Risk Analysis for a BOT Project

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ABSTRACT

There are several risks in a BOT project. Major critical risks are total project cost and revenue/tollable traffic. This paper presents a sensitivity analysis for a BOT project with a real case study varying equity from 10% to 90%.Traffic and cost are varied ± 20% and financial analysis is carried out with spread sheet, and test results are prepared in graphical forms and presented. Total Project Cost (TPC), Net Present Value (NPV) and Financial Internal Rate of Return (FIRR) are plotted with various percentages of equity. Linear and non-linear graphs are found. FIRR decreases with increasing TPC/Equity, and probability of project risk increases with increasing percentage of equity up to 30 % and decreases beyond this value.

KEYWORDS: Risk analysis, BOT projects.

INTRODUCTION

The global trend toward greater utilization of private capital for infrastructure development shows no sign of abating. In the United States, twenty states have enabled legislation that permits some form of public-private initiatives for transportation projects (Reinhardt, 2004). Internationally, the Private Finance Initiative (PFI) in the United Kingdom is well known, and the use of private capital for infrastructure projects has become ordinary within emerging economies where financially challenged public administrations look toward the private sector to develop basic infrastructure (Esty, 2003).

Private investment in public infrastructure occurs within the Build-Operate-Transfer (BOT) model, where a public entity, the government, and a private entity, the sponsor, enter into an agreement according to which the sponsor is bound to design, build, finance and operate

an infrastructure project on behalf of the government for a predetermined period of time, the concession period. At the end of the concession period, the sponsor transfers its ownership rights back to the government.

Typically, the sponsor finances the BOT investment through project finance rather than corporate loans (Yescombe, 2003); this introduces another active party, the lender. Thus, the BOT model becomes a trilateral negotiation game with complex interrelationships.

The critical success factor for a BOT project is the efficient and effective allocation of project risks and returns among the government, the sponsor and the lender. The next section presents a review of the available literature.

LITERATURE REVIEW

During its life cycle, a BOT project is exposed to various risks that, if not mitigated, may financially distress sponsors and lenders (Yescombe, 2003; Dailami et al., 1999). Therefore, before entering into contractual arrangements, sponsors and lenders appraise the risks

involved in the project very carefully (Hoffman, 2001). If they are not comfortable with the level of such risks and there are no available alternatives to mitigate them, they will likely withdraw from the project. In other words, sponsors and lenders finalize the BOT project "only if " the mitigation of the project's risks improves the likelihood that their investment will be profitable. Thus, risk management and risk mitigation play a central role in the successful realization of BOT infrastructure projects.

Governments may enhance the "marketability" of BOT infrastructure projects by offering financial support packages to private sector investors (i.e. sponsors). These supports have often a dual effect. While they augment the investment rate of return of the sponsors, they may also improve the credit worthiness of the project which ,in turn, permits sponsors to negotiate more competitive interest rates with lenders. Irwin (2003) describes fiscal instruments that governments may provide to sponsors:

a. Output-based cash subsidies (i.e., cash subsidies tied to the provision of certain services);

b. In-kind grants (e.g., land grant, right-a-way grant,… etc.);

c. Tax breaks (e.g., reduced taxes , "tax holiday",… etc.);

d. Capital contributions (e.g., public authority participates in the BOT equity investment,… etc.);

e. Guarantee of risks under government's control (e.g. political risk, regulatory risk guarantees,… etc.);

f. Guarantee of risks not under governmental control (e.g. natural disaster risk, revenue risk,… etc.).

One of the more significant risks of a BOT project is the revenue risk. The revenue risk is the adverse possibility that the project cash flows may not be sufficient to cover the project costs, to service the debt and to generate the sponsor's expected investment rate of return. Dailami et al. (1999) differentiate the revenue risk into two sub-categories:

a. Operating cash-flow risk or equity cash flow risk, the risk that may negatively affect the sponsor's investment rate of return;

b. Counter party risk, the risk that may negatively affect the sponsor's ability to service the debt.

In general, a successful mitigation of the equity cash-flow risk entails the mitigation of the counter party risk as well. The latter mitigation occurs because of the "cash-flow waterfall system" employed in the BOT project finance structure, in which debt service payments are due before the sponsor's equity cash flows are paid.

An essential part of the agreement between the government and the private contractor is the allocation of risk between the parties: that is, when an event occurs that influences the cost or quality of the contracted service, which party must pay to rectify the situation or, alternatively, which party should gain the resulting benefits (Arndt, 1999)? Compared with conventional delivery methods, there is a higher risk exposure for the BOT sponsor because of the following:

- High front-end development costs,
- Extensive and lengthy negotiations with the host government,
- Multiparty involvement,
- Long-term commitment and
- Equity contribution from the sponsor.

The high-risk exposure associated with BOT projects means that special attention must be paid to analyzing and managing risks (Chee and Yeo, 1995). Risk in a construction project, however, cannot be eliminated, but it can be minimized or transferred from one party to another (Kangari, 1995). BOT infrastructure projects carry higher-than-traditional levels of risk as they typically involve high capital outlays, long lead times and long-lived assets with little value in alternative use. The identification, analysis and allocation of various types of risks are an important aspect for the validation of privately promoted infrastructure projects (Dias and Ioannou, 1995). On the other hand, determining the relative importance of these types of risks is very essential for BOT management decision makers. The decision makers of construction companies should evaluate and rank BOT projects with respect to their risk. Therefore, there is an essential need

for a tool that uses a risk index (F) to evaluate the pending BOT projects. This paper presents the results of a study that aims at developing a prototype model for evaluating BOT risk. This model provides the risk evaluation and risk index (F) determination. This procedure was accomplished through the following case studies of BOT projects: Plymouth County, Wyatt Detention Facility, State Route 91, Dulles Green Way,

Wijker Tunnel and Indian Power Plant.

Chart 1 shows the BOT main risk areas that can be encountered in construction projects. Each main area consists of several attributes that build the identity of this area. Both BOT risk areas and attributes have been categorized and defined in this study phase (Zayed and Chang, 2002).
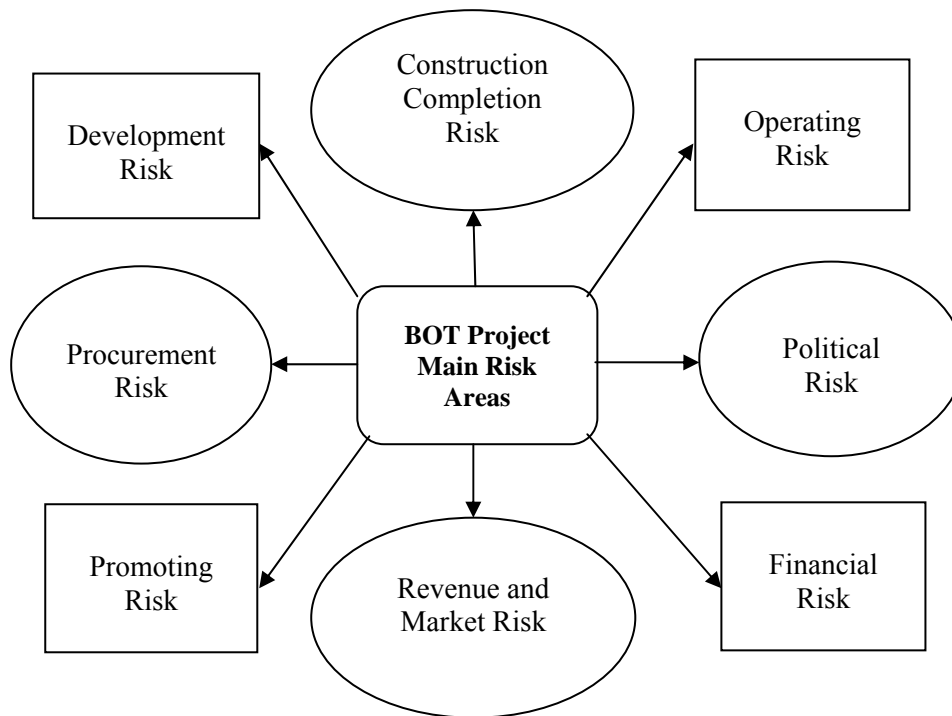
Chart 1: Build operate transfer (BOT) projects main risk areas

There are many risk definitions in construction. Jaafari (1990) defined risk as the presence of potential or actual constraints that could stand in the way of project performance, causing partial or complete failure either during construction and commissioning or at the time of use. Risk is the exposure to the chance of occurrence of events adversely or favorably affecting project objectives as a consequence of uncertainty (Al-Bahar, 1990). Then, risk is the uncertainty of an event, potential loss/gain from an event. Dias and Ioannou

(1995) concluded that there are two types of risk. Pure risk exists when there is a possibility of financial loss but no possibility of financial gain, for example, physical damages; and speculative risk involves the possibility of both gain and loss, that is, financial risk and production risk.

Dias and Ioannou (1995) emphasized that project financing requires the identification and analysis of risk areas during different phases of the project using different parameters. Several writers have proposed

classification and definition of risk in project financing, concluding that the allocation of risks to the parties in BOT projects is the key ingredient for successful project-financing undertakings. They classified risks according to the following BOT project phases:

- Development phase -technology, credit and bid risks;
- Construction phase -completion, cost overrun, performance and political risks;
- Operating phase -performance, cost overrun, liability, equity resale and off-take risks;
- Ongoing risks -interest rate and currency risks.

The identification of possible sources of risk is an essential area in the risk management process because it allows project parties to recognize the existence of uncertainty in the project and hence to analyze its potential impact and to consider an appropriate strategy to mitigate its effect on the project. Dias and Ioannou (1995) have classified sources of risk in the following 10 categories: country political and regulatory, force majeure, physical, financial, revenue, promoting, procurement, developmental, construction and operating risks.

Traffic/Revenue Forecast

In transportation BOT projects, the revenue risk is tightly related to the traffic risk, which is the risk that the actual traffic volume may be lower than the projected value considered in the financial base-case analysis. One possibility for mitigating the transportation revenue risk is for a government to guarantee a specific level of revenue for the sponsor during a project's operation period. Hence, if the actual revenue generated by the project falls below the guaranteed amount, then the government will finance the difference. This type of government guarantee has been employed successfully in Asia, Europe and South America (Wibowo, 2005; Vassallo and Soliňo, 2006).

Cost Estimate Variations

The basic cost components of a BOT project are construction and maintenance-operating costs. One of the causes of construction cost estimate variations is an unpredictable situation during the construction of a BOT project. Sometimes, it can be caused by natural disasters such as floods, storms,… etc. Cost estimate variations can also be caused by mistakes such as not properly investigating construction requirements of the BOT project. Furthermore, poor advanced construction planning highly affects cost estimate variations. In addition, uncertainty of cost estimate can be caused by other events that are difficult to control; for example, political turmoil, labor strike and delay in land delivery by the host government (Chang, 1992). For the maintenance-operating cost variation, its unexpected increase can be caused from damages of structure or equipment, from some kind of natural disaster or from increasing the cost of faulty, poorly installed or manufactured equipment. When the construction and maintenance-operating costs exceed original estimates, this leads to cost overrun risk. The results of inaccurate cost estimates definitely lead to an improper assessment of the BOT project.

MAJOR FINDINGS

Following major conclusions can be drawn from the literature review:

- BOT project consists of several numbers of risks.
- The government of a country transfers risk to the concessionaire.
- Major risks are country political and regulatory, force majeure, physical, financial, revenue, promoting, procurement, developmental, construction and operating risks.

OBJECTIVE AND SCOPE OF WORK

The future of a BOT project is uncertain. The concessionaire may like to know what will happen to the viability of a project when some variables like construction cost or revenue deviate from their expected values. In other words, the concessionaire may want to conduct "what if" analysis or sensitivity analysis.

These two variables; construction cost and revenue,

vary from 0 to ± 20% of the base value determined during the preparation of the detailed project report/feasibility study report representing the values of financial parameters.

Based on major research works carried out a by researchers, the objective of the present work is to carry out sensitivity analysis to determine the range of various financial parameters like NPV, FIRR and TPC of a BOT project.

CASE STUDY

Traffic

A case study has been conducted. The traffic study has been carried out in December 1999 on a selected section of the existing two lanes of NH 4, and growth factors of traffic have been established.

The growth rate has been determined based on the following methods:
- Past trend analysis;
- Net state domestic product and *per capita* income;
- Previous studies.

Considering all the above-mentioned methods, suitable growth factors are established for projected traffic. Opening year traffic (Tollable) is shown in Table 1.

Table 1. Base year traffic

Vehicle Type	Number of Vehicles
Car	6432
Bus	1734
Light Commercial Vehicle	1161
2-Axle Vehicle	1148
3-Axle Vehicle	579
Multi-Axle Vehicle	2158

Induced and Generated Traffic

After the improvement of the existing facility, traffic of other roads may be attracted to improved roads for better road geometry, riding quality, less travel time, shorter distance… etc. Existing traffic may be capable to generate more trip due to less travel time/increasing travel speed for the upgrading of the road. This traffic is assumed to be 5% of the traffic at the time of opening.

Year 2004 is the year of opening. Traffic is obtained by multiplying the projected 2004 traffic by 1.05, and the numbers of vehicles according to vehicle type are shown in Table 1. Tollable traffic is determined based on growth rate factor 0.05 for all vehicles as mentioned in MCA Guide line.

Toll Rate

Toll rate has been selected using guidelines prepared by the Government of India. Inflation rate has been determined based on the Reserve Bank of India Bulletin (2000). Whole Price Index (WPI) for all commodities had an average value of 8.3 %.

Using this value, the future toll rate has been projected. Toll rates for the opening year, 2004, and for the year 1997 are mentioned in Table 2. Toll rate increasing factor for the year 2004 is $1.083^7 = 1.74$.

Project Cost

The project road is 15.1 km long. The project cost was worked out and found to be 50 million Rs per km (2000 costing) as base cost. Total Project Cost (TPC) was calculated as follows:

TPC=Base cost + Interest of debt during construction + Inflation during construction period… (1)

TPC has been calculated varying the equity from 10% to 90 % and varying the base cost by ± 20%. TPC for various cases is shown in Fig. 1.

Concession Period

Concession period is taken 25 years.

Financial Analysis

Financial analysis has been carried out taking the following major cost components into account:
- Project Cost (50 million Rs per km);
- Annual Routine Maintenance Cost (repair of pot hole, clearing C D structure,… etc) (0.21 million Rs per km);

- Periodic Maintenance Cost (thin overlay every 3 to 5 years) (2.85 million Rs per km);

- Toll Operation Cost (toll administrative cost) (6.1 million Rs for toll plaza).

Table 2. Toll rate /km vehicle-wise

Year	Car	Full Bus	Multi-Axle	LCV	2A-,3A-Truck
Toll Rate Rs (1997)	0.40	1.40	3.00	0.70	1.40
Toll Rate Rs (2004)*	0.69	2.40	5.20	1.20	240

Note: Toll rate for the year 2004 is obtained by multiplying the toll rate for the year 1997 by 1.74

RISK ANALYSIS

The variation of base cost and base traffic for the sensitivity analysis is shown in Table (3).

Table 3. Variation of Base Cost and Traffic for Sensitivity Analysis

Base Cost	Increase by 20%	Decrease by 20%
Base Traffic	Increase by 20%	Decrease by 20%

Financial analysis has been carried out considering various combinations of cost and traffic. Final results are shown in graphical forms (See Figs. 1-11).

Results of Financial Analysis

Total transportation cost is shown in Fig 1. From Fig. 1, it is found that TPC increases with decreasing the percentage of equity. This is due to adding interest of debt in TPC.TPC varies linearly with a negative slope.
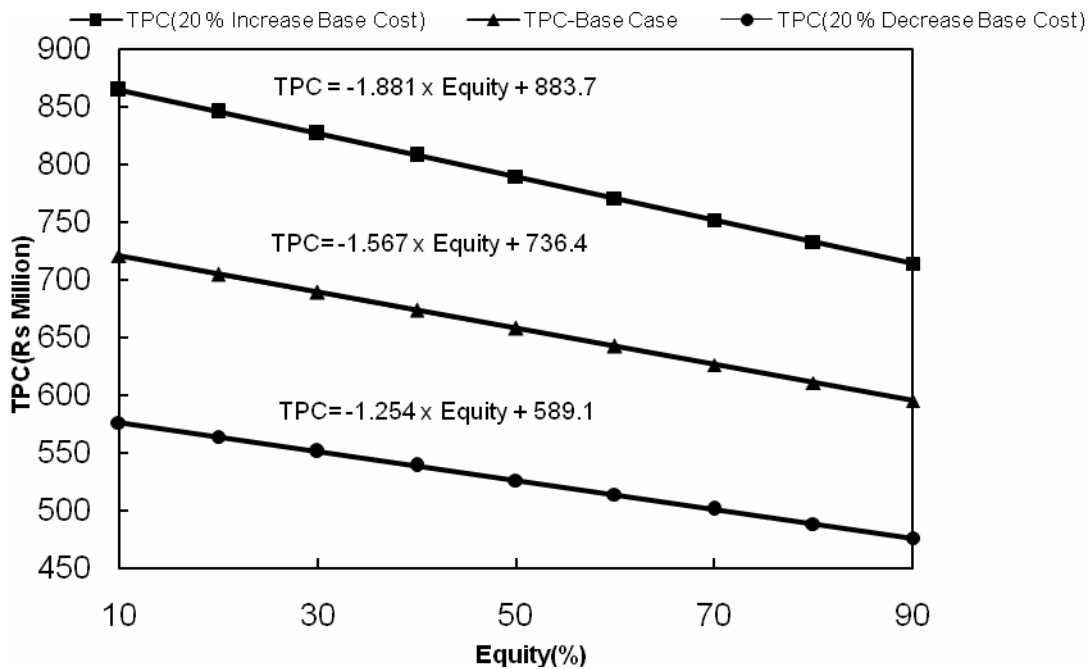
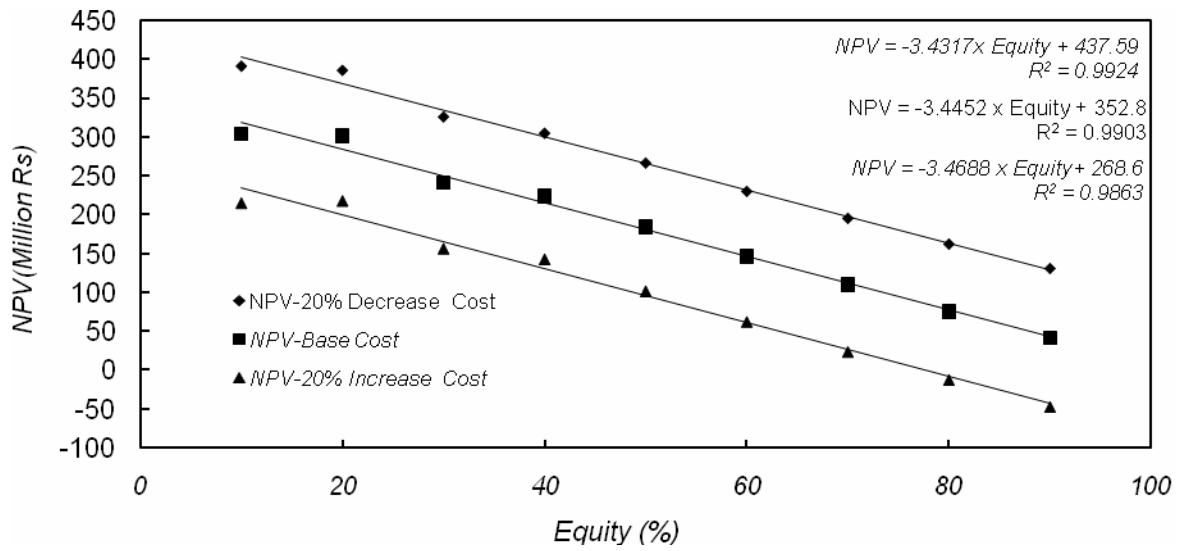**Figure 1: Variation of TPC for various cases with different percentages of equity**

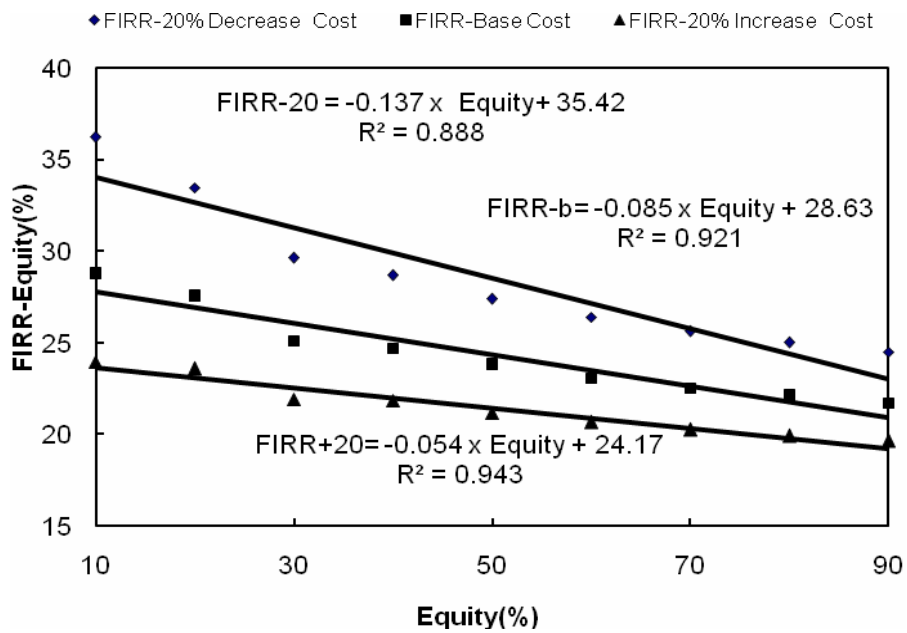**Figure 2: Variation of NPV with equity for base traffic**

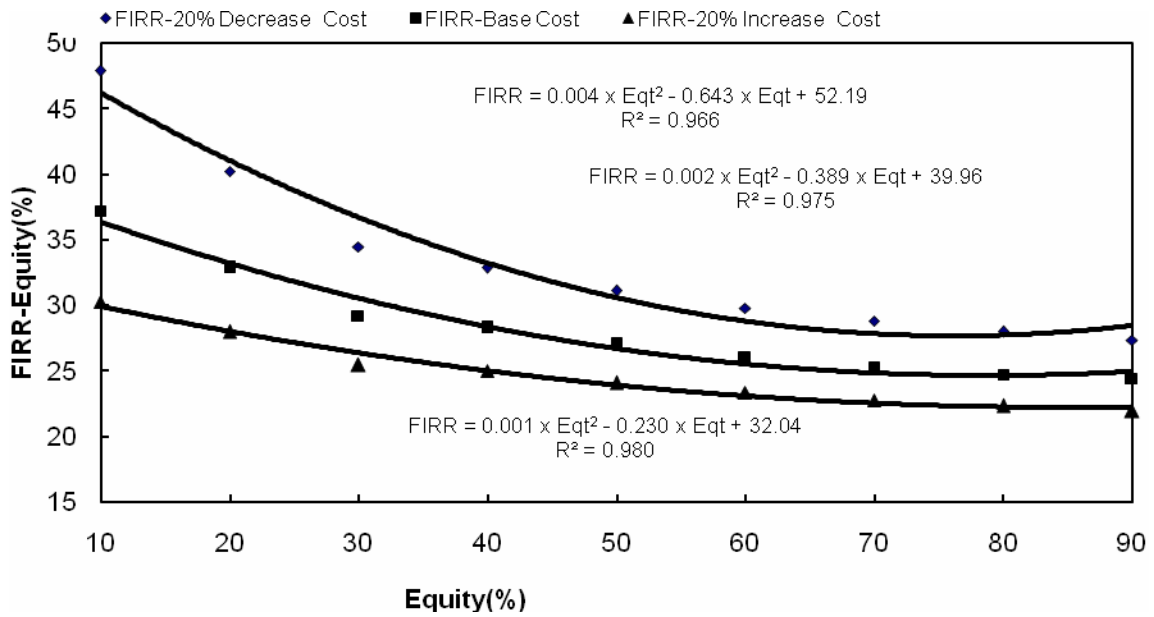**Figure 3: Variation of FIRR with equity for base traffic**

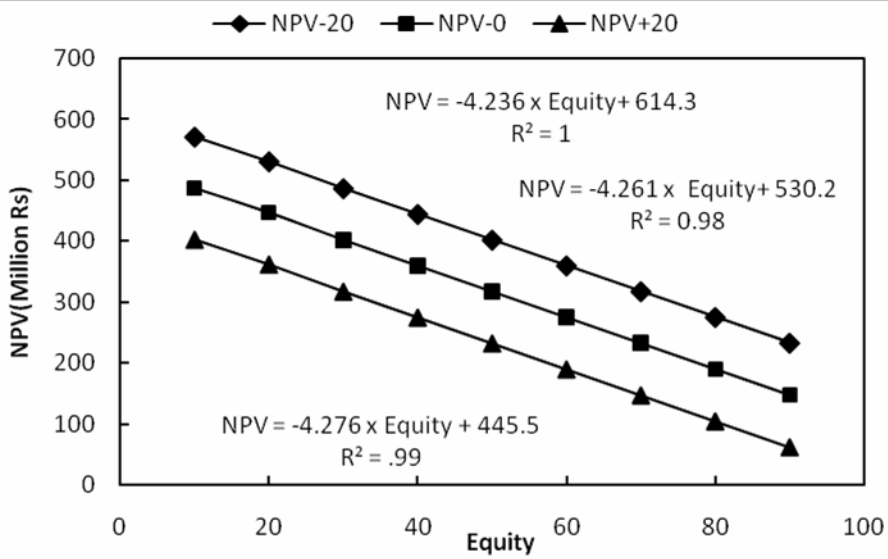**Figure 4: Variation of FIRR with 20 % increase of base traffic**

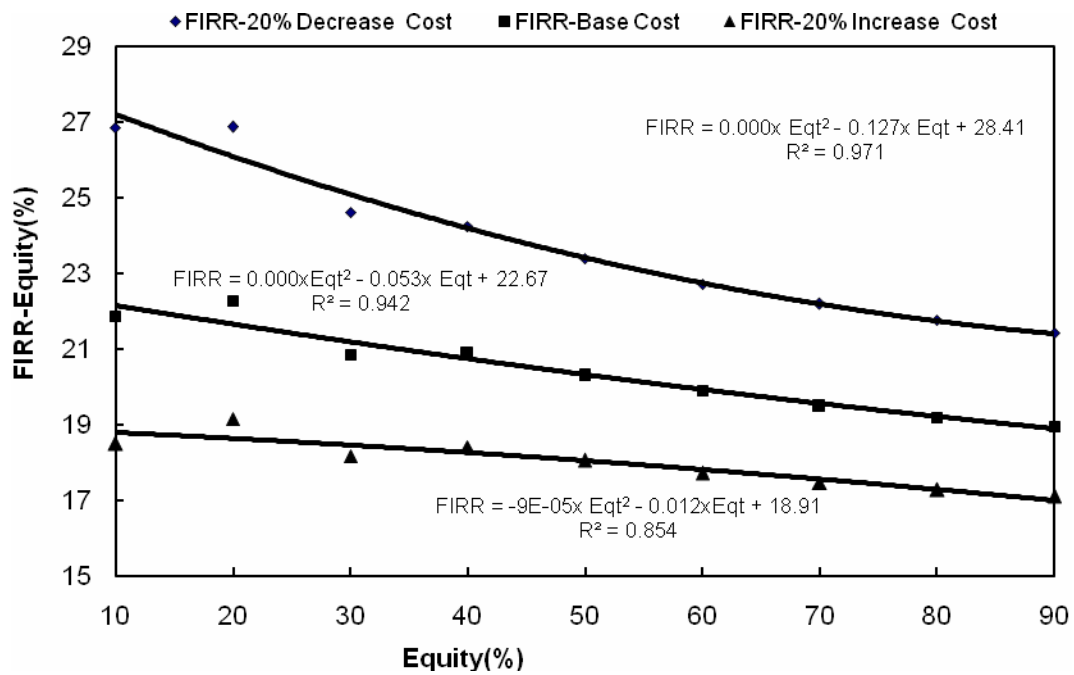**Figure 5: Variation of NPV with 20% increase of base traffic**

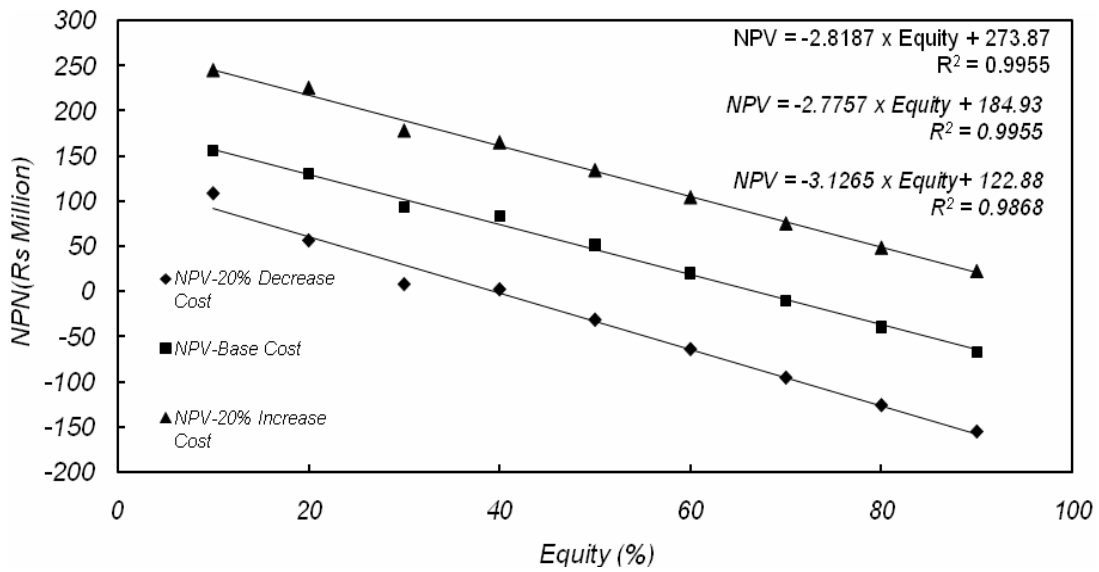**Figure 6: Variation of FIRR with 20% decrease of base traffic**

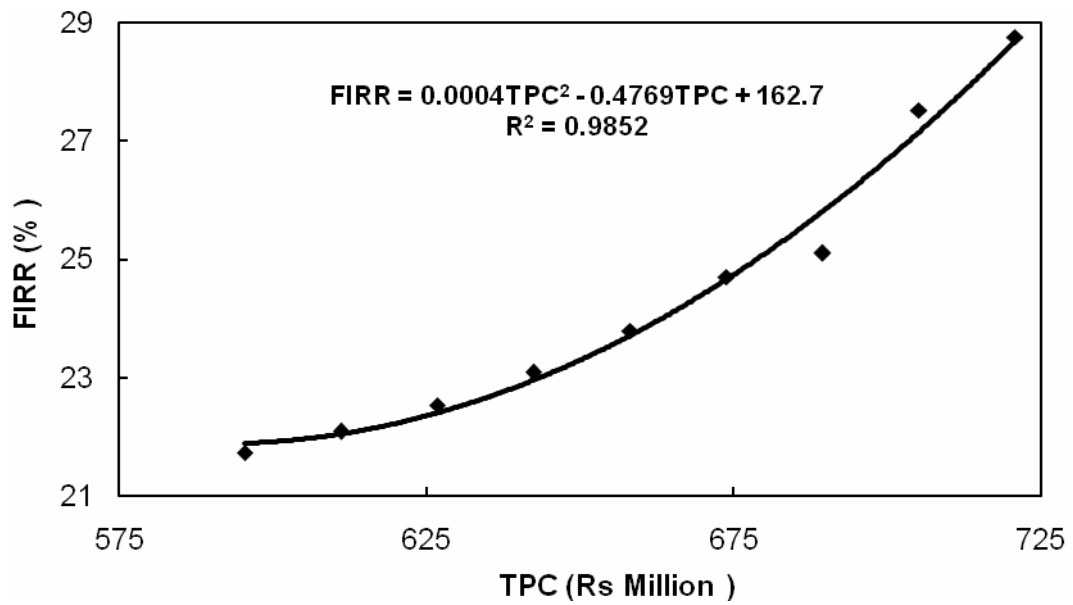**Figure 7: Variation of NPV with 20% decrease of base traffic**

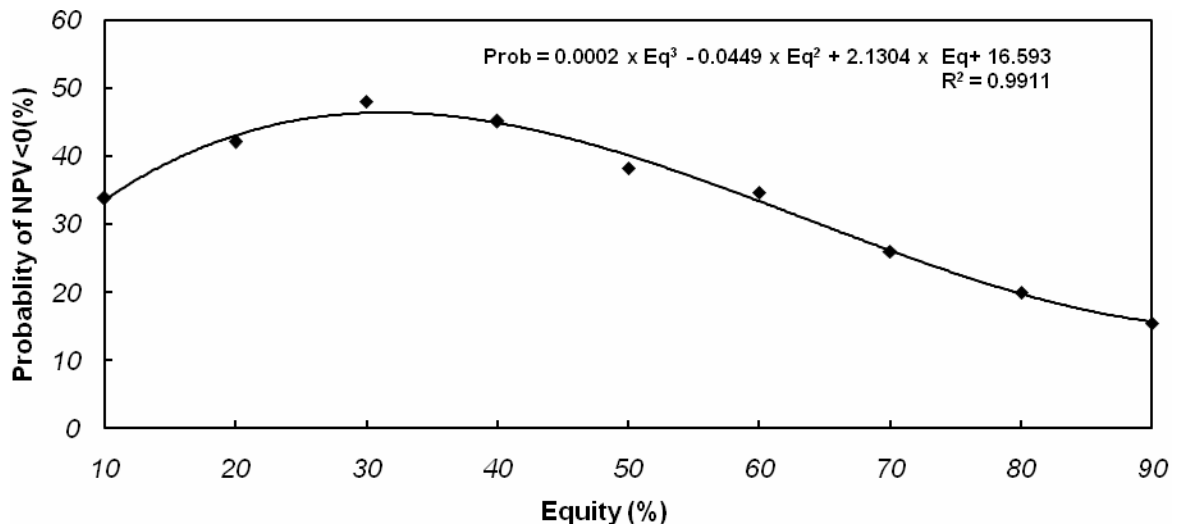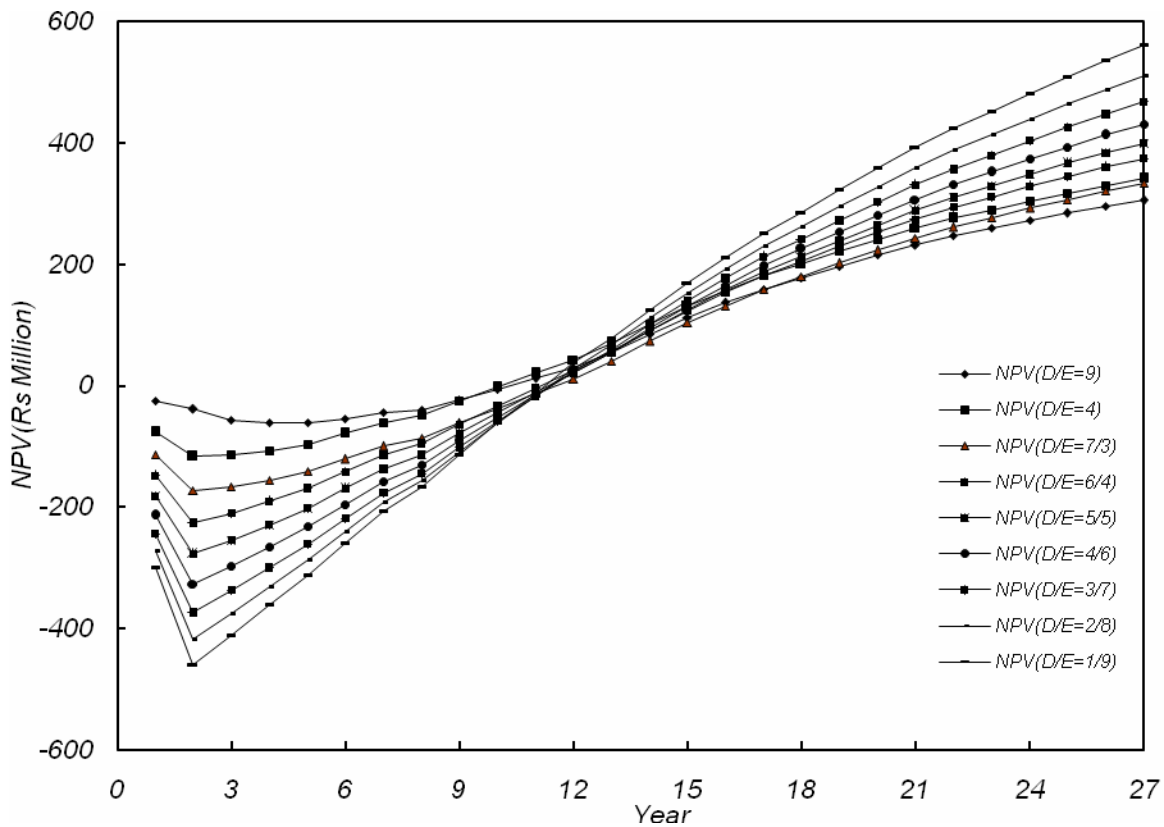**Figure 8: Variation of FIRR and TPC for base case**

Figure 9: Probability of NPV< 0 for base cost and base traffic

**Figure 10: Variation of NPV (equity) for various debt equity ratios for base cost and 20%
increase of base traffic**

NPV and FIRR for various percentages of equity for base traffic with varying cost of the project are shown in Fig. 2 and Fig. 3, respectively. NPV and FIRR vary linearly with positive and negative slopes, respectively, for the case of base traffic.

FIRR and NPV for various percentages of equity for a 20% increase of base traffic with varying equity percentages are shown in Fig. 4 and Fig. 5, respectively. FIRR varies non-linearly (second degree equation) with a negative slope and NPV varies linearly with a positive slope.

FIRR and NPV for various percentages of equity for a 20% decrease of base traffic with varying equity percentages are shown in Fig. 6 and Fig. 7, respectively. FIRR varies non-linearly (second degree equation) with a negative slope and NPV varies linearly with a positive

slope.

Fig. 8 shows the variation of FIRR and TPC for the base case. FIRR varies non-linearly (second degree equation) with a positive slope. FIRR increases with increasing TPC.

Fig. 9 shows the probability of NPV < 0 for base cost and base traffic. It is found from this figure that the probability of NPV <0 increases with increasing the percentage of equity up to 30%, and beyond 30% of equity the probability of NPV <0 decreases. Maximum risk is found at 30% equity.

Fig. 10 shows the variation of NPV of equity during the operation period for various debt equity ratios. NPV is lower at higher debt equity ratios for the base case.

Fig. 11 shows the variation of FIRR (equity) for various debt equity ratios for the base case. From this
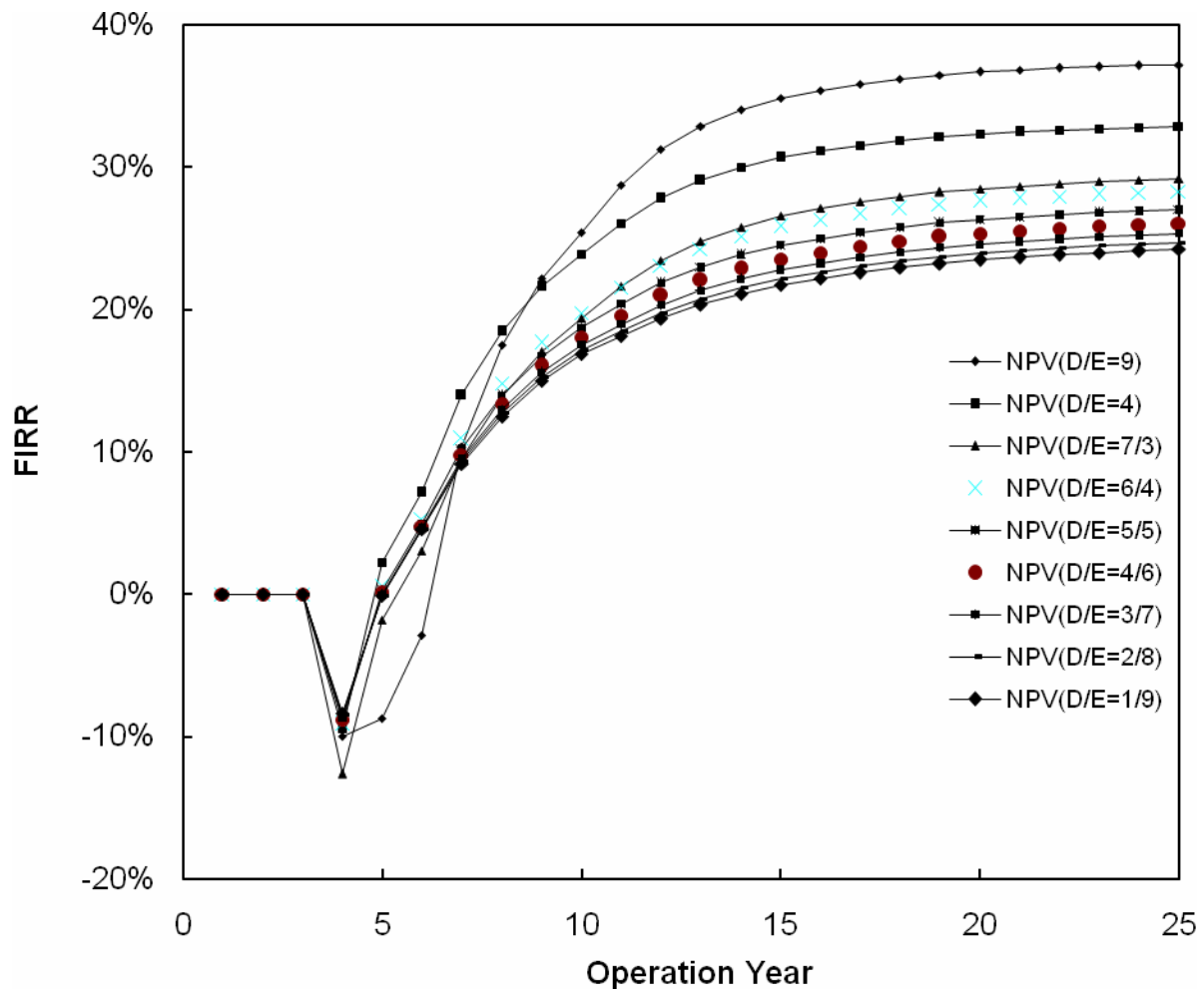
Figure 11: Variation of FIRR (equity) for different concession periods and various debt equity ratios for base cost and 20% increase of base traffic

figure, it is found that FIRR is highest at highest debt equity ratio.

Similar figures can be drawn for NPV and FIRR varying project cost and traffic for sensitivity analysis.

CONCLUSIONS

Sensitivity analysis may be carried out to determine the uncertainty of a project. Similar graphs/figures may be developed to study various financial parameters like financial internal rate of return (FIRR) and net present value (NPV) and measure the risk of the project. The following conclusions may be drawn from the present study.

- Total project cost, financial internal rate of return and net present value vary linearly with a negative slope for the base case.
- FIRR varies non-linearly (second degree equation) with a negative slope, and NPV varies linearly with a negative slope for the case of 20% increase of base traffic as well as for the case of 20% decrease of base traffic.
- FIRR increases with increasing total project cost (TPC) forn the base case.

- Probability of NPV <0 increases with increasing the percentage of equity up to 30%, and beyond 30% of equity the probability of NPV<0 decreases. Maximum risk is found at 30% equity.

- NPV is lower at higher debt equity ratios for the base case.
- FIRR is highest at highest debt equity ratios for the base case.

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