ASSESSMENT AND MODELLING OF FINANCIAL EXPOSURE OF PPP BASED INDIAN HIGHWAY INFRASTRUCTURE PROJECTS

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ABSTRACT

Recent studies indicate that India must invest more than $150 billion over the next 5 years in the development of urban infrastructure. Lack of the financial resources and limitations in the capacity makes need to have public-private partnerships (PPPs). Unexpected conditions threaten the continuity of the project which arise from the prior knowledge. These barriers are distrust between the public and private sector, a lack of political willingness to develop PPPs, the absence of an enabling institutional environment for PPPs andpoorly designed withunstructured PPP projects. For such kind of scenarios, uncertainties associated with the underground projects must be assessedfor the existing risks and prioritize them to reduce, mitigate and/or even eliminate the financial risks. Some of the major techniques include Monte Carlo simulation or statistical based approach. Parameters such traffic flow, project cost etc. are identified the and models the risk by analysing real world PPP based highway projects in recent studies, however till now, accurate risk analysis cannot be quantified. This research aims to accuratelyestimate various parameters involved with uncertainty associated with NPV. This model is then applied to 30 real world infrastructure projects to identify the critical risk factors. This paper contributes by providing factored logic model to real world PPP based projects which help inmaking investment decisions by private and public sector by identifying weightage for different source of uncertainty on priority basis. Government agencies can use this by identifying the factors that have the largest impacts.

KEYWORDS:NPV-at-risk; PPP; uncertainties; highway infrastructure; Monte Carlo Simulation; project cost; investment risk; financial analysis.

1. INTRODUCTION

World's biggest markets for PPP with over 1100 major national level infrastructure projects is in India from which half of them are road infrastructure projects which are generally functioned under various models such as BOT Annuity, Engineering Procurement and Construction (EPC) etc. (PPP India Database 2014). National highways form the economic backbone of the country. There is a wide gap lies between the request of the infrastructure and the resource available (Shetty 2012). Therefore, plausible efforts are to be made for considerable raise in infrastructure share and improve the quality of infrastructure facilities. Some of the problems associated with transportation infrastructure development include financing, land acquisition, delays in construction etc.

Project delivery system such as Public-Private-Partnership (PPP) can address some of these issues as there is a private party is responsible for providing and operating a public service or a project and collect revenues (Delmon 2011). Because of this, majority of financial, technical and operational risk associated with the project is vested with the private party. Private investors are being contacted by Government of India for such kind of projects which look forward to huge investments in infrastructure from. Now a days, majority of focus is on the development of tools and activities to attract more investments through PPP format (Ernst and Young 2012). PPP arrangements help in two folds. Private funds are used to finance their infrastructure projects which helps governments which have fiscal constraints. Secondly, Private entity brings in expertise and experience which helps to build and operate a facility in a more cost-effective way (Delmon 2011).

Build-Operate-Transfer (BOT) model is a form of PPP which has extensive applications in infrastructure projects. Private entity construct and operate a transportation infrastructure facility and earns profit by collecting tolls for a specified period of time. PPP-BOT projects have high financial risks because of their long-term nature and uncertainties associated with projected future cash flows, cost overrun etc. One of the major unanswered questions is the risk assessment and modelling of these uncertainties for road transport infrastructure projects. In India, scene of many of the past BOT projects was very bad due to inefficient financial risk management and strategy planning. For example, Loss is there in ‘Vadodara-Halol Toll project’ in Gujarat state due to wrong traffic projections which has been operational since 2000 (Raghuram 2003).

This paper (with the help of 30 real-world highway projects) investigates the investment risk associated with a BOT highway infrastructure project. After applying Net Present Value (NPV)-at-risk model providing a cumulative probability distribution curve for NPV. Profitability of a project can be appropriately judged using developed model after appropriate customizations. Helps in identifying actual relationship between parameter and associated NPV and which source of uncertainty has the most influence on the project’s financial returns. Appropriate Mitigation strategies and its applications are discussed towards the end.

2. LITERATURE REVIEW

Prior research endeavours have focused on the analysis of various options like NPV within aconfidence interval, binomial lattice, government guarantees and fuzzy set theory to analyse the uncertainties with a BOT projects (Iyer and Sagheer 2011; Ashuri et al. 2012; Ye et al. 2013). NPV-at-risk can be used for incorporating the risk profile by combining Weighted Average Cost of Capital (WACC) and dual risk-return methods which gives NPV within a confidence interval using a Monte Carlo Simulation (MCS) technique (Ye and Tiong 2000). Attarzadeh et al. (2011) used different techniques like Fuzzy set theory, probability modelling for decision making using insufficient data about parameters and complete information about their probability. Methods for quantifying payments of guarantees given to protect project sponsors from skyrocketing costs of acquiring land, delays in scheduled toll adjustment, and compensation payments in case of nationalization events (Wibowo et al. (2012)). Nemuth (2008) implemented a two stage model, identifying and analysing the risks and then evaluating using MCS and discussed alternative actions. Further details of existing state-of-the-art research are illustrated in Table 1.

Major uncertainty involved in calculating NPV for a highway project is associated with estimating future traffic flow. Bagui and Ghosh (2011) proposed a method to determine lower and upper limits of traffic/revenue at risk. Iyer and Sagheer (2011) proposed a traffic band using binomial lattice method which was combination of both upper and lower limits of traffic which ensure certainty through an equitable risk and revenue sharing mechanism. Pathan and Pimplikar (2013) represented the risk of financing during the post construction period due to fluctuation in prime lending rate (PLR) through a case study and provided a reasonable agreement to change concession period corresponding to the change in prime lending rate.

Krishnamurthi (2008) introduced risk associated with a project which is the probability of investment's actual return being different from the estimated return. Different versions of risk are measured differently eg. Standard deviation of historical returns or average returns of a specific investment. Various valuation methods have been used to estimate the profitability and risk of a project which can be broadly categorized into two categories – Discounted cash flow (DCF) models and Non-Discounted cash flow models. Former gives importance to the time value of money and calculates the present value of future and past cash flows using a discount rate. It includes tools like NPV, internal rate of return (IRR), modified IRR etc. On the other hand, the latter focuses on the time required to recover the initial cost of investment without accounting for the time value of money and includes methods like payback period, accounting rate of return etc. (Atrill and McLaney 2014).

One of the major aspects of every investment as all projects is Time value of money which deals with cash flows over a long period of time; thus DCF models are a better valuation method (IFAC report 2012). Among different DCF models, NPV is the most commonly used valuation method which is calculated as the "difference amount" between sums of discounted cash inflows and outflows. However, this decision rule fails to provide decision-makers with a confidence level. Therefore, the concept of NPV-at-risk is developed which computes NPV at some specific confidence levels.

Extensive research (in individualistic approaches) has been done for the success and improvement of BOT projects like including risks associated with future traffic flow, lending rate, project cost etc. Combining uncertainties associated with different parameters still has a wide gap while estimating future cash flows. Further application of such models for real-world PPP based highway projects in India is yet to explore. This paper aims to narrow down the gap by outlining a standard NPV-at-risk tool (supported by Monte Carlo Simulation) to analyse PPP highway projects. This method of such powerful tools is applied for 30 real-world projects. In this paper, probability distributions have been assigned to different parameters which affect the NPV of the project; and Monte Carlo Simulation is applied which incorporates uncertainties associated with different parameters to give NPV within a certain confidence interval. Also, the critical influencing parameter (parameter which affects output the most) is determined and appropriate risk mitigation efforts are discussed.

TABLE 1 Review of Project Risk Assessment Models

Author	Model Name/Utility	Research Tool	Remarks
Ye and Tiong (2000)	Evaluation of investment decision in infrastructure project	Monte Carlo Simulation	Developed a new method – NPV-at-Risk – by combining Weighted Average Cost of Capital (WACC) and dual risk return methods which incorporated confidence interval.
Bagui and	Traffic and Revenue	Monte Carlo	Lower and upper limit of traffic/revenue at

Author	Model Name/Utility	Research Tool	Remarks
Ghosh (2011)	Forecast	Simulation, Regression Analysis	risk can be determined using proposed method. Regression equations are developed can be determined using proposed method.
Iyer and Sagheer (2011)	Real Options based traffic risk mitigation model for BOT highway projects	Binomial Lattice	Only one risk variable was considered. NPV was calculated by incorporating traffic guarantee options.
Attarzadeh et. al (2011)	Risk Management of Long Term Infrastructure PPP-BOT projects	Uncertainity, probabilistic and stochastic model, fuzzy set theory	Decision making based on incomplete or insufficient data and complete information about probability.
Ashuri et. al (2012)	Evaluating BOT Highway Projects with Government Minimum Revenue Guarantee (MRG)	Real options analysis, risk neutral valuation method with MCS	The approach treats the risk of overestimating future traffic demands internally and adjusts for traffic market risk in valuation of MRG.
Wibiwi et. Al. (2012)	Modelling Contingent Liabilities arising from government	Monte Carlo Simulation, WACC. Capital	Provided methods for quantifying payments of guarantees given to protect sponsors from skyrocketing costs of a acquiring land.

3. METHODOLOGY

A good number of parameters influence a highway BOT project; Uncertainties associated with those parameters are one of the major complications with the investors. In this paper, we first identify various risk categories influencing a BOT highway project and the associated parameters. Then, to forecast the actual value of parameter, corresponding probability distribution is assigned to each parameter. Results have been interpreted and analysed after data is fed into a model developed in *@Risk*. The steps shown in Figure 1 summarize the whole methodology used in this paper for developing the NPV-at-risk model.

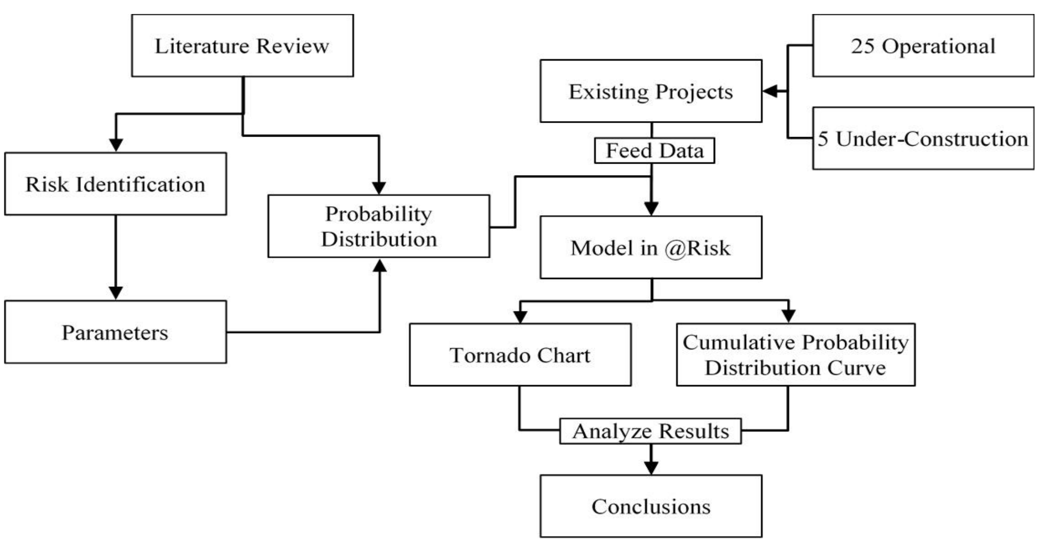

FIGURE 1 Methodology

3.1.Risk Identification and Assigning Probability Distribution

A highway BOT project is influenced by various types of risks and each risk is associated with a different parameter as shown in Table 2.

TABLE 2 Identification of Risk and Associated Parameters

Risk Category	Risk Identification	Associated Parameter
Traffic Revenue	Uncertainity about future traffic demands can lead to financial failure of BOT projects	Toll rate, Estimated Traffic
Land Acquisitions	Delays in land acquisition can lead to delays in start of constructing resulting in escalation of project cost	Construction period, Construction cost
Cost Overrun	In event of actual cost exceeding estimates used for establishment of financial viability, residual cash.	Construction period, Construction cost and Maintenance Cost
Debt Servicing	Determination of project viability is predicated on existing interest rate scenario prevailing in country.	Discount Rate
Economical	The projected revenue and consequently achievement of designated rate of return would be adversely affected in case the inflation rate is lower than what has been assumed in the financial market	Inflation Rate

Analysing profitability of these projects is difficult due to uncertainties associated with these parameters. Forecasting the actual value of parameter is done by using various Probability distributions. Some of those uncertain parameters which have been incorporated in the model developed in this paper are stated below along with their distributions:

Traffic:

Annual Average Daily Traffic (AADT) data is used to measure traffic and is calculatedin terms of Passenger Car Units (PCU) by using conversion units shown in Table 3. Growth in traffic is one of the most critical parameter and prone to risk more than any other parameter. Normal probability distribution with a COV (Coefficient of Variation) of 0.1 (Ye and Tiong 2000) is presumed to be advancement rate for traffic**.**

TABLE 3 PCU Conversion (Source: Kadiyali 2013)

Type of Vehicle	PCU
Car/Jeep/Van or LMV	1
Light Commercial Vehicle, Light goods vehicle, Mini Bus	1.5
Bus or Truck (2 Axles)	3
Three Axle Commercial Vehicle	3
Heavy Construction machinery(HCM), Earth moving equipment (EME) or Multi axe vehicle (MAV) 3 to 6 axles	4.5
Oversized vehicle (7 or more axles)	4.5

Discount rate:

The discount rate refers to the interest rate used in discounted cash flow (DCF)analysis to determine the present value of future cash flows. The discount rate in DCF analysis takes into account not only just the time value of money, but also the risk or uncertainty of future cash flows; the greater the uncertainty of future cash flows, the higher the discount rate (Kelly et al. 2015). Grimsey and Lewis (2004) have argued about the need for incorporating uncertainty in the Discount rate. This research accepts discount rate to be the same as interest rate given by Reserve Bank of India (RBI). For getting probability distribution, mean and the standard deviation of interest rate for the past 10 years' data is used; and the results conclude it to be normally distributed.

Toll rate:

National Highways Authority of India (NHAI) has laid out a set of fixed criteria forcalculation of toll fee to be levied on customers. Formula for determining the applicable rate of fee (GoI Report 2009)

$$TollRate = BaseRate \cdot [1 + 0.4 \cdot (\frac{WPI_A - WPI_B}{WPI_B})]$$

Where, A and B are two consecutive years and WPI is wholesale price index which is "the price of a representative basket of wholesale goods". It is a measure of inflation; the rate at which the general level of prices for goods and services is rising, and, subsequently, purchasing power is falling.

Project Cost:

The concessionaire aims to bear minimal cost so maximum probability occurs at lower cost values and hence it follows a lognormal probability distribution. It is one of the most significant costs which the concessionaire has to bear and sohas to be estimated in the best possible way keeping in mind all the indecisions.

Concession Period:

It is the most crucial factor in a BOT project as in case of a revenue shortfall, duration of concession period can be increased for the concessionaire to recover all the costs. It is defined as the time period for which the concessionaire owns thetransport facility and has the right to collect revenue. It generally varies from 15 to 30 years. In this paper, concession period is not taken as an uncertain variable rather NPV is calculated for the specified concession period and as per the profitability, decision is made to change the concession period.

Construction Period:

The concessionaire generates no revenue during the construction period.Thus, the concessionaire targets to complete the project in the given time to avoid cost overruns. Hence lognormal probability distribution can be assumed but for the scope of this paper it has been set as a fixed parameter.

Operations and Maintenance Cost:

O&M costs mean all operation, maintenance andadministrative costs relating to the projects after the construction has completed and the services have commenced. It is also a highly uncertain expenditure and is considered to be normally distributed with a COV of 0.1 (Ye and Tiong 2000).

3.2. Developing NPV-At-Risk Model

NPV-at-risk is a concept which computes NPV generated from a particular project within a specific confidence level (the minimum expected NPV at a given confidence level) by drawing a cumulative distribution graph of NPV. The first step towards developing model is dividing all the parameters into two categories: certain (construction period, concession period) and uncertain (growth in traffic, WPI, discount rate, project cost, operations and maintenance cost) inputs. NPV is set as the desired risk output and the relationships between different parameters and their effects on NPV are examined.

Costs include initial project cost for the construction period and operations and maintenance cost for the subsequent years till the end of concession period. Revenue starts only after construction period is completed and it is calculated on the basis of AADT (Annual Average Daily Traffic) and toll rate taking into account the net increase in revenue. The base revenue is calculated as follows:

$$\textit{Base Revenue} = \sum (\textit{Vehicle count} \cdot \textit{Toll rate}) \cdot 365$$

After the model is created in @Risk, static values for all parameters are fed in the model, cash flows throughout the concession period are calculated, number of iterations are fixed at 1000 and MCS is done to obtain the cumulative probability distribution graph and tornado chart for NPV.

Traffic is assumed to be linearly increasing throughout the concession period until it reaches the highway capacity. For the projects with multiple toll plazas, the final revenue is calculated as the sum total of individual revenues. Formulas used are:

$$\Delta R = (\Delta T_r) \cdot (1 + \Delta T)$$

$$\Delta T_r = (1 + 0.4 \cdot I_r)$$

$$\Delta T = \left(\frac{PCU_b - PCU_a}{n \cdot PCU_a}\right)$$

$$NPV = \sum_{i=1}^{c} \frac{R_i - C_i}{(1 + D_r)^i}$$

I_r = Inflation Rate
n = Year b – Year a
C = Concession Period
R_i = Revenue for year i
C_i = Cost for year i
D_r = Discount rate
ΔT = Growth in Traffic
ΔR = Net Increase in Revenue
factor ΔT_r = Increase in Toll Rate
factor PCU_b = PCU value for year b
PCU_a = PCU value for year

4. DATA COLLECTION

The paper studies 30 BOT highway projects spread across major states in India which is illustrated in Figure 2. The relevant project data (that includes project characteristics like type of project, brownfield, total project cost, operations and maintenance cost, construction period, concession period etc.) is obtained from National Highways Authority of India's (NHAI) website.Variational parametersare taken from different Government sites. There are a number of methods to calculate discount rate but due to unavailability of data, discount rate is assumed to be same as the interest rate for past 10 years, given by Reserve Bank of India (RBI). Also, to calculate the change in toll fee every year, Wholesale Price Index values for the past ten years have been taken from Ministry of Commerce and Industry, Government of India website.

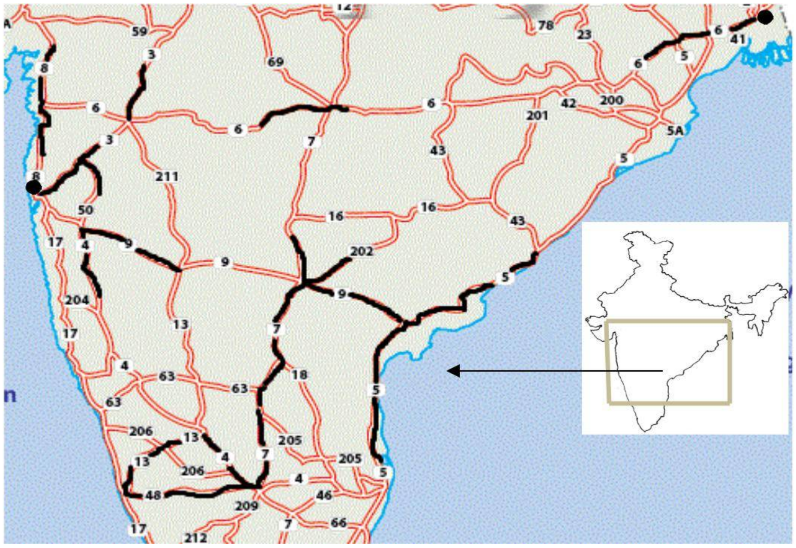

FIGURE 2 National Highways under Consideration

4.1Project Specific Characteristics and Data

The 30 projects considered in this paper are Build-Operate-Transfer projects. Each project involvs widened to 4 lanes or 6 lanes considering wide range of projects with length of stretch varying from 19.5 km to 291 km. Thus, the base toll for each project is set differently on the basis of their length using Table 4 (GoI Report 2009). The toll revenue from only 13% of these projects are collected by NHAI Agency; for other projects, concessionaire has the right to collect tolls. Among these, around 17% of the projects are in construction phase and remaining are operational.

TABLE 4 Base Rate of Fee Per Km (Source: GoI Report 2009)

Type of Vehicle	Base rate of fee per km for year 2006-2007 (in Rs.)
Car/Jeep/Van or LMV	0.6
Light Commercial Vehicle, Light goods vehicle, Mini Bus	1.00
Bus or Truck (2 Axles)	2.10
Heavy Construction machinery(HCM), Earth moving equipment (EME) or Multi axe vehicle (MAV) 3 to 6 axles	3.25
Oversized vehicle (7 or more axles)	4

The traffic flow (Annual Average Daily Traffic) for different type of vehicles for few years is also obtained from NHAI's website and is converted to Passenger Car Unit (PCU) when used in the model. Information about all 30 projects and few of the input parameters are mentioned in Table

5. ANALYSIS WITH EXAMPLE

Thorough analysis of a project titled “Andhra Pradesh - from Katdal to Armoor National Highway-7” is presented here for thorough understanding of the model. It provides detailed information on input data (Table 5 and Table 6). The complete model outcome of 30 projects has been summarized in the next section.

The project started on 4th May 2007 and the revenue collection began from 21st August 2009 and has collected Rs 64.85 Crore (with discounting) as on 31st March 2015. The average traffic was 17000 PCU/day as on 30th November 2013. The project also involved construction of 2 major bridges and has a tollable length of 31.77 km road.

TABLE 5 Input Data for NH-7 Katdal to Armoor

Parameter	Mean Value	Probability Distribution	COV
Concession Period	20 years	Constant	-
Construction Period	2 years	Constant	-
Number of lanes	8	Constant	-
Project Cost	Rs. 273.1 Crore	Lognormal	1
O& M Cost per year	Rs. 3.2145 Crore	Normal	0.1
Inflation (WPI)	4.88%	Normal	0.5
Discount Rate	7%	Normal	0.3

Traffic data and the corresponding toll rate for the project are outlined in Table 6. This data is used to calculate the growth in traffic between the years 2011-2012 and 2013-2014 by converting traffic count into PCU values.

TABLE 6 AADT and Toll data for NH-7 Katdal to Armoor

Type of Vehicle	2011-2012		2012-2013		2013-2014	
	Count	Toll Rate	Count	Toll Rate	Count	Toll Rate
Car / Jeep/Van or LMV	816	55	921	20	1199	30
Light Commercial Vehicle, Light goods vehicle, Mini bus	318	75	413	40	514	50
Bus or Truck (2 Axles)	712	180	689	110	944	125
Three Axle Commercial Vehicle	725	250	314	100	1321	135
Heavy Construction machinery (HCM), Earth moving equipment (EME) or Multi axle vehicle (MAV) 3 to 6 Axles	725	250	1263	140	611	190
Oversized vehicle (7 or more axles)	0.4	290	1	175	1	225

Since the construction period of the project is 2 years, costs include initial project cost for the first 2 years and then a constant operations and maintenance cost for the subsequent years till the end of concession period. Revenue starts after 2 years and base revenue is calculated from the above data using traffic count of the year 2011-2012. Thereafter, revenue keeps increasing due to increase in traffic count and toll rate. Also, PCU per lane is calculated for each year and as it reaches the limiting value of 700 PCU per hour per lane capacity (i.e. 16800 PCU per day).

(Kadiyali 2013), there is no further growth in traffic flow and net increase in revenue is only due to increase in toll rate. For this project, cash flows throughout the concession period and final NPV are shown in Table 7.

TABLE 7 Cash Flows for the simulation (in CroreRs)

Year	Cost	Revenue	Cash flows	Present Value
1	163.038	0.000	-163.038	-152.372
2	108.692	0.000	-108.692	-94.936
3	3.215	12.314	9.099	7.428
4	3.215	14.430	11.215	8.556
5	3.215	16.909	13.695	9.764
6	3.215	19.815	16.600	11.062
7	3.215	23.220	20.005	12.458
8	3.215	27.210	23.995	13.966
9	3.215	31.885	28.671	15.595
10	3.215	37.365	34.150	17.360
11	3.215	43.785	40.571	19.275
12	3.215	51.309	48.095	21.355
13	3.215	60.126	56.911	23.616
14	3.215	70.458	67.243	26.078
15	3.215	82.565	79.350	28.760
16	3.215	96.752	93.538	31.685
17	3.215	113.378	110.163	34.875
18	3.215	132.860	129.646	38.358
19	3.215	155.691	152.476	42.161
20	3.215	182.444	179.229	46.316
Total	**329.591**	**1172.515**	**842.924**	**161.359 (NPV)**

This project was completed 100 days ahead of the scheduled completion date and has been under operation since 2009. Similar process of valuation has been applied to other 29 projects.

After the simulation is completed, *@Risk* provides a series of graphs and charts which can be used to analyse the results. One of such graphs is the Cumulative Probability Distribution curve of NPV (Figure 3) through which the probability of occurrence of different values of NPV can be computed. Concessionaire can judge the profitability of a project based on the obtained probabilities and make the go-no-go decision. At α% confidence level, NPV-at-risk is the value at which α% of the possible values are smaller and 1-α% are larger. It also provides a Tornado chart which ranks input by their effect on NPV through which effect of different parameters on NPV can be examined. For example, discount rate is the critical influencing parameter for the above case study project (Figure 4).

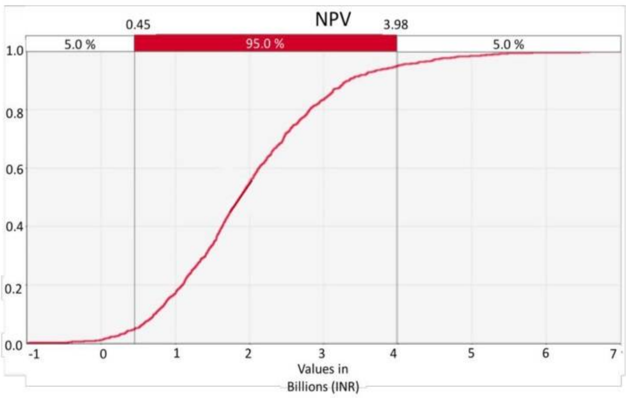

FIGURE 3 Probability Distribution Curve 1 for AP – Katdal to Armoor

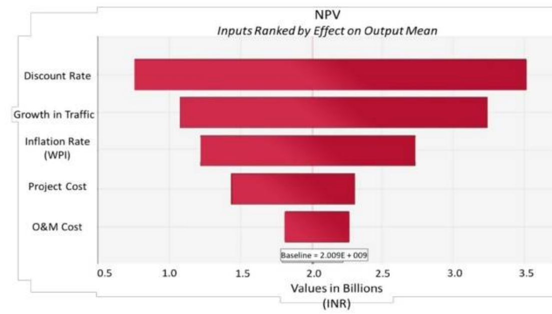

FIGURE 4 Tornado Chart 1

6. RESULTS AND FINDINGS

Excel-VBA is used to decrease the computational time on applying the above model on 30 projects. A summary of results obtained for all 30 projects which includes static NPV, NPV-at-risk for 95% confidence interval, critical influencing parameter and probability of positive NPV are provided in Table 8. Discount rate is the critical influencing factor which can be concluded by looking at its maximum influence on NPV, as in 56% projects (i.e. 17 out of 30 projects). This shows the importance of arriving at an accurate Discount Rate while doing financial feasibility studies for a PPP project by private investors. The percentage of each parameter in having the maximum influence on NPV is shown in Figure 5.

Below table also illustrated that by changing the standard deviation for project cost from 100% to 50% results in increased NPV at risk (see Figure 6).

TABLE 8 Output Data of 30 Projects

S. No.	Project Name	Static NPV (in crRs)	NPV-at-risk (in crRs)	Influencing Parameter	Probability of positive NPV
1	AP AdloorYellareddy to Gundla	-274.46	-423.80	Project Cost	0.0%
2	AP Hyderabad – Vijaywada	-1389.83	-2075.00	Project Cost	0.0%
3	AP Hyderabad - Yadgiri	1579.57	533.60	Discount Rate	100.0%
4	AP Katdal to Armoor	161.36	43.19	Discount Rate	98.5%
5	AP MH-AP Border-Islam Nagar	910.88	469.40	Growth in Traffic	100.0%
6	AP Vijayawada - Chilakaluripet	202.48	25.33	Project Cost	95.7%
7	GJ Vadodara to Bharuch	805.99	581.30	Discount Rate	100.0%
8	HR-Ambala-Chandigarh	81.18	-27.34	Discount Rate	88.9%
9	HR-PB-HP-Zirakpur-Parwanoo-	10.79	-94.30	Discount Rate	27.5%
10	HR-PB-Panipat-Jalandhar	159.86	-472.90	Toll Rate	64.6%
11	KT-AP border-Nandi	17.42	-90.31	Discount Rate	62.1%
12	KT-Banglore Elevated	623.49	349.50	Discount Rate	99.9%
13	KT-Banglore-Neelamangla	322.30	137.80	Discount Rate	99.8%
14	KT-Bijapur-Hungad	1021.97	165.80	Discount Rate	99.6%
15	KT-Hyderabad-Banglore	510.30	27.67	Growth in Traffic	97.0%
16	KT-Neamangla-Devihalli	65.77	-111.60	Discount Rate	55.9%

S. No.	Project Name	Static NPV (in crRs)	NPV-at-risk (in crRs)	Influencing Parameter	Probability of positive NPV
17	KT-Tumkur-Chitradurga	1543.61	426.80	Discount Rate	99.6%
18	MH-Kondhali- Talegaon	-136.07	-191.30	Project Cost	0.0%
19	MH-MP&Maharashtra Border	-158.52	-211.20	Project Cost	0.1%
20	MH-MP&Maharastra Border	3613.14	1014.00	Discount Rate	100.0%
21	MH-Nagpur- Kondhali	-135.95	-180.50	Project Cost	0.0%
22	MH-Pimpalgaon-Nashik-Gonde	-666.30	-1020.00	Project Cost	23.4%
23	MH-Pune Satara	7126.88	2349.00	Discount Rate	100.0%
24	MH-Pune Solapur (Package-I)	-816.03	-1136.00	Project Cost	0.0%
25	MH-Satara-Kagal	394.79	35.02	Discount Rate	96.2%
26	MH-Vadape-Gonde	1916.11	1225.00	Discount Rate	100.0%
27	PB-Kurali-Kiratpur	833.45	402.70	Discount Rate	100.0%
28	RJ Bharatpur-Mahua	673.10	392.10	Discount Rate	100.0%
29	RJ Jaipur-Gurgaon NH-8	2349.22	1493.00	Toll Rate	100.0%
30	WB Dhankuni-Kharagpur	68.75	-320.30	Toll Rate	53.7%

Above model is a stepping stone to develop a complete financial exposure assessment model and can be customized to include more data points such as Premiums, Government guarantees, Debt repayments etc. as per the project requirements. The results of this analysis can be used by the concessionaire/government to prioritize different risk parameters on the basis of their impact on NPV and accordingly can make the action plan to overcome/reduce the impacts.

To conclude, the Government should be liberal in terms of revisiting the contracts to ensure the risks faced by the concessionaire are properly accommodated and not entirely transferred to the general public in terms of higher tolls. Also, it's worth noting that revisiting contracts alone would not help in attaining successful PPP BOT road projects but an appropriate dispute resolution mechanism is equally important.

7. CONCLUSION

This paper contributes by applying a standard risk-analysis model (NPV-at-risk tool supported by Monte Carlo Simulation) for analysing financial risk involved in 30 real-world PPP based highway infrastructure projects. Structural changes in PPP models are required to incorporate risk and uncertainty within the project model to avoid huge losses. NPV-at-risk as discussed in this paper can be used to find the associated uncertainty and efficient risk analysis of PPP based BOT highway projects. Contingent plans can be made while making crucial investment decisions in the bidding phase by judging the profitability of a project. The private sector can use this model to make better go-no-go decisions for PPP highway projects by carefully considering the profits to concessionaire. Identification of high risk projects at a very early stage and monitoring their critical influencing parameters separately become possible due to this. It can also be used to examine the effects of different input parameters on final output and take appropriate measures to minimize the risk and maximize the profit. Thus, the model facilitates project appraisal for both private investors and public sectors. This paper discusses various risk mitigation approaches and its application across the world towards the end. Some parameters like construction period and concession period have been assumed to be certain, as this paper targets most uncertain parameters like project cost and traffic. Thus, further research can be done to incorporate more uncertainties by taking a lead from this study.

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