Assessment of Financial Risk Parameters Associated with Public-Private Partnership Port Projects in India

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Abstract –
In developing countries infrastructure investment is increased in last few decades. Public private partnership plays important role in low- and middle-income countries for providing finance. 95% of India international trade is transport through port sector. Hence it is big infrastructural project for India to connect with other countries. Public private partnership is new way for private investment in port infrastructure project. Central Ministries would oversee implementing the projects listed under the Sagarmala programme mostly in a private or PPP approach. In public private partnership model some issues may arise during whole life cycle of port project. Some of the problems include financial, legal, social, land acquisition as well as construction time delay. The aim of this paper is to investigate risk parameter associated with public private partnership project and further modelling the risk. Monte Carlo simulation is used in the Net Present Value (NPV) @RISK model to mitigate risk. Various risk parameter associated with port project are found out by previous literature survey. The two risks that have the most effects on public-private partnership projects are discount rate and capital cost. The application of this paper helps to identify which sources of risk affect more. The proposed model can be used as decision making for investment by private investors and gives profitability of the project. This will be more helpful for public authorities to identify parameter which have largest impact on investment. It helps to apply corresponding strategy to minimize the financial risk during preconstruction stage.

Keywords –
Financial risk, Monte Carlo simulation, Net Present Value (NPV), port infrastructure, public-private partnership.

1 Introduction

In both developed and developing countries, the financial crisis that began in 2008, brought new interest in Public-Private Partnerships (PPP). By 2047, the government wants to see India become a developed country. To achieve this, the economy will need to grow quickly, driven by strong exports, investments, and domestic demand. A strong increase in exports will be made possible through maritime trade and port facilities. Therefore, to make Indian ports and exports competitive on a global scale, the government must promote the construction of world-class port infrastructure in India. By realizing the full potential of India's coastline and waterways, the ambitious national effort Sagarmala hopes to significantly improve the performance of the logistics sector in that country.

The government faces many constraints on public resources and is therefore looking towards the private sector as a funding source [1]. The Government of India (GOI) took a step forward in the fiscal year 2019–20 by allocating 0.149 million USD in capital expenditure over five years (2020–25) under the National Infrastructure Pipeline (NIP) program. PPP in the infrastructure sector is a key tool for accelerating the development of India's infrastructure and closing the infrastructure development gap envisioned by NIP. In India, the shift toward PPP as a means of enhancing infrastructure and customer service levels started early and has advanced tremendously. The challenges need to be resolved and chance must be provided of learning for various nations hoping to use PPP in the port sector. India is one of the world's largest PPP markets, with over 1500 big national construction industry projects as of March 31, 2014, [7]. Examining PPP as a way of combining private sector innovation and technologies to improve operational effectiveness and provide better public services.

To reap the rewards of speed in project delivery and greater service standards, the performance of the public sector must be competent. Due to the nature of long-term PPP projects and the unpredictability surrounding

predicted future revenue flows, traffic projections, construction delays, and cost overruns, these projects often carry considerable financial risks [12].

This paper aims to investigate and assess the financial risk parameters associated with public-private partnership port projects in India using NPV @RISK decision tool. The objectives of this research are (i) to investigate risk factors associated with the PPP port project, (ii) to identify financial risk parameters associated with the PPP port project that affect the Net Present Value (NPV) of cash flow, (iii) to develop a risk assessment model using the NPV @RISK decision tool of the current case study in India, (iv) to analyse the results.

Using a real-world PPP port project as an example, this study examines the investment risk connected to a PPP port infrastructure project. It employs the Net Present Value (NPV) @RISK model, which generates a cumulative probability distribution curve for NPV by considering a few related parameters and appropriate distributions. The proposed model can be utilized as a decision-making tool by private investors during the planning stage to assess the feasibility of the project and make investment decisions.

2 Literature Review

Using the Scopus search engine, a thorough desktop search on financial risk assessment in the PPP was conducted. Scopus was chosen because it is often used by other studies in this field and because of other factors including its usability, breadth of coverage, potency, and accuracy of the search results. The study objectives and prior literature were carefully considered while choosing and finalising the Scopus search terms. Relevant keywords included phrases like crucial risk elements, risk identification, risk assessment, and risk allocation. The initial search using the above string yielded 22 papers. Some irrelevant papers still appeared in the search from other subject areas. Search results were further scrutinized by manually defining the source type of relevant papers in the search options to 'journal'. This reduced the number of papers to 3.

NPV @RISK is a tool used for analysing the financial feasibility of projects by considering the uncertainty associated with the project's cash flows. In the literature, several studies have used the different approach to assess the financial risk parameters associated with PPP projects in India. Kagne and Vyas (2020) created a financial risk model using NPV @RISK to investigate the major investment risk factors linked with the Build operate and Transfer (BOT) road project in India. Kumar et al., (2018) examined the investment risk related to road projects by defining variables like traffic volume and project costs and then analyzed the risk by examining actual PPP based projects in India. The authors used the NPV @RISK tool to develop model and performed Monte Carlo simulation.

Gad et al. (2022) classified economical risks like Financial Market Risk (FMR), Financial Operational Risk (FOR) and Financial Credit Risk (FCR). For example, the elements were discovered and found through interviews and surveys with professionals involved in construction industry projects. Modelling of financial risk is done using the Financial Risk Analysis Model (FRAM) model. Kara E. et al. (2021) used the Fuzzy Analytic Hierarchy Process (FAHP) method to assess and rank the risks associated with five construction machines utilized in port loading and unloading activities. Then, recommendations are made for each risk on preventative measures to lessen the listed risks and consequences. Ebrahim Jokar et al. (2021) used case studies of PPP-based freeway projects in Iran to identify the most significant hazards in these projects. The findings of a quantitative risk evaluation using the FAHP method revealed first-level risks in seven distinct groups, including risks to the economy and investment, risks to construction, risks to operations, risks to the law and politics, risks to other entities, and risks to the government.

Several researchers focus on risks in port projects. Xu et al. (2020) analyzed the possible issues associated with investing in port development projects in China and offered recommendations for risk assessment of such investments along with the features of investment risks associated with port construction projects. Joubert & Pretorius, (2020) described a method for identifying risks during the preconstruction phases of a port of shipment and associated container terminal, as well as a questionnaire of 215 potential issues and related risk breakdown structures (RBS).

Numerous studies have been conducted to help PPP projects succeed and get better, including those that take an individualistic approach and include future market conditions, inflation rates, and cost concerns. Only a limited number of research studies could be identified when looking specifically for risk in port projects. There is still a need for further investigation of the use of such models for actual public and private-based port construction work in the world.

3 Research methodology

The parameters related to the PPP port project and the many risk categories influencing it are initially identified in this article. Then, for each factor, a respective probability distribution is allotted to predict the parameter's real worth. The model was created using

NPV @RISK tool. The entire process utilized in this paper is summed up in Figure 1

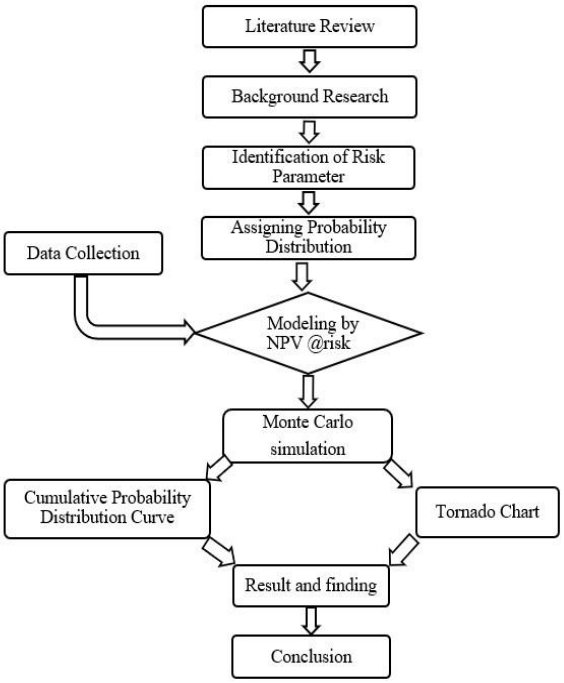


Figure 1. Flowchart of Research Methodology

3.1 Identification of financial risk parameters and probability distribution allocation

Given the complexity of the port construction project, several risk variables could affect it. These elements are interconnected in a complicated way, and the intensity of the effects they could have on the project is also varied. Making decisions about investments while totally ignoring these risk variables or only considering a small portion of them will result in poor choices. These include capital cost, concession period, construction period, discount rate, operating costs, and inflation rate.

3.1.1 Capital cost:

It is among the most significant expenses that the contractor must bear, thus it needs to be expected as accurately as possible while taking all potential unexpected circumstances into account. Since the concessionaire seeks to incur the least amount of expense possible, the largest likelihood happens at cheaper cost levels.

3.1.2 Concession period:

This is the time when the franchisee owns the port infrastructure and has the power to receive payments. It is the most important component of a PPP project because, if revenue is low, the concession period can be extended to allow the franchisee to cover all expenses, and a decision regarding the length of the concession period is made based on profitability.

3.1.3 Construction Period:

The construction stage is the time when the actual construction of the port is done. Throughout the construction phase, the concessionaire does not make any money. As a result, the franchisee strives to complete the project within the time frame specified to avoid funding issues.

3.1.4 Discount rate:

To calculate the present value of future cash flows, discounted cash flow analysis, uses an interest rate known as a discount rate. This aids in determining if the cash flows from a project or investment will be more valuable than the capital expenditure required to support it in the present. The discount rate must equal or be higher than the cost of capital, which is the lowest rate required to justify the expense of a new endeavor.

3.1.5 Operating cost:

90% of the running expenses incurred during construction are often administrative[9]. Utility and maintenance expenses, however, are predicted to be 20% or less after commissioning. Additionally, it is a very uncertain expense [9].

3.1.6 Inflation Rate:

A state of inflation is one in which there is a steady rise in the price of products over time. Because of this inflation, people's purchasing power may decline, which will have a negative impact on port. Every nation consistently tries with a variety of strategies to keep inflation within the established normal ranges. Variable inflation makes people's welfare unclear and lowers their purchasing power for goods and services.

3.2 Allocation of probability distribution

3.2.1 Normal probability distribution

It is possible to simulate a variety of events using the normal distribution, which is a flexible distribution. Financial risk characteristics, such concession period, interest rates, and inflation rates, behave similarly to natural phenomena.

3.2.2 Lognormal probability distribution

A few issues with normal distributions may be resolved by log-normal distributions. Log-normal distributions contain all positive variables, whereas normal distributions can also include negative random variables. The analysis of asset prices is one of the most typical uses of log-normal distributions in finance. A representation of a market's projected returns using a

normal distribution is possible. Even though, a log-normal distribution may be graphed for the market's price data. The compound return that the investment is likely to experience over time may thus be better determined using the log-normal distribution curve.

Table 1 shows the identified parameters with allocation of probability distributions.

Table 1. Allocation of the probability distribution

Sr. No.	Parameters	Probability distribution [Authors]
1	Capital cost	For capital cost the probability distribution consider as Lognormal [7], [12]
2	Concession period	Normal [8]
3	Construction period	Lognormal[10]
4	Discount rate	Normal [7], [12]
5	Operating costs	Lognormal [9]
6	Inflation rate	Normal [7], [12]

3.3 Data Collection

The Nhava Sheva International Container Terminal (NSICT) was India's first PPP port container terminal under Jawaharlal Nehru Port Trust (JNPT) and is still one of the country's most extensive ports. Based on the highest NPV of royalty given, a 30-year license for the port was granted in 1997. A total of 90 million USD was spent over two years to develop the terminal project. The financial data of NSICT is taken from GOI website [3], which is shown in Table 2.

Table 2. NSICT Financial Data

Parameter	Values
Concession period (in years)	30
Construction period (in years)	2
Capital cost (in million USD)	90
Operation and Maintenance cost	20% of revenue
Discount rate	7%
Inflation rate	5%

4 Development of model

Since the project involves working capital over a long period, the value of money over time is an important consideration in any investment. By creating a present value cumulative probability graph, the idea of NPV @RISK calculates the NPV generated from a single project within a certain confidence level. The uncertain parameters are then given the corresponding probability distribution along with their mean and standard deviation. The relationship between various parameters and how they affect net present worth is explored with net present worth selected as the appropriate risk output [7]

4.1 Cash flow for simulation

The costs include both the initial capital investment and the operating costs for the successive periods until the concession agreement expires. Revenue is calculated based on container traffic in Twenty feet Equivalent Unit (TEU) per year, tariff charge, and inflation rate and does not initiate until the construction period is complete [10]. The revenue is calculated as follows (see Equation (1)).

$$\text{Revenue} = (\text{Traffic in TEUs/year} \times \text{Tariff}) \quad (1)$$

Considering operation and maintenance cost 20% of the revenue for corresponding year [9]. All values are in Indian rupees. Then cash flow value for each year is calculated and then represented them in cash flow diagram which is shown in Figure 2. NPV of the cash flow diagram is calculated using following Equation (2) and its value is 22.98 million USD.

$$\text{NPV} = \sum_{t=1}^{n} \frac{CFt}{(1+i)t} \quad (2)$$

Table 3. Cash flow for simulation

Year	Cost	Revenue	Cash Flow	Present Value
1	45	0	-45	-42.056
2	45	0	-45	-39.304
3	0	12.906	10.325	8.428
4	0	30.314	24.251	18.501
5	0	41.178	32.942	23.487
6	0	52.398	41.918	27.932

7	0	53.682	42.945	26.744
8	0	53.765	43.012	25.033
9	0	49.784	39.827	21.663
10	0	44.979	35.983	18.292
11	0	55.050	44.040	20.923
12	0	52.096	41.676	18.505
13	0	59.826	47.860	19.860
14	0	61.993	49.594	19.233
15	0	58.712	46.969	17.024
16	0	43.729	34.983	11.850
17	0	40.602	32.482	10.283
18	0	48.592	38.873	11.501
19	0	57.169	45.735	12.646
20	0	60.027	48.022	12.409
21	0	63.028	50.423	12.177
22	0	66.180	52.944	11.950
23	0	69.489	55.591	11.726
24	0	72.963	58.371	11.507
25	0	76.612	61.289	11.292
26	0	80.442	64.354	11.081
27	0	84.464	67.571	10.874
28	0	88.688	70.950	10.671
29	0	93.122	74.4972	10.471
30	0	97.778	78.222	10.275
NPV= 22.98 million USD				

Table 3 shows the capital cost, revenues, and present value for each financial year for 30-year concession period.

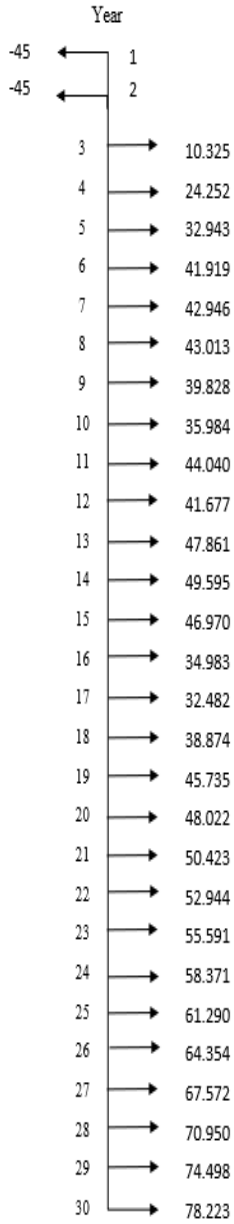


Figure 2. Cash flow diagram shows the net cash flow values of the project

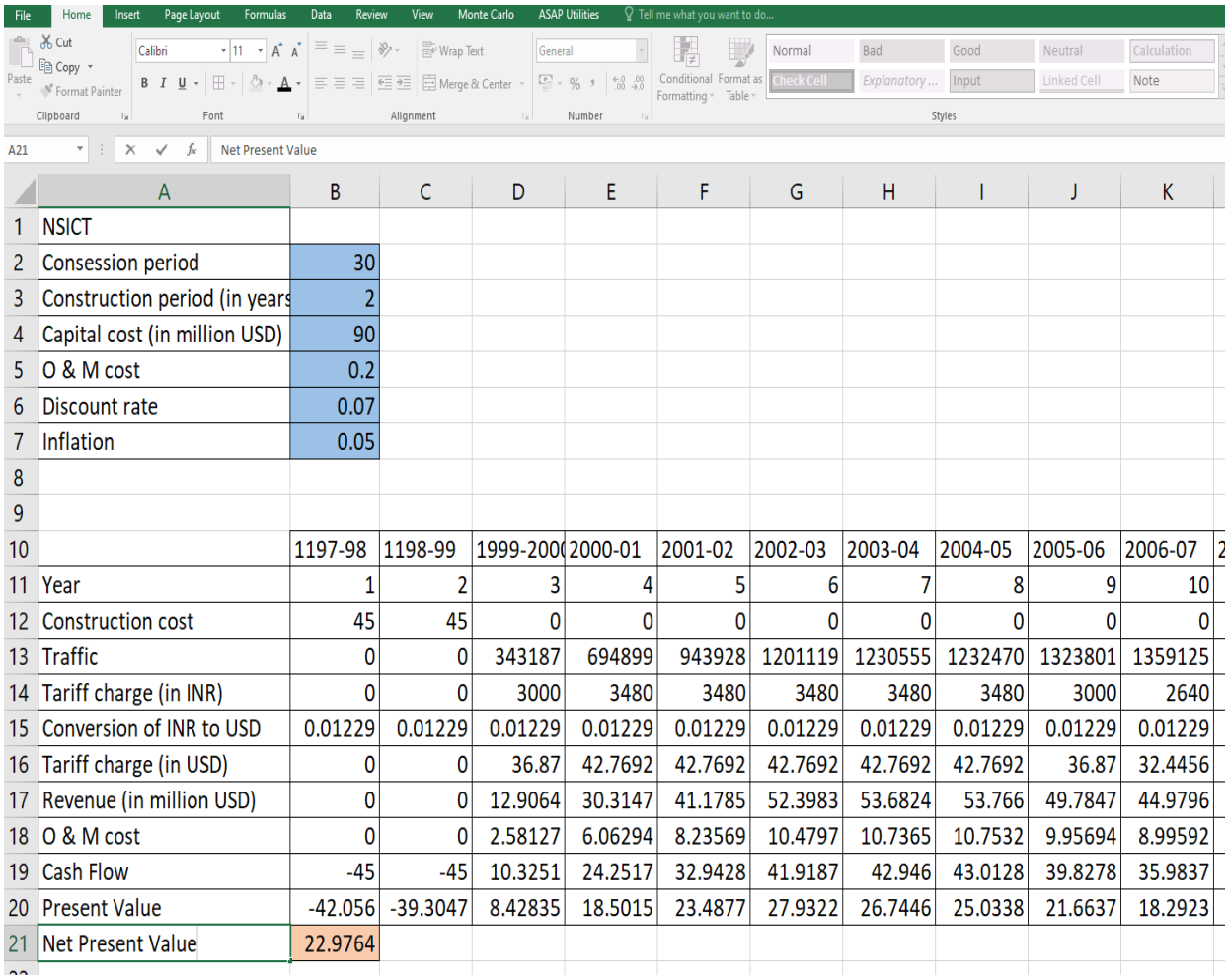
4.2 NPV @RISK decision tool

NPV is a financial statistic used to evaluate the present value of future cash flows, discounted at a specific rate. NPV @RISK decision tool which is excel add-in tool is used for risk analysis and making decisions in uncertain situations. The project inputs, such as the capital cost, concession period, construction period, operation and maintenance cost, discount rate, and inflation rate factors, must first be defined before using

@RISK for NPV analysis. After that, using @RISK to generate a probability distribution based on input data.

4.3 Monte Carlo simulation

The simulation of Monte Carlo is a computer-aided numerical approach for calculating risk in statistical analysis and decision-making, [4]. Monte Carlo simulation computes the outcomes using repeated random sampling and statistical analysis. The random experiments in which the precise outcome is not known beforehand, are very closely related to this simulation technique. Monte Carlo simulation can be seen as a methodical approach to performing a what-if analysis in this situation. Monte Carlo simulation of 5000 iterations is performed for NPV @RISK.



	A	B	C	D	E	F	G	H	I	J	K
1	NSICT										
2	Consession period	30									
3	Construction period (in years	2									
4	Capital cost (in million USD)	90									
5	O & M cost	0.2									
6	Discount rate	0.07									
7	Inflation	0.05									
8											
9											
10		1197-98	1198-99	1999-200	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
11	Year	1	2	3	4	5	6	7	8	9	10
12	Construction cost	45	45	0	0	0	0	0	0	0	0
13	Traffic	0	0	343187	694899	943928	1201119	1230555	1232470	1323801	1359125
14	Tariff charge (in INR)	0	0	3000	3480	3480	3480	3480	3480	3000	2640
15	Conversion of INR to USD	0.01229	0.01229	0.01229	0.01229	0.01229	0.01229	0.01229	0.01229	0.01229	0.01229
16	Tariff charge (in USD)	0	0	36.87	42.7692	42.7692	42.7692	42.7692	42.7692	36.87	32.4456
17	Revenue (in million USD)	0	0	12.9064	30.3147	41.1785	52.3983	53.6824	53.766	49.7847	44.9796
18	O & M cost	0	0	2.58127	6.06294	8.23569	10.4797	10.7365	10.7532	9.95694	8.99592
19	Cash Flow	-45	-45	10.3251	24.2517	32.9428	41.9187	42.946	43.0128	39.8278	35.9837
20	Present Value	-42.056	-39.3047	8.42835	18.5015	23.4877	27.9322	26.7446	25.0338	21.6637	18.2923
21	Net Present Value	22.9764									

Figure 3. Developed financial model

Figure 3 Shows the developed financial model in which firstly, input financial data is inserted (from Table 2) and then detailed cash flow is prepared for concession period i. e., for 30 year and shown here up to 10 years. Then NPV is calculated and then using NPV @RISK Monte Carlo simulation is performed.

5 Results and discussions

In the NPV @RISK tool, a financial risk model is created for the real port project NSICT at JNPT in India. The NPV for the project is 22.98 million USD, according to the model's calculations. Figure 4 shows the probability of having a positive net present worth is 55.4 %, which implies that this project could occasionally have a negative net present worth under extreme circumstances. As a result, for this project, the likelihood of success is 55.4 % and the likelihood of failure is 42.1 %. When compared to the other 6 elements affecting this project's NPV, the discount rate is the most significant risk parameter which is shown in Figure 5.

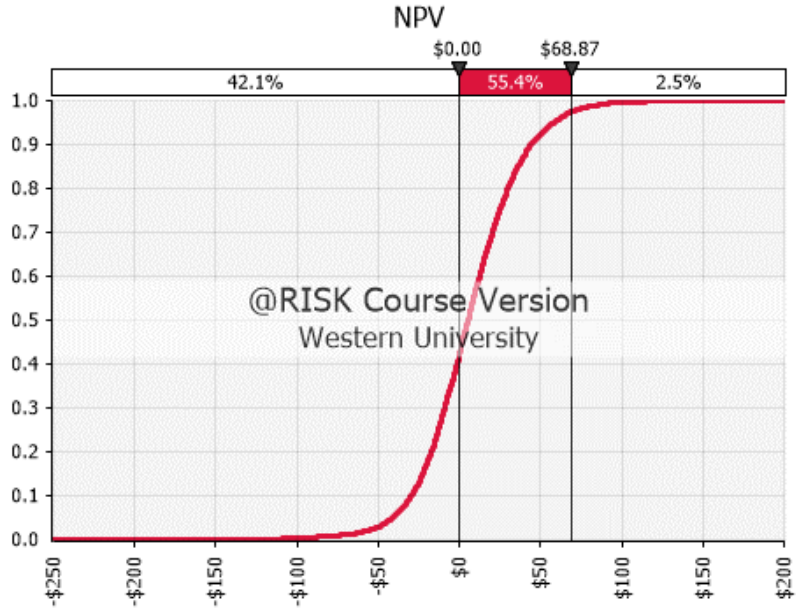


Figure 3 Cumulative probability of positive NPV

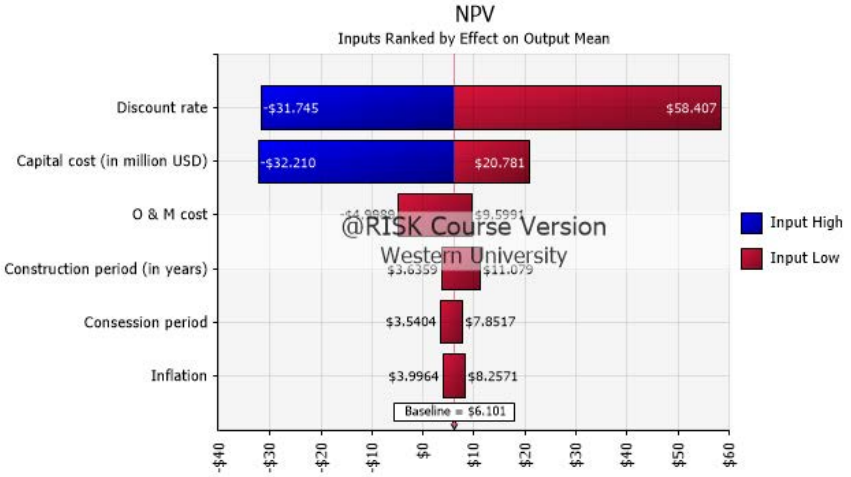


Figure 4 Tornado chart showing critical parameter

6 Conclusion

According to previous literature, several studies have already been done in PPP projects, regardless of the port sector project. The main contribution of this paper is the application of risk-analysis model for analyzing the investment risk associated with PPP-based port infrastructure projects. This will help to prevent the concessionaire from suffering significant losses and from having their money wasted. The PPP-based port projects can be effectively risk analyzed by using NPV @RISK, as detailed in this work, to identify the related uncertainty. Additional PPP port project financial data can be conducted to modify the financial evaluation. By carefully weighing the profits to the concessionaire, the port sector in the world can use NPV @RISK decision tool. NPV @RISK model is more accurate and take less time for simulation other than FRAM and FAHP. Therefore, by following the example set by this study, more case studies and parameters can modify the results obtained which will reduce financial risk .

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