

SYNOPSIS

PERFORMANCE ASSESSMENT OF TOLL ROAD SYSTEM: A STUDY IN PUNE REGION

By

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Background

The Pune Metropolitan region has vast road and highway network. The roads laid by private firms mainly comprise National highways and a few other primary roads like State highways and expressways. The toll roads in Pune region have been operational for quite some time and are slated to reduce travel time and improve connectivity in the region. The network of toll roads carry huge amount of traffic and generate more toll revenue for the road developers and contribute to the regional economy to a considerable extent. However, there has been a strong dissatisfaction among the travellers that the system is unable to manage the mandated tolling operational services, road user services and thereby perform poorly on various service indicators such as tolling operational features, safety of commuters, security, and toll stretch wayside amenities.

Introduction

Most developing countries urgently need to develop highway construction programmes. The primary objective of road infrastructure development project is to generate benefits to the users, such as, convenience, cost savings, reduced travel time, and thereby accelerating economic development in the area of the road project. The infrastructure project will not be undertaken unless it is beneficial and the economic viability is fully established prior to the decision on investment in road projects (Chakraborty, 1996). Traditionally, highways in India have been viewed as a public convenience that need be financed and operated by the public sector. But the Government faced funding constraints in the later stage of development because of prolonged budgetary constraints. The sector witnessed the emergence of Public Private Partnership (PPP) model in highway development in early 1990s and subsequently the National Highway Authority of India (NHAI) was set up in the year 1995 for overseeing the functioning of the private entities in the highway development

(Subra, 1999). Since then a number of projects have been implemented on PPP model, particularly through Build, Operate and Transfer (BOT) contract. Consequently, it is increasingly accepted that highways should be built, financed, and operated by private firms and the road user should pay toll fee for using them. Moreover, users are likely to accept the concept of paying for roads owned by private sector that builds highways faster and more efficiently than state-owned firms.

Furthermore, the NHAI continues to carry out regulatory functions to monitor the projects, setting up quality norms, etc. During the specified period prescribed in PPP contract, the private firm operates and maintains the infrastructure created, thereby assuring road users adequate quality services, safety measures, and security standards on the toll way stretches.

Thus, the system of toll road has been operating for quite some time in India and has benefited all passengers travel on toll roads. While the toll collection and recovering the project development costs are the key objectives of private entities, the issues arise out to provide quality services to the toll road commuters is the matter of highest concern and need to be addressed with immediate effect.

It is mandated to ensure that the highway users are provided with quality services for the toll fee charged. It ensures that the road contractors and developers maintain the standards that are proposed, according to the concession agreement between the contractors and NHAI. This is because of the fact that the commuter is levied toll for not just the highway usage but for certain services as well. It is often observed that once the road is ready for operation, toll collection starts and service performance parameters are forgotten. The concessionaire continues to collect toll from the ever-increasing traffic and neglects quality services to the commuters and deviates from the service deliveries as promised in the concession agreement. (Das, 2010).

Road User Services have the advantages or service benefits accruing to the vehicle drivers or owners or occupants through features like road safety, comfort, convenience, etc. (Khanna, 1993). For example, the toll road operators are expected to provide services for public which include; patrolling services, ambulance facilities at the time of accidents, communication facilities, parking lots, rest rooms along road side, motels etc.

Objectives and Scope of Study

This study aims to take a holistic approach to performance of toll roads through analysis of the performance indicators, both quantitative and qualitative, with the following main objectives:

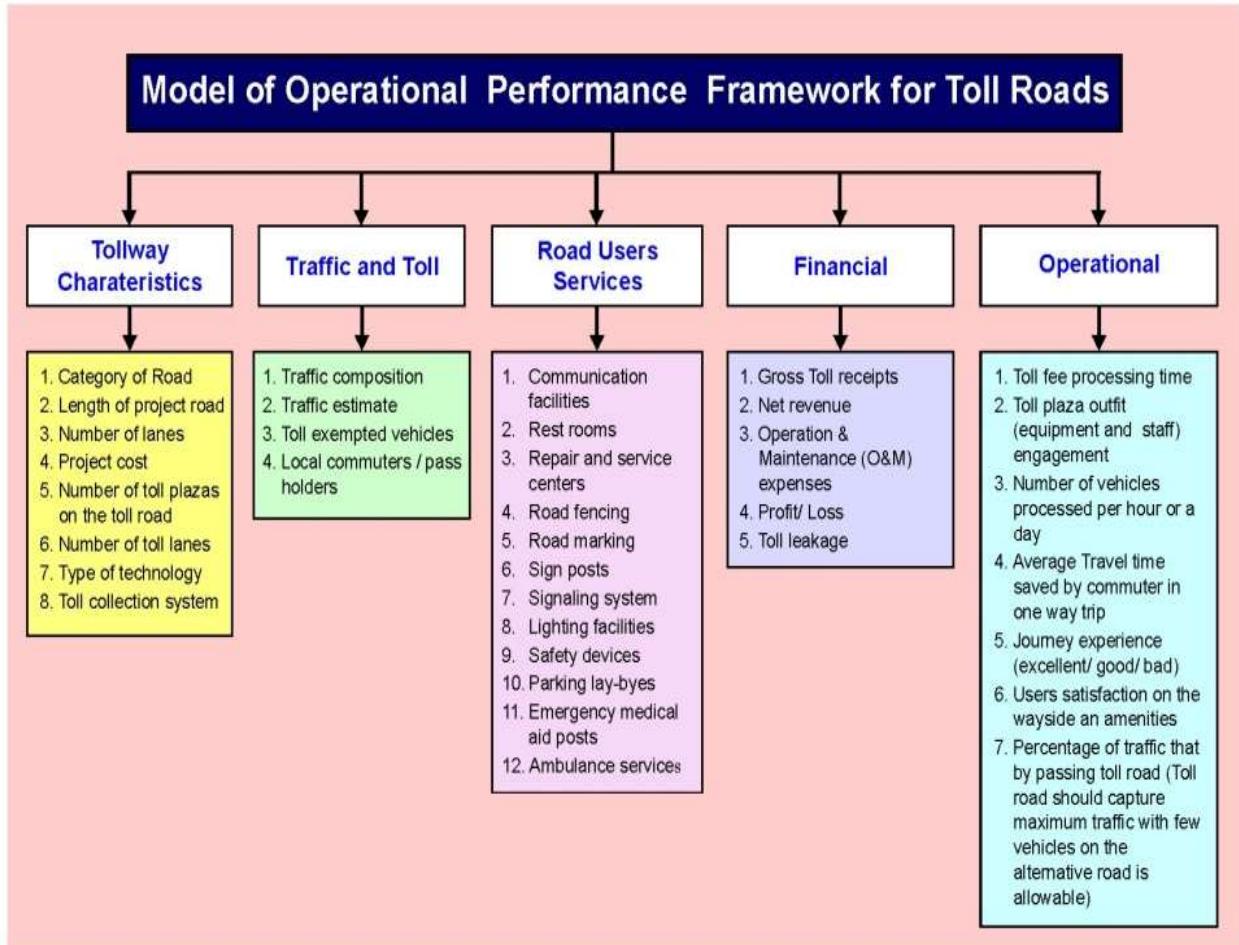
1. To identify specific indicators to evaluate performance of toll roads
2. To develop the performance evaluation criteria to measure performance of toll roads
3. To study the causal factors for performance deficiency and suggest measures for improvement in key performance areas

Conceptual Framework of the Study

The Operational toll roads are the roads that have exited the construction phase and able to demonstrate the intended function for toll traffic (Moody, 2006). Performance is the barometer of measuring the effectiveness of meeting the set objectives. It can be perceived as a measure of the system's ability to produce efficient and satisfactory results compared to the standards set out prior to its implementation. In other words, it can be further defined as the operational objectives of each business area forming the project. Further, it can be equal to actual results on the standard expected results. Performance is central to the Highway Projects on BOT model as the performance particularly revenue stream depends on the effective Operation and Maintenance (O&M) of the project. This phase is one of the important phases of the Highway projects. The BOT road projects are generally based on

the premise to utilize the efficiency of private sector and in this context it is relevant to consider the private sector is efficient in design, construction, and maintenance and in collection of toll (Shi, 2006). In BOT road projects, the developer (concessionaire) has to maintain the project road as well as recover investment by charging toll / user fee from road users as set out in Concession agreement. The O&M activities essentially include traffic operation, toll collection, etc. As the toll road is high profile public project as many different categories of road users operate on the facility and pay the toll, and user expectations are high on the quality of service. Thus the contractor is required to deliver high quality operations through multiple services for which the operational objectives are established. ‘The high level of operational performance’ means the system must be well maintained and individual operating units must collaborate well with each other, and be available for use. For monitoring, performance evaluation of the operating conditions is carried out from time to time for all the performance areas through ‘Performance Indicators (PIs). The term key PI was originated in Australia for the performance specified road contracts. The data of PIs, either internal or external, can be further ordered into statistical / textual information and presented into ‘indicators’ that are believed to express physical or functional status or change of the operational condition of the system. The stakeholders relevant to the road sector use the PIs depending on the requirement and interest. Some PIs can be measured objectively at individual facility level (toll fare processing time at the toll booth) (Ralph *et al.* 2009). However, the questions arise as to what all the services that need evaluation, the parameters that need to be checked, whether the contractor provides quality services to road users, are the road users guided adequately for safe travel on the road?. Are adequate safety measures provided? Why the strict actions cannot be initiated against road service offenders, why the public is not acting against contractors and why the

legal provisions are so lenient that contractors can get away with it with poor penalty. To address all these problems the performance of the system needs to be analyzed holistically.



Source: Compiled by the Researcher from various Sources

Scope of the Study

This study is a modest attempt to develop a performance evaluation framework for toll road network in Pune region, which covers performance assessment of the operational toll roads in the toll way network of nearly 500 km. including toll posts in the region. The performance of six toll roads and eight toll plazas are analyzed against standard criteria that is set, based on key objectives of the projects. The study is intended to cover a Holistic Performance Model-a novel concept in researchers' perspective. The focus is on three key components of toll way operational system; (i) Traffic and Toll Revenue (ii) Toll Plaza

Operations and (iii) Public opinion about road user amenities. Thus the Pune tollway system is assessed on corresponding performance parameters, such as system output (*toll traffic, toll revenue, etc.*), tolling operations services and road way quality of service to travellers. Then the performance of the toll roads through these parameters is compared. These parameters are selected primarily to ensure that the toll road system fulfils the results that are envisaged. A range of studies are conducted to carry out the assessment which includes:

- i. A study of toll traffic and financial factors which are key output indicators of the toll road system. This assessment is based on traffic demand and toll revenue projections which are the toll road operators' primary concern in toll business.
- ii. A field survey at operational sites for collecting information on tolling service parameters related to toll posts meant for toll collection. This is required to know how the operators run toll plazas to handle traffic congestion around it and manage toll lanes.
- iii. Public is very important component in PPP projects like toll road projects. So, a road user study in terms of passengers' survey was carried out for overall analysis of the performance of roadway level of services to the travelers, and this assessment is required to evaluate how each toll way performs on each service indicator.

Overview of Research Approach

A literature study was carried out to identify factors that influence toll road functional system across various key performance areas. Followed by this, an appropriate framework of factors involved in performance measurement and detailed data collection methods was developed. Data collection is a multipronged approach. It covers a comprehensive search of secondary literature available in the public domain to determine the efforts of all the stakeholders and present state of work in the sector, followed by a primary research. The study is basically a cross-sectional, partly qualitative and partly quantitative in nature. The

primary data collection techniques broadly include a structured observational study and a questionnaire survey. The data thus collected across toll road segments in Pune region is mostly for a primary research study. For example, quantitative data is all about traffic data and financial data. Qualitative data is toll operational indicators and Roadway Service indicators. Suitable methods are developed for data collection in field and a questionnaire survey to capture user experiences. The data collection process involved (i) Toll traffic and Toll revenue (ii) Observation of the tolling process (iii) Road user survey through questionnaire for structured interviews.

Based on the type of data – quantitative or qualitative, different analyses techniques are used to analyse and interpret the data. The analysis is carried out by using standard analysis techniques, descriptive and inferential statistics. The key analyses techniques are frequency distribution, ranking, one way ANOVA, factor analysis etc. The software primarily used for Analyses are MS-Excel and SPSS.

Analysis of Data

On the analysis front, firstly, it provides and compares the financial indicators of the toll roads, toll rates for different class of vehicles along with volume of traffic, operational expenditures of the toll ways, toll revenue and operating ratios as part of the analyses. An elaborate year wise and toll road wise revenue are presented along with the details of traffic count relating to various categories of vehicles.

Growth of the overall traffic density for the tollways under study has been found to be in the order of 7% to 12 % during the period 2014-2016. The toll revenues have increased 3% during this period. Heavy Commercial Vehicles, Multi-axel vehicles and Cars contribute to huge revenue across these toll roads in the region. The top grosser projects are Pune-Mumbai Expressway and Pune Mumbai Highway which jointly generated whopping toll revenue of about 1200 crore per year on average during this period. Another important

indicator has been derived for assessing these toll organisations is Operating Ratio (OR). It is an important and commonly used indicator for assessing financial condition of large organisations deal with toll roads projects. These organisations require enormous growth in revenue to maintain their operations. The estimated OR is in the range of 1.15% - 10.5% across these toll projects which indicate that these projects are doing exceedingly well on the financial front as the ratios found are far below the envisaged normal target.

Secondly, the toll booths set up on the toll roads are evaluated through 24 elements under four key dimensions related to tolling operations at booth level and assessed as best, medium and poor performing toll booths. It was found that the operational situation is not very satisfactory as most of the toll booths lack essential tolling infrastructure. It is observed that due to lack of deployment of advanced tolling technologies, people have to wait for long durations at toll collection.

The performance in terms of physical operations of tolling are measured across the toll booths and compared on performance efficiency scores obtained through a specially devised performance measurement process. It is found that none of the toll booths scored more than 60 points out of 100 points. However, the Shirur toll plaza on Pune-Ahmednagar road, Anewadi toll plaza and Khed-Shivapur toll plaza on Pune-Satara road clinched 1st, 2nd and 3rd positions respectively due to well maintained and adequate facilities. Other five toll booths have been termed as poor performers that need to work harder to improve their operational conditions. At the same time, tollways are also assessed almost through similar procedure of employing questionnaire survey based on sample data of 336 commuters across all the roads which cover various types of vehicles. It was found that the tollways are compared poorly on several service indicators thereby perform below par. Relevant statistical analyses involving reliability, hypothesis testing, ANOVA and factor analyses have been conducted for validating the results of study. A perception study of road users

has shown that their average level of satisfaction is poor with all the six roadways under study though there are wide individual variations among the roads. The Pune-Ahmednagar (PA) Road secured the highest performance level with the overall index value of 2.57, followed by Pune-Mumbai Expressway (PEx) with 2.47 and Pune-Nashik) PN, with 2.43 ranking the first, second and third respectively in terms of their overall performance standard compared to others. The Pune-Satara (PS) road came out to be the worst performing road with 6th position in quality of service ranking of the Pune region toll roads, followed by Pune-Mumbai (PM) highway and Pune-Solapur (PSo) ranking 4th and 5th respectively. The rankings given to them on computation of quality score which are just relative and no toll road could be considered perfect. However, there is scope for better performance in each of these roads.

Inter-Relationships Among Key Study Factors

1. Pune-Ahmednagar road-way

From the survey, it was evident that people i.e. commuters, using the Pune-Ahmednagar road attach higher importance to ‘value for time’, ‘safety on road’, and ‘travel comfort’ as compared to ‘value for money’ and ‘travel amenities’. Pune-Ahmednagar is an industrial belt so there are more commuters using the road for business purpose than those using for personal reasons. Considering this, travel time becomes a more pertinent aspect for commuters than value for money. This observation about the preference is also in-line with their complaints. The top three complaints are ‘delay at toll plaza’ (which concerns ‘value for time’), ‘poor roadway maintenance’ (which relates with time, safety and travel comfort), and ‘biased revenue and toll projection’ (which involves ‘value for money’). This demonstrates that people complaints are aligned with the parameters which they prefer more over the other factors. Thus, it is observed that people on the Pune-Ahmednagar route place more importance to factors that save them time, makes them feels safe and makes their

travel comfortable, Since Roadway maintenance affects all thee parameters, ‘poor roadway maintenance’ tops the complaints list followed by ‘delay at Toll Plaza’.

2. Pune-Nashik road-way

The nature of commuters on Pune-Nashik road is similar to that of the travellers on Pune-Ahmednagar road, both being busy industrial traffic belts. So, it is not surprising that the commuters travelling on the Pune-Nashik road-way also place similar preference to the factors affecting travels as those attached by the commuters on Pune-Ahmednagar roadway i.e. ‘value for time’, ‘safety on road’, and ‘travel comfort’ are preferred as compared to ‘value for money’ and ‘travel amenities’. Since, value of time is the topmost preference; their biggest complaint is the delay on toll plaza. Moreover, government policies on toll roads also figure as one of the top-3 complaints. Government policies include (but not limit to) factors such as toll rates decisions, differential toll charges for different vehicle types, period of charging tolls, and concessions extended to special travellers like VIPs and localities. Since these policy parameters impact the road-way traffic and by extension the factors affecting road travel, the commuters have complaints about biased toll projections and government policies on toll roads.

3. Pune-Satara Road-Way

The survey of the people travelling on the Pune-Satara road-way revealed that the three more significant factors affecting their travel are ‘value for time’, ’value for money’, and ‘safety on road’. These commuters render lesser importance to ‘travel comfort and amenities’ and ‘visual appeal (of the roadway)’. These commuters are more concerned about travel time, money and safety over others. Therefore, when it comes to complaints, their main grouse, naturally, is about ‘delay at toll plaza’, ‘biased revenue and toll projection’ and ‘poor roadway maintenance’ which clearly coincide with factors affecting their travel.

4. Pune-Solapur Road-Way

The Pune-Solapur commuters carry similar perceptions, preferences and complaints about the factors affecting their travel as those carried by the Pune-Satara road-way commuters. A detailed analysis of their survey responses disclosed that Pune-Solapur roadway commuters place exactly the same level of importance to the six factors affecting travel; they value time, money and safety on the road more than the travel comfort and amenities. Also, they also have the same grievances (as mentioned above) of the Pune-Satara road-way travellers, in that delay at toll plaza and poor roadway maintenance are their topmost grumbles. This observation is rather obvious considering the similar demographic profile of the commuters on the two roadways.

5. Pune-Mumbai Road-Way

The study of the survey respondents travelling on the Pune-Mumbai road-way divulged that the factors affecting their travel are more in line with the factors affecting the travels of commuters on Pune-Ahmednagar roadway and Pune-Nashik roadway. This observation is quite enlightening in the sense that all the three roadways are used more for business travel than for leisure travel. Most leisure travellers commuting between Pune and Mumbai use the Pune Expressway and the Pune-Mumbai roadway is primarily employed by business people and heavy vehicles. Therefore, their travel preferences and complaints are similar in nature as those of their counterparts on the other two road-ways.

6. Pune Expressway

The survey responses of the commuters on Pune Expressway revealed some interesting observations. People travelling on Pune Expressway primarily fall into leisure and family

traveller category, rather than primarily business travellers. It is not that there are no business travellers on Pune Expressway; just that there is higher proportion of people travelling for personal and leisure reasons than for professional reasons. This is reflected in their preference for the factors affecting their travel. The survey indicated that the Pune Expressway commuters accord higher level of importance to ‘safety on the road’, ‘travel comfort’, and ‘value for time’ as compared to the other factors i.e. ‘value for money’, ‘travel amenities’, and ‘visual appeal’. In fact, ‘Safety on the Road’ is the factor of topmost concern in addition to time factor. A quick analysis of their complaints shows that they are more bothered about ‘delay at toll plaza’, ‘Poor Roadway maintenance’ and ‘biased revenue and toll projection’. In addition to performing the analysis of the factors affecting travel at the individual roadway level, an overall top-level analysis was also performed to study the factors affecting travel in terms of how they are similar or different at a higher level. The analysis revealed that commuters accord higher preference for time, safety, and comfort related factors as compared to value for money, travel amenities and visual appeal. In fact, ‘value for time’ is the single-most important factor valued by commuters followed by ‘safety on road’ and ‘travel comfort’. Therefore, it is quite intuitive that when it comes to commuter complaints, they grumble more about ‘delay at toll plaza’ and ‘poor roadway maintenance’ which directly affect the travel factors such as time, safety and comfort. The analysis of complaints also implied that people complain less about tertiary factors such as bad signage of roads and robbery/theft on highway.

Correlation Analysis:

The following table illustrates various parametric data for the six roadways Pune-Ahmednagar (PA), Pune-Nashik (PN), Pune-Mumbai (PM), Pune-Satara (PS), Pune-Solapur (PSo), and Pune-Expressway (PEx). The data includes six operational parameters which includes the volume of traffic on the roadway (Traffic Volume in absolute numbers),

Revenue earned at the tollways (Revenue in Lakh rupees), expenses to operate the tollways (operational cost in Lakh rupees), operational ratio (as a ratio of operational cost and toll revenue), efficiency of operating the tollways (Tolling operational Efficiency in percentage), and the survey rating of the services provided at the roadside of these roadways (Road User Services ratings out of 5). These six operational parameters, together, define the operational performance of each of the roadways. Therefore, it is relevant to analyse the operational parameters and the correlations among them.

Roadways	Traffic Volume	Toll Revenue (Rs. in Lakhs)	Operational Cost (Rs.in Lakhs)	Operational Ratio	Tolling Operational Efficiency*	Road User Services#
PA	8991706	8941	396	4.42	42.31%	2.57
PN	10704409	7592	293	3.87	28.85%	2.43
PM	10053068	25877	701	2.71	40.38%	2.37
PS	7822231	5205	524	10.08	46.15%	1.74
PSo	6781614	7377	733	9.95	38.46%	2.19
PEx	34004126	93633	1097	1.17	38.46%	2.47

* Efficiency =
average(28,16)/52

Rating, out of 5

The theoretical and statistical inferences are drawn based on the above data and the corresponding correlation table displayed above.

THEORETICAL INFERENCES:

- Theoretically speaking, the toll revenue increases as the traffic passing through the tollways increases. This is irrespective of the special concessions extended to certain VIP and other vehicles as those vehicles form minuscule percentage of the overall traffic. So, irrespective of the type of vehicle, the toll revenue is directly proportional to the toll road traffic.

- The operational cost is also expected to be somewhat directly proportional to the toll road traffic. This is because, with the increased traffic, there is more wear and tear of the roadway requiring more intensive and frequent operational maintenance. Also, other operational expenses associated with toll road, such as patrolling and security also increases with the increase in volume. Hence the operational cost increases with increased traffic.
- In an ideal scenario, a toll road must have minimal operational cost and maximum revenue. However, there is always some operational cost associated with a toll road, whose performance is measured in terms of an additional parameter called operational ratio.
- There are many services offered on a toll road in order to improve the comfort and provide good travel experience to the end-users (or commuters). Examples of such user services include Food malls, petrol pumps, hygiene services (or toilets), emergency calling services, towing services, accident support services, medical services, security services, apart from other patrolling and landscape related services. These services are a necessary and important aspect of every toll road therefore, it is essential that these services are available, reliable, and enjoyable by the commuters. Theoretically speaking, better the quality of services, higher will be the traffic and higher will be the toll revenues. It is believed that the above mentioned six operational parameters tell much about the performance of the roadways. Therefore, the correlations among the operational parameters are calculated by using spreadsheet software, elucidated here in the table below, and explicated in the corresponding paragraphs below the table.

	Traffic Volume	Toll Revenue (in Lakhs)	Operational Cost (in Lakhs)	Operational Ratio	Tolling Operational Efficiency*	Road User Services#
Traffic Volume	1					
Toll Revenue (in Lakhs)	0.98	1				
Operational Cost (in Lakhs)	0.75	0.85	1			
Operational Ratio	-0.65	-0.65	-0.27	1		
Tolling Operational Efficiency*	-0.13	-0.04	0.20	0.38	1	
Road User Services#	0.36	0.35	0.06	-0.80	-0.50	1

STATISTICAL INFERENCE:

The following statistical inferences are drawn from the correlation table given above:

- **Traffic Volume:** There is a significant positive correlation between traffic volume and the toll revenue (+0.98). This is in-line with the theoretical inference as intuitively speaking; toll revenues are directly proportional to the traffic volume. There is a considerably significant correlation (+0.75) between traffic volume and operational cost indicating that the operational cost is directly proportional to traffic volume – as the traffic volume increases, the toll road needs more operational support and the corresponding operational cost increases almost linearly. It typically does not increase absolutely linearly (i.e. correlation of +1) because of the efficiency of scale. The traffic volume correlates negatively (-0.65) with operational ratio (which is a ratio of operational cost and toll revenue). With respect to road user services, the traffic volume has medium positive correlation (+0.36); this is a great observation because the toll roads with high traffic volumes typically deserve and get more attention from the various service providers. And that is likely to fetch them better survey ratings on the road user services.
- **Toll Revenue:** The correlation between toll revenue and operational cost is high positive (+0.85). This correlation indicates that the operational cost is directly proportional to toll revenue as well, i.e. as the traffic volume (and therefore toll revenue) increases, the operational support increases thereby increasing the cost. Operational ratio is a metric to

measure and control operational costs associated with a toll road. A high operational ratio is detrimental to the operability of the toll road. From the table above, it is evident that there is a medium negative correlation between operational ratio and toll revenue (-0.65) which is in-line with the theoretical inference. While there is no correlation between toll revenues and tolling operational efficiency (-0.04), the road user services correlate somewhat positively (+0.35) with the toll revenue.

- **Operational Cost:** Operational cost is somewhat negatively correlated with operational ratio (-0.27) and road user services (0.06). However, it is positively correlated tolling operational efficiency (+0.20). This is because as the cost (and the cost base) increases, the efficiency increases a bit.
- **Operational ratio** is not correlated (-0.08) with road user services as the ratio has to do with operational cost and toll revenue.
- There is one specific observation based on the radar-chart of road user services provided below. As per the chart, the road-user services for Pune-Ahmedabad (PA) tops the chart even though there is not much difference among the road user service ratings for all the different roadways. Also, the road service ratings for PM are the least at 1.74.



Limitations of the Study

It is a broad study covering various types of users and hence presents an aggregate analysis dealing more with the system operational elements but not focused on specific type of road user. The results obtained with regard to the performance factors are mostly as per user expectations, and at the same time they may not hold well in another region in the state of Maharashtra or elsewhere in the country. This is because of the fact that the characteristics of tollways and the people acceptance levels may be different in other places. One of the constraints for the study is small size of sample. The toll roads are used by different types of users but only a few users are knowledgeable and understand the economic and other benefits of the tollway systems. So, during the survey, the researcher had to identify and convince a number of respondents to give unbiased feedback. Finally, the findings of the study are based on most of the data collected during specific months during 2014-2016.

Scope for Future Research

The aim of this study is to analyze the most prominent factors across operational performance of tollways in the Pune regions and at the same it leaves ample scope for the future research into interesting facts of toll road system. i) 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 tollway client organisations and toll revenues are biased. Annual Operation and maintenance costs involved in running the toll business are not revealed. Hence a full scale study may be designed to investigate into these aspects and for obtaining accurate results.

- i) Tollways, like any other business organisations, can also show some performance variation across days, weeks and seasons and qualitative performance in various seasons like during heavy monsoons, extreme cold weathers with lots of fog around. Hence, studies can be focused deeply during extreme seasons.

ii) 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.

iii) Tollway 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. Time series data on roadway accidents, nature of injuries, accident prone areas, incidents such as robberies vandalism may be procured and analyzed for fruitful results. Therefore, further work can be carried out for factors like investigating deeper aspects of safety issues on roads and safety audit of Toll Projects.

iv) Traffic and Revenue Risks - during initial period of some years in Operation, suffer on traffic and revenue front, thereby the toll contractors do not get clues as to what to with this kind of unforeseen situations. For doing away with such risks toll traffic and revenue management studies need to be conducted accurately.

v) Performance of Tolling Technology- A comparison of electronic toll which has been introduced very recently and manual tolling operations compare the performance of toll roads with non-toll roads and so on. Performance of Toll lanes in terms of Toll transaction across ETC and manual lanes and a toll transaction process model specific to ETC and non ETC toll plazas would give better estimate of the waiting times at the manual and automatic lanes. Further the number of ETC lanes and their time of implementation are decided based on the delays at the ETC lane and the value of the benefits. Thus an algorithm can be developed with suitable software to decide upon the optimum number of ETC lanes as compared to the manual and automatic lanes and also take into account the lane type that needs to be converted in order

to maximize the benefits and reduce the delays at the toll plaza. Sudden political and economic conditions may also destabilize the system giving scope for good research studies concentrating these aspects in terms of economics and politics in toll Roads.

Recommendations

The NHAI and other road management agencies should not only look at toll tariff structures for passengers and toll operators but also set standards of performance and efficiency for customer satisfaction. Particularly in this case the road users' satisfaction in both tolling operations and roadway services would be enforced under the Tollways Act. The regulator, the NHAI should be responsible for recommending for passengers' toll fares, setting performance standards for toll operations and must provide guidance on quantity and quality of service provided to passengers. These may include setting quantitative and qualitative standards including the number of toll lanes, presence of weighing bridges, the electronic toll collection systems, traffic wardens, roadway surface smoothness, safety standards and road user amenities.

Contribution of Research

Toll road system which is considered not on par in functional performance areas, and it is believed that such toll road system can prove to be detrimental to regional growth. At the same time monitoring and measuring operational performance of toll roads in an integrated way is felt necessary, thereby the assessment of performance levels of operational parameters and services gives the functional status of tollways and reminds the agencies of their responsibilities regarding road maintenance and management which enable stakeholders to take decisions on improvement of the system. In the present study, a comprehensive performance measurement tools are developed for operational toll roads. A model comprising good set of performance indicators across main key performance areas is designed. The framework describing the concepts, sources of data and methods, thus

developed can be used elsewhere for evaluating tolling systems operating virtually under similar conditions.

Conclusion

The Study is focussed on analysing performance of toll road sector in Pune region of Maharashtra. The scope of the study is Six functional toll roads and Eight operational toll booths. The key factors studied are toll traffic, toll revenue, operations of toll plazas and road user services. Appropriate tools are developed to analyse the data related to these factors besides sub factors. The results are comprehensively presented and causal factors are found out for the tollway system for non-performance. 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. Further suitable recommendations are given to bring the system in par with desirable quality standards for potential improvement of toll road system across various key functional areas particularly tolling operational services and road user services.

Research Methodology Flowchart

