# Comparative Study of Prospective PPP Models for Highway Projects of India


**Naimish Bhatt and Debasis Sarkar**

**Abstract** Infrastructure is necessary for any development, and for development, finance is required. Therefore, the government introduced the public–private partnership in infrastructure development to fulfill the need for finance. Generally, in India, three basic models, namely EPC, BOT (toll), and BOT (annuity), are adopted to fulfill infrastructure needs using private investment. As a result, they will get a good return on investment. However, due to specific terms and conditions of finance and a few government loopholes, the private firms interest is declining in PPP infrastructure development, particularly in the road sector. Therefore, the government introduced a new model in January 2016, the Hybrid Annuity Model (HAM), in the road sector, combining EPC and BOT (annuity). In the present study, a financial study has been carried out for three different PPP models for a case study of Porbandar-Dwarka. HAM is the best suitable model for a financial return on investment and the development of new infrastructure in low traffic, a region having only religious and social importance.

**Keywords** BOT (Toll) · BOT (Annuity) · HAM · IRR · NPV

## 1 Introduction

Over the past few years, Indian road (highway) segments have been experimenting with PPP challenges. However, the policy has reduced the enthusiasm of private investors for road infrastructure development since 2015. With the private sector's subsidized evaporation, the government depended on engineering, procurement, and construction (EPC) (Press Information Bureau 2016). In 2015, the government proposed the Hybrid Annuity Model (HAM) as a mid-way component to

N. Bhatt (✉) · D. Sarkar
Pandit Deendayal Petroleum University, Gandhinagar, Gujarat, India
e-mail: naimish.bhatt@sot.pdpu.ac.in

D. Sarkar
e-mail: Debasis.Sarkar@sot.pdpu.ac.in



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renew private sector interests in the roadway portion (Press Information Bureau 2016). The HAM model is supposed to be a mixture of the traditional EPCs and the different long-term concession framework variations that can conceive different risk allocations. The present study will discuss the financial aspects of India's best-adapted three PPP models to develop road infrastructure. Financial aspects of Build, Operate, and Transfer (BOT-Toll), BOT-Annuity, and Hybrid Annuity Model (HAM) are compared, and the best adoption feasibility of the HAM model is discussed.

### *1.1 Significance of HAM*

(a) This model is best suitable for attracting private investors where low traffic is observed and a need to develop a particular corridor for some important reason.
(b) 40% of Bid project cost, as cash support during construction period payable to the concessionaire by authority after achieving different milestones mentioned in the agreement.
(c) The concessionaire must bear 60 percent of the bid project bill during the construction phase.
(d) Inflation-indexed project costs are the weighted average of the Wholesale Price Index (WPI) and the Factory Workers' Consumer Price Index at 70:30.
(e) Toll collection is the responsibility of authority, and O&M payments made by authority as quoted in the agreement shall be inflation-adjusted.
(f) The concessionaire period consists of two major parts: (i) the Construction period and (ii) fixed one year of operation.

## 2 Methodology

There is a need for a new model for attracting private investors in road development via PPP mode, which leads to adopting the new model, which gives a better return on investment. Here, we are analyzing the HAM model from the data available. First, we calculate the net present value (NPV) and internal rate of return (IRR). The following methodology was adopted for the analysis:

**Step 1: Cash Flow Diagram**

Engineers use the cash flow diagram as a guide that displays cash transfers during the project. Initial funding, service, operating costs, project earnings or savings, etc., are included.

**Step 2: Net Present Value**

The net present value (NPV) of a project is the sum of the actual values of all the cash flows expected to happen over the project's life. The general formula for NPV is

$$\text{NPV} = \sum_{t=1}^{n} \frac{Ct}{(1+r)^t} - \text{Initial investment} \tag{1}$$

$Ct$ = the cash flow at the end of the year $t$, $n$ = life of the project, and $r$ = discount rate.

A good NPV means that the investment's gain increases the estimated expense and would be profitable. A negative valuation of the NPV, on the other hand, results in a net investment loss.

**Step 3: Internal Rate of Return**

A project's internal rate of return (IRR) is the discount rate, making its NPV equivalent to zero. In other words, the discount rate contrasts the actual value of potential cash flows with the original investment. For example, it is the value of $r$ in the following equation:

$$\text{Investment} = \sum_{t=1}^{n} \frac{Ct}{(1+r)^t} = 0 \tag{2}$$

$Ct$ = the cash flow at the end of the year $t$, $n$ = life of the project, and $r$ = internal rate of return. The IRR is the value of $r$, which satisfies the following equation;

$$\text{Investment} = \frac{P1}{(1+r)} + \frac{P2}{(1+r)^2} + \frac{P3}{(1+r)^3} + \cdots + \frac{Pn}{(1+r)^n} \tag{3}$$

In general, to get a higher percentage of return on their savings, investors go for a higher IRR value. But, again, the IRR value depends on the project types, whether they are single or many.

## *2.1 Case Study and Data Collection:*

The National Highway Authority of India (NHAI) has taken up the upgrade of the existing two-lane road from Km 356.766 (design chainage km 379.100) to Km 473.000 (design chainage km 496.848) in the State of Gujarat to four lanes with a paved shoulder layout of the Porbandar-Dwarka portion of NH-8E. The length of the project is 117.748 km (Fig. 1).

The present study's main objective is to establish the project's technical, environmental, and social viability and prepare the detailed project report to upgrade the existing two-lane road to 4 lanes configuration. The socio-economic analysis's primary purpose is to provide an overview of the state's socio-economic set up and the related status of the project influence area within the state. The details include the present status, past performance, and the economy, population, and urbanization perspective. In addition, the profile depicts the spatial distribution of


**Fig. 1** Location of road Location of Road-Project Case Study

economic activities. It is observed that over 80 percent of the vehicular traffic on the project corridor originates or terminates in the State of Gujarat. Therefore, the socio-economic analysis of the broad influence area is confined to this state.

## 3 Result and Discussion

It would help assess a project if you calculated the applicable cash flows and the incremental after-tax cash flows associated with the project. Three essential elements form the cash flow stream of a traditional project: (1) Original investment, (2) Operational cash inflow (3) Terminal cash outflow. A diagram noted as cash flow allows the representation of the cash inflow and outflow graphically. Figure 2 shows that the timeline is represented with a horizontal axis and subdivided into duration into days, months, or years. Every cash flow represents payment or receipt against the line at the end of the duration. An upward arrow represents the positive cash flow, and a downward arrow reflects the spending over the projects.

Here, Figs. 3, 4, and 5 show cash flow diagrams for the different cases considered under study. BOT (toll), BOT (annuity), and HAM, three models used for PPP projects, are considered for the case study, and all three are analyzed for cash flow and calculating the values of NPV and IRR of the project. The cash flow diagram for BOT (Toll) is shown in Fig. 3, which shows an initial investment, and after that gradient, the cash inflow demonstrates a gradual increase every year. Similarly, for the case

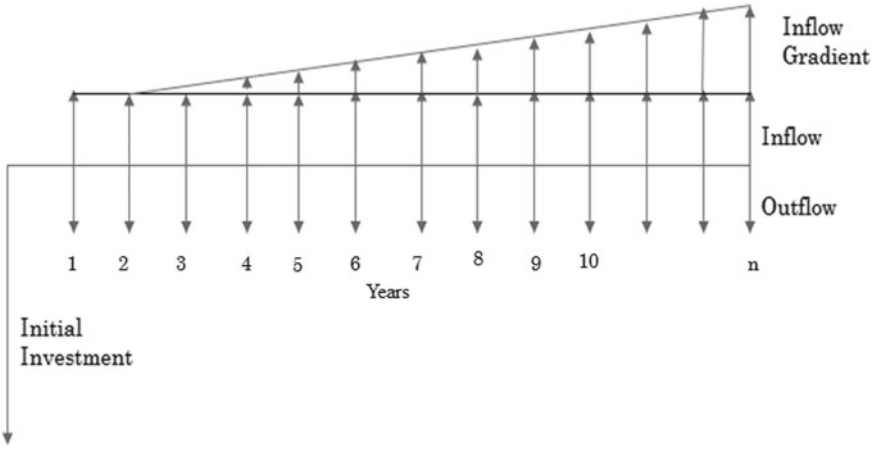
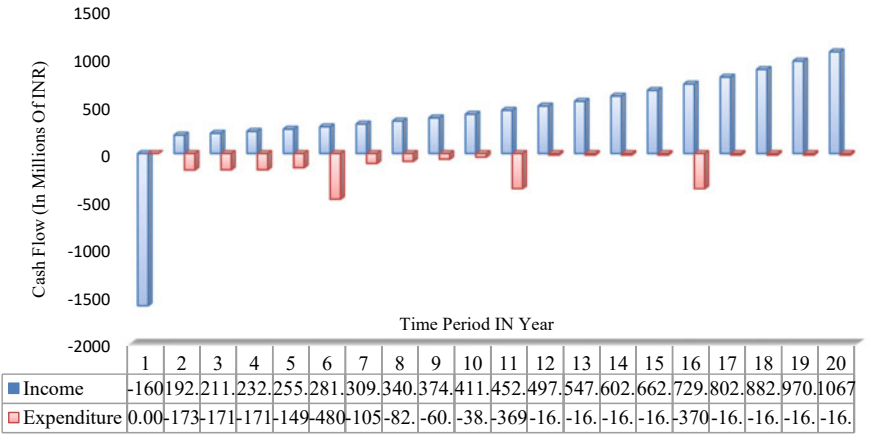



**Fig. 2** Cash flow diagram

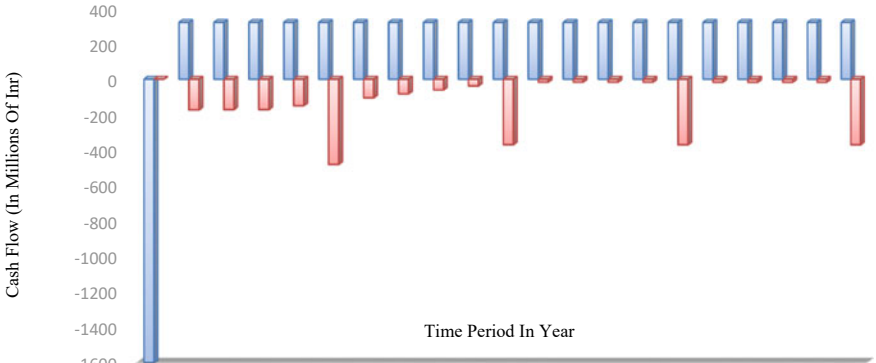
of BOT (annuity), Fig. 4, annuities are 20%. Therefore, the BOT (annuity) model displays a flat income source and is represented by its cash flow diagram. Figure 5 shows the newly adopted hybrid annuity model (HAM) for PPP road construction and a gradual decrease in the cash inflow, and simultaneously cash outflow is also reduced.

For the evaluation process of the expenditure, NPV and IRR are used. Net present value (NPV) discounts the actual value of the stream of projected cash flows associated with the planned investment and provides the project with a cash surplus or deficit. The internal rate of return (IRR) measures the percentage rate of return at which the net present value of zero will result from the same cash flows. Net present



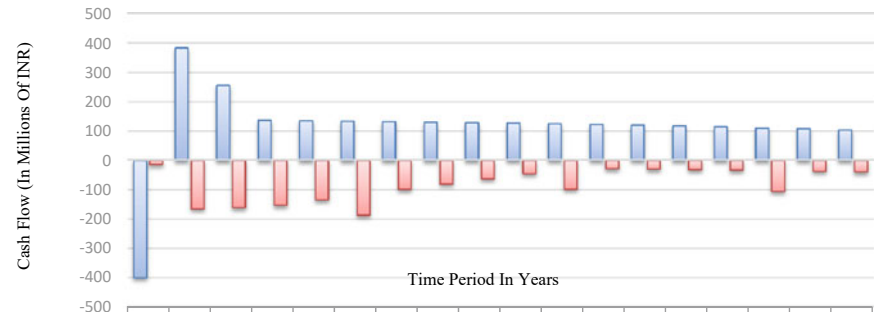

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Income | -160 | 192. | 211. | 232. | 255. | 281. | 309. | 340. | 374. | 411. | 452. | 497. | 547. | 602. | 662. | 729. | 802. | 882. | 970. | 1067 |
| Expenditure | 0.00 | -173 | -171 | -171 | -149 | -480 | -105 | -82. | -60. | -38. | -369 | -16. | -16. | -16. | -16. | -370 | -16. | -16. | -16. | -16. |

**Fig. 3** Cash flow diagram for BOT (Toll)




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Income | -16 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 | 320 |
| Expenditure | 0.0 | -17 | -17 | -17 | -14 | -48 | -10 | -82 | -60 | -38 | -36 | -16 | -16 | -16 | -16 | -37 | -16 | -16 | -16 | -16 | -37 |

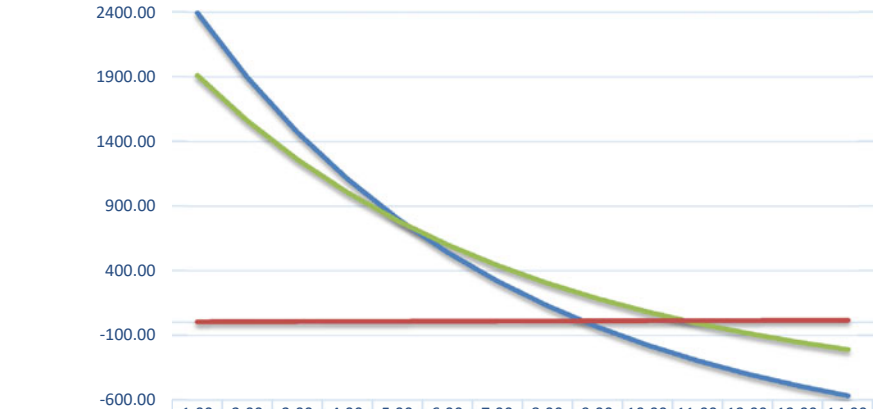
**Fig. 4** Cash flow diagram for BOT (annuity of 20%)




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Income | -400 | 384. | 256. | 137. | 135. | 134. | 132. | 130. | 129. | 127. | 125. | 122. | 120. | 118. | 115. | 110. | 108. | 103. |
| Expenditure | -14. | -165 | -160 | -153 | -134 | -187 | -98. | -80. | -62. | -44. | -97. | -28. | -29. | -31. | -33. | -105 | -36. | -39. |

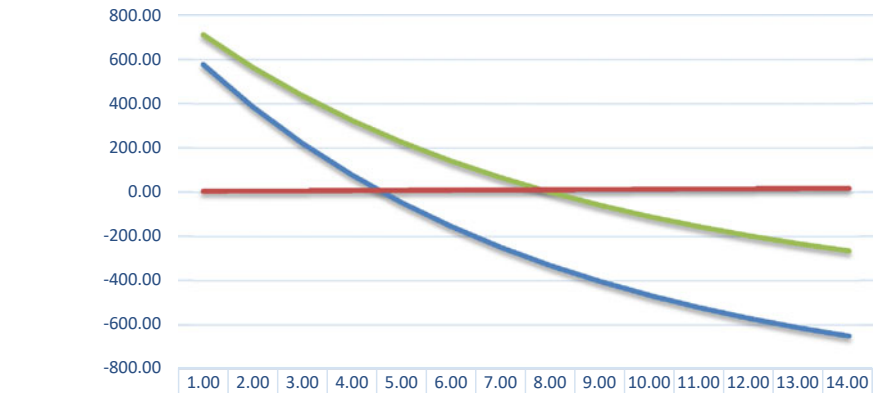
**Fig. 5** Cash flow diagram for HAM

value (NPV) for every three cases is calculated before and after-tax consideration. For example, for the first case of BOT (Toll), the value of NPV is around 2395.3 INR in millions for a 5% rate to − 649.5 INR for a 18% rate, and a graph of NPV and IRR is shown for the same in Fig. 6. Then, according to Fig. 6, the NPV becomes zero (0) at the rate of 8.32%, which becomes its internal rate of return (IRR) before tax, and similarly, after tax; the value of IIR is around 11.46%, which is also mentioned in Fig. 6. NPV and IRR are also calculated for the BOT (annuity) case of an annuity of 20% to the concessionaire. In such a case, the NPV and IRR are 577.69 INR in a million at a 5% rate to − 649.5 INR in a million at a 18% rate for an annuity amount of 20% as shown in Fig. 7.




| | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 | 9.00 | 10.00 | 11.00 | 12.00 | 13.00 | 14.00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NPV Before Tax | 2395.3 | 1894.1 | 1469.7 | 1109.4 | 803.01 | 541.80 | 318.73 | 127.90 | -35.63 | -175.9 | -296.5 | -400.3 | -489.7 | -566.7 |
| NPV After Tax | 1911.4 | 1559.5 | 1260.3 | 1005.3 | 787.41 | 600.76 | 440.53 | 302.66 | 183.80 | 81.10 | -7.78 | -84.86 | -151.8 | -210.0 |
| % IRR | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |

**Fig. 6** NPV versus IRR for BOT (Toll)




| | 1.00 | 2.00 | 3.00 | 4.00 | 5.00 | 6.00 | 7.00 | 8.00 | 9.00 | 10.00 | 11.00 | 12.00 | 13.00 | 14.00 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NPV Before Tax | 577.69 | 386.23 | 220.77 | 77.46 | -46.92 | -155.0 | -249.3 | -331.5 | -403.4 | -466.3 | -521.4 | -569.7 | -612.2 | -649.5 |
| NPV After Tax | 711.83 | 564.31 | 436.03 | 324.20 | 226.46 | 140.82 | 65.62 | -0.56 | -58.93 | -110.5 | -156.1 | -196.6 | -232.6 | -264.6 |
| % IRR | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |

**Fig. 7** NPV versus IRR for BOT (annuity of 20%)

HAM is a newly adopted model, and NPV and IRR are also calculated for that model. The graph in Fig. 8 shows details of the NPV and IRR getting for the HAM model. The value of NPV is varied from 53.53 INR in a million to −72.05 INR in a million for a 12% and 23% rate of return.

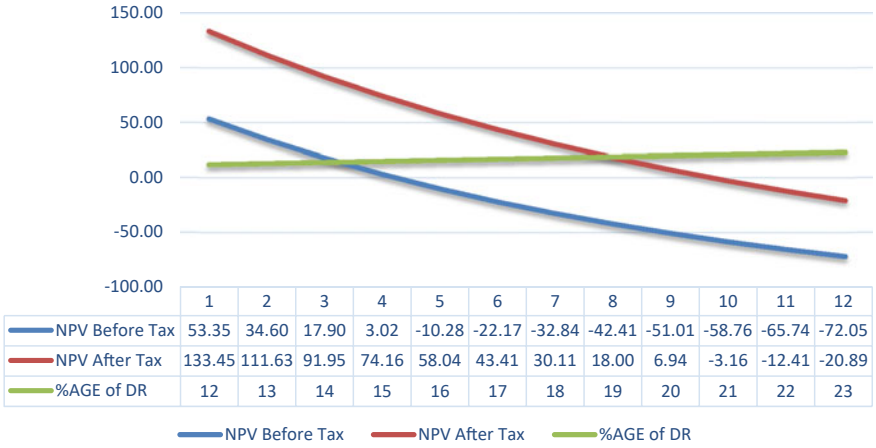



**Fig. 8** NPV versus IRR for HAM

## 4 Conclusion

This paper compares the financial aspects of the three different PPP models used for highway construction in India. According to the case study taken, HAM proves a better model than the other two BOT (toll) models (toll) and BOT (annuity). The following points reflect the consideration and adoption of the HAM model are better than any other for the given case study. Porbandar and Dwarka have social and religious critical only and very low traffic census on such a road. Developing road BOT (toll) and BOT (annuity) models do not work correctly. Due to low traffic, private investors will not get a proper return on their investment, and the road remains undeveloped. In such a situation, HAM offers a good return on investment, and the development of roads is also taken care of by the private concessionaire in PPP mode.

As discussed in the result section, the financial analysis of the HAM model shows a lower difference, 53.53 INR in a million to −72.05 INR in a million, of net present value (NPV) for the higher rate of return, which shows that there are significantly fewer chances of inflation due to annuity payment. In comparison, there is a higher difference in the value of NPV for other models with less return on investment. HAM is a combination of the two most attractive models, EPC and Annuity, so as per clause during the construction period, the concessionaire will get 40% of the invested amount, and the remaining 60% will get during the concessionaire period of fix 15 years as an annuity decided by the authority. In BOT (toll), the leading financial risk belongs to the concessionaire only. The return on investment is calculated based on IRR, and as discussed earlier, the value of IRR in the HAM model is around 15% before tax and 21% after tax. IRR in BOT (toll) is around 9% before tax and 12% after tax; similarly, for BOT (annuity), the highest value of IRR is around 14% before tax and 18% after tax. Therefore, HAM gives a good return regarding IRR while comparing it with the other two models.

HAM is the solution for new road infrastructure development for some social and religiously important places where low traffic flow is observed. HAM is the only suitable model to develop road infrastructure in such areas from the case study we discussed.

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