CHAPTER 31

Cash Flow Analysis for Hybrid Annuity Model of Road Project

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ABSTRACT

It is a financial study on the four-laning of Ujjain-Garoth Package 1, from Chandesari to Khedakhajuriya, as a project of road construction in India, emphasizing how important road transportation is for economic expansion and the government's efforts in upgrading infrastructure through a number of programs. The project belongs to a general national strategy toward highway improvement, which provides a means of facilitating trade and communicating different areas. Background The bidding process of the project involves information gathering from case studies to estimate the anticipated markup percent for bids. Several construction tasks' prices include site clearing, digging, building bridges and underpasses, and many more. In addition, the document analyzes various bidding models to determine the final bid price that incorporates both direct and indirect costs. The outcome is expected to enlighten readers on successful tactics in bidding and budgeting for future infrastructure projects of this nature. Considering all factors, the document provides a comprehensive understanding of the financial aspects of road building using the Hybrid Annuity Model. It also helps in decision making regarding the expected mark-up amount of bid using different bidding models.

Keywords: Cash flow analysis; Hybrid annuity model.

1.0 Introduction

Road Transport is a critical infrastructure for the economic development of a country. It impacts the pace, structure, and pattern of development. The capacity of National Highways in terms of handling traffic (passenger and goods) needs to keep pace with economic growth. India has the second largest road network in the world of about 63.72 lakh km. This comprises National Highways, Expressways, State Highways, Major District Roads, Other District Roads, and Village Roads. The National Highways have a total length of 1,40,995 km, which in total serves as the arterial network of the country. The Government of India had launched major initiatives to upgrade and strengthen National Highways through various phases of the National Highways Development Project (NHDP) and is taking the initiative forward through the umbrella program of Bharatmala Pariyojna, Phase-I and other schemes and projects.

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DOI: 10.17492/JPI/NICMAR/2507031 *ISBN: 978-93-49790-54-4*

2.0 **Literature Review**

Infrastructure is considered as one of the key factors by the government of India which is directly related to growth of economy. The world economic forums global competitiveness report 2019-18 shows that India's global competitiveness ranking has fallen significantly in 2019-18. India's rank jumped 10 places lower vis-à-vis 2017- 18, from 58th place to 68th place in 2019-18 which affects the economic growth of country) now in 2022-23 rank is 37th. The National Highways Development Project (NHDP) is a project to rehabilitate, widen and upgrade major highways in India to superiority. National Highways carry about 40% of the total traffic across the country whereas account for only about 2% of the total length of roads (MoRTH 2020). The PPP approach increases the economic value of infrastructure outputs (Zhang *et al.,* 2005) and facilitates the overall development of infrastructure (Li *et al.,* 2016).

The financial success of PPP Project depends on its ability to service the debt and generate the expected rate of return from the Government as well as Private Entrepreneur Point of view. PPP Projects in India involve many risks and problems. It's crucial for private entrepreneurs and the Government to identify and manage the risk associated with investment in PPP Projects (Singh, 2019). The study showed that the three traditional topics risk, procurement, and financing have been expanded over the years to include the following seven research topic categories: investment environment, procurement, economic viability, financial package, risk management, governance issues, and integration research (Cui, 2018).

3.0 Public Private Partnership

Physical infrastructure includes substantial investments that may impose burden on the public treasury, such as roads, water and sanitation networks, and transit systems. This strain is especially beneficial for nations with economies that are rapidly urbanising and developing, like India, where there is a tremendous demand for expanding infrastructure. Governments and public sector authorities throughout the world are increasingly turning to public-private partnerships (PPPs) as a way to offer their citizens and economies more affordable access to infrastructure services.

3.1 Different Public Private Partnership (PPP) models

- Engineering, Procurement and Construction (EPC) Model-Cost is completely borne by the government. Government invites bids for engineering knowledge from the private players. Procurement of raw material and construction costs are met by the government. of engineering expertise. The difficulty of the model is the high financial burden for the government.
- Build Operate Transfer (BOT)-A BOT model is generally used to develop a discrete asset rather than a whole network, for example a toll road. This simple structure provides the most freedom for the private sector partner during construction and the public sector bears the equity risk.

DOI: 10.17492/JPI/NICMAR/2507031 *ISBN: 978-93-49790-54-4*

- Build Own Operate (BOO)-This is a similar structure to BOOT (below), but the facility is not transferred to the public sector partner. A BOO transaction may qualify for tax exempt status and is often used for water treatment or power plants.

4.0 Bidding Model

The bidding process represents a game where contractor would like to "win" a bid at a price that gives him the maximum profit. The probability of winning a bid decrease as a contractor tries to increase his profit margin. The probability for a contractor to win a bid depends not only on his mark-up, etc., but also on the approach adopted by the competitors. It is also observed that in present-day construction, the criteria laid down by the client for evaluation of bids become relevant to the bidding process. At times, a client may choose to evaluate a bid on criteria such as the contractor record on quality in executing the job and schedule compliance, apart from consideration of the price quoted. A suitable model based on probability to explain the bidding phenomenon in a construction project has yet eluded researchers, though initial efforts in the direction were made as early as 1956 by Friedman.

5.0 Determining Bid Price

In this research work, we take one case study project which was floated by National Highway Authority of India (NHAI) on e-tenders website. Name of the project is 4- laning of Ujjain- Garoth (Package-I) Chandesari to Khedakhajuriya from Km. 0.00 to (-) 750 & Km 0+000 to km 41.400 section of NH-148NG in state of Madhya Pradesh on Hybrid Annuity Mode. After going through all the schedules, we did the rate analysis.

The tender price or the bid price can be mathematically represented as the sum of total cost and mark-up. The total cost consists of direct costs and indirect costs-the cost of material, labour and plant and equipment could be taken under the former head, while expenses on items such as personnel recruitment, training, and research and development are essentially indirect costs. Generally, a direct cost of an activity is physically traceable to the activity in an economic manner, and thus, is a cost not incurred if the activity is not performed. Indirect costs, on the other hand, are business costs other than direct costs and are not physically traceable to the activity and may be incurred even if the activity is not performed. Cost of project is 678.22 Cr.

5.1 Friedman's model analysis

Calculation of Expected Mark-up amount of contractor under study for new project with estimated cost 500,000,000 Rs using Friedman's Model. For mark-up percentage of 1%, x would be 1.01 and Z approximately -1.27. Similarly, other values of Z can be calculated for different values of x. The probability value corresponding to Z = -1.27 can be read out from standard normal distribution table, which is 0.0985. Thus, probability of winning the bid when only single competitor is there = 1-0.0985 = 0.9015

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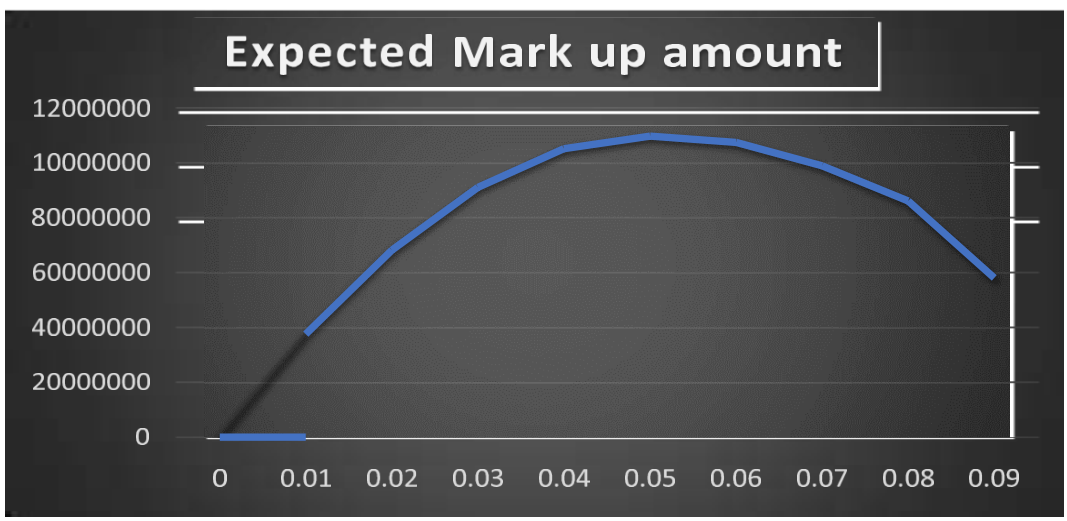
Table 1: Friedman's Model Analysis

Mark up%	XX= 1+(Markup%/100)	Z Z= (X-μ)/σ	Probability from standard normal distribution table	Probability of winning the bid with only one typical competitor	Final Probability of winning the bid with 2 typical competitors	Expected Mark up amount = 5000000000x(x-1) x Final Probability of winning the bid
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0%	1.00	-0.92	0.0985	0.9015	0.8127	0.00
1.00%	1.01	-0.77	0.1335	0.8665	0.7508	37541112.50
2.00%	1.02	-0.62	0.1736	0.8264	0.6829	68293696.00
3.00%	1.03	-0.46	0.2206	0.7794	0.6075	91119654.00
4.00%	1.04	-0.31	0.2743	0.7257	0.5266	105328098.00
5.00%	1.05	-0.15	0.3372	0.6628	0.4393	109825960.00
5.20%	1.052	-0.12	0.3483	0.6517	0.4247	110425351.40
5.50%	1.055	-0.08	0.3707	0.6293	0.3960	108905084.75
6.00%	1.06	0.00	0.4013	0.5987	0.3584	107532507.00
7.00%	1.07	0.15	0.4681	0.5319	0.2829	99021163.50
8.00%	1.08	0.31	0.5359	0.4641	0.2154	86155524.00
9.00%	1.09	0.46	0.6406	0.3594	0.1292	58125762.00

Figure 1: Expected Markup Cost using Friedman's Model



Expected mark-up cost = 11,04,25,351.40 Optimum Mark up % = 5.20%

5.2 Gate's model analysis

Calculation of Expected Markup amount of contract or understudy for new project with estimated cost 500,000,000 Rs using Gate's bidding model.

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Table 2: Gate's Model Analysis

Mark up%	X X = 1 + (Markup% / 100)	Z Z = (X-**μ)/σ**	Probability from standard normal distribution table	Probability of winning the bid with only one typical competitor	Final Probability of winning the bid with 2 typical competitors	Expected Markup amount
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0%	1.00	-0.92	0.0985	0.9015	0.8207	0
1.00%	1.01	-0.77	0.1335	0.8665	0.7644	38222320.25
2.00%	1.02	-0.62	0.1736	0.8264	0.7042	70415814.59
3.00%	1.03	-0.46	0.2206	0.7794	0.6385	95780763.56
4.00%	1.04	-0.31	0.2743	0.7257	0.5695	113897826.26
5.00%	1.05	-0.15	0.3372	0.6628	0.4957	123915644.63
6.00%	1.06	0.00	0.4013	0.5987	0.4272	128173838.58
6.20%	1.062	0.03	0.4129	0.5871	0.4155	128813787.25
6.30%	1.063	0.05	0.4207	0.5793	0.4078	128443372.99
7.00%	1.07	0.15	0.4681	0.5319	0.3623	126806757.03
8.00%	1.08	0.31	0.5359	0.4641	0.3022	120867243.96

Upto column 5 all the calculations are similar to previously mentioned model. The final probability (column 6) is computed using the expression

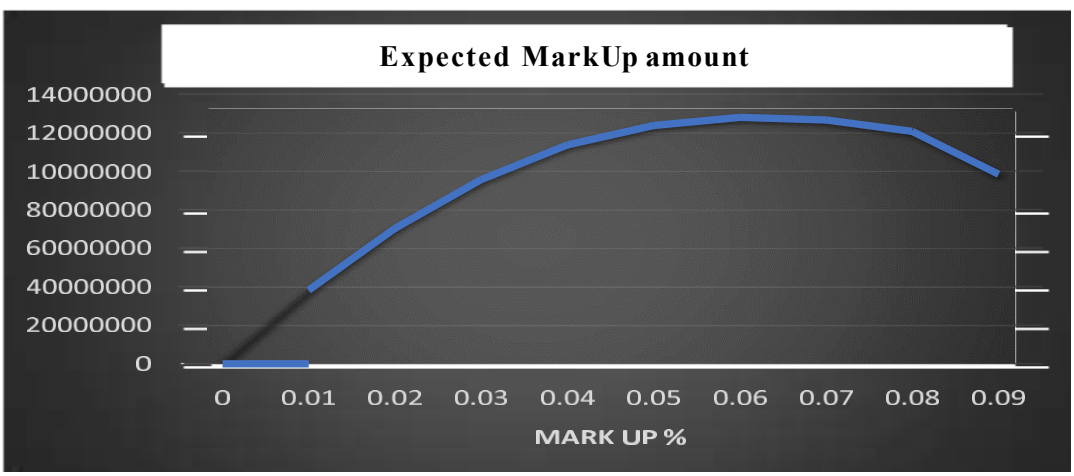
$$p = \frac{1}{n \times \left[\frac{(1-p(typ))}{p(typ)}\right] + 1}$$

Where n = 2 is considered

Expected markup cost = 12,88,13,787.25

Optimum Mark up % = 6.20%

Figure 2: Expected Markup Cost using Gate's Model



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Now, after analyzing both models we get 5.20% and 6.20% mark up percentage by Friedman's model and Gate's model respectively. Current scenario suggests average of both percentages can be used as final mark-up percentage i.e. 5.75%

6.0 Result

In previous point, after analysing Friedman's and Gate's bidding model we get mark up percentage as 5.20% and 6.20% respectively. As per literature review average of both models result are suggested to be used in practical applications. We are going to apply this mark up percentage on previously mentioned project as case study in abstract of cost in Table 6.1. So, the final bid price is 653.94 Cr.

Table 3: Application of Results from Bidding Model in Abstract of Cost

Four Laning of Ujjain Garoth Package 1 Chandesari to Khedakhajuriya		
Bill No	**Description**	**Tender Amount**
1.	Site clearance and dismantling	90,74,695
2.	Earth work	42,93,10,420
3.	Granular sub-bases, bases courses	63,35,11,228
4.	Bituminous courses (flexible pavement)	75,68,27,748
5.	Bill of quantities box culverts	41,90,07,669
6.	Bill of quantities minor bridge box	1,82,61,493
7.	Bill of Quantities of Major & Minor Bridge (Pile Foundation)	84,96,30,799
8.	Bill of Quantities of Minor Bridge (Open Foundation)	13,09,89,642
9.	Bill of Quantities of Underpasses	1,43,13,81,828
10.	Bill of Quantities of Flyover	28,21,05,234
11.	Bill of Quantities of ROB	56,04,61,680
12.	Drainage works	38,88,717
13.	Bill of Quantities of River Training & Slope Protection Work	2,84,00,416
14.	JUNCTION	24,33,695
15.	TRAFFIC SIGNS, MARKINGS & APPURTENANCES	31,90,25,131
16.	Bill of Quantities of Toll Plaza	8,42,31,416
A	TOTAL CONSTRUCTION COST Excluding GST	5,95,85,41,810
B	Supervision Charges @ 3% of Civil Construction Cost (A1)	17,87,56,254
C	Add Labour Cess@ 1%	5,95,85,418
D	Add Mark up cost @5.75%	34,26,16,154.08
	Total Amount(A+B+C+D)	6,53,94,99,637
	RFP Cost	6,78,00,00,000
	% Above/Below	3.55%

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7.0 Conclusion

- It ensures a steady cash flow over the project's lifespan.
- More stable cash flows because risk is shared.
- It makes easier to manage finances and plan for future investments.
- There is saving of government money and still high-quality infrastructure outcomes are made.
- Better connectivity helps to reduce travel time & helps to boost economic development.

References

Babatunde, S. O., Opawole, A., & Ujaddughe, I. C. (2015). Barriers to public private partnership projects in developing countries: A case of Nigeria. *Engineering, Construction and Architectural Management.* https://doi.org/10.1108/ECAM-12-2014-0159

Carr, R. I. (1982). General bidding model. *Journal of the Construction Division, 108*(4), 639–650.

Cui, C., Zhu, J., Chan, A. P. C., & Liu, Y. (2018). Review of studies on the public private partnerships (PPP) for infrastructure projects. *International Journal of Project Management, 36*(5), 773–794. https://doi.org/10.1016/j.ijproman.2018.03.004

Grimsey, D., & Lewis, M. K. (2002). Evaluating the risks of public private partnerships for infrastructure projects. *International Journal of Project Management, 20*(2), 107–118. https://doi.org/10.1016/S0263-7863(00)00040-5

Li, Y., Wang, X., & Wang, Y. (2017). Using bargaining game theory for risk allocation of public-private partnership projects: Insights from different alternating offer sequences of participants. *Journal of Construction Engineering and Management, 143*(3), 04016102. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001249

Mahalingam, A. (2010). PPP experiences in Indian cities: Barriers, enablers, and the way forward. *Journal of Construction Engineering and Management, 136*(4), 419–429. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000130

Pellegrino, R., Vajdic, N., & Carbonara, N. (2013). Real option theory for risk mitigation in transport PPPs. *Built Environment Project and Asset Management.* https://doi.org/10.1108/BEPAM-05-2012-0027

DOI: 10.17492/JPI/NICMAR/2507031 *ISBN: 978-93-49790-54-4*

Singh, L. B., & Kalidindi, S. N. (2006). Traffic revenue risk management through annuity model of PPP road projects in India. *International Journal of Project Management, 24*(7), 605–613. https://doi.org/10.1016/j.ijproman.2006.07.008

Willoughby, C. (2013). How much can public private partnership really do for urban transport in developing countries. *Research in Transportation Economics, 40*(1), 34–55. https://doi.org/10.1016/j.retrec.2012.06.038

Zhang, X. (2005). Critical success factors for public-private partnerships in infrastructure development. *Journal of Construction Engineering and Management, 131*(1), 3–14. https://doi.org/10.1061/(ASCE)0733-9364(2005)131:1(3)

DOI: 10.17492/JPI/NICMAR/2507031 *ISBN: 978-93-49790-54-4*