Study of Price Variation using Linking Factor in Construction Contracts in India

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Abstract

The economy of India is fifth position in the world by nominal Gross Domestic Production (GDP) with share of global GDP of 7.74%. Large instability exists in an economic system, this instability reflects in adverse effect on prices of commodities. Construction sector depends on resources such as materials, machineries, labour and are the major cost drivers of construction projects. Variation in cost of these resources of work affects the budget of a construction project adversely. This price correction is referred as escalation or price adjustment in construction contract documents. Escalation is a phenomenon of economics reflected through rate of inflation computed from Wholesale price index (WPI) data. Wholesale price index is an index that measures and tracks the changes in price of goods in the stages before the retail level i.e. at the wholesale market level. This project studies the current structure of calculation of wholesale price index, linking factor and its effects on arriving at escalation amount by doing a case study on project in Andhra Pradesh, India. It is concluded that by using linking factors WPI has been worked out for continuing with old base year index..

Keywords: Index, Whole Sale Price Index, Consumer Price Index Variation, Linking Factor.

1. Introduction

In any project Cost, time and Scope are the three major factors that are considered which affect the Quality of outcome. The construction of any project largely depends on Quality triangle, when there is delay in any activity or change in the scope of project, the cost of construction is affected and vice versa.Escalation is a phenomenon of economics reflected through rate of inflation computed from Wholesale Price Index data or Market Rate Method. Escalation is the change in cost or price of specific goods or services in a given economy over a period. It is the increase in the cost of any construction elements of the original contract or base cost of a project due to passage of time. Escalation affects the budget and causes severe financial overrun by the contractor. It also adds to contingency in the contractor's bid and is a major contributor to the overall cost uncertainty of escalation in his tender rates from the employer. Construction work is carried out according to the pre confirmed contract agreement. To cope up with the sudden price escalation, regulated provision is necessary in construction contract document.

Different government organizations, however, adopted varying formulae and linked them with the Whole Sale Price Index (WPI), Consumer Price Index (CPI), Cost of petrol/diesel etc. compiled and published by the Government periodically. The principle that the contractor needs to be compensated for increase in costs over the tendered prices due to increase in labor wages, cost of POL and other materials is now fully accepted.

This project studies about the current structure of construction of wholesale price index, linking factor and its effects on arriving at escalation amount by considering same and different base year conditions.

2. Literature Review

Dr .N.B. Chaphalkar& Ms. Sayali (2012) in their work "Wholesale Price Index and its effect on Price Escalation of materials for Indian construction industry" it is noted that the WPI comprises of basket of

material which are not directly connect to the construction business and in percentage wise it is of 91% and felt that the WPI is not adequate for computation, hence it is expressed that it is of not correct result and concluded that there is a requirement of development of excusive index especially for construction industry business.

S. Shanmugapriya , Dr. K. Subramanian(2013) in their study "Investigation of Significant Factors Influencing Time and Cost Overruns in Indian Construction Projects" it is concluded that material market rate, contract modification, high level of quality requirement, project location and whole responsibility are of five important factor that led for time over run, where as high transportation cost, change in material specification, increase in material cost, frequent breakdown of construction plant and equipment and rework are of five important factor that led for cost overrun.

K.Vamsidhar, D.A.Eshwarswaroop, K. Ayyappapreamkrishna & R.Gopinath (2014) in their work "Study and Rate Analysis of Escalation in Construction Industry" it is found that steel, cement, bricks, composite materials, equipments, labours found to be critical parameters in increasing the project cost, cost of the construction has increased during 2008-2009, 2009 -20010, 2010-2011, 2011-2012, 2012-2013 by 10.61%, 9.00%, 13.21%, 13.26%, 10.24% respectively. Increase in labour component by 140% during 2008-2013 years, forecasted price for years 2013-2014, 2014-2015, 2015-2016 is 11.85%, 11.85% and 11.94% respectively.

Christina Eldho And M Vadivel (2016) in their work "Rate Analysis and Mitigation of Cost Overrun by Forecasting Escalation" it is noted that major factors that influencing the cost escalation are steel, cement, aggregate, bricks, equipments and labour cost, during their study it established that price of steel, cement, aggregate, bricks, equipments and labour are found to be 21.4%, 4%, 10.5%, 20% and 27% respectively for a duration of 2013- 2016.

Yogini patil (2016) in their work "Investigation of Factors Influencing Cost Overrun in High-Rise Building Constructions" it is found that high transportation cost, change in material specification, increase in material cost, frequent breakdown of construction plant and equipment and rework are leading to cost overrun in a high-rise construction, hence research shall be carried out to minimize the cost overrun.

S Vaishnavi Devi, R Jegan (2017) in their study "Cost Escalation in Construction Projects" it is concluded that factors related to site management from contractor end is most significant than any other factors that leads in project completion delays, in turn it leads for cost overrun.

Sampatti Goyal (2017) in their study "Effect of Inflation on Project Costs in Rajasthan", it is found that increase in material cost is primary reason for cost overrun during project progress, rates of iron and steel, cement, bitumen, concrete, crude oil etc fluctuates very sharply. There will be a demand for increase labour rate because of inflation or because of increase food articles as well as housing and education and medical care and recreation, excluding the food articles rest of the mentioned factors are not part of the WPI basket. Monsoon will affect the inflation in Rajasthan and Rajasthan is an agrarian economy. It is noted that no two projects will be influenced in a similar way by inflation due to uniqueness of the project. In a project Barsingsar had awarded at project cost of ₹ 1114.18 Crore, which was approved in December 2004, but project cost of completion was ₹ 1626.09 Crore, hence there is increase in cost by ₹ 511.91 Crore, in terms of percentage it is 46% and 66% of mentioned percentage was over all WPI inflation (all commodities) during project completion period.

Surabhi Kharbanda &Ketan Jain (2018) in their work **"Study of Price Escalation in Construction Projects"** it is expressed that escalation clause is applicable, when duration of the project is longer, to revise the rate WPI shall be considered and these WPI has been published by the reserve bank of India.

Joe M Vazathara & Jeena Mathew (2018) in their study " Developing A Computer Based Technology For Cost Escalation In Construction Industry " it is expressed that Cost Escalated System (CES) will fulfill the needs of the construction contract organizations, through this study important factors that change the cost is established and it is concluded that a) fuel rate, b)inflation in labor rates, c) shortage of material supply, d) inflation of material price and e)inflation of plant and machinery cost are of important factors.

YaseerElfahham (2019) in his study "Estimation and prediction of construction cost index using neural networks, time series and regression" it is expressed that the authors have experienced there was no authorized agency for declaring the index in Egypt, to overcome this challenge construction cost index (CCI) has been utilized, and study restricted to concrete structures only, the data was sourced from "Central Agency for Public Mobilization and Statistics" of Egypt, the derived weightage of steel, cement, sand,

aggregate and bricks are of 54%, 30%, 10%, and 6% respectively. The CCI has calculated for the study period of 2002 -2018 considering that base year as 2010. CCI could be used in calculating the escalation during the construction period.

Krishnankoil,Identification and evaluation of factors affecting cost escalation in building construction projects in India become necessary for undertaking a systematic study. The following were identified as the factors that influence cost overruns. Such as design related factors, client related factors, contractor related factors, site related factors, labour and equipment related factors, store related factors, external factors, market condition related factors. The results obtained from the ranking analysis shows that the followings, design issues, market condition issues as the major significant factors that causes the cost overruns in construction projects in India.

Objectives of the Study:

The objective of the study is
- to construct the WPI for a project where base year changed, by using the linking factor
- to calculate the price variation of resources of a project using constructed WPI.

Scope:

- Data collection of Whole Sale Price Index (WPI) data from Office of Economic Advisor.
- Data collection of Consumer Price Index (CPI) data from Ministry Central Statistics Office of the MOSPI
- Review of published research papers on price variation adjustment

Limitation/s:

- The study restricted to a project which was awarded considering a base year data, but the project got spilled over in to new revised base year data (i.e. change in base year)

3. Methodology: Civil construction projects have experienced time and cost over runs due to various reasons, the reasons might be either from contractor, employer, supply chain issue or from nature etc., every contract agreement has facilitated with a clause of price adjustment and also mentioned in that base year, but due to prolongation of project completion due to any reason price adjustment clause will be invoked and compensated but there is possibility of having change in base year of WPI once in every year. The study envisages to continue with initial/agreed base year index with proper and new index construction, the effort put at hear is to construct the WPI using linking factors. To carry out the new WPI construction, required data has been considered. Primary data has been collected from the contract agreement, secondary data has been extracted from Office of Economic Advisor, labour bureau etc., WPI, linking factors and CPI, linking factors data has been extracted from Office of Economic Advisor, CPI data labour bureau official websites respectively.

The linking factor is derived by the following formula:

Linking factor = Old Wholesale Price Index / Current Wholesale Price Index

Generally Current Wholesale Price index is considered as 100 for starting of new series and to forecast new data with the help of derived linking factor by above formula (refer to Table 1).

Table 1: Linking Factor (Source: Office of Economic Advisor (OAE))

	WPI (Base 2004-05)for 2011-12	Linking Factor
All commodities	156.1	1.561
Primary articles	200.3	2.003
Fuel and power	169.0	1.690
Manufactured Products	139.5	1.395

Linking factor due to change of base year of Wholesale Price Index (WPI) from 2004-05 to 2011-12:
The Wholesale price index (WPI) series has been last revised on May12, 2017 by shifting base year from 2004-05 to 2011-12. In order to maintain continuity in the time series data on wholesale price index,

linking factor have been provided so that the new series, may be compared with the earlier one. The linking factor to link the WPI 2004-05 to WPI 2011-12 is developed by using the Arithmetic conversion method as was the case during earlier transition to new base year. For any old contracts signed and still continuing the data for WPI of 2004-05 series as released by OEA would be used without applying linking factor till March, 2017. Linking factor for conversion of WPI (2011-12) indices to WPI (2004-05) series shall be used from April 2017 onwards.

4. CASE STUDY:

The main aim of this case study is to application of linking factor in obtaining the new WPI based on previous base year (i.e. contracted base year). The considered running account bill is of hypothetical one only and interest of consideration is to demonstration of how to use the linking factor .

4.1 Project details:

Pula Subbaiah Veligonda project (Package-VII) located in Prakasam district. Tender Notice for the work was invited vide tender notice no 12/2008-09 (package-VII) under EPC open category with operation and maintenance of 3 years over and beyond the defective liability period of 2 years for civil works and 13 years over and beyond the defective liability period of 2 years for electro mechanical items. The last date of bid submission was on 03.02.2009. The Agreement Amount of this project is ₹ 7,53,14,32,133/-. This project was awarded to Joint Venture; Contractor name is M/s. XXX (JV). This project work consists of Investigation, design and excavation of western branch canal taking off at KM. 25.465 of Eastern main canal including construction of tunnel, CM&CD works distributaries system, pump house, delivery cisterns and pressure main to create an IP of 60,300 Acres by lift including formation of reservoirs of Turimella, Racherla and Seetharam Sagar and also formation of independent reservoirs of Rallavagu & Gundla Brahmeswaram to create an IP of 5000 Acres in Prakasam, Kadapa and Nellore districts.

4.2 Price Adjustment for Labour, Machinery, Cement, Steel, Fuel and Other Materials:

The Client has given certain guidelines for Price Adjustment of Labour, Machinery and Other Materials components:

- The Price Adjustment will be made for the Price Variations beyond 5% on the basic rates furnished in the Bid Document.
- Price Adjustment formula for Component $V_L = (0.85) * (P_1/100) * (R) * [(L_1 - L_0)/L_0]$
- P_1 = Perectnage as per Table 2; R = Volume of the work done; L_1 = current labour index; L_0 = Base labour index, V_L = Adjusted price of the resource
- The percentage of each component (Table 2) in the work are considered as given below:

Table 2: Percentage of Components in work

S.No.	Description of Component	Percentage of Each Component in work
1	Labour	20.59%
2	Machinery	23.09%
3	Other Materials	31.03%
4	Cement	9.8%
5	Steel	6.13%
6	Fuel	9.36%
7	Total	100%

- Refer to Table 3 for price adjustment for Labour, Table 4 for Price Adjustment for Machinery, Table 5 for Price Adjustment for other materials, Table 6: for Price Adjustment for Cement Component in Earth and Concrete works, Table 7: for Price Adjustment for Steel Component in Earth and Concrete works, Table 8: for Price Adjustment for Fuel Component in Earth and Concrete works.
- Running account bill for the month of May-2017 it is ₹ 3,06,62,072/- and June it is ₹4,05,00,750/- and July it is ₹ 3,54,50,200/-

- VAT is 2.8% and Seignorage charges for the month of May-2017 it is ₹ 16,87,754/- and June-2017 it is ₹ 14,58,352/- and July 2017 it is ₹ 18,34,547/-

Table 3: Price Adjustment for Labour Component in Earth and Concrete works:

S.No	Month	Col.1 (%)	Col.2 (Rs.)	Col.3	Col.4	Col.5	Col.6 (Rs.)
1	May-2017	20.59	2,81,15,780	148	155.4	278	38,82,083.43
2	June-2017	20.59	3,79,08,377	148	155.4	280	53,19,581.80
3	July 2017	20.59	3,26,23,047	148	155.4	285	47,61,609.62

- ✓ Col.1 – Percentage component of Labour in Total work (P)
- ✓ Col.2 – Total Amount of work done after deductions of taxes and seigniorage charges (R)
- ✓ Col.3 – CPI in Feb 2009 as per Base year 2001-02 at the time of Bid opening
- ✓ Col.4 - CPI value after 5% of variation (L_0)
- ✓ Col.5 - CPI in RA Bill month 2017 (L_1) as per Base year 2001-02
- ✓ Col.6 – Total Price Adjustment $V_L = (0.85) *(P_1/100)*(R)*(L_1-L_0)/L_0$

- The Total Amount of work done R = (R.A Bill) - (VAT charges) - (Seignorage charges) = (₹3,06,62,072/-) - (₹ 8,58,538/-) - (₹ 16,87,754/-) = ₹ 2,81,15,780/-
- Consumer Price index (L_0) of labour during the time of bid tender opening on Feb-2009 is 148 as per Base year 2001-02.
- As per Condition in Contract for Price Adjustment i.e. up to 5% of variation cannot be claimed by contractor. Therefore, $L_{0 (New)} = L_{0 (Old)}*1.05$ i.e. (148*1.05) = 155.4
- Consumer Price index of labour during the month of RA Bill generated i.e. on May 2017 is 278 as per Base year 2001-02.
- The Percentage (P)for Labour component is 20.59%
  - Price Adjustment formula for Labour Component $V_L = (0.85) *(P_1/100)*(R)*(L_1-L_0)/L_0$

- $(V_{L, May}) = (0.85) *(20.59/100)*(₹2,81,15,780)*[(278-155.4)/(155.4)] = ₹ 38,82,083.43$
- $(V_{L,June}) = (0.85)*(20.59/100)*(₹3,79,08,377)*[(280-155.4)/(155.4)] = ₹ 53,19,581.80$
- $(V_{L,July}) = (0.85)*(20.59/100)*(₹3,26,23,047.40)*[(285-155.4)/(155.4)] = ₹ 38,82,083.43/-$

Legend:

- ✓ Col.1 – Percentage component of Machinery/other materials/cement/steel/fuel in Total work (P)
- ✓ Col.2 – Total Amount of work done after deductions of taxes and Seignorage charges (R)
- ✓ Col.3 – WPI in Feb 2009 as per Base year 2004-05 at the time of Bid opening
- ✓ Col.4 - WPI value after 5% of variation (M_0)/ (OM_0)/(C_0)/(S_0)/(F_0)
- ✓ Col.5 - WPI in RA Bill month 2017 as per Base year 2011-12
- ✓ Col.6 – Linking Factor as per Arithmetic Conversion Method
- ✓ Col.7 - WPI in RA Bill month 2017 (M_1) as per Base year 2004-05
- ✓ Col.8 – Total Price Adjustment $V_M = (0.85) *(P_1/100)*(R)*(M_1-M_0)/M_0$

Table 4: Price Adjustment for Machinery Component in Earth and Concrete works:

S.no	Month	Col.1 (%)	Col.2	Col.3	Col.4	Col.5	Col.6	Col.7	Col.8
1	May-2017	23.09	2,81,15,780	117.8	123.69	108.1	1.251	135.23	514968.74
2	June-2017	23.09	3,79,08,377	117.8	123.69	108.5	1.251	135.73	724429.58
3	July 2017	23.09	3,26,23,047	117.8	123.69	107.9	1.251	134.98	584572.36

- The Total Amount of work done R = (R.A Bill) - (VAT charges) - (Seignorage charges) == (₹3,06,62,072/-) - (₹ 8,58,538/-) - (₹ 16,87,754/-) = ₹ 2,81,15,780/-
- Wholesale Price index of Machinery and Tools during the time of bid tender opening on Feb-2009 is 117.8 (M_0) as per Base year 2004-05.
  - As per Condition in Contract for Price Adjustment i.e. up to 5% of variation cannot be claimed by contractor. Therefore, $M_{0 \ (New)} = M_{0 \ (Old)} * 1.05$ i.e. $(117.8 * 1.05) = 123.69$
- Wholesale Price index of Machinery and Tools during the month of RA Bill generated i.e. on May 2017 is 108.1 as per Base year 2011-12.
- As the Base year changed during the project execution the WPI for the month of May 2017 according to the od series i.e. with base year 2004-05 has to be constructed using the linking factor.
- Linking Factor is calculated by (Average value of index values for Machinery and Tools from April-12 to March-13 according to Base year 2004-05 / Average value of index values for Manufacture of Machinery & Equipment from April-12 to March-13 according to Base year 2011-12) = 1.251
- Wholesale Price index of Machinery and Tools during the month of RA Bill generated i.e. on May 2017 according to the base year 2004-05 is Current WPI as per base year 2011-12 * Linking factor = $108.1 * 1.251 = 135.23$ (M_1)
- The Percentage for Machinery and Tools component is given as 23.09% (P).
- Price Adjustment formula for Machinery and Tools Component: $V_M = (0.85) * (P_1/100) * (R) * (M_1 - M_0)/M_0$
- $(V_{M, \ May}) = (0.85) * (23.09/100) * (₹ 2,81,15,780) * (135.23 - 123.69)/123.69 = ₹5,14,968.74$
- $(V_{M, \ June}) = (0.85) * (23.09/100) * (₹379,08,377/-) * (135.73 - 123.69)/123.69 = ₹ 7,24,429.50$
- $(V_{M, \ July}) = (0.85) * (23.09/100) * (₹ 326,23,047.40) * (134.98 - 123.69)/123.69 = ₹ 7,24,429.58$

Table 5: Price Adjustment for Other Materials Component in Earth and Concrete works

S.no	Month	Col.1 (%)	Col.2	Col.3	Col.4	Col.5	Col.6	Col.7	Col.8
1	May-2017	31.03	2,81,15,780	123.3	129.46	112.9	1.561	176.24	2679066.3
2	June-2017	31.03	3,79,08,377	123.3	129.46	112.7	1.561	175.92	3588061.8
3	July 2017	31.03	3,26,23,047	123.3	129.46	113.9	1.561	177.8	3212297.1

- The Total Amount of work done R = (R.A Bill) - (VAT charges) - (Seignorage charges) = (₹3,06,62,072/-) - (₹ 8,58,538/-) - (₹ 16,87,754/-) = ₹ 2,81,15,780/-

- Wholesale Price index of Other Materials during the time of bid tender opening on Feb-2009 is 123.3 (OM_0) as per Base year 2004-05.
  - As per Condition in Contract for Price Adjustment i.e. up to 5% of variation cannot be claimed by contractor. Therefore, $OM_{0\ (New)} = OM_{0\ (Old)} * 1.05 = (123.3 * 1.05) = 129.465$
- Wholesale Price index of Other Materials during the month of RA Bill generated i.e. on May 2017 is 112.9 as per Base year 2011-12.
- As the Base year changed during the project execution the WPI for the month of May 2017 according to the Old series i.e. with base year 2004-05 has to be constructed using the linking factor.
- Linking Factor is calculated by (Average value of index values for All Commodities from April-12 to March-13 according to Base year 2004-05 / Average value of index values for All Commodities from April-12 to March-13 according to Base year 2011-12) = 1.561
- Wholesale Price index of Other Materials during the month of RA Bill generated i.e. on May 2017 according to the base year 2004-05 is (Current WPI as per base year 2011-12 * Linking factor) = 112.9 * 1.561 = 176.24 (OM_1)
- The Percentage for Other Materials component is given as 31.03% .
- Price Adjustment formula for Other Materials Component: $V_{OM} = (0.85)\ (P_1/100) * (R) * (OM_1 - OM_0)/OM_0$
- $V_{OM,\ May} = (0.85) * (31.03/100) * (₹2,81,15,780) * (176.24-129.465)/129.465 = ₹26,79,066.38$
- $V_{OM,\ June} = (0.85) * (31.03/100) * (₹\ 379,08,377/-) * (175.92-129.465)/129.465 = ₹\ 35,88,061.83$
- $V_{OM,\ July} = (0.85) * (31.03/100) * (₹3,26,23,047.40) * (177.80-129.465)/129.465 = ₹32,12,297.1$

Table 6: Price Adjustment for Cement Component in Earth and Concrete works

S.no	Month	Col.1 (%)	Col.2	Col.3	Col.4	Col.5	Col.6	Col.7	Col.8
1	May-2017	9.8	2,81,15,780	144.2	151.41	113.7	1.58	179.65	436760.9
2	June-2017	9.8	3,79,08,377	144.2	151.41	112.9	1.58	178.38	562521.06
3	July 2017	9.8	3,26,23,047	144.2	151.41	111.3	1.58	175.85	438719.81

- The Total Amount of work done R = (R.A Bill) - (VAT charges) - (Seignorage charges) = (₹3,06,62,072/-) - (₹ 8,58,538/-) - (₹ 16,87,754/-) = ₹ 2,81,15,780/-
- Wholesale Price index of Cement during the time of bid tender opening on Feb-2009 is 144.2 as per Base year 2004-05.
- As per Condition in Contract for Price Adjustment i.e. up to 5% of variation cannot be claimed by contractor. Therefore, $C_{0\ (New)} = C_{0\ (Old)} * 1.05 = (144.2 * 1.05) = 151.41$
- Wholesale Price index of Cement during the month of RA Bill generated i.e. on May 2017 is 113.7 as per Base year 2011-12.
- As the Base year changed during the project execution the WPI for the month of May 2017 according to the Old series i.e. with base year 2004-05 has to be constructed using the linking factor.
- Linking Factor is calculated by (Average value of index values for Grey Cement from April-12 to March-13 according to Base year 2004-05 / Average value of index values for Ordinary Portland Cement from April-12 to March-13 according to Base year 2011-12) = 1.58
- Wholesale Price index of Cement during the month of RA Bill generated i.e. on May 2017 according to the base year 2004-05 is (Current WPI as per base year 2011-12 * Linking factor) = 113.7 * 1.58 = 179.65 (C_1)
- The Percentage for Cement component is given as 9.8% .

- Price Adjustment formula for Cement Component: $V_c = (0.85) *(P_1/100)*(R)*(C_1-C_0)/C_0$

- $V_{c, May} = (0.85) *(9.8/100)*(₹\,28115780)*(179.65-151.41)/151.41 = ₹436760.90$
- $V_{c, June} = (0.85) *(9.8/100)*(₹\,28115780)*(178.38-151.41)/151.41 = ₹\,5,62,521.06$
- $V_{c, July} = (0.85) *(9.8/100)*(₹\,28115780)*(175.85-151.41)/151.41 = ₹\,4,38,719.81$

Table 7: Price Adjustment for Steel Component in Earth and Concrete works:

S.No	Month	Col.1 (%)	Col.2	Col.3	Col.4	Col.5	Col.6	Col.7	Col.8
1	May-2017	6.13	2,81,15,780	135.6	142.38	86	1.687	145.08	27801.35
2	June-2017	6.13	3,79,08,377	135.6	142.38	84.6	1.687	142.72	4719.54
3	July 2017	6.13	3,26,23,047	135.6	142.38	86.3	1.687	145.59	38300.36

- The Total Amount of work done R = (R.A Bill) - (VAT charges) - (Seignorage charges) = (₹3,06,62,072/-) - (₹ 8,58,538/-) - (₹ 16,87,754/-) = ₹ 2,81,15,780/-
- Wholesale Price index of Steel during the time of bid tender opening on Feb-2009 is 135.6 (S_0) as per Base year 2004-05.
- As per Condition in Contract for Price Adjustment i.e. up to 5% of variation cannot be claimed by contractor. Therefore, $S_{0\,(New)} = S_{0\,(Old)}*1.05 = (135.6*1.05) = 142.38$
- Wholesale Price index of Steel during the month of RA Bill generated i.e. on May 2017 is 86 as per Base year 2011-12.
- As the Base year changed during the project execution the WPI for the month of May 2017 according to the Old series i.e. with base year 2004-05 has to be constructed using the linking factor.
- Linking Factor is calculated by (Average value of index values for Rebars from April-12 to March-13 according to Base year 2004-05 / Average value of index values for MS Bright bars from April-12 to March-13 according to Base year 2011-12) = 1.687
- Wholesale Price index of Steel during the month of RA Bill generated i.e. on May 2017 according to the base year 2004-05 is (Current WPI as per base year 2011-12 * Linking factor) = 86*1.687 = 145.08 (S_1)
- The Percentage for Steel component is given as 6.13% .
- Price Adjustment formula for Steel Component: $V_s = (0.85) *(P_1/100)*(R)*(S_1-S_0)/S_0$
- $V_{s,May} = (0.85) *(6.13/100)*(₹2,281,15,779.98)*(145.08-142.38)/142.38 = ₹\,27,801.35$
- $V_{s, June} = (0.85) *(6.13/100)*(₹\,3,79,08,377/-)*(142.72-142.38)/142.38 = ₹\,4,719.54$
- $V_{s, July} = (0.85) *(6.13/100)*(₹\,3,26,23,047.40)*(145.59-142.38)/142.38 = ₹\,38,300.36$

Table 8: Price Adjustment for Fuel Component in Earth and Concrete works:

S.no	Month	Col.1 (%)	Col.2	Col.3	Col.4	Col.5	Col.6	Col.7	Col.8
1	May-2017	9.36	2,81,15,780	124	130.2	90.9	1.76	159.98	511701.81
2	June-2017	9.36	3,79,08,377	124	130.2	89.6	1.76	157.7	636925.3
3	July 2017	9.36	3,26,23,047	124	130.2	88.4	1.76	155.58	506020.81

- The Total Amount of work done R = (R.A Bill) - (VAT charges) - (Seignorage charges) = (₹3,06,62,072/-) - (₹ 8,58,538/-) - (₹ 16,87,754/-) = ₹ 2,81,15,780/-
- Wholesale Price index of Fuel during the time of bid tender opening on Feb-2009 is 124 (S_0) as per Base year 2004-05.

- As per Condition in Contract for Price Adjustment i.e. up to 5% of variation cannot be claimed by contractor. Therefore, $F_{0\ (New)} = F_{0\ (Old)}*1.05 = (124*1.05) = 130.2$

- Wholesale Price index of Fuel during the month of RA Bill generated i.e. on May 2017 is 90.9 as per Base year 2011-12.

- As the Base year changed during the project execution the WPI for the month of May 2017 according to the old series i.e. with base year 2004-05 has to be constructed using the linking factor.

- Linking Factor is calculated by (Average value of index values for Fuel from April-12 to March-13 according to Base year 2004-05 / Average value of index values for Fuel from April-12 to March-13 according to Base year 2011-12) = 1.76

- Wholesale Price index of Fuel during the month of RA Bill generated i.e. on May 2017 according to the base year 2004-05 is (Current WPI as per base year 2011-12 * Linking factor) = 90.9*1.76 = 159.98

- The Percentage for Steel component is given as 9.36%.

- Price Adjustment formula for Steel Component: $V_f = (0.85) *(P_1/100)*(R)*(F_1-F_0)/F_0$

- $V_{f,\ May} = (0.85) *(9.36/100)*(2,81,15,780)*(159.98-130.2)/130.2 = ₹\ 511701.81$

- $V_{f,\ June} = (0.85) *(9.36/100)*(3,79,08,377.00)*(157.70-130.2)/130.2 = ₹\ 6,36,925.30$

- $V_{f,\ July} = (0.85) *(9.36/100)*(3,26,23,047.40)*(155.58-130.2)/130.2 = ₹\ 511701.81$

5. Results:

The summary of the price escalation calculations compiled in the Table 9 and Table 10

Table 9: Price increase/escalation of the project cost

S.No.	Month-year	R.A.Bill (in ₹)	Adjusted R.A. Bill (in ₹)	Increase in the bill(in ₹)
1	May-2017	3,06,62,072.00	3,87,14,454.00	80,52,382.00
2	June-2017	4,05,00,750.00	5,13,36,989.00	1,08,36,239.00
3	July-2017	3,54,50,200.00	4,40,08,679.00	85,58,479.00

Table 10: Price increase / escalation of the resources

S.No.	Description	May-2017 (in ₹)	June-2017(in ₹)	July-2017 (in ₹)
1	Labour	38,82,083.00	53,19,581.00	47,61,609.00
2	Machinery	5,14,968.00	7,24,429.00	5,84,572.00
3	Other Materials	26,79,066.00	35,88,061.00	32,12,297.00
4	Cement	4,36,760.00	5,62,521.00	4,38,719.00
5	Steel	27,801.00	4,719.00	38,300.00
6	Fuel	5,11,701.00	6,36,925.00	5,06,020.00

6. Conclusion

Even though the base year (i.e. WPI/CPI) changes during the project execution, one can establish the indices considering old base year indices using the linking factor and linking factor is mentioned in the WPI/CPI indexes sheet itself, which is published from the government end.

REFERENCES:
K.Vamsidhar, D.A.Eshwa₹waroop, K. Ayyappapreamkrishna & R.Gopinath (2014)

1. Dr.N.B. Chaphalkar ,Ms.Sayali S Sandbhor (2012), "Wholesale Price Index and its effect on Price Escalation of materials for Indian construction industry", International Research Journal of Engineering and Technology (IRJET), Vol-1 Issue-3, May 2012,   1-8 pp

2. S. Shanmugapriya, Dr. K. Subramanian (2013), "Investigation of Significant Facto₹ Influencing Time and Cost Overruns in Indian Construction Projects", International Journal of Emerging Technology and Advanced Engineering(IJETAE), Vol-3 Issue-10, Oct 2013, 734-740 pp.

3. K.Vamsidhar, D.A.Eshwa₹waroop, K.Ayyappapreamkrishna, R. Gopinath (2014), "Study and Rate Analysis of Escalation in Construction industry", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), Vol-11 Issue-2, April 2014, 14-25pp.

4. Prof. Yogini K. Patil, Prof. Pankaj P. Bhangale (2016), "Investigation of Facto₹ Influencing Cost Overrun in High-Rise Building Constructions", International Journal of Latest Trends in Engineering and Technology, Vol-6 Issue-3, Jan 2016, 338-342pp

5. Christina Eldho, M.Vadivel (2016), "Rate Analysis and Mitigation of Cost Overrun by Forecasting Escalation", International Journal of Earth Sciences and Engineering, Vol-9 Issue-3, June 2016, 462-465pp.

6. Sampatti Goyal (2017), "Effect of Inflation on Project Costs in Rajasthan, SARC-ACN International Conference", May-2017, 49-51pp.

7. S Vaishnavi Devi, R Jegan (2017), "Cost Escalation in Construction Projects", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol-5 Issue-1, Jan 2017, 271-277pp.

8. Surabhi Kharbanda, Ketan Jain (2018), "Study of Price Escalation in Construction Projects", International Journal of Research in Engineering, Science and Management, ISSN (Online): 2581-5782 ,Vol-1 Issue-10, Oct-2018, 344-347pp.

9. Joe M Vazhathara, Jeena Mathew(2018), "Developing a Computer Based Technology For Cost Escalation In Construction Industry", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, Vol-5 Issue-5, May 2018, 1240 -1245 pp.

10. YaseerElfahham (2019), "Estimation and prediction of construction cost index using neural networks ,time series and regression", https://doi.org/10.1016/j.aej.2019.05.002, Alexandria Engineering Journal.Vol-58, May 2019, 499-506pp.

11. Manual On Wholesale Price Index ,published by Office of the Economic Adviserhttps://eaindustry.nic.in/

12. Wholesale Price Indices published by Office of Economic Advisor.https://eaindustry.nic.in/

13. Consumer Price Indices published by Labour Bureau, Ministry of Labour https://labour.gov.in/ and http://labourbureau.gov.in/