

A Study on Forecasting Price Escalation of Various Resources in Construction by Least Square Method

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Abstract - Cost variation is one of the major problems in the construction industry which will affect the total cost of the project. The variation of cost is mainly due to the increase in cost of men, material and equipment. In construction project 80-85% of cost is spent for materials, equipment and labours. So change in cost of these items will greatly fluctuate the total project cost. The main objective of this study is to compare the cost of construction materials, equipment and labour for the past 7 years and then to forecast the future cost for materials, equipment and labour for the next 5 years in the construction industry. A statistical method such as method of least square is used to measure the price variations. This forecasted cost can be compared to the actual cost of the project and the percentage of variation of the increase in cost can be measured.

KeyWords - cost variation, material, equipment, labour, forecasting, statistical method, method of least square.

I. INTRODUCTION

The construction industry is large, volatile and requires tremendous capital outlays. Over the past few years the construction industry has been facing several problems due to rapid increase in the price of construction materials, labour, interest charges and equipment cost. Rate escalation is defined as changes in the cost or price of specific goods or services in a given economy over a period. This is a similar to the concepts of

inflation and deflation except that escalation is specific to an item or class of items, it is often not primarily driven by changes in the money supply, and it tends to be less sustained.

Medium to large construction projects take over a year for completion and the cost of materials and labour often increase, which leads to major problems in administration of the contract. This needs serious attention for improving the construction cost performance as rarely projects are completed within budget.

II. OBJECTIVE

The main objective of the proposed work is

- To compare the cost of construction such as building materials, labours and equipments for past six years from the year 2009 to 2015.
- To found out the increase in percentage of cost for the building materials, labours and equipments for past six years from the year 2009 to 2015.
- To forecast the percentage increase in cost of construction for the next three years 2016, 2017 and 2018 using least square method.
- To forecast the rate of BOQ of a project and then it can compare to the

actual cost of the BOQ and found out the increase in percentage of cost.

III. STEPS INVOLVED IN METHODOLOGY

The detailed methodology is as follows:

Step 1: Selection of topic.

Step 2: Study of literature is available in the form of books, journals to get proper understanding of the issue.

Step 3: List out various books required for reference and related topic, collect literatures and carry out clear methodology.

Step 4: Making a list of companies and hardware shops to approach.

Step 5: Collecting labour rates, material rate and equipment rate from a construction company and hardware shop for the past years.

Step 6: Comparing the variation of prices.

Step 7: Collection of bill of quantity for residential apartment / industrial building from a construction company.

Step 8: Forecasting is done using method of least square Regression for Materials, Equipment, Labour rent and BOQ rates.

Step 9: Preparation of bill of quantity with rates obtained.

Step 10: Measure the percentage of variation with the total cost of the project.

IV. LEAST SQUARE REGRESSION

Linear Regression, or Least Squares Regression (LSR), is the most popular method for identifying a linear trend in historical sales data. The method calculates the values for a and b to be used in the formula:

$$Y = a + b X$$

This equation describes a straight line, where Y represents sales and X represents time. Linear regression is slow to recognize

turning points and step function shifts in demand. Linear regression fits a straight line to the data, even when the data is seasonal or better described by a curve. When sales history data follows a curve or has a strong seasonal pattern, forecast bias and systematic errors occur.

Forecast specifications: n equals the periods of sales history that will be used in calculating the values for a and b.

Minimum required sales history: n periods plus the number of time periods that are required for evaluating the forecast performance (periods of best fit).

V. DATA COLLECTION

Data Collection is an important aspect of any type of research study. Inaccurate data collection can impact the results of a study and ultimately lead to invalid results. Data are primarily collected to provide information regarding a specific topic. Data's are collected from two different regions of Coimbatore such as Siganallur and Vadavalli. The average values of these two regions are considered for this study.

5.1 CONSTRUCTION LABOUR

Table 5.1 Comparison of Price Changes of Labour Cost

Item no	Item description	Unit	Basic Rate in Rupees							Cumulative % of hike
			2009	2010	2011	2012	2013	2014	2015	
1	Manson	Per Day	250	300	400	500	600	625	650	61.53
2	Male helper	Per Day	170	200	300	350	350	375	400	57.50
3	Female helper	Per Day	130	150	200	250	300	325	350	62.85
4	Fitter grade-I	Per Day	250	300	400	450	550	600	650	61.53
5	Fitter (helper)	Per Day	170	200	225	250	300	325	350	51.42
6	Carpenter 1 st class	Per Day	250	300	400	450	550	600	650	61.53
7	Carpenter (helper)	Per Day	200	225	300	350	450	490	560	64.28
8	Painter	Per Day	250	300	350	400	500	525	550	54.54
9	Painter (helper)	Per Day	200	225	250	300	350	375	400	50.00
10	Tile layer	Per Day	250	300	400	450	500	550	600	58.33
11	Tile layer (helper)	Per Day	200	225	250	300	400	425	450	55.55
12	Glazier	Per Day	250	300	400	450	550	650	700	64.28
13	Welder	Per Day	400	450	500	600	650	650	700	42.85
14	Grinder	Per Day	300	340	360	400	420	470	500	40.00
15	Mechanic	Per Day	400	450	500	600	650	650	700	42.85
16	Tower crane operator	Per Day	650	750	800	850	900	900	1000	35.00
17	Hoist operator	Per Day	500	550	575	575	600	600	650	23.07
18	JCB Operator	Per Day	450	500	550	600	650	700	700	35.71
19	Bob Cart operator	Per Day	500	525	550	550	580	600	600	16.66
20	Store keeper	Per Day	450	500	500	520	550	600	650	30.76

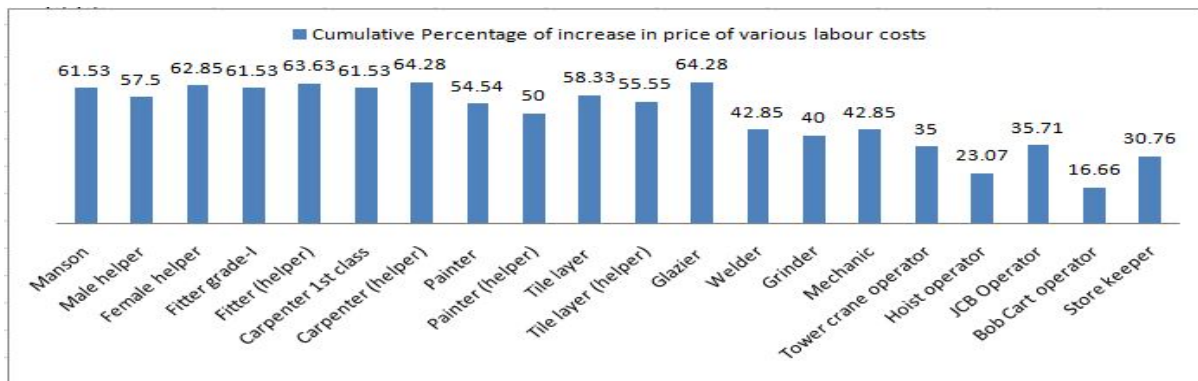


Figure 5.1 cumulative percentages of hikes in various labour costs

Table 5.1 shows the labour costs of the different classes of labour from 2009 to 2015. Using Microsoft excel software the construction labour costs were analyzed and found out the cumulative percentage increase in each type of labours in the construction industry. The price of Mixer Machine Operator, glazier, Carpenter, fitter and Watch man were escalated by 66%, 64.28%, 64.28%, 63.63% and 57.5% during the period 2009 to 2015 are the top five cost escalated labour costs. Figure 5.1 shows the cumulative percentages of hikes in various labour costs.

5.2 CONSTRUCTION EQUIPMENTS

Table 5.2 Comparison of price changes of construction equipments

Item no	Item description	Basic Rate in Rupees per hour							Cumulative % of hike
		2009	2010	2011	2012	2013	2014	2015	
1	JCB	500	580	600	650	850	900	850	41.17
2	Bob carts (with diesel)	140	145	160	170	190	210	200	30.00
3	Bob carts (without diesel)	500	550	580	600	610	650	625	20.00
4	Crawler crane	1300	1500	1600	1800	2000	2500	2300	43.47
5	Concrete mixer	75	90	110	120	150	190	250	70.00
6	Road roller	740	810	850	900	1100	1200	1150	35.65
7	Tractor	240	260	270	300	375	450	400	40.00
8	Dipper (with diesel)	350	400	430	480	500	550	500	30.00
9	Dipper (without diesel)	250	290	330	360	375	400	375	33.33
10	Fork lifts	250	280	300	350	400	425	410	39.02
11	Bar cutting machine	310	380	430	450	450	475	500	38.00
12	Cut-off machine	250	270	280	300	300	350	380	34.21
13	Hoist	30000	32000	35000	38000	40000	40000	42000	28.57
14	Tower crane	4 lakhs	5 lakhs	5.5 lakhs	6 lakhs	6 lakhs	6.5 lakhs	6.5 lakhs	23.07
15	Grinding machine	150	160	180	180	200	200	250	40.00

Table 5.2 shows the equipment rents of the different classes of equipment rents from 2009 to 2015. Using Microsoft excel software the equipment rent were analyzed and found out the cumulative percentage increase in each type of equipment used in the construction industry. The rent of Concrete Mixer, Crawler Crane, JCB, Tractor and Forklifts were escalated by 70%, 43.47%, 41.47%, 40% and 39.02% during the period 2009 to 2015 are the top five cost escalated equipment rents in construction industry. Figure 5.2 shows the cumulative percentages of hikes in various equipment rents.

5.3 CONSTRUCTION MATERIALS

Table 5.3 Comparison of price changes of construction materials

Construction materials										
Item no	Item description	Unit	Basic Rate in Rupees							Cumulative % of hike
			2009	2010	2011	2012	2013	2014	2015	
1	Cement	Bag	220	225	260	280	300	340	380	42.20
2	Reinforcement steel	Kg	29	32	38	45	62	50	45	35.55
3	Structural steel	Kg	48	42	45	55	85	80	74	48.64
4	River Sand	Cft	18	22	22	26	40	42	45	60.00
5	40mm Aggregate	Cft	17	19	18	20	22	30	35	51.42
6	20mm Aggregate	Cft	18	19	20	21	24	32	36	50.00
7	12 mm Aggregate	Cft	14	17	17	20	21	27	30	53.33
8	Quarry Dust	Cft	6	8	10	12	15	22	26	76.92
9	Bricks	Nos	3.25	3.25	4	4	4.5	5.5	6.5	50.00
10	Fly ash bricks 9"×4"×3"	Nos	2.75	3.5	4.5	5	6	6.5	7	60.71
11	Fly ash bricks 9×4×4"	Nos	3.5	4.5	5	6	6.5	7	8	56.25
12	Fly ash bricks 9×9×4"	Nos	14.5	16	18	20	20	22	25	42.00
13	RR Stone	Nos	10	11.5	11.5	12	12.5	13.5	15	33.33
14	Brick Aggregate	Cft	24	28	30	35	36	38	42	42.85
15	Solid block, 200mm Thick	Nos	25	26	30	30	31	33	33	24.24
16	Solid block, 150mm Thick	Nos	21	24	28	28	29	30	31	32.25
17	Solid block, 100mm Thick	Nos	13	16	19	25	26	27	28	53.57
18	Soling stone	Cft	14	16	16	20	20	22	24	41.66
19	Bitumen	Kg	36	38	40	41	45	48	49	26.53
20	K2 oil	Litre	65	65	68	68	72.5	72.5	72.5	10.34

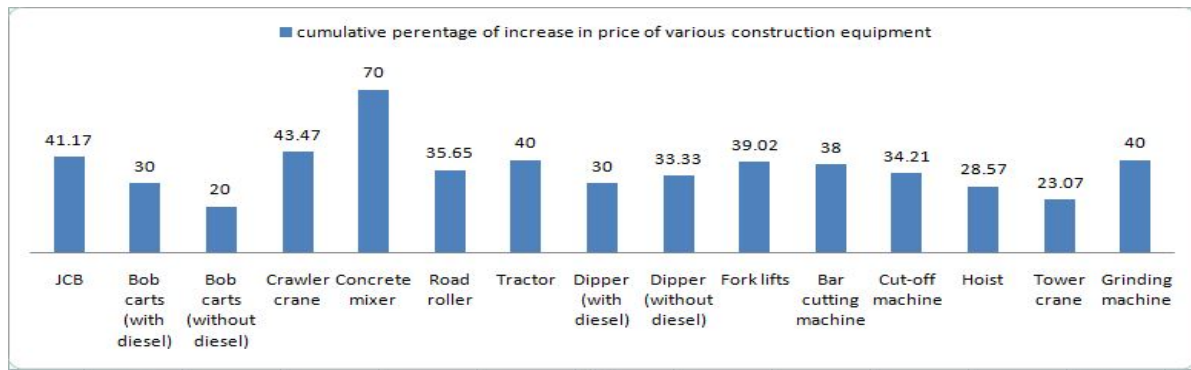


Figure 5.2 cumulative percentages of hikes in various equipment rents

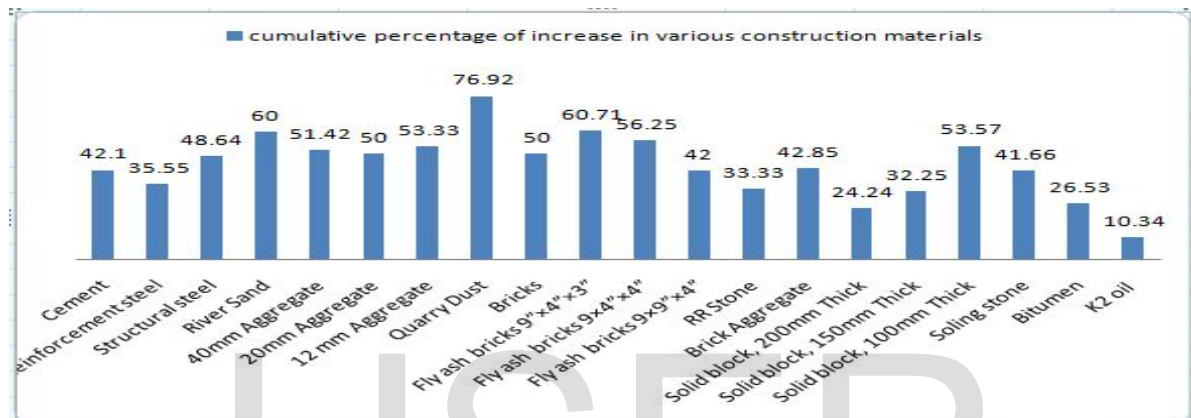


Figure 5.3 cumulative percentages of hikes in various materials

Table 5.3 shows the cost of various construction materials from 2009 to 2015. Using Microsoft excel software the material costs were analyzed and found out the cumulative percentage increase in materials used in the construction industry. It is found that the price of quarry dust, Fly Ash Bricks, Solid Block, Aggregate and Bricks were escalated by 76.92%, 60.71%, 53.57%, 51.42% and 50% during the period 2009 to 2015 are the top five cost escalated construction materials. Figure 5.3 shows the cumulative percentages of hikes in various material costs.

VI. FORECASTING THE FUTURE

Least square regression has been used to measure the cost trends in the construction industry. Estimating the increase in price over the long term is almost impossible because of the many uncertainties beyond the control of all parties. The same is true of long term construction projects with multiyear schedules and start dates in the future. Despite this

difficulty, the owners of large long-term projects need to come up with the estimated cost of these projects. The more prudent way to approach these problems is to calculate a range of possible costs rather than a single figure.

The below example calculation shows how future cost is forecasted based on the least square regression. The past cost data of reinforcement steel is taken as input data and the output cost can be calculated as follows

YEAR	COST (Y)	X= YEAR - 2013	X ²	XY
2011	38	-2	4	-76
2012	45	-1	1	-45
2013	62	0	0	0
2014	50	1	1	50
2015	45	2	4	90
	$\sum Y = 240$	$\sum X = 0$	$\sum X^2 = 10$	$\sum XY = 19$

By using the normal equation,
 $\sum Y = na + b\sum x \Rightarrow 240 = 5a + 0$
 $a = 48$

then,
 $\sum xy = a\sum x + b\sum x^2 \Rightarrow 19 = 0 + 10b$
 $b = 1.9$

the trend equation be,
 $Y = a + bX$
 $Y = 48 + 1.9X$

For 2016, $X = \text{Year} - 2014$
 $= 2016 - 2014 = 2$
 $Y = 48 + 1.9 \times 2 \Rightarrow Y = 53.70$

For 2017, $X = \text{Year} - 2014$
 $= 2017 - 2014 = 3$
 $Y = 48 + 1.9 \times 3 \Rightarrow Y = 55.60$

For 2018, $X = \text{Year} - 2014$
 $= 2018 - 2014 = 4$
 $Y = 48 + 1.9 \times 4 \Rightarrow Y = 57.50$

The forecasted costs for reinforcement steel in the future years are,

Year	2016	2017	2018
cost	53.70	55.60	57.50

Likewise, the cost can be forecasted for all the resources considered for this study.

Table 6.1 forecasted price of Labour Cost

Item no	Item description	Unit	Forecasted cost for future in MRP		
			2016	2017	2018
1	Manson	Per Day	742.50	805.00	867.50
2	Male helper	Per Day	402.50	425.00	447.50
3	Female helper	Per Day	397.50	435.00	472.50
4	Fitter grade-I	Per Day	725.00	790.00	855.00
5	Fitter (helper)	Per Day	387.50	420.00	452.50
6	Carpenter 1 st class	Per Day	725.00	790.00	855.00
7	Carpenter (helper)	Per Day	628.00	694.00	790.00
8	Painter	Per Day	622.55	675.00	727.50
9	Painter (helper)	Per Day	447.50	485.00	522.50
10	Tile layer	Per Day	650.00	700.00	750.00
11	Tile layer (helper)	Per Day	522.50	575.00	627.50
12	Glazier	Per Day	790.00	870.00	950.00
13	Welder	Per Day	755.00	800.00	845.00
14	Grinder	Per Day	535.00	570.00	605.00
15	Mechanic	Per Day	755.00	800.00	845.00
16	Tower crane operator	Per Day	1025.00	1070.00	1115.00
17	Hoist operator	Per Day	667.50	690.00	712.50
18	JCB Operator	Per Day	760.00	800.00	840.00
19	Bob Cart operator	Per Day	621.00	636.00	651.00
20	Store keeper	Per Day	678.00	716.00	754.00

Table 6.1 shows the forecasted price of the various labours in the construction industry for the periods 2016 to 2018.

Table 6.2 forecasted price of various construction materials

Item no	Item description	Unit	Forecasted cost for future in MRP		
			2016	2017	2018
1	Cement	Bag	420.00	460.00	500.00
2	Reinforcement steel	Kg	53.70	55.60	57.50
3	Structural steel	Kg	92.70	101.00	109.30
4	River Sand	Cft	53.60	59.80	66.00
5	40mm Aggregate	Cft	38.20	44.60	49.00
6	20mm Aggregate	Cft	39.50	43.80	48.10
7	12 mm Aggregate	Cft	32.90	36.20	39.50
8	Quarry Dust	Cft	29.60	33.80	38.00
9	Bricks	Nos	6.85	7.50	8.15
10	Fly ash bricks 9"×4"×3"	Nos	7.75	8.40	9.05
11	Fly ash bricks 9"×4"×4"	Nos	8.60	9.30	10.00
12	Fly ash bricks 9"×9"×4"	Nos	25.80	27.40	29.00
13	RR Stone	Nos	16.95	17.80	18.65
14	Brick Aggregate	Cft	44.33	47.00	49.70
15	Solid block, 200mm Thick	Nos	34.10	35.00	35.90
16	Solid block, 150mm Thick	Nos	31.60	32.40	33.20
17	Solid block, 100mm Thick	Nos	31.00	33.00	35.00
18	Soling stone	Cft	25.80	27.60	29.40
19	Bitumen	Kg	52.10	54.60	57.10
20	K2 oil	litre	74.50	76.10	77.45

Table 6.2 shows the forecasted price of the various materials used in the construction industry for the periods 2016 to 2018.

Table 6.3 forecasted price of equipment rents

Item no	Item description	Unit	Forecasted cost for future in MRP		
			2016	2017	2018
1	JCB	Per Hour	995.00	1070.00	1145.00
2	Bob carts (with diesel)	Per Hour	222.00	234.00	246.00
3	Bob carts (without diesel)	Per Hour	655.00	669.00	683.00
4	Crawler crane	Per Hour	2670.00	2880.00	3090.00
5	Concrete mixer	Per Hour	326.00	380.00	438.00
6	Road roller	Per Hour	1310.00	1400.00	1490.00
7	Tractor	Per Hour	482.00	523.00	564.00
8	Dipper (with diesel)	Per Hour	555.00	576.00	597.00
9	Dipper (without diesel)	Per Hour	407.00	420.00	433.00
10	Fork lifts	Per Hour	465.00	495.00	524.50
11	Bar cutting machine	Per Hour	510.50	527.00	543.50
12	Cut-off machine	Per Hour	397.00	422.00	447.00
13	Hoist	Per Month	55800.00	61400.00	67000.00
14	Tower crane	Per Month	685000.00	710000.00	735000.00
15	Grinding machine	Per Hour	256.00	274.00	292.00

Table 6.3 shows the forecasted price of the various equipments used in the construction industry for the periods 2016 to 2018.

VII. CONCLUSION

From this study, it is found out the cumulative cost escalation of various resources in the construction industry from 2009 to 2015.

Table 7.1 shows the top five highly cumulative escalated costs of various resources in the construction industry.

Table 7.1 Top five high rates of escalated resources

TOP FIVE HIGH RATE OF COST ESCALATED RESOURCES					
MATERIAL COST		LABOUR RENT		EQUIPMENT RENT	
NAME OF MATERIAL	% OF INCREASE	TYPE OF LABOUR	% OF INCREASE	NAME OF EQUIPMENT	% OF INCREASE
Quarry dust	76.92%	Mixer Machine	66%	Concrete Mixer	70%
Fly Ash Bricks	60.71%	Glazier	64.28%	Crawler Crane	43.47%
Solid Block	53.57%	Carpenter	64.28%	JCB	41.47%
Aggregate Bricks	51.42%	Fitter	57.5%	Tractor	40%
	50%	Watch man	57.5%	Forklifts	39.02%

The study also finds out the forecasted cost of various resources involved in the construction industry. Table 6.1, 6.2 and 6.3 shows the forecasted cost of the various resources for the periods 2016, 2017 and 2018.

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