# Study of Road Infrastructure Cost & Revenue Period with Case Study of Six Lane Project of NH48

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*Abstract-* **The toll road system has been historically accounted for the bulk of the financing of highway network. By building a toll roadway, it is possible to provide a number of improved services to the road users, which can be measured in order to ensure that they deliver the outcomes that are envisaged. In toll road sector, the major stakeholders, typically the Government and the contractors are responsible for development of the toll project and delivering operational services, using associated technologies, thereby fulfilling the primary objective of creating a toll way, being the customers' satisfaction. In this paper, the primary data collection methodologies broadly include toll traffic studies, structured observation study and a survey using a structured questionnaire. At the outset, traffic studies across various toll plaza sites were conducted in order to capture a variety of vehicles using toll ways and determine toll revenue thereof. The observation of study involved a field visit at the toll plazas with an observation sheet with clearly defined format for capturing various aspects or elements of the toll operational zone and that of road corridors. Finally paper conclude with the revenue period for the selected case study.**

**Index Terms- Road infrastructure cost, Cost increment due to delay in construction, Revenue period, Toll Rates**

## I. INTRODUCTION

In early history, human compassion has exposed an urge for mobility leading to a measure of society's progress. For any country to develop with right momentum modern and proficient transport is a must. It is an essential convenience with which people not just connect but progress. Throughout history, people's progress has been persistent on the convenience, speed and safety of the modes of transport.

In the 1830's the East India Company started a programmed of metalled road construction, for both commercial and administrative purposes. The Grand trunk road, from Calcutta, through Delhi to Peshawar was rebuilt at a cost of £1000 / mile, roads from Bombay to Pune Camp, Bombay to Agra, and Bombay to Madras, were constructed, and a Public Works Department, and the Indian Institute of Technology Roorkee founded, to train and employ local surveyors, engineers, and overseers, to perform the work, and maintain the roads. The programme resulted in an estimated 2,500 km (1,600 miles) of metalled roads being constructed by the 1850s.

Important road project is the 7,142 km long 4/6 laned North–South and East– West Corridor comprising national highways connecting four extreme points of the country. The North–South and East–West Corridor connects Srinagar in the north to Kanyakumari in the south, including spur from Salem to Kanyakumari (via Coimbatore and Kochi) and Silchar in the east to Porbandar in the west. As of May 2017, under NHDP about 28,915 kilometers of 4/6 lane highways has been constructed, while a total of 48,793 km of road has been planned to be 4/6 lane under the NHDP.

1.1 Role of Transport:

Growth of any nation or region mainly depends upon mode transportation facility available. Following are the main roles of transport:-

- Transport contributes in Growth of industries whose product requires quick marketing.
- Transport helps to increase the demand for goods.
- Transport creates place utility. Transport bridges the gap between production and consumption centers.
- It has been made possible by virtue of the improvements in the speed of transport & helps the product to be distributed in the minimum possible time.
- Transport helps in stabilization of price.

- Transport ensures even flow of commodities into the hands of the consumers throughout the period of consumption.
- Transport enables the consumers to enjoy the benefits of goods not produced locally. Such factor consider for further development of marketing and economy.
- Transport identifies competition, which in turn, reduces price due to large-scale production & it is possible only due to transport.
- Transport increases mobility of labor and capital.

1.1 Status of National Highways

| Sr.No. | Roads/ Ways | Length(km) |
|--------|-------------|------------|
| 1 | Expressways | 200 |
| 2 | National Highways | 66,590 |
| 3 | State Highways | 1,31,899 |
| 4 | Major District Roads | 4,67,763 |
| 5 | Rural & Other Roads | 26,50,000 |

1.2 Toll collection strategies:

The choice of toll collection method should be based on the operational requirements of the individual toll project, recognizing the need for interoperability with other systems around the State.

- Manual
- Automatic
- Electronic

## 2. LITERATURE REVIEW

In this chapter, the researcher has reviewed related literature concerned with expressways. In related literature, researcher has discussed the views of various authors.

2.1 Qamar (2010) Study on Private Investment:-

In order to bring private investment into the road sector, the Ministry of Road Transport and Highways (MoRTH) aims to award over 85 % of National highways and expressways projects on a Built Operate Transfer (BOT) toll basis. While this will result in a large number of toll booths on the Indian road network, the road user would prefer to travel seamlessly across toll roads. An appropriate combination of technology and operational procedures is required to meet all the functional requirements of tolling and deliver a satisfactory user experience.

2.2 Chandrasekhar, (2010):-

The National Highway fee rules, 2008 prescribed the stretches on which user fee is collected, the capping rates per km for different types of vehicles, the mechanism to compute toll rates for BOT projects, concession to be given to local and frequent users, revision of rates, etc.

2.3 Case Study of Mumbai – Pune Expressway and Coimbatore Bypass: Harish Diwakar, Ramaswamy, Maharnar Patir, L. Sridhar and Vinod Kumar R.S.

The attempts of attracting private participation are foiled by the problem of recovery of the investment through toll taxation. The Central Road Fund is the alternative suggested. For BOT projects, the private participants should be allowed to find out the feasibility of a project and the possibility of recovering the investment through tolling. It is imperative to bridge the gap between demand and supply for roads. Toll collection is the way to recover the investment but there are many issues such as opposition by the public, political opposition, access control, congestion and many others. This hampers the process of recovering the investment and ultimately private investment is not made into the mega projects of road development.

## 3. OBJECTIVE OF STUDY

In this study the part of national highway 48 (NH48) from Kini toll plaza to Kognoli toll plaza was consider. Consider construction cost of 6-lane project with the help of existing 4-lane project and finding the revenue cost and its period by simple project management formulas. The distance between these two plazas is 46 km. Since from past 20 years collecting toll from people even if the cost of construction is covered by them. So in our study we are finding the ways to reduce the revenue period and try to minimize it.

NH 48 is Delhi and terminates at Chennai and goes through Jaipur, Udaipur, Ahmedabad, Mumbai, Pune, Bengaluru and Vellore traversing through six states of India. It has a total length of 2807 km (1744 miles).Its stretch from Delhi to Mumbai was earlier designated NH 8 and the stretch between Mumbai and Chennai was designated NH 4 before all the national highways were renumbered in the year 2010. On the route of Pune to Bangalore for single trip,

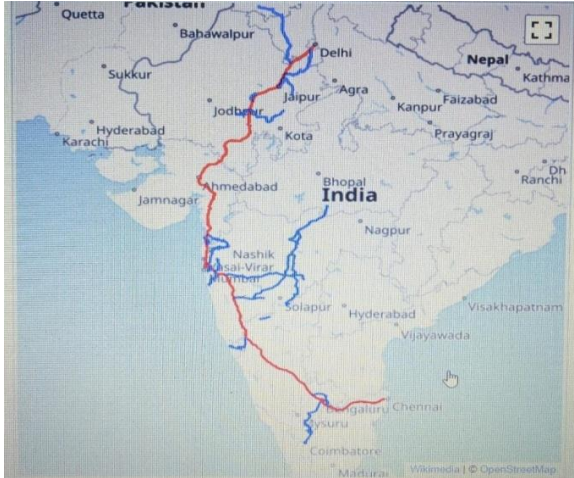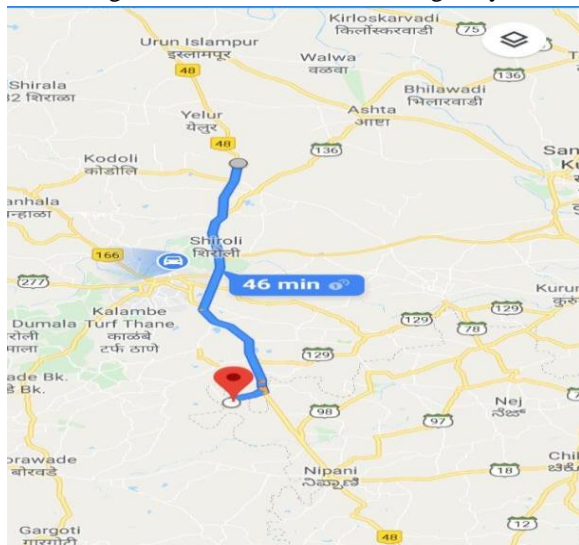| No. of Toll Gates on route | 17 |
|---|---|
| Total Distance | 837.18 Km |
| Driving Time | 13 hours 27 mins |
| Total Toll Cost | Rs. 987 |


Fig.3.1 Delhi-Chennai NH48 Highway


Fig. 3.2 Kini-Kognoli NH48 Highway (Area of study)

3. BENEFITS AND POTENTIAL CONSEQUENCES OF TOLL ROAD SYSTEM

3.1 Benefits of Toll road system:
•New Source of Finance:
The toll revenue is a "new" source of revenue, where previously roads were supported out of general Government revenues. This has been a major objective in many countries, given pressure to reduce taxes.
•Stable Source of Finance:

Tolls provide an ongoing revenue source, which is not tied to the annual Government budgetary process.
• Dedicated Source of Finance:
The funds from toll revenues can be dedicated to the support of construction and maintenance for a particular road thereby ensuring that maintenance funds in particular do not compete with the requirements of other roads in the network.
•User Pays and Internalizing of Externalities:
Some Governments have introduced tolls in pursuit of a general policy to increase the extent of "use related payment" or with the goal of reducing road use and internalizing the negative effects of road usage.
•Private Sector Development:
Some Governments have sought private sector participation in roads where they wanted to develop the road network, and to develop the private sector within their economy at the same time.

3.2 Potential Consequences of Toll Road System:
•Cost and Revenue Mismatch:
Traffic and toll levels may not be sufficient to cover all costs, including construction, operation and maintenance.
•Diversion of Traffic:
Price elasticity of demand and the provision of free alternatives to the tolled road, will affect the level of traffic on the facility.
•Political Opposition to Toll:
Political opposition to road tolling has been significant in many countries. The opposition has meant that toll rates have not been increased as planned or un-tolled facilities have been developed to provide an alternative.
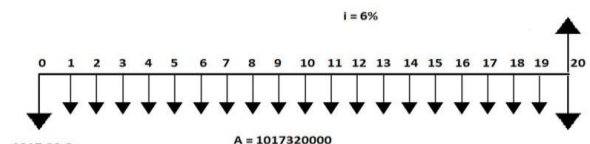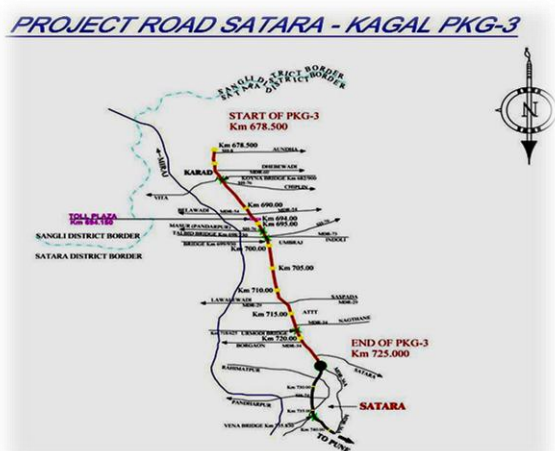•The Government Initiatives for Financing National Highways:
Traditionally financing for development of National Highways in India was from the normal budgetary resources of Government of India. But the funds were quite inadequate, to meet the demands; which was mainly due to more demands from other priority sectors such as health and education.

4. METHODOLOGY

Based on the data collection to achieve the toll fixation rates and to estimate the concession period, a

methodology is adopted which includes generation of different data.



PROJECT ROAD SATARA - KAGAL PKG-3

The different stage are used, which are as follow

4.1 Data collection:

(a) Highway data

- Cost of project: 1017.32 cr.
- Annual operating and maintenance cost per year: 10.17 cr.

(b) Traffic volume data

4.1 Traffic volume data at Kini and Kognoli Toll Plaza

| Method of Payment | Vehicle Class | Count |
|---|---|---|
| Single journey | Car | 2995 |
| Single journey | LCV | 1127 |
| Single journey | Truck | 1039 |
| Single journey | III Axel | 512 |
| Single journey | HCM | 801 |
| Single journey | Bus | 88 |
| Return pass | Car | 1684 |
| Return pass | LCV | 327 |
| Return pass | Truck | 154 |
| Return pass | III Axel | 30 |
| Return pass | HCM | 25 |
| Return pass | Bus | 145 |
| Local pass | Truck | 74 |
| Local pass | Bus | 206 |
| Total Count/ day | | 9284 |

4.2 Economic Evaluation of project :

For analysis of future cost of study area project use Future worth method of economic analysis and find the future cost of project considering 20 years life span for toll collection.



$F = P(1 +i)n + A [(1+i)n-1/i]$

Where,

F = Future cost

P = Principle cost

i = Rate of interest

A = Annual O & M Cost

Future cost (F) = 7004 Cr.

4.5 Toll fixation:

For calculating toll rates decide base rate for satara – kagal road

4.2 Base Rate Calculations



For base rate and vehicle data calculate revenue for various class of vehicle.

4.5.1 Kognoli toll plaza

4.3 Revenue from Kini Toll Plaza per year:

| Years | Number of vehicles in Cr. In 1 year | | | | | |
|---|---|---|---|---|---|---|
| | Cars | Bus | LCV | MCV | Trucks | Total |
| 2017 | 10.3 | 2.0 | 5.6 | 8.9 | 74.6 | 101.3 |
| 2018 | 11.3 | 2.2 | 6.0 | 9.7 | 9.5 | 38.7 |
| 2019 | 13.7 | 2.7 | 6.8 | 11.6 | 11.2 | 46.0 |
| 2020 | 14.9 | 3.0 | 7.0 | 12.6 | 99.9 | 137.3 |
| 2021 | 18.0 | 3.6 | 7.9 | 14.8 | 14.0 | 58.2 |
| 2022 | 19.6 | 3.9 | 8.1 | 15.9 | 14.9 | 62.3 |
| 2023 | 23.5 | 4.7 | 9.2 | 18.6 | 17.5 | 73.4 |
| 2024 | 25.6 | 5.1 | 9.5 | 19.7 | 18.6 | 78.5 |
| 2025 | 30.7 | 6.2 | 10.7 | 22.9 | 21.8 | 92.3 |
| 2026 | 33.4 | 6.8 | 11.1 | 24.2 | 23.2 | 98.6 |
| 2027 | 40.1 | 8.2 | 12.5 | 27.9 | 29.9 | 118.6 |
| 2028 | 43.7 | 8.9 | 12.9 | 29.3 | 31.8 | 126.6 |

| Years | Number of vehicles in Cr. In 1 year | | | | | |
|---|---|---|---|---|---|---|
| | Cars | Bus | LCV | MCV | Trucks | Total |
| 2029 | 52.4 | 10.8 | 14.6 | 33.7 | 37.2 | 148.8 |
| 2030 | 57.1 | 11.8 | 15.1 | 35.2 | 39.7 | 158.8 |
| 2031 | 68.6 | 14.2 | 17.1 | 40.4 | 46.5 | 186.7 |
| 2032 | 74.8 | 15.5 | 17.6 | 42.0 | 49.5 | 199.4 |
| 2033 | 89.6 | 18.7 | 19.9 | 48.0 | 58.0 | 234.2 |
| 2034 | 97.7 | 20.5 | 20.5 | 49.8 | 61.7 | 250.2 |
| 2035 | 117.0 | 24.7 | 23.2 | 56.8 | 72.3 | 294.0 |
| 2036 | 127.5 | 27.0 | 23.9 | 58.8 | 77.0 | 314.2 |
| 2037 | 152.9 | 32.6 | 27.0 | 66.8 | 90.3 | 369.6 |
| 2038 | 166.6 | 35.6 | 27.8 | 72.2 | 96.2 | 398.4 |
| 2039 | 197.6 | 42.9 | 31.5 | 85.8 | 112.6 | 470.4 |
| 2040 | 215.4 | 47.0 | 32.5 | 92.6 | 119.9 | 507.4 |
| 2041 | 257.9 | 56.6 | 36.8 | 110.1 | 140.6 | 601.9 |
| 2042 | 281.1 | 62.0 | 37.9 | 118.9 | 149.7 | 649.6 |
| 2043 | 337.0 | 74.7 | 42.8 | 141.2 | 175.4 | 771.1 |
| 2044 | 367.4 | 81.7 | 44.1 | 152.5 | 186.8 | 832.5 |
| 2045 | 440.6 | 98.5 | 50.0 | 181.2 | 218.8 | 989.0 |
| 2046 | 480.2 | 107.8 | 51.5 | 195.7 | 233.0 | 1068.3 |
| 2047 | 575.6 | 129.9 | 58.3 | 232.4 | 273.1 | 1269.4 |

4.5.2 Kini toll plaza:

4.4 Revenue from Kini Toll Plaza per year:

| Years | Number of vehicles in Cr. In 1 year | | | | | |
|---|---|---|---|---|---|---|
| | Cars | Bus | LCV | MCV | Trucks | Total |
| 2017 | 13.2 | 2.7 | 7.0 | 6.1 | 80.2 | 109.3 |
| 2018 | 14.5 | 3.0 | 7.5 | 6.7 | 10.8 | 42.5 |
| 2019 | 17.5 | 3.6 | 11.6 | 8.0 | 12.8 | 53.5 |
| 2020 | 19.1 | 3.9 | 11.9 | 8.7 | 107.7 | 151.4 |
| 2021 | 22.9 | 4.7 | 13.5 | 10.2 | 15.9 | 67.4 |
| 2022 | 25.0 | 5.2 | 13.9 | 10.9 | 17.0 | 72.0 |
| 2023 | 30.0 | 6.3 | 15.8 | 12.8 | 19.9 | 84.8 |
| 2024 | 32.7 | 6.9 | 16.2 | 13.6 | 21.2 | 90.6 |
| 2025 | 39.2 | 8.3 | 18.4 | 15.8 | 24.8 | 106.4 |
| 2026 | 42.7 | 9.0 | 19.0 | 16.6 | 26.4 | 113.8 |
| 2027 | 51.2 | 10.9 | 21.5 | 19.2 | 34.9 | 137.7 |
| 2028 | 55.8 | 11.9 | 22.1 | 20.2 | 37.2 | 147.2 |
| 2029 | 66.9 | 14.4 | 25.0 | 23.2 | 43.5 | 173.0 |
| 2030 | 72.9 | 15.7 | 25.8 | 24.2 | 46.4 | 185.0 |
| 2031 | 87.3 | 19.0 | 29.2 | 27.8 | 54.3 | 217.6 |
| 2032 | 95.1 | 20.8 | 30.1 | 28.9 | 57.9 | 232.8 |
| 2033 | 114.2 | 25.0 | 34.1 | 33.0 | 67.8 | 274.1 |
| 2034 | 124.4 | 27.4 | 35.1 | 34.3 | 72.2 | 293.4 |
| 2035 | 149.2 | 33.0 | 39.7 | 39.1 | 84.6 | 345.6 |
| 2036 | 162.6 | 36.1 | 40.9 | 40.4 | 90.1 | 370.3 |
| 2037 | 194.8 | 43.5 | 46.4 | 46.0 | 105.6 | 436.3 |
| 2038 | 212.3 | 47.7 | 47.8 | 49.6 | 112.5 | 469.9 |
| 2039 | 251.1 | 57.4 | 54.1 | 59.0 | 131.7 | 553.3 |
| 2040 | 273.7 | 62.9 | 55.8 | 63.7 | 140.3 | 596.3 |
| 2041 | 328.0 | 75.7 | 63.2 | 75.7 | 164.3 | 706.9 |
| 2042 | 357.5 | 82.9 | 65.1 | 81.8 | 174.9 | 762.2 |

| Years | Number of vehicles in Cr. In 1 year | | | | | |
|---|---|---|---|---|---|---|
| | Cars | Bus | LCV | MCV | Trucks | Total |
| 2043 | 428.6 | 99.8 | 73.7 | 97.1 | 204.9 | 904.2 |
| 2044 | 467.2 | 109.3 | 75.9 | 104.9 | 218.2 | 975.6 |
| 2045 | 559.8 | 131.7 | 86.0 | 124.7 | 255.6 | 1157.7 |
| 2046 | 610.2 | 144.2 | 88.6 | 134.6 | 272.2 | 1249.7 |
| 2047 | 730.9 | 173.6 | 100.4 | 160.0 | 318.7 | 1483.7 |

4.5.3 Total Overall Revenue from both toll plazas per year for identified revenue period:

In this consider the total future cost (Rs. 7005.0 Crs) for collection of toll for next 20 years.

4.5 Cumulative revenue cost for both Kognoli and Kini toll plaza:

| Years | Total toll collection Cost in Crs | | | |
|---|---|---|---|---|
| | Kognoli (A) | Kini (B) | Total(A+B) | Cumulative remaining cost |
| 2017 | 101.3 | 109.3 | 210.5 | 6794.4 |
| 2018 | 38.7 | 42.5 | 81.3 | 6713.2 |
| 2019 | 46.0 | 53.5 | 99.5 | 6613.7 |
| 2020 | 137.3 | 151.4 | 288.7 | 6325.0 |
| 2021 | 58.2 | 67.4 | 125.6 | 6199.4 |
| 2022 | 62.3 | 72.0 | 134.4 | 6065.0 |
| 2023 | 73.4 | 84.8 | 158.2 | 5906.9 |
| 2024 | 78.5 | 90.6 | 169.1 | 5737.8 |
| 2025 | 92.3 | 106.4 | 198.7 | 5539.0 |
| 2026 | 98.6 | 113.8 | 212.4 | 5326.7 |
| 2027 | 118.6 | 137.7 | 256.2 | 5070.4 |
| 2028 | 126.6 | 147.2 | 273.8 | 4796.6 |
| 2029 | 148.8 | 173.0 | 321.8 | 4474.9 |
| 2030 | 158.8 | 185.0 | 343.9 | 4131.0 |
| 2031 | 186.7 | 217.6 | 404.3 | 3726.7 |
| 2032 | 199.4 | 232.8 | 432.2 | 3294.5 |
| 2033 | 234.2 | 274.1 | 508.3 | 2786.3 |
| 2034 | 250.2 | 293.4 | 543.6 | 2242.7 |
| 2035 | 294.0 | 345.6 | 639.6 | 1603.0 |
| 2036 | 314.2 | 370.3 | 684.5 | 918.5 |
| 2037 | 369.6 | 436.3 | 805.8 | 112.7 |
| 2038 | 398.4 | 469.9 | 868.3 | -755.6 |
| 2039 | 470.4 | 553.3 | 1023.8 | |
| 2040 | 507.4 | 596.3 | 1103.7 | |
| 2041 | 601.9 | 706.9 | 1308.8 | |
| 2042 | 649.6 | 762.2 | 1411.8 | |
| 2043 | 771.1 | 904.2 | 1675.3 | |
| 2044 | 832.5 | 975.6 | 1808.1 | |
| 2045 | 989.0 | 1157.7 | 2146.7 | |
| 2046 | 1068.3 | 1249.7 | 2318.0 | |
| 2047 | 1269.4 | 1483.7 | 2753.0 | |

## 5. RESULT

- We taken the principal cost of NH48 six lane projects from tender document published by government of India and calculate its cost

including all expenses for next 20 years by Future worth Method.

- Principal Cost for NH48 six lane project: 1017.32 Cr.
- Future cost of NH48 six lane project after 20 years: 7005 Cr.
- We calculate the toll collected from different class of vehicle for next 20 years by multiplying base rate of each vehicle given by government of India to total length of road.
- Total years required for collection of toll from Kini and Kognoli toll plaza by taking current toll rates will be 29 years and 6 months.
- So we increased the toll rates by 10% per year for each class of vehicle,
- Total years required for collection of toll from Kini and Kognoli toll plaza : 20 years and 50 days.
- Due to delay in construction cost of project increases thus year required to collect toll also increases.
- If construction quality of road is excellent then annual maintenance cost required will be less, so collection period will decrease.
- As number of vehicles changes, the duration of toll collection period will be effected.
- Taking in account above points the national highway will be available for toll free access for public.

### 6. CONCLUSION

The Study is focused on analyzing performance of toll road sector in Satara- Kolhapur region of Maharashtra. The key factors studied are toll traffic, toll revenue, operations of toll plazas and road user services. Appropriate tools are developed to analyze the data related to these factors besides sub factors. The region recorded a wide range of problems such as issues with the Government toll policy, poor roadway maintenance and delay at toll plazas, etc. across the region for the past several years. Roadway maintenance problems and skewed toll policy emerged as the most important reasons for toll roads falling short in delivering services of standard quality. The aim of this study is to analyze the most prominent factors across operational Performance of toll ways in the Satara-Kagal regions and at the same

it leaves ample scope for the future research into interesting facts of toll road system.

a) Accurate Traffic and Toll Revenue Studies:
There are a few limitations in obtaining accurate data particularly quantitative data from relevant sources due to confidential reasons. Apparently, toll traffic counts are not accurately reported to the toll way client organizations and toll revenues are bias. Hence a full scale study may be designed to investigate into these aspects and for obtaining accurate results.

b) Toll Period Estimation-
Another interesting aspect for investigation is that the accurate gestation period. The toll paying community needs to know exactly how long the toll is paid. This is only possible with accurate traffic analysis and revenue projection with devoted long term studies.

c) Toll way Safety and Security –
Safety and highway security are big problem areas always. Accidents and roadway robberies can be minimized through the creation and improvement of road way infrastructure with enhance safety standards and assured level of service.

d) Traffic and Revenue Risks –
Toll projects during initial period of some years in Operation, the toll project can suffer on traffic and revenue front, thereby the toll contractors do not get clues as to what to do with this kind of unforeseen situations. For doing away with such risks toll traffic and revenue management studies have ample scope for future research.

### 7. ACKNOWLEDGMENT

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