Evaluation of Price Adjustment Coefficient for Construction Contracts

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ABSTRACT

Purpose: *There are many bridges being constructed in Nepal. Brides of different types like Bailey truss, cable stayed, RCC Arch, pre-stressed, RCC Slab, RCC T-Beam, Steel truss, RCC Box, Stone masonry arch, suspension, and suspended bridges are being tendered and constructed at present in Nepal. Most of the bridges being constructed are of RCC T-beam and Prestressed bridges. It has been found the need to carry out research to develop logical price adjustment coefficient ranges for RCC T-beam and Prestressed bridges contracts to make the price adjustment provision more uniform.*
Design/Methodology/Approach: *Primary data was collected by office visits, constituting focus group discussions and interviews of the beneficiaries (clients & contractors) and the secondary data was collected through the Interim payment certificates and contract documents of the selected bridge. Price adjustment calculation was done and price adjustment coefficient ranges for RCC T-girder and prestressed concrete bridges were fixed.*
Findings/Result: *Price adjustment coefficients (Labour coefficient, Material coefficient & Equipment coefficient) were found significantly different since their corresponding weightage in bridge construction are different. Thus, different ranges are to be adopted as per their weightage which is justified by this ANOVA Test. If price adjustment coefficient ranges are not provided in the bidding document, it was seen that the contractor tried to manipulate price adjustment provision to his/her benefit.*
Originality/Value: *The necessary ranges have been developed for coefficients of price adjustments to provide a guideline to the contractor in bidding price adjustment coefficients*
Paper Type: *Research paper*
Keywords: Price adjustment coefficients, ranges, manipulate, RCC, T-beam, Pre-stressed, Bridges

1. INTRODUCTION :

At the point when Swiss geologist Toni Hagen was strolling in Nepal quite a while back, he would ask residents what they needed most: a school, a wellbeing post, or a street. The response all over Nepal was something similar "We need a bridge" [1].
Even at present context, a bridge is still high requirement of many Nepalese. The reason was not just accessibility. It increases the accessibility towards market and also necessary for social, economic & other reasons. Probably that might be the reason that bridges are under construction even during budget gap and filling the gap with foreign donations and loans [2, & 3]. Around 13,500 km of highways should be made more effective through bridges for creating economic value (DOR, 2022) [4].
There are many bridges being constructed in Nepal. Brides of different nature/type like Bailey truss, cable stayed, RCC Arch, pre-stressed, RCC Slab, RCC T-Beam, Steel truss, RCC Box, Stone masonry arch, suspension and suspended bridges are being tendered and constructed at present in Nepal. Most of the bridges being constructed are of RCC T-beam and Prestressed bridges [5].
Price Adjustment formulas comprise of two components: one is fixed or non-adjustable & the other is adjustable cost components. Each cost part has a coefficient or weight that is determined in view of its

relative worth to the complete agreement sum according to design's gauge. A cost file is utilized to gauge the periodical change of unit cost of each cost part remembered for the equation (ADB, 2018) [6]. It is seen that nonadjustable cost component in Standard Bidding Document (PPMO) is given a value equal to 0.15 & adjustable cost components has been given a range to bid by the contractor (ADB, 2018). There had not been any specific coefficients to be used for any specific bridge (RCC T-beam and Prestressed bridges) projects. Because of non-uniformity in price adjustment coefficients, both the parties involved in contract (client and contractor) were facing the problems in payment [7-8].

2. STATEMENT OF THE PROBLEMS :

The contractor had issues that they were not paid with proper price adjustment as per market price fluctuation and client had the issues that in the name of price adjustment unnecessary costs were being paid.

Many researches had been done on this price adjustment topic. But, the research related to formulation of price adjustment coefficients and test of economic analysis of payment for bridge construction contracts had not been done. So it had been necessity to study for the assessment of price adjustment coefficient for bridge works.

There had not been any scientific literature in this topic. So, it had been found necessary to carry out research to develop specific coefficient for RCC T-beam and Prestressed contract to make the price adjustment provision more uniform and economical.

3. OBJECTIVES :

To narrow down the range of price adjustment coefficient for RCC T-beam and Pre-stressed bridges construction contracts.

4. LITERATURE REVIEW :

4.1 Practice of Price Adjustment in Construction Projects

As per Pokharel & Mishra (2020) [9], The main Factor Affecting Price adjustment factor is “Weightage of coefficient proposed by bidders”. The consolidated RII esteem is 0.8484 which positions, (1) Likewise, from the consolidated positioning "Value Change Equation utilized in the agreement" is positioned, (2) with joined RII esteem 0.8234. "Cost variances in market" is positioned, (3) with consolidated RII esteem 0.8172. "Cutoff points of coefficients set by the client" is positioned, (4) with RII esteem 0.7438. It very well may be reasoned that a large portion of the Clients, Workers for hire and Specialists are impacted by cost change. PPMO equation ought to be utilized for cost changes in development contracts. After the underlying culmination date of agreement has crossed and augmentation of time has been finished, the cost change component ought to be determined in light of the records previously and up to the underlying consummation date just and Value change ought to be given after the underlying fulfillment date of agreement too. The exploration discoveries likewise propose that 25% of bidders bid for the worth scope of 0-5% beneath the Specialists' Gauge while just 13.85% of bidders if there should arise an occurrence of E-offering bid for a similar reach. Foremost, the norms shall be designed and revised by the independent body under the constitution of Nepal. The implementing agency shouldn’t have adopted the norms by themselves. This contradicts internationally accepted standard work culture for civil works contracting process.

Since, weightage of coefficient proposed by bidder seriously affects the price adjustment so it had been necessary to carry out research to find out the coefficient ranges for construction projects. While bidding through online system, contractors don't bid much below than engineer's estimate; it indicates that these contractors might take into consideration price fluctuation issues. If the time extension occurs because of the client, contractor has the right to get the price adjustment using current indices but in general practice it is seen that in general practice it is seen that contractor are paid with the indices at the intended time of completion or current indices, whichever is less.

The research conducted by Mishra & Aithal (2020) [10] illustrates that the worth of cost change factor utilizing various recipes are unique. Likewise, it very well may be seen that throughout time the cost change factor determined utilizing various recipes is unique. Consequently, it can't be summed up which recipe could give the least worth of cost change. It relies on condition like time, record and cost. As the majority of the respondents liked to utilize PPMO recipe so it proposed to involve PPMO equation in

the development contracts. In PPMO equation under the cutoff points set by the client, assuming the coefficient of work is picked greatest almost certainly, the cost change element would be more.
In general practice, PPMO bidding documents are used & the price adjustment formula suggested in the bidding documents are preferred for price adjustment calculations in Nepalese construction contracts.
As per the research conducted by Mishra & Regmi (2017) [11] using case studies & professional practicing engineers & contractors perception analysis, the problem of price fluctuation in Nepalese construction industry occurs in an uncertain way where, Contractors lose their at least 52 % of the expected profit when price escalates by 27 % . Only few contractors are found to bid to cope with the situation of price adjustment, while others are found to be neglecting the price fluctuation issues. Price adjustment condition isn't good for the workers for hire. The cost change framework that is set up is restricted to not many development inputs. In addition, workers for hire get remuneration just for part of the cost increment of data sources. Project delay was viewed as one of the significant impacts of cost increment and postpone brought about by the workers for hire is influencing them by making them helpless against impacts of cost increment.
Generally, it is found that in case of small works, contractors bid without considering price fluctuation issues. Normally, class 'A' contractors bid for large amount of works, while bidding they take into account price fluctuation issues.
As per Koirala & Panta (2019) [12], Project worker add risk premium in bid cost in the event that cost change condition isn't relevant in agreement and Offered cost goes higher on the off chance that cost change statement isn't given in Development contract. In normal found bid cost goes higher by 5.4%.
If price adjustment provision is not provided, contractors try to bid with high margin and eventually contract process goes uneconomical. For making the contract process economical, it has also been necessary to provide price adjustment provision in construction contracts, so that contract do not add risk premium in their bid.
A key factor for a contractor while bidding at a cost that is both favourable to the client and profitable for the contractor is proper evaluation of the underlying costs and any expected increases in prices. These figures should be accurately evaluated and projected because even a minor difference could seriously affect profit of contractor and hinders the project performance. The problem that the contractors face for long duration project is the problem of price fluctuation that the concerned party cannot evaluate and forecast during the time of bidding. In 2004 the cost of steel rose 50-60%, contrasted with earlier years when it had stayed level or had even diminished. In 2005, the cost of black-top hopped 40% in spite of there just having been an increment of 4% throughout the two going before years. In expansion to such sensational expansions in material expenses, the development business has additionally been fundamentally affected by the unpredictability and generally speaking increment of fuel costs. This might seriously affect profit of contractor and effectiveness of project performance [13, 14, 15, 16, & 17].
Thus, price adjustment provision can be meant as essential element in long term contract so that price fluctuation issues can be addressed.

5. METHODOLOGY :

5.1 Study Area:

The bridges that have been tendered by Department of Local Infrastructure (DOLI) are under the area of study. It consists of bridges being constructed throughout the country.

5.2 Study Population and Sample Selection:

In this research, two variety of bridges (RCC T-beam & Prestressed bridges) were considered. There were total 350 numbers of bridges completed and being monitored from DoLI and 28 numbers of bridges were completed in last five years interval.

5.3 Sample Size:

The most ideal case for determining the characteristics of a population is to study the entire population. The population includes a total of 28 bridges which were constructed through unit rate NCB contract in different districts of Nepal in a period of 5 years through Department of Local Infrastructure (DoLI). The economical and practical limitations of the approach of using the entire population compel us to

resort to sampling. Researchers mostly prefer using formulas for determining the sample size (Singh & Masuku, 2012)[18]. Most commonly used formulas include Cochran's formula, Cohen's formula, Yamane's formula and Rao's formula.

Price adjustment provisions for 8 bridges constructed along non-strategic roads were collected and analyzed in detail. Among 28 nos of bridges, 4 bridges are of prestressed type. So, 4 nos of bridges of prestressed type and equal nos (4 nos) of bridges of T-beam type are considered for study. The bridges selected as samples were of similar nature in terms of span and intended time of completion so that result obtained could be generalized [19].

Table 1: List of bridges considered for study

S. N.	Name of Bridges	Description
1.	Seti (Jhanana) River Bridge	Name of work: Construction of Seti (Jhanana) River Bridge Name of contractor: M/S Sharma BKOI JV Original contract Amount: Nrs. 9,55,26,877.2 Contract No: 12/LRBP/NCB/Seti (Jhanana)/072/073 Date of Agreement: (4/14/2016) 1/02/2073 Initial completion period: 30 months after the date of agreement Revised completion period: 2077/02/22
2.	Marsyangdi River Bridge	Name of work: Construction of Marsyangdi River Bridge along Abukhareni- Deurali- Palumtar Road Name of contractor: M/S Swachhanda-Rubina-Mana JV Original contract Amount: Nrs. 11,36,61,022.06 (with VAT) Contract Amount with VO: Nrs. 12,07,95,690.64 (with VAT) Contract No: 10/LRBP/NCB/Marsyangdi/071/072 Date of Agreement: (7/02/2015) 3/17/2072 Initial completion period: 3 years after the date of agreement Revised completion period: 2077/06/30
3.	Luham Khola Bridge	Name of work: Construction of LuhamKhola Bridge, Salyan Name of contractor: M/S Elite Construction Company Pvt. Ltd., Kapan-01, Kathmandu Original contract Amount: Nrs. 8,27,67,636.04(with VAT) Contract No: 02/LRBP/NCB/LUHAM/2074/075 Date of Agreement: 2075/03/25 Initial completion period: 2.5 years after the date of agreement
4.	Kamala Nadi Bridge	Name of work: Construction of Kamala Nadi Bridge along Belsot-Bhiman Road Name of contractor: M/S Amar/ Surya JV Original contract Amount: Nrs. 12,57,35,056.50 Revised Contract Amount: Nrs. 14,19,44,133.55 Contract No: 11/LRBP/NCB/Kamala/071/072 Date of Agreement: 3/24/2072 Initial completion period: 3 years after the date of agreement Revised Intended completion time: 3/22/2077
5.	Sabha Khola Bridge	Name of work: Construction of SabhaKhola Bridge along Khadbari- Bardeni- Chainpur Road Name of contractor: M/S Nilgiri/ Rubina/ Mana JV Original contract Amount: Nrs. 3,18,83,192.72 Contract No: 03/LRBP/NCB/Sabha/070/071 Date of Agreement: Jun 19, 2014 Initial completion period: 2 years after the date of agreement Revised Intended completion time: 3/31/2075
6.	Kaligandaki Bridge	Name of work: Construction of Kaligandaki Bridge along

		Kagbeni- Jhaite Road at Chaile in Mustang District Name of contractor: M/S Lumbini/ Rafina J.V., Baneshwar, Kathmandu Original contract Amount: Nrs. 4,73,88,068.40 Contract No: 07/LRBP/NCB/Kaligandaki/070/071 Date of Agreement: Jun 25, 2014 Initial completion period: 2 years after the date of agreement Revised Intended completion time: Jun 25, 2017
7.	Sardu Khola Bridge	Name of work: Construction of SarduKhola Bridge, Sunsari Name of contractor: M/S Karki Bandu Nirman Sewa Pvt. Ltd. Original contract Amount: Nrs. 8,40,32,436.08 Contract No: 01/LRBP/NCB/Sardu/074/075 Date of Agreement: Jul 08, 2018 Initial completion period: 2 years after the date of agreement
8.	Sabha Khola Bridge	Name of work: Construction of Sabha Khola Bridge along Khadbari- Bardeni- Chainpur Road Name of contractor: M/S Nilgiri/ Rubina/ Mana JV Original contract Amount: Nrs. 3,04,78,281.80 Contract No: 05/LRBP/NCB/Sabha/070/071 Date of Agreement: Jun 19, 2014 Initial completion period: 2 years after the date of agreement Revised Intended completion time: 3/31/2075

The sampled bridges are studied in detail to understand the price adjustment. The secondary sources of data were Estimates, Measurement and contract bill, price adjustment payment from client. Further clarifications were obtained through primary sources of data such as stakeholders involved in the project.

5.4 Method of Data Collection:

Both primary and secondary data was required for the fulfillment of the purpose of this research. Primary data was collected by office visits, constituting focus group discussions and interview of the beneficiaries (clients & contractors) related to the price adjustment provision in bridge construction project. Technical, financial and other related data will be collected from Local Infrastructure Development Project Office, Janakpurdham, Department of Local Infrastructure (DOLI), and Suspension Bridge Division (SBD). Questionnaire was developed to address the project objective. The opinion of the experts was taken as key informant interview with senior divisional Engineer, Project Engineer and Contractor of the projects associated to find the relevancy of single specific price adjustment coefficient in price adjustment clause.

The questionnaires were distributed through online in ‘Department of Local Infrastructure (DoLI) [19]’, ‘Local Infrastructure Development Project Office, Janakpur’, 'Suspension Bridge Division' and to the contractors to know their view of price adjustment. Total respondents were 40 out of which 20 were Clients and 20 were contractor.

The secondary data was collected through the Interim payment certificates and contract documents of the selected bridge contracts of Department of Local Infrastructure (DoLI) [19]. We also collected the data from Price index published by NRB. Secondary data was obtained from various sources such as Price adjustment Guidelines of ADB, 2018 [6], previous Thesis on the related topics, relevant text books regarding price adjustment. FIDIC [20] and PPMO [7&8] documents, Journals Data from previously mentioned offices.

Secondary data will be collected from the respective project implementing office, i.e., Department of Local Infrastructure (DOLI).

5.5 Data Analysis:

Data analysis **summarizes collected data**. It involves the interpretation of data gathered through the use of analytical and logical reasoning to determine patterns, relationships or trends.

5.6 Analysis of primary data:

Data collected from questionnaire was used to know the view of Client and Contractor regarding price adjustment.

Table 2: Analysis of Primary Data

To know the view of client and contractor on price adjustment.	Questionnaire survey	Client and contractor	Qualitative analysis	Understanding the view of client and contractor on price adjustment.

Table 3: Responses from Questionnaire Survey

	Asked	Replied	% Replied	Average % of reply
Client	32	20	62.50	76.70
Contractor	22	20	90.90	

5.7 Analysis of secondary data:

The secondary data was collected through the Interim payment certificates and contract documents of the selected bridge contracts of Department of Local Infrastructure (DoLI).

5.8 Calculation of price adjustment coefficients for T-girder and Pre-stressed bridges:

Estimates of sample T-girder and pre-stressed bridges were obtained. From the estimates so obtained, total labour cost, equipment cost, material cost and overhead & profit costs were calculated. Corresponding price adjustment coefficients were obtained as:

Fixed coefficient (A) = $\frac{Totalcostincurredinoverhead\&profit}{Totalestimatedcost}$

Labour coefficient (b) = $\frac{Totalcostincurredinlabour}{Totalestimatedcost}$

Material coefficient (c) = $\frac{Totalcostincurredinmaterial}{Totalestimatedcost}$

Equipment coefficient (d) = $\frac{Totalcostincurredinequipment}{Totalestimatedcost}$

The coefficients so obtained from the sampled bridges were averaged and so obtained coefficients were taken for calculation.

5.9 Comparison of price adjustment payments:

Calculation of payments from the contractor's quoted coefficients and from the so calculated coefficients were done separately and comparison was made.

The formula used for calculation of price adjustment payment was:(ADB, 2018)[6]

$$P_n = A + b\frac{Ln}{Lo} + c\frac{Mn}{Mo} + d\frac{En}{Eo}$$

Where,

pn = price adjustment factor

A = coefficient. This also fix coefficient. Generally, its value is 0.15.

b = labor coefficient or proposed weightage of labor in escalation. Shall be submitted by the contractor while bidding.

c = construction material coefficient. Shall be submitted by contracted while bidding.

d = equipment coefficient. Shall be submitted while bidding.

Ln = Current Labor index value

Mn = Current Construction Material index value

En = Current Equipment index value

Lo = Base period Labor Index Value

Mn = Base period Construction Material index value

En = Base period Equipment index value

Here the ANOVA test was also done to find whether there was a significance difference or not in the coefficients between different types of T-girder and pre-stressed bridges and also between price adjustment coefficients.

5.10 Summary of Research Matrix:

The research will be conducted in the field regarding collection of data, methodology and analysis of data as shown in table below:

Table 4: Research Matrix

S. N.	Objectives	Data Required	Data Collection Methods	Data Analysis
2	To determine specific price adjustment coefficient for T-girder and pre-stressed bridge.	Primary and Secondary Data	Questionnaire survey, Official documents, Estimates, Measurement Book, etc. office consultation	ANOVA test

6. RESULTS AND ANALYSIS :

6.1 Assessment of Price Adjustment Coefficients for T-girder & Pre-stressed Bridges:

One of the major objectives of this study is also to assess the price adjustment coefficients for T-Girder and pre-stressed bridges. For this purpose, estimates of different T-girder and pre-stressed bridges of different spans and of different districts are considered. Each of the BOQ cost is broken down into four components: Labour cost component, Material cost component, Equipment cost component and contractor's overhead and profit cost component. Then, the total cost incurred in Labour, Material, Equipment and overhead & profit cost is calculated.

6.2 The coefficients Estimation:

b= Labour coefficient = (Total labour cost incurred / Total Engineer's estimate)

c= construction material coefficient = (Total cost incurred in material / Total Engineer's estimate)

d= Equipment coefficient = (Total cost incurred in equipment / Total Engineer's estimate)

A= coefficient =(contractor's overhead, profit & price contingencies/ Total Engineer's estimate).

6.2.1 Price adjustment coefficients for Talahikhola T-girder Bridge:

This bridge is located along Baluwatole- Hulaki Road, Gadimai municipality-09, Bara. Longitude: 85°04'3.96"E and Latitude: 26°57'39.76"N.

Total length of bridge: 25m (1*25)

Span arrangement: Single span (1*25)

Total width of bridge: 8.40m (6.0m carriageway with 1.2m footpath on each side)

Type of superstructure: T- Beam type bridge

Type of bearings: Elastomeric Bearings (400mm*300mm*75mm)

Type of abutments: RCC Type Abutments

Name of Bridge: TalahiKhola Bridge, Bara

Table 5: Calculation of price adjustment coefficient for Talahikhola Bridge

S. N.	BOQ Item	Unit	Quantity	Rate	Amount	Amount Incurred in Labour	Amount Incurred in material	Amount Incurred in Equipment	Amount Incurred in contractor overhead & profit
1	Earthwork in excavation of foundation of structures.	cum	622.45	105.93	65936.12	10140.0069	0	47724.13	8074.06
2	Stone soling works	cum	29.81	4225.68	125967.52	14085.225	95451.62	0	16430.67
3	PCC(M15/40)	cum	19.87	12,997.53	258286.94	31296.4132	174094.64	19206.29	33689.60
4	PCC for RCC(M35/20)	cum	570.17	17,042.94	9717371.85	923675.005	6949430	576783.5	1267483.28
5	Boring RCC Piles	Rm	432	13,987.43	6042569.76	1332522.58	388800	3533087.3	788161.49
6	Reinforcement works	MT	91.73775	119,803.19	10990475.4	832061.393	8724873.8	0	1433540.27

7	Laying and fixing geo-textile	m2	168.54	225.44	37996.2785	1185.42613	31854.816	0	4956.03
8	Providing and laying graded filter material	m3	39.46	2,098.75	82823.391	28216.188	43804.152	0	10803.05
9	PCC for RCC(M25/20)	m3	167.55	20,877.71	3498060.54	441407.685	2096870	406995.64	552787.15
10	False works	m2	336.00	5,924.43	1990608.48	1417920	313016.93	0	259644.67
11	Embankment construction	m3	1350	378.33	510745.5	15165	243000	185962.5	66619.12
12	Stone Masonry works	m3	120	11663.34	1399600.8	426898.8	776375.52	13770	182556.72
13	Gabion works	m3	522.5	4825.63	2521391.68	352165	1840349.5		397441.19
				Total	37241834.3	5826738.72	21677921	4783529.5	5022187.34

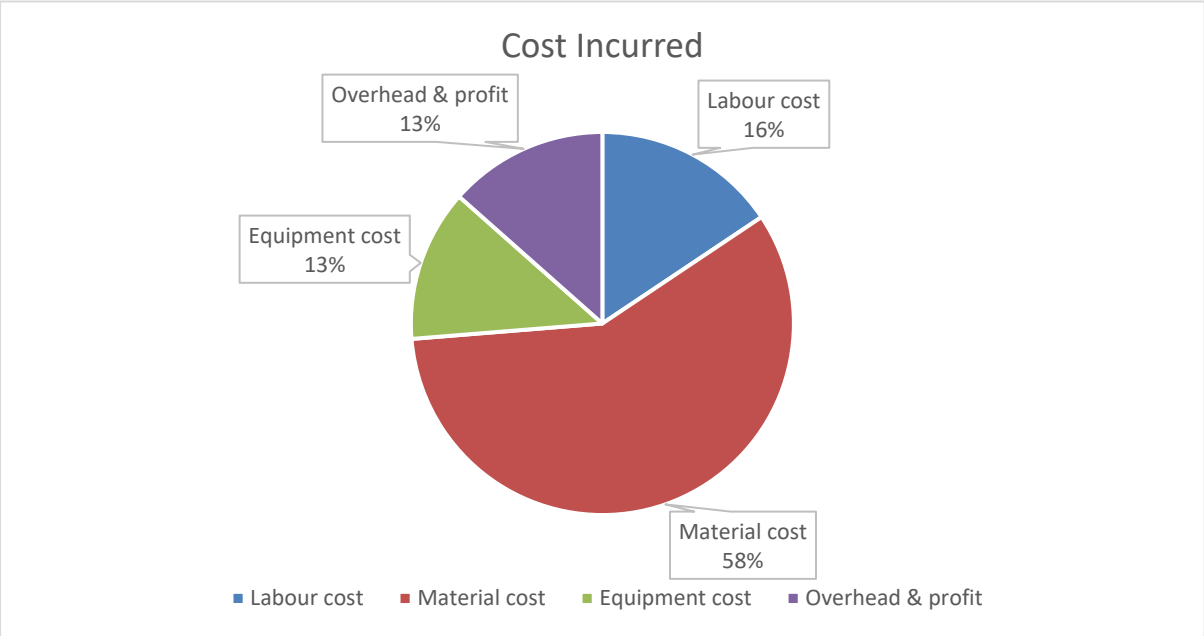


Fig. 1: Cost Incurred in Thalahikhola Bridge

From the pie-chart above, it was seen that approximately labour cost covers 16%, material cost covered 58%, Equipment cost covered 13% and overhead & profit covered 13% of Total estimated cost. Therefore, labour coefficient(b), material coefficient(c) and equipment coefficient(d) can be taken as:

b= 0.16
c= 0.58
d= 0.13

6.2.2 Assessment of price adjustment coefficients for Pauraikhola T-girder Bridge:

This bridge is located along Mangalpur- Paurai Road, Chandrapur municipality-01, Rautahat. Longitude: 85°26'42.07"E and Latitude: 27°7'45.99"N.

Total length of bridge: 50m (2*25)
Span arrangement: Double span (2*25)
Total width of bridge: 8.40m (6.0m carriageway with 1.2m foothpath on each side)
Type of superstructure: T- Beam type bridge
Type of bearings: Elastomeric Bearings (400mm*300mm*75mm)
Type of abutments: RCC Type Abutments

Table 6: Calculation of price adjustment coefficient for Pauraikhola Bridge

Name of Bridge: Pauraikhola Bridge, Rautahat

Type of superstructure: T-Beam Type Bridge									
S.N.	**BOQ Item**	**Unit**	**Quantity**	**Rate**	**Amount**	**Amount Incurred in Labour**	**Amount Incurred in material**	**Amount Incurred in Equipment**	**Amount Incurred in contractor overhead & profit**
1	Earthwork in excavation of foundation of structures.	cum	414.00	105.93	43855.02	6744.25714	0	31741.97143	5370.171429
2	Stone soling works	cum	25.06	4225.68	105895.5	34582.8	80242.12	0	13812.5708
3	PCC(M15/40)	cum	16.71	13,002.55	217272.6	23059.8	152143.98	13728.94	28328.96778
4	PCC for RCC(M35/20)	cum	522.89	17,346.41	9070264.32	721588.2	6735990.3	429606.424	1162380.228
5	Boring RCC Piles	Rm	420	13,987.43	5874720.6	1295508.06	378000	3434946.06	766268.118
6	Reinforcement works	MT	93.51893	128,670.00	12033080.7	841670.37	9622075.7	0.00	1569561.869
7	Laying and fixing geo-textile	m2	438.72	225.44	98904.30	3085.664	82918.08	0	12900.5616
8	Providing and laying graded filter material	m3	47.23	2,098.75	99123.9625	33769.45	52425.3	0	12929.2125
9	PCC for RCC(M25/20)	m3	302.12	20,877.71	6307574.16	795930.109	3780999	733879.5916	996765.4811
10	Embankment construction	m3	5000	378.33	1891650	56166.6667	900000	688750	246737.5
11	Stone Masonry works	m3	180	11663.34	2099401.2	640348.2	1164563.3	20655	273835.08
12	Gabion works	m3	660	4825.63	3184915.8	444840	2324652		502030.98
					41026658.2	4897293.58	25274010	5353307.983	5590920.741

From above, it is seen that approximately labour cost covers 12%, material cost covers 61%, Equipment cost covers 13% and overhead & profit covers 14% of Total estimated cost. Therefore, labour coefficient (b), material coefficient(c) and equipment coefficient (d) can be taken as:

b= 0.12
c= 0.61
d= 0.13

6.2.3. Assessment of price adjustment coefficients for Amsotriver T-girder Bridge:

This bridge is located over AmsotKhola, Saptari district. Geographically the bridge site is located at Longitude 86°46'48"E and Latitude 26°36'8.80"N.

Total length of bridge is 20m.
Span arrangement 1 x 20m (c/c of bearing).
Total width of bridge: 8.40m (6m carriageway with 1.2m footpath on both sides)

Type of superstructure: RCC
Type of bearing: Neoprene

Table 7: Calculation of price adjustment coefficient for Amsot River Bridge

Name of Bridge: Amsot River, Saptari									
Type of superstructure: T-Beam Type Bridge									
S. N.	**BOQ Item**	**Unit**	**Quantity**	**Rate**	**Amount**	**Amount Incurred in Labour**	**Amount Incurred in material**	**Amount Incurred in Equipment**	**Amount Incurred in contractor overhead & profit**
1	Earthwork in excavation of foundation of structures.	cum	667.92	107.37	71714.5704	9064.62857	4390.6516	49477.22359	8778.37
2	Piling works	rm	576.00	12331.18	7102759.68	1704960	506880	3964474.36	926447.61
3	PCC M15/40 Works	cum	23.09	12,901.98	297906.71	34173.2	217066.83	7809.04	38857.39133
4	M35/20 Works	cum	246.27	16,533.89	4071801.09	385823	3071582.5	83290.48416	531104.4044
5	M30/20 Works	cum	213.85	16,193.40	3462958.59	335031.667	2603910.7	72325.7808	451690.2633
6	Reinforcement works	MT	106.34	130,354.79	13861928.4	1004913	11048938	0.00	1808077.752
7	Formwork	sqm	1,232.59	777.45	958277.09	675459.32	157822.06	0	124992.0215
8	M25/20 Works	cum	26.84	15,370.63	412547.70	39723.2	309936.33	9077.50272	53810.54976
8	Embankment construction	cum	5,866.83	360.94	2117573.62	68446.35	782376.98	990555.57	276206.8363
9	Sub-base works	cum	1,199.55	3,447.34	4135256.7	38385.6	3332058.2	225429.99	539381.0562
10	Bio-engineering works	sqm	2270.58	897.69	2038276.96	467285.364	837844.02	467285.36	265862.2122
11	Stone Masonry works	m3	96	11663.34	1119680.64	341519.04	621100.42	11016	146045.376
					39650681.7	5104784.37	23493906	5880741.33	5171253.856

From above, it is seen that approximately labour cost covers 13%, material cost covers 59%, Equipment cost covers 15% and overhead & profit covers 13% of Total estimated cost. Therefore, labour coefficient(b), material coefficient(c) and equipment coefficient(d) can be taken as:

$$b= 0.13, c= 0.59, d= 0.15$$

6.2.4. Assessment of price adjustment coefficients for Jangahriver T-girder Bridge:

This bridge is located over Attabedanda- Nepaltole Road, Mahottari district. Geographically the bridge site is located at Longitude 85°52.576'E and Latitude 27°01.897'N.

Table 8: Calculation of price adjustment coefficient for Jangah River Bridge

Name of Bridge: Jangaha river, Mahottari									
Type of superstructure: T-Beam Type Bridge									
S. N.	BOQ Item	Unit	Quantity	Rate	Amount	Amount Incurred in Labour	Amount Incurred in material	Amount Incurred in Equipment	Amount Incurred in contractor overhead & profit
1	Earthwork in excavation of foundation of structures.	cum	1264.02	145.2	183535.7	19532.11	0	140064.73	23939.51
2	Stone-soling	cum	52.74	6251.4	329698.836	160118.64	126576	0	43004.19
3	PCC M10 Works	cum	21.14	10,971.95	231947.023	25269.3467	159012.83	17368.62	30253.96
4	M30 Works	cum	601.02	16,168.57	9717633.94	991683	6798938.6	493798.032	1267517.52
5	M20 Works	cum	69.57	14,598.16	1015593.99	114790.5	711176.08	57158.712	132468.79
6	Reinforcement works	MT	132.43	128,670.00	17039768.1	1191870	13625600	0.00	2222620.36
7	M35/20 Works	cum	89.10	20,418.79	1819314.19	194386.5	1296119.9	91505.7	237301.81
8	Asphalt concrete	cum	222.15	29,917.44	6646159.3	37742.2382	4653210.9	1088316.339	866890.43
8	G.I. Pipe Railing works	m	474.00	1,114.31	528182.94	0	459291.78	0	68895.9
9	Formwork	sqm	1,987.36	1,212.16	2408998.3	972812.72	1121960.1	0	314215.52
10	Falsework	sqm	1947.16	5129.19	9987353.6	5515330.7	3169317.6	0	1302697.04
11	Earthwork Filling	m3	6493.79	364.83	2369129.41	2000087.32	0	60002.6196	309013.49
12	Gabion Works	m3	2100	4825.63	10133823	1415400	7396620		1597371.3
13	Sub-grade works	sqm	2315.09	106.55	246672.84	15279.594	61044.293	138164.5712	32173.26
14	Sub-base works	cum	1018.64	332.08	338269.971	36603.1307	40287.212	217255.5392	44122.18
15	Base works	cum	520.89	4808.2	2504543.3	19258.4608	2106247.9	52358.1265	326679.05
					65500624.4	12710164.3	41725403	2355992.996	8819164.37

From above, it was seen that approximately labour cost covers 19%, material cost covers 64%, Equipment cost covers 4% and overhead & profit covers 13% of Total estimated cost. Therefore, labour coefficient (b), material coefficient (c) and equipment coefficient (d) can be taken as:

b= 0.19
c= 0.64
d= 0.04

6.2.5. Assessment of price adjustment coefficients for Gerukariver T-girder Bridge:

This bridge is located over Gerukariver, Gaucharan, Chandranagar-02, Sarlahi district. Geographically the bridge site is located at Longitude 85°37'12.89"E and Latitude 26°57'24.64"N.

Total length of bridge is 20.00m.
Span arrangement 1 x 20m (c/c of bearing).
Total width of bridge: 8.40m (6.0m carriageway with 1.20m footpath on both sides)

Type of superstructure: RCC T- Beam with deck
Type of Bearing: Neoprene
Type of foundation: Pile foundation

Table 9: Calculation of price adjustment coefficient for Geruka River Bridge

Name of Bridge: Geruka river, Sarlahi									
Type of superstructure: T-Beam Type Bridge									
S. N.	**BOQ Item**	**Unit**	**Quantity**	**Rate**	**Amount**	**Amount Incurred in Labour**	**Amount Incurred in material**	**Amount Incurred in Equipment**	**Amount Incurred in contractor overhead & profit**
1	Earthwork in excavation of foundation of structures.	cum	422.69	106.01	44809.3669	6885.82138	0	32408.24614	5482.893143
2	PCC(M15/40)	cum	25.98	13,002.55	337806.249	35852.4	236547.02	21345.17	44044.6788
3	PCC for RCC(M35/20)	cum	727.27	17,346.41	12615523.6	1003632.6	9368860.9	597525.032	1616715.31
4	Boring RCC Piles	Rm	432	13,987.43	6042569.76	1332522.58	388800	3533087.376	788161.4928
5	Reinforcement works	MT	95.71	128,670.00	12315005.7	861390	9847512.9	0.00	1606335.386
6	Laying and fixing geo-textile	m2	63.00	225.44	14202.615	443.1	11907	0	1852.515
7	Formwork	m2	763.85	736.24	562376.924	403312.8	85712.372		73329.6
8	Providing and laying graded filter material	m3	18.90	2,098.75	39666.375	13513.5	20979	0	5173.875
9	PCC for RCC(M25/20)	m3	24.16	20,877.71	504405.506	63649.1177	302359.77	58687.04797	79709.56581
10	Embankment construction	m3	3359	378.33	1270810.47	37732.7667	604620	462702.25	165758.2525
11	Sub-base works	m3	656	1964.12	1288462.72	19680	977440	123281.2928	168060.1808
12	Bio-Engineering	m2	1761.72	863.19	1520699.09	336136.176	650074.68	336136.176	198352.0548
				Total	36556338.4	4114750.86	22494814	5165172.589	4752975.805

From above, it is seen that approximately labour cost covers 11%, material cost covers 62%, Equipment cost covers 14% and overhead & profit covers 13% of Total estimated cost. Therefore, labour coefficient(b), material coefficient(c) and equipment coefficient (d) can be taken as:

b= 0.11
c= 0.62
d= 0.14

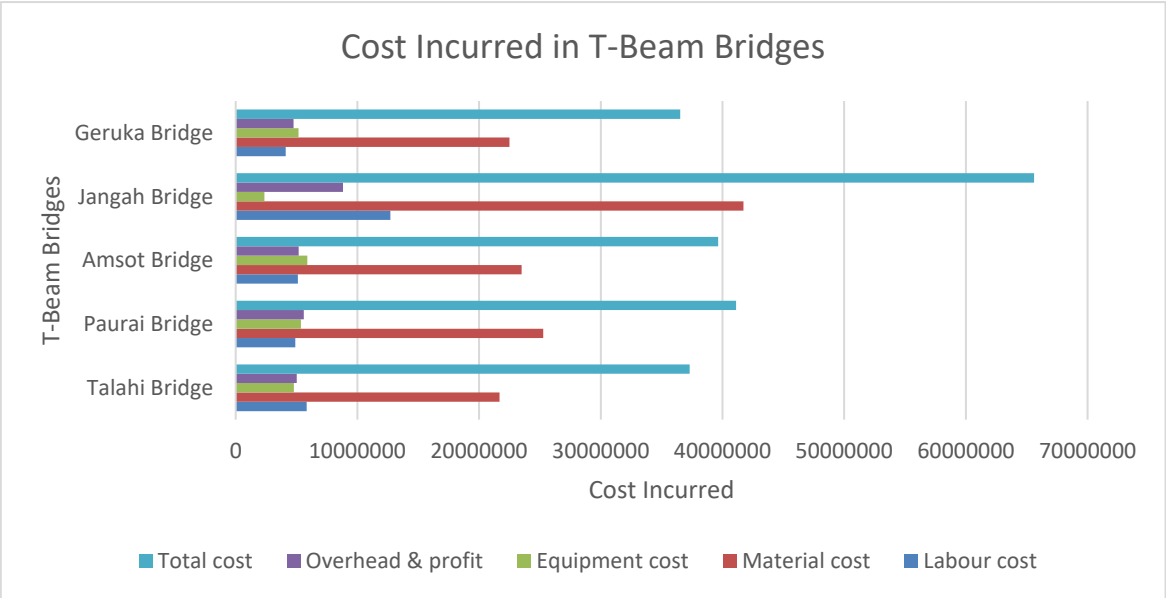


Fig. 2: Summary of Cost Incurred in T-girder Bridges

All the so calculated coefficients are averaged for better result:
bavg = (0.16+0.12+0.13+0.19+0.11)/5 = 0.15(approx)
cavg = (0.58+0.61+0.59+0.64+0.62)/5 = 0.60(approx)
davg = (0.13+0.13+0.15+0.04+0.14)/5 = 0.10(approx)
Adopting, range of coefficients as:
b = 0.11-0.19
c= 0.58-0.64
d= 0.04-0.15

These ranges of coefficients so derived assist the client in providing the price weightage coefficient range while formulating the bidding document. With these ranges so provided, contractor is bounded to bid in between the ranges which can bring uniformity in price adjustment provision for T-girder bridges.

6.2.6 Assessment of price adjustment coefficients for Jeeta River Pre-stressed Bridge:

This bridge is located over Jeeta river, Tilathi Koiladi-04, Saptari district. Geographically the bridge site is located at Longitude 86°48'57.10"E and Latitude 26°28'26.85"N.

Total length of bridge is 41.00m.
Span arrangement 1 x 40m (effective).
Total width of bridge: 8.40m (6.0m carriageway with 1.20m footpath on both sides)
Type of superstructure: Three girder, RCC Pre-stressed Girder & Deck
Type of Abutments: Rectangular RCC with cantilever return wall
Type of foundation: Pile foundation

Table 10: Calculation of price adjustment coefficient for Jeeta River Bridge

Name of Bridge: Jeeta river, Saptari									
Type of superstructure: Pre- stressed type Bridge (Span: 40m)									
S. N.	**BOQ Item**	**Unit**	**Quantity**	**Rate**	**Amount**	**Amount Incurred in Labour**	**Amount Incurred in material**	**Amount Incurred in Equipment**	**Amount Incurred in contractor overhead & profit**

1	Earthwork in excavation of foundation of structures.	cum	467.92	106.01	49604.1992	7622.63962	0	35876.09486	6069.590857
2	PCC(M15/40)	cum	39.94	12,901.98	515305.0812	59111.2	375472.03	13508.03	67213.69467
3	PCC for RCC(M35/20)	cum	841.41	16,533.89	13,911,780.38	1318209	10494418	284571.5933	1814579.758
4	Boring RCC Piles	Rm	480	14,299.73	6,863,870.40	1633920	485760	3799287.936	887845.63
5	Reinforcement works	MT	119.99	130,354.79	15,641,271.25	1133905.5	12467200	0.00	2040165.97
6	Laying and fixing geo- textile	m2	814	160.23	130,427.22	5969.33333	107448	0	17012.6
7	Formwork	m2	2,139.50	777.45	1,663,354.28	1172446	273943.72	0	216958.13
8	Providing and laying graded filter material	m3	50.40	3,860.78	194,583.31	37296	131906.88	0	25380.43
9	Backfilling	m3	568.32	627.89	356,842.44	194933.76	79564.8	35800.18176	46544.83
10	M45 Works	m3	235.94	17,607.57	4,154,330.07	394019.8	3138643.8	79796.79	541869.08
11	M25 Works	m3	34.19	15,370.63	525,521.84	50601.2	394810.16	11563.33	68546.30
12	Falsework	m2	344.40	4,051.55	1,395,353.82	980816.76	220402.14	0	180182.85
13	Fixing High Tensile Steel wires	MT	10.61	330,856.68	3,510,389.37	344051.061	2587744.4	120717.03	457876.9422
14	Elastomeric slab seal expansion	rm	16.80	21,279.79	357,500.47	2170	308700	0	46630.5
15	Steel pipe railing	rm	288.00	906.15	260,971.20	4608	218689.92	3632.64	34039.728
16	Sub-base works	m3	756	3447.34	2606189.04	24192	2099984.1	142074.17	339937.547
17	Gabion works	m3	1205	7912.81	9534936.05	1456041.67	6835201.8	0	1243686.525
18	Stone Masonry work	m3	338.83	13103.51	4439862.293	1491728.89	2369021.4	0	579111.9722
					66112092.72	10311642.8	42588911	4526827.8	8613652.11

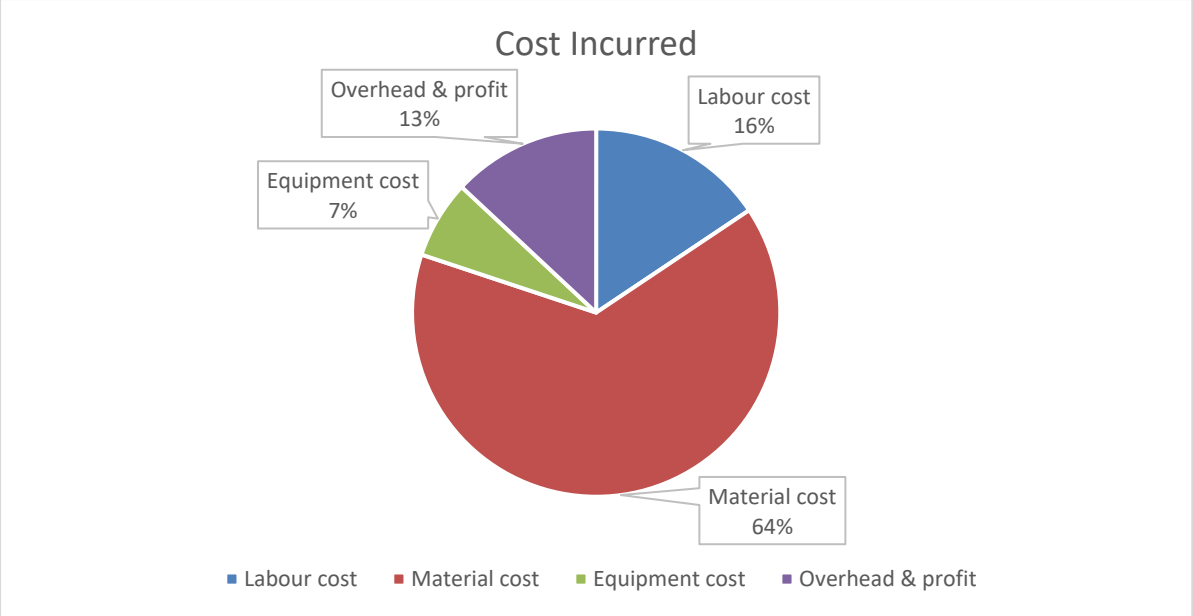


Fig. 3: Cost Incurred in Jeeta River Bridge

From above, it is seen that approximately labour cost covers 16%, material cost covers 64%, Equipment cost covers 7% and overhead & profit covers 13% of Total estimated cost. Therefore, labour coefficient (b), material coefficient (c) and equipment coefficient (d) can be taken as:

b= 0.16
c= 0.64
d= 0.07

6.2.7 Assessment of price adjustment coefficients for Lamaha River Pre-stressed Bridge:

This bridge is located over Lamahariver, Harshada Chedchauk Road, Rautahat district. Geographically the bridge site is located at Longitude 85°18'01.943"E and Latitude 27°00'04.764"N.

Total length of bridge is 41.00m.
Span arrangement 1 x 40m (effective).
Total width of bridge: 8.40m (6.0m carriageway with 1.20m footpath on both sides)
Type of superstructure: Three girder, RCC Pre-stressed Girder & Deck
Type of Abutments: Rectangular RCC with cantilever return wall
Type of foundation: Pile foundation

Table 11: Calculation of price adjustment coefficient for Lamaha River Bridge

Name of Bridge: Lamaha river, Rautahat									
Type of superstructure: Pre- stressed type Bridge (Span: 40m)									
S. N.	**BOQ Item**	**Unit**	**Quantity**	**Rate**	**Amount**	**Amount Incurred in Labour**	**Amount Incurred in material**	**Amount Incurred in Equipment**	**Amount Incurred in contractor overhead & profit**
1	Earthwork in excavation of foundation of structures.	cum	467.92	106.01	49604.199	7622.63962	0	35876.09486	6069.590857
2	PCC(M15/40)	cum	23.09	11,509.44	265752.96	34173.2	189107.19	7809.22	34663.44688
3	PCC for RCC(M35/20)	cum	841.41	15,685.83	13,198,214.22	1318209	9873924.5	284571.5933	1721505.788

4	Boring RCC Piles	Rm	480	14,299.73	6,863,870.40	1633920	485760	3799287.936	887845.632
5	Reinforcement works	MT	119.99	130,354.79	15,641,271.25	1133905.5	12467200	0.00	2040165.972
6	Laying and fixing geo- textile	m2	286.00	266.49	76,216.14	2097.33333	64178.4	0	9941.36
7	Formwork	m2	2,139.50	635.78	1,360,251.31	921375.675	249628.56	0	175650.9175
8	Providing and laying graded filter material	m3	50.40	3,860.78	194,583.31	37296	131906.88	0	25380.432
9	Backfilling	m3	568.32	627.89	356,842.44	194933.76	79564.8	35800.18176	46544.83968
10	M45 Works	m3	235.94	16,753.57	3,952,837.31	394019.8	2963433.6	79796.79552	515587.5704
11	M25 Works	m3	34.19	14,351.18	490,666.84	50145.3333	364502.39	11563.33152	64000.03307
12	Falsework	m2	344.40	4,051.55	1,395,353.82	980816.76	220402.14	0	180182.8579
13	Fixing High Tensile Steel wires	MT	10.61	330,856.68	3,510,389.37	344051.061	2587744.4	120717.034	457876.9422
14	Elastomeric slab seal expansion	rm	16.80	21,279.79	357,500.47	2170	308700	0	46630.5
15	Steel pipe railing	rm	288.00	863.60	248,716.80	4608	208033.92	3633.5808	32441.328
16	Sub-base works	m3	756	3447.34	2606189.04	24192	2099984.1	142074.1728	339937.547
17	Gabion works	m3	820	7912.81	6488504.2	990833.333	4651340.7	0	846326.1
18	Stone Masonry work	m3	338.83	13103.51	4439862.293	1491728.89	2369021.4	0	579111.9722
				Total	61496626.4	9566098.29	39314433	4521129.943	8009862.83

From above, it is seen that approximately labour cost covers 16%, material cost covers 64%, Equipment cost covers 7% and overhead & profit covers 13% of Total estimated cost. Therefore, labour coefficient(b), material coefficient(c) and equipment coefficient(d) can be taken as:

b= 0.16
c= 0.64
d= 0.07

6.2.8 Assessment of price adjustment coefficients for Maraha and Kadima River Pre-stressed Bridges:

From similar above calculations, labour coefficient(b), material coefficient(c) and equipment coefficient(d) for Maraha river pre-stressed bridge are:

b= 0.15
c= 0.62
d= 0.08

For kadimakhola pre-stressed bridge:

b= 0.15
c= 0.60
d= 0.09

Adopting, range of coefficients as:

b = 0.15-0.16
c= 0.60-0.64
d= 0.07-0.09

6.2.9 Significancy Analysis of Coefficients:

Here the ANOVA test is to done to find whether there is significance difference or not in the coefficients between different types of T-girder bridges and also between price adjustment coefficients.
ANOVA Test for T-girder Bridges:

Table 12: Summary of Calculated Price Adjustment Coefficients for T-girder Bridges

Price Adjustment coefficients	T- girder Bridges			
	1	2	3	4
b	0.16	0.12	0.13	0.11
c	0.58	0.61	0.59	0.62
d	0.13	0.13	0.15	0.14

Hypothesis Set-up:
For T-girder bridges (columns):
Null Hypothesis: H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$
There is no significance difference between in the coefficients between different types of T-girder bridges.
Alternative Hypothesis: There is significance difference in the coefficients between different types of T-girder bridges.
H_1: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4$
For price adjustment coefficients (Rows):
Null Hypothesis: H_0: $\mu_1 = \mu_2 = \mu_3$
There is no significance difference between in the coefficients between the price adjustment coefficients.
Alternative Hypothesis: There is significance difference between price adjustment coefficients.
H_1: $\mu_1 \neq \mu_2 \neq \mu_3$
Calculations for ANOVA Test for Significance of Price Adjustment Coefficients
Result and Conclusion:
For column: $F_{calc} < F_{tab}$, accept null hypothesis i.e. There is no significance difference between in the coefficients between different types of T-girder bridges.
For Row: $F_{calc} > F_{tab}$, accept alternative hypothesis i.e. There is a significance difference between price adjustment coefficients.
ANOVA Test for Pre-stressed Bridges:

Table 13: Summary of Calculated Price Adjustment Coefficients for Pre-stressed Bridges

Price Adjustment coefficients	Pre-stressed Bridges			
	1	2	3	4
b	0.16	0.16	0.15	0.15
c	0.64	0.64	0.62	0.60
d	0.07	0.07	0.08	0.09

Hypothesis Set-up:
For pre-stressed bridges (columns):
Null Hypothesis: H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$
There is no significance difference between in the coefficients between different types of T-girder bridges.
Alternative Hypothesis: There is significance difference in the coefficients between different types of T-girder bridges.
H_1: $\mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4$
For price adjustment coefficients (Rows):
Null Hypothesis: H_0: $\mu_1 = \mu_2 = \mu_3$

There is no significance difference between in the coefficients between the price adjustment coefficients.
Alternative Hypothesis: There is significance difference between price adjustment coefficients.
H_1: $\mu_1 \neq \mu_2 \neq \mu_3$
Calculations for ANOVA Test for Significancy of Price Adjustment Coefficients:
Result :
For column: $F_{calc} < F_{tab}$, accept null hypothesis, i.e., There is no significance difference between in the coefficients between different types of Prestressed bridges.
For Row: $F_{calc} > F_{tab}$, accept alternative hypothesis i.e. There is a significance difference between price adjustment coefficients.

7. DISCUSSION :

Utilization of fitting expense components in price adjustment can be useful to both venture proprietors and bidders. On the off chance that appropriate price adjustment is given, intensity of venture is expanded as they don't add expansion risk premium while the client can anticipate more sensible bid costs [21, 22, & 23]. Hence, it is important to comprehend issues common in price adjustment contract organization so the issues could be settled which makes development contracts deliberate, impartial and with least ambiguities. Suitable agreement organization helps in overseeing issues of expansion to client and worker for hire in legitimate way which further develops project execution in regard of cost, time and quality boundaries (ADB, 2018) [24, 25, & 26].
Except if generally gave in the Bid Information Sheet and the States of Agreement, the costs cited by the Bidder will be fixed. Assuming that the costs cited by the Bidder are dependent upon change during the exhibition of the Agreement as per the arrangements of the States of Agreement, the Bidder will outfit the lists and weightings at the cost change formulae in the Table of Change Information in Segment IV (Offering Structures) and the Business might require the Bidder to legitimize its proposed files and weightings (PPMO, 2063).
As indicated by Pokhrel and Mishra (2020), The primary Element Influencing Value change is Weightage of coefficient proposed by bidders with rank 2 and RII esteem 0.8078 for client 0.8706 for expert and 0.8791 for project worker. The contractor is asked to bid the labour coefficient (b), material coefficient(c) and equipment usage coefficient (d) keeping non-adjustable coefficient (A) constant to 0.15. It is the responsibility of client/employer to provide the range of these respective coefficients that assists the contractor in bidding process. But in actual practice, it is found that in major construction contract projects bidding option is left open to contractor. Only in some cases, range is provided but these ranges so provided are not found more logical. Ranges are just provided on thumb rule basis. Ranges so provided should be as per nature of construction works (i.e. different for building works, road works, bridge works etc) but in actual practice either the range column in price adjustment table is left blank or range if provided is not found more logical.
Assessment of price adjustment coefficients were done for T-girder and pre-stressed bridges. For this, cost incurred in different T-girder and pre-stressed bridges were broken down into labour, material and equipment costs. These individual costs were summed up and respective price adjustment coefficients were calculated. The coefficients represent the proportional cost as per the total cost estimate. The significance of these coefficients is that it can be used as reference for both clients and contractors in bidding price adjustment coefficients. Also, ANOVA Test was done to find the significance of price adjustment coefficients.
From the above analysis, it was found that the price adjustment coefficients calculated for four different types of T-girder and Pre-stressed bridges were significantly similar which was as expected. Thus, it can be concluded that these calculated price adjustment coefficient ranges could be used for bidding purpose of T-girder & Pre-stressed bridges contracts. Price adjustment coefficients (Labour coefficient, Material coefficient & Equipment coefficient) were found significantly different since their corresponding weightages in bridge construction are different. Thus, different ranges are to be adopted as per their weightages which is justified by this ANOVA Test.

8. CONCLUSION :

The price adjustment coefficient ranges for RCC T-girder and pre-stressed concrete bridges are found to be:

Table 14: Coefficients Ranges

Price Adjustment coefficients	For RCC T-girder Bridges	For pre-stressed Bridges
b	0.11-0.19	0.15-0.16
c	0.58-0.64	0.60-0.64
d	0.04-0.15	0.07-0.09

If price adjustment coefficient ranges are not provided in bidding document, it was seen that contractors tried to manipulate price adjustment provision to his/her benefit. So, it has been necessary to provide a guideline to contractors in bidding price adjustment coefficients.

The timely viability of the corrected drawing with any information on location to work with smooth execution of work and settle on brief choices in regards to the specialized and legally binding issues by taking business endorsement where fundamental in determined time as required. Specialists ought to sort out a post agreement grant meeting mutually with workers for hire (counting specialized group) to affirm material accessibility, constructability and different limitations hailed up by project workers before their site preparation. Claims arise due to design error and quality of works can be reduced by strictly enforcement of standard specification and Quality Assurance Plan (QAP).

9. RECOMMENDATIONS :

Following are the recommendations.

(1) The project monitoring / evaluation and control system should be enforcing strongly.

(2) A dispute settlement unit after the amicably (i.e. negotiation) stage should be one of conciliation/mediation/adjudication for to facilitation on the basis of evidence before the arbitration as arbitration is time and resource consuming.

10. ACKNOWLEDGEMENT :

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