies remain struggling, thus making relation of sub-sectors even more complex. This may lead serious economical setbacks due to an insecure environment for business by disturbing the rate of return on investments[6]. Keeping in view the importance to construction industry in economic uplift, many solutions have been practiced in various part parts of world to manage the impact of escalations. Some solution pertains to local level but many global level solutions are also practised. Compensation for price escalation through price adjustment mechanism is one of the such solutions being implemented in various construction sectors around the globe[7, 8]. The components of such process may vary from region to region to manage the prime local concerns. However, it remains vital to explore the relationship of these components with the process to ensure that realistic compensations are being assessed.

2 LITRATURE REVIEW

With ever increasing population and urbanization, sustainable infrastructure development is required [9] especially in developing countries to bear the fruits of economic and social prosperity. Besides the complex linkage with the economy, the role of construction industry remains pivotal by ensuring social and urban development leading to urbanization, industrialization, job creations and much more[10]. Table 1 details some of contributions around the globe

Table 1. Contribution of Construction Industry to GDP of different Countries [11]

Country/Region	Month/Year	Contribution in GDP	Currency (unit)
UK	Jun/23	32,658	GBP Million
US	Jun/23	820	USD Billion
China	Sep/23	60,197	CNY Hundred Million
Japan	Dec/21	28,324	JPY Billion
Saudi Arabia	Sep/23	32,872	SAR Million
Qatar	Sep/23	18,860	QAR Million

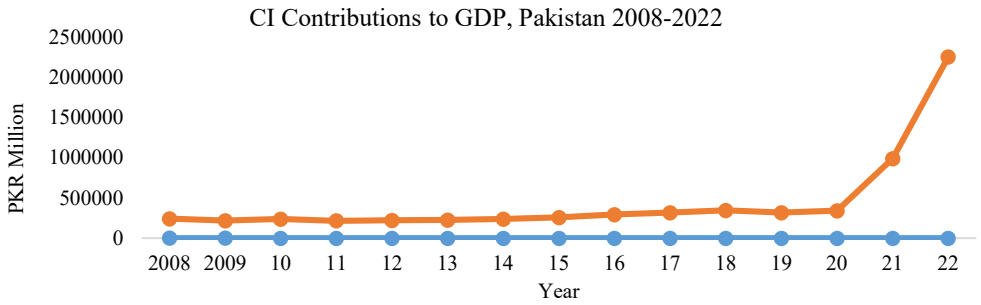


Figure 1. Contributions of Construction Industry to GDP of Pakistan [11]

Construction industry is dynamic and contribute to the economy. However, the both have a complex relation. To impose the conceived design by developing physical features on site, number of activities and resources are involved e.g. contractor & sub-contractor, suppliers of materials & equipment, professional workers like engineers, architects & surveyors, skilled & unskilled workers etc [12]. According to Sarhan and Fox [13], besides many other barriers to the performance of construction industry , inflation also part of budget barriers. Inflation can be defined as *"a rise in the price level of a good or service or market basket of goods and/or services"[14]*. Increase in raw materials prices, rising wages of labor, upward trend in imported item price by fall of exchange rate, increase in taxes utility bills etc. result in boosting the impact of inflation in construction projects [15]. Labor plays key role in construction project. Variation in labor wages from time to time have great part in inflation. Keeping in view this serious impact, it is proposed to adopt Industrial revolution (IR) 4.0 in construction industry as to compensate for labor [16]. According to Asian Development bank, *"Price escalation is the upward moment of price and can be factored in into a contract. If it goes beyond what is expected, price escalation can affect a contractor's cash flow and lead to delays in construction and lower quality work"* [17]. The impact of inflation in form of cost and time overrun is likely to put construction industry at risk. Therefore, the impact of inflation needs to be considered at the planning stage of construction projects [15].

3 METHODOLOGY

In order to observe the relationship, a real-life construction project of a multistory office building was selected as a case study. Data pertinent to escalation provisions was acquired covering the period from July 2011 to May 2018. Figure 2 presents the summary sheet of price adjustment provision for some months during project.

Price adjustment formula Pn= a+(b x Ln/Lo)+(c x Mn/Mo)+(d x En/Eo)+(e x Fn/Fo) — Tender opening date March 30, 2011 — Commencement Date= June 29,2011

					LABOUR			CEMENT			REINFORCING STEEL			FUEL				
IPC NO.	Statement Submission Date	Effective Month	This Bill/Segregated Workdone Value	Fixed Portion Weight-age (A)	Weight-age (b)	Current Rate (Ln)	Base Rate (Lo)	Weight-age (c)	Current Rate (Mn)	Base Rate (Mo)	Weight-age (d)	Current Rate (En)	Base Rate (Eo)	Weight-age (e)	Current Rate (Fn)	Base Rate (Fo)	Price adjustment Factors (Pn)	Increase/decrease in Cost =Workdone x (Pn-1.00)
1	2		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
01	Sep,2011	Jul,2011	540,746.00	0.445	0.175	400.00	375.00	0.083	395.00	357.50	0.247	70500.00	62250.00	0.050	92.10	82.22	1.05911617	31,966.83
		Aug,2011	3,721,091.00	0.445	0.175	400.00	375.00	0.083	390.00	357.50	0.247	70000.00	62250.00	0.050	92.20	82.22	1.05603221	208,500.95
		Sep,2011	8,313,664.00	0.445	0.175	400.00	375.00	0.083	400.00	357.50	0.247	69500.00	62250.00	0.050	92.64	82.22	1.05663753	470,865.36
03	Oct,2011	Oct,2011	19,250,986.00	0.445	0.175	400.00	375.00	0.083	410.00	357.50	0.247	70000.00	62250.00	0.050	94.15	82.22	1.06186141	1,190,893.09
04	Nov,2011	Nov,2011	27,266,438.76	0.445	0.175	400.00	375.00	0.083	410.00	357.50	0.247	70000.00	62250.00	0.050	94.15	82.22	1.06186141	1,686,740.28
06	Dec,2011	Dec,2011	55,673,585.77	0.445	0.175	400.00	375.00	0.083	425.00	357.50	0.247	70500.00	62250.00	0.050	98.82	82.22	1.07016780	3,906,493.17

Figure 2: Example of Summary sheet working for price adjustment

3.1 Price Adjustment Provisions

Price of construction related item and services are fluctuating due to change in currency market. Price adjustment formula is considered as one of tools to account price increase or decrease of services and goods in construction. Such practice encourages realistic competitive bids and support contracts to execute in a disciplined manner. For the current work, price adjustment was calculated based on methodology provided in the contract agreement of our case study under the provisions of FIDIC shame using eq -1 [18].

$$Pn = A + b\frac{L_n}{L_o} + c\frac{M_n}{M_o} + d\frac{E_n}{E_o} + e\frac{F_n}{F_o} \qquad (eq-1)$$

$$PA\ (increase\ /\ decrease) = Wd \times Pn \qquad (eq - 2)$$

where,

"Pn" is adjustment factor for carried out work in a particular month, "A" is a fixed portion, "b, c, d, f" are weightages of specified elements (labour, cement, steel and fuel respectively),
"Lo, Mo, Eo, Fo" are the base rate of specified elements,
"Ln, Mn, En, Fn" are the current rate of specified elements
" PA" is escalation worked out for a particular month
"Wd" is work done in that particular month

3.2 Regression

In order to observe the relationship of specified elements with the price adjustment provisions, regression analysis has been adopted, eq – 3.

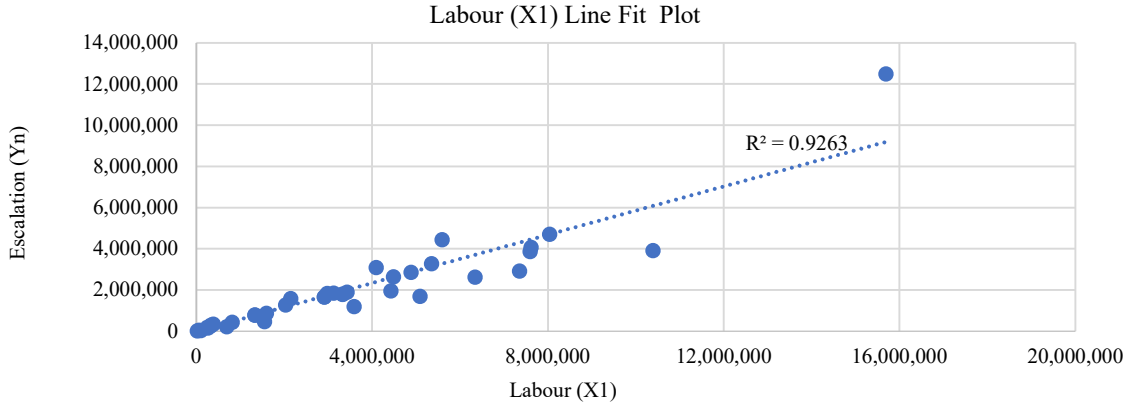
$$Y = \beta_0 + \beta_1.X_1 + \beta_2.X_2 + \ldots\ldots + \beta_n.X_n + \mathcal{E} \qquad (eq - 3)$$

where,

Y Is dependent variable, β_0 y-intercept, $\beta_1, \beta_2, \ldots, \beta_n$ are Coefficients of each independent variable, $X_1, X_2, \ldots, X_n$ are values of independent variables, $\mathcal{E}$ is error term (unconsidered factors) [19]

4 RESULTS AND ANALYSIS

In our study, the escalation was dependent variable denoted by Y_n. Whereas labor (X_1), cement (X_2), steel reinforcement (X_3) and fuel (X_4) were independent variables. In first stage, simple regression analysis was performed to observe the relationship of escalation with each predictor (independent variable). Figure 3 presents the relationships in a graphical format.



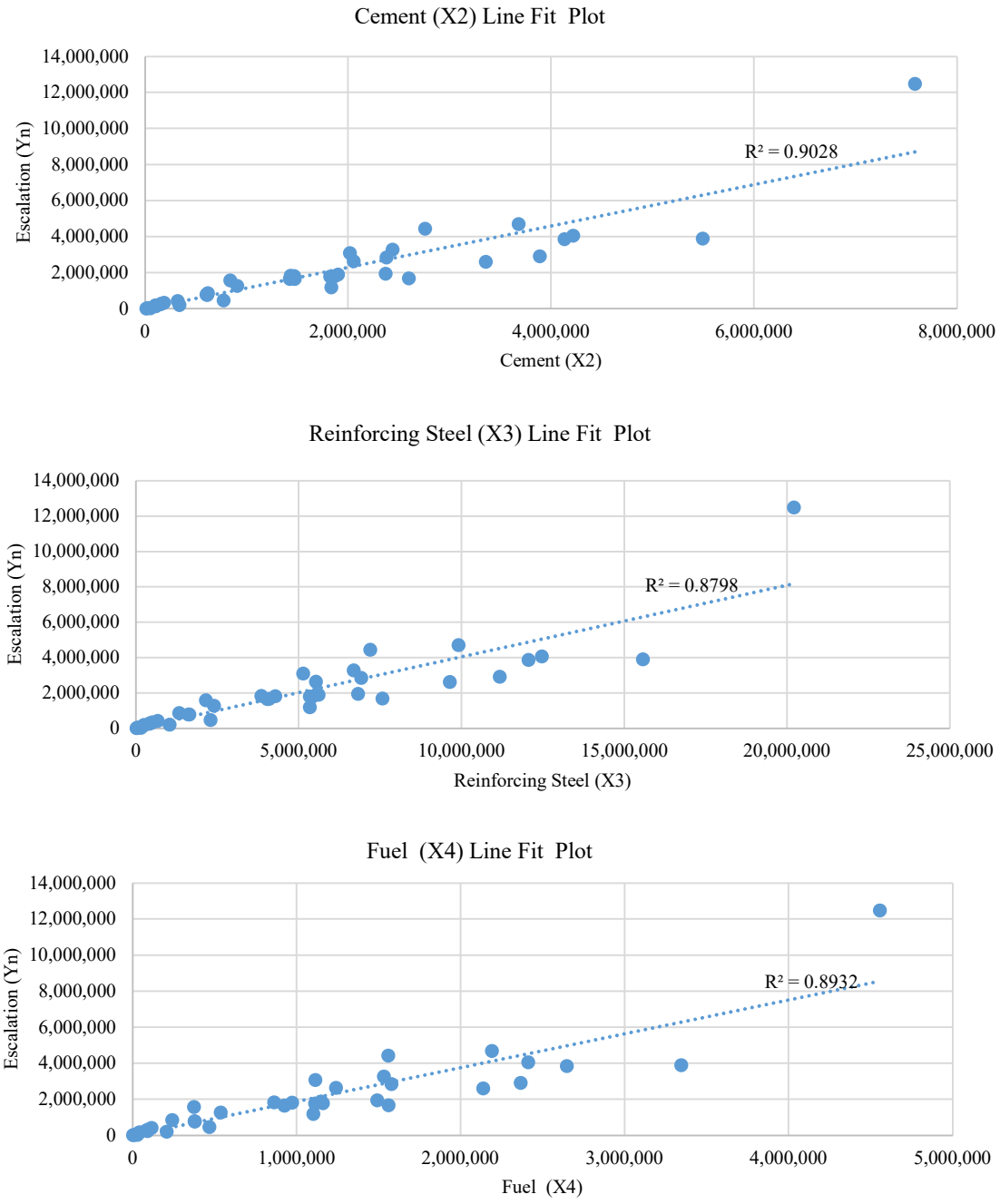


Figure 3: Relationship of escalation with individual predictors

After the assessment through simple regression, combined impact of predictors was investigated using multiple regression technique. SPSS was utilized to achieve this objective. The results in the form of model summary and coefficients are shown on Figure 4 below

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.972[a]	.944	.937	558570.5190

a. Predictors: (Constant), Fule (X4n), Labour (X1n), Reinforcing Steel (X3n), Cement (X2n)

b. Dependent Variable: Escalation

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-114955.587	147943.616		-.777	.443
	Labour (X1n)	.479	.518	.719	.925	.362
	Cement (X2n)	5.896	2.322	4.503	2.539	.016
	Reinforcing Steel (X3n)	-2.152	.588	-4.590	-3.661	.001
	Fule (X4n)	.574	1.634	.268	.351	.728

a. Dependent Variable: Escalation

Figure 4: Multiple Regression model summary for the case study

5 DISCUSSIONS AND RECOMMENDATIONS

Based upon the exploration of price escalation with individual components of price adjustment formula, a strong positive correlation was observed in each case with coefficient of determination (R^2) ranging from 0.87 to 0.93. Steel reinforcement depicted the strongest relationship. In case of multiple regression analysis, again the strong positive relationship was observed. However, the standard error in the model requires further exploration. One of the reasons can be attributed towards the fixed portion as it has not been considered in the model. It is therefore recommended to further investigate this aspect of standard error term. Based upon the type of data, it is also recommended that further studies may be conducted by adopting the approach of time series analysis which may provide a more dynamic understanding of the escalation phenomenon.

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