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

By

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Declaration of Authorship

I declare that this thesis entitled **"Performance Assessment of Toll Road System: A Study in Pune Region"** submitted by me in fulfillment of the requirements for the award of the degree of Doctor of Philosophy of the ICFAI University Jharkhand, Ranchi is my own work. It contains no material previously published or written by another person nor material which has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text. I further confirm that the thesis complies with the Plagiarism Guidelines of the ICFAI University, Jharkhand.

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Acknowledgments

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Date: **Nagarjuna Pilaka**

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Thesis Completion Certificate

This is to certify that the thesis on "**Performance Assessment Of Toll Road System: A Study In Pune Region**" by **Nagarjuna Pilaka**, in Partial fulfillment of the requirements for the award of the Degree of Doctor of Philosophy is an original work carried out by him under our joint guidance. We also certify that the thesis complies with the Plagiarism Guidelines of the ICFAI University, Jharkhand. It is certified that the work has not been submitted anywhere else for the award of any other diploma or degree of this or any other University.

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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 tollway, being the customers' satisfaction.

Toll roads have been gaining popularity for more than a decade in India. A few years after the tollway projects are put into operational mode, they are expected see a lot of traffic every day comprising a variety of vehicles ranging from personal vehicles, light and heavy commercial to multi axle trucks and so on. As per the prescribed Government policy guidelines, toll fares are levied on most of the vehicles using toll road facility. It is important to provide good quality road infrastructure as well as other required amenities to the road users, with focus on enhancing the safety measures.

There are six major toll roads on the prominent highway corridors in and around Pune region. The region has a toll road system comprising 'toll road segments' and 'a network of toll plazas'. The toll plazas are set up by the private developers for collecting toll from the vehicles passing through the toll road as part of the toll road contract agreement made with the Government. Most of the road users feel that roads in the study region are not up to the desired operational standards. As the contractors do not follow reportedly stipulated norms, as laid down in the roadway Operation & Maintenance contract and fail to perform contractual obligations, the road users do not get basic services like toilets and parking base along the roads. Therefore citizens are not ready to

pay toll but they cannot refuse. As per the general feedback received from the road users across the region, they are unwilling to pay the toll fees for the roads that have been commercially operational for a long time as the operators have recovered the costs and are not taking any steps to reduce travel time. They are also questioning why toll fees are levied on all types of vehicles. Most of these toll roads are mainly towards the major cities like Mumbai, Satara, Nashik and Solapur and carry huge amount of traffic everyday and generate a lot of toll revenue for the road operators. The toll collection figures across the toll organisations have been rising year-on-year on account of the higher traffic volumes generated on some major roadway corridors in the region, particularly with high percentage of cars and commercial vehicles and contributing to the regional economy to a considerable extent. Moreover, it is believed that the tollways built around the region have brought in significant socio-economic development through numerous travel benefits in terms of savings in commuters travel time, low vehicle operation cost, reduction in rate of accidents, etc.

The tolling operation needs to be looked upon as a distinct and important aspect in a project's success. With a large number of projects not meeting their financial targets, senior management personnel are now getting involved in toll operations. This has resulted in tolling operations becoming a separate and independent entity within the organization. However, the toll road system under the study comprising these toll ways appears to be not functionally up to the mark with some visible deficiencies in major functional areas such as tolling operations, roadway services and so on. So, the key question remains here as to how to understand and assess the relative performance of the tollways , operating virtually under similar physical and traffic conditions and how these toll organisations compare on key operational performance Indices . It calls for a detailed

study on the tollway characteristics in terms of traffic, toll revenue, operational standards, tollway user services, etc.

The present study is therefore intended to analyse the operational standards and assess the level of performance of the Toll Road System in the Pune region, covering Six Toll way Stretches. The assessment exercise is considered very important keeping in view:

i) The lack of commitment on the part of toll road operators in providing desired toll road related services.
ii) No proper mechanism in place for the review of operational standards
iii) The concerns of the public with the regulation of toll norm prevailing in the region.
iv) Dissatisfaction of the road users with aspects like the prevailing condition of the roads and long waiting time at toll plazas

The study therefore contemplates developing performance framework for evaluating operational toll roads with primary objective of identifying performance indicators in various operational areas. The framework is primarily concerned with identifying performance indicators in key performance areas, assessing roadways for operational deficiencies, finding causal factors for the same and suggesting ways for further improvement of the system. Three different methodologies are used to collect data on various factors considered in the study, after conducting literature survey on these performance criteria.

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. The Questionnaire Survey was employed for gathering the data on user satisfaction parameters as it is a way of assessing the system performances in terms of user service quality and bringing in improvement in the system. The data collection techniques are explained in detail in Chapter 4, Research design.

Responses from the survey were analysed through quantitative methods as covered in the chapter 6, 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. It is observed that due to lack of deployment of advanced tolling technologies, people have to wait for long durations at toll collection sites. An elaborate year wise and toll road wise revenue are presented along with the details of traffic count relating to various categories of vehicles in Chapter 6.

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 by 7% to 10% during this period. Heavy Commercial Vehicles, Multi-axle 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 Rs.1200 Crore per year on average during this period. Another important indicator that 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 big organisations dealing with toll roads projects. These organisations require a large 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 twenty four 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.

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 on Pune–Satara, Talegaon toll plaza on Pune-Mumbai Highway road obtained 1st, 2nd and 3rd positions respectively due to well maintained and adequate facilities. Other five toll booths have been termed 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, covering various types of vehicles. It was found that the tollways compare 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 were 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 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 4 and 5 respectively. The rankings given to them on computation of quality score are just relative and no toll road could be considered perfect. However, there is scope for better performance in each of these roads. 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 top reasons for toll roads falling short in delivering services of standard quality.

Lastly, the results are comprehensively presented and causal factors are found out for the tollway system not performing at par and suitable recommendations are given to bring the system in par with desirable quality standards across various service indicators. The study came out with some recommendations which are presented very broadly in the following paragraph.

The National Highway Authority of India (NHAI) 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 that would be enforceable 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.

CHAPTER 1

INTRODUCTION

1.1Background

Most developing countries are in urgent need of 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 influence area of the road project. No infrastructure project should be undertaken unless the economic benefits criteria and economic viability is fully established prior to the decision on investment in road projects (Chakraborthy, 1996). Traditionally, highways in India have been viewed as a public convenience that must be financed and operated by the public sector. But the Govt. faced funding constraints in later stage development because of chronic budgetary problems. The sector witnessed the emergence of Public Private Partnership 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 thereafter (Subra, 1999). Since then a number of projects have been implemented on PPP model, particularly through Build, Operate and Transfer (BOT) contract. Consequently, it has become increasingly accepted that highways should be built, financed, and operated by private firms and that road user should pay toll for using them. Moreover, users are more likely to accept the concept of paying for roads owned by private sector that builds highways faster and more efficiently than state-owned firms.

However, the National Highway Authority of India (NHAI) continues to carry out regulatory functions including monitoring 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 of adequate quality services, safety, 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 benefitted all passengers travelling on toll roads. While the toll collection and recovering the project development costs are the key objectives of private entities, the issues arising out of providing quality services to the toll road commuters is the matter of highest concern and need to be addressed adequately.

It is mandated to ensure that the highway users are provided with quality services for the toll they pay. It ensures that the road contractor and developers maintain the standards that they are supposed to, according to the concession agreement between the contractors and NHAI, as after all the commuter is levied toll for not just the highway usage but certain services as well. But, 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. (Mamuni Das, 2010)

Road User Services are 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, a group of services the toll road operators are expected to provide to the travelling public include patrolling services, ambulance facilities at the time of accidents, communication facilities, parking lots, rest rooms along road side, motels etc.

1.2 Objectives and Scope of the 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

Scope of Study

The 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 are 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. The Pune tollway system will be assessed on corresponding performance parameters, such as system output (toll traffic, toll revenue, etc.), tolling operations services and road way quality of service to travelers. Then the performance of the toll roads using these parameters is compared. These parameters are selected primarily to ensure that the toll road system fulfills the results that were 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 will enable us 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.

1.3. Motivation for The Study

The need for this study is primarily to solve the problems related to operational toll roads, as users of these roads frequently complain about the very functioning of the system and are utterly dissatisfied with the way the operators collect hefty toll amount but fail miserably in providing quality service across several mandated quality parameters. As bad roads are detrimental to regional growth, monitoring of toll road infrastructure facilities is required. The assessment of performance levels of operational parameters and services gives the status of roads and fixes the responsibility of the agencies involved in road maintenance and management. As the owner, mostly the NHAI, is not conducting customer satisfaction surveys across all the toll stretches rigorously, these kinds of studies can help the authorities to take appropriate actions. It also enables the citizens to provide feedback about the poor condition of the road system and penalize the developers for not maintaining consistence performance.

1.4. Overview of Research Approach

A literature study was carried out to identify factors influencing toll road operations followed by a feasibility study. The literature sources include primary sources comprising reports, thesis, conference reports, company reports and government publications. Secondary sources include newspapers, books, journals, internet, etc. (Mark Saunders et al. 2003). Following this, an appropriate framework of factors involved in performance measurement and detailed data collection methods was developed. Data collection is a multi-pronged approach. It covers a comprehensive search of secondary literature available in the public domain, to determine the efforts of all the stakeholders and current-state of the work in the sector, followed by primary research. The study is basically a cross-sectional, partly descriptive and partly quantitative in nature. The primary data collection techniques broadly include a structured observation study and a questionnaire survey. Data on variables is collected across toll road segments and is partly quantitative and partly qualitative. For example, quantitative data is traffic data and financial data. Qualitative data is toll operation indicators and Roadway Service indicators. Suitable methods are developed for data collection in field and a questionnaire survey for capturing user experience. The data collection process involved (i.) Toll traffic and Toll Revenue (ii) Observation of the tolling process, (iii) Structured interviews for toll road users.

Based on the type of data–quantitative or qualitative, different analyses techniques are used to analyse and interpret the data. The analysis was 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.

1.5. Contribution of Research

As badly maintained roads are proving detrimental to regional growth, monitoring of toll road infrastructure facilities giving various road way services is required. The assessment of performance levels of operational parameters and services gives the status of road and reminds the agencies of their responsibilities regarding road maintenance and management. As the owner, in this case mostly NHAI, is apparently not conducting customer satisfaction surveys, this kind of study can help the authorities to take appropriate corrective actions. It also enables the citizens to provide feedback about the poor condition of the road system and penalize the developers for not maintaining consistent performance.

1.6. Outline of Chapters

Chapter 1: Introduction

Each component of the study such as background, scope and objectives, methodology and data collection procedure is presented.

Chapter 2: Literature Review

This chapter presents a comprehensive coverage of various studies carried out in the toll road system with emphasis on operational performance. Global toll road scenarios with their present status and evolution of toll concepts in Indian context are discussed. Gap analysis is carried out for identifying the scope of the work for the study.

Chapter 3: Conceptual Framework

This chapter covers mainly the theoretical concepts studied for the study and primarily includes performance indicators, performance framework of operational toll road, and the method of measurements of some quantitative and qualitative variables.

Chapter 4: Research Design

The research methodology covering data sources, acquisition of data, data coding and analysis techniques are elaborated. Sampling procedure including sampling frame, size, etc. are specially covered in this section.

Chapter 5: Pilot Study

A small scale research study has been carried out as pilot study for gaining experience prior to the final research study. Two toll ways in Pune region are assessed on the operational performance indicators particularly representing tollway infrastructure services created along tollway side**.**

Chapter 6: Data Analysis and Findings

The data after proper editing is taken through various analysis processes comprising descriptive inferential, and expected outcomes are derived and presented in the most meaningful way.

Chapter 7: Conclusions and Recommendations

This chapter presents summary of the whole study with inferences. The scope for future research will also be discussed.

1.7 Summary

The thesis on "Performance Assessment of Toll Road System- a Study in Pune Region" is an academic inquiry to address the problem of toll roads performance during operational phase. The Scope of the study, the objectives, motivation for the research and a broad research approach and outline of chapters are covered in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1. Global Toll Road Scenario

Tolls have been placed on roads at various times in history, often to generate funds for repayment of toll revenue bonds used to finance constructions and/or operation. In recent years there has been a growing realization in the govt. that road development cannot be brought about only through budgetary support or even through private investment support. The consensus is that a combination of different sources of funding would be the best way forward for the road development. Involving private sector in exchange for the right to charge user tolls was seen as a way to shifting the financial burden to users and maintaining roads more efficiently. However question arise as to what kind of roads in terms of traffic density are suitable for tolling, levy of user charges and commercially viable model of finance and to what extent the toll roads are successful and toll fee support the finance required for the road development in India.(Nagarjuna et al. 2015)

After World War II, high performance expressways were built in most developed countries in Europe, U.S.A, Canada and Japan. For funding these expressways, some countries adopted tax financing while others relied on toll financing. Even both these systems have been used in some countries as in the U.S. In France, Spain, and Italy only intercity expressways were tolled. However, in recent times, it has been observed that many developed countries which once depended on tax financing have also turned to toll system due to erosion of the purchasing power of government taxes because of inflation. Many developing countries such as Mexico, Malaysia, Indonesia and Thailand, however,

have recently started to build high performance expressways relying mostly on toll financing and private concessions (Kapila *et. al.* 1996**).**

Highway infrastructure traditionally has been funded through general government budgets and dedicated taxes and fees rather than tolls. In most industrial countries 90 percent or more of highway kilometers are publicly funded; in developing countries governments often bear the entire cost. However, the limited resources available through traditional government funding sources has led to increasing interest in private toll roads as an alternative way of meeting highway needs. Several additional factors have contributed to the renewed interest in private tolling, including a worldwide trend toward commercialization and privatization of state-owned enterprises; the success of public toll roads in raising capital; and advances in tolling technology, making tolling more efficient and convenient (Fisher, Babbar, 1996 **).**

Road tolls were introduced in Europe to finance the construction of motorways in the 20th century. Italy was the first European country to charge tolls in 1924 on a 50 km tollway section near Milan. It was followed by Greece, which made users pay for network of motorways around and between its cities in 1927. Later in the 1950s and 1960s, France, Spain and Portugal started to build tollways largely with the aid of concessions, allowing faster development of this toll way infrastructure without massive state debts. In most countries toll roads, toll bridges and toll tunnels are often used primarily for revenue generation to pay repay for long term debt issued to finance the toll facility, or to finance capacity expansion, operation and maintenance of the facility itself, or simply as general tax funds .

The most common form of user charges have been fuel taxes and direct fares or tolls .The popularity of toll financing fluctuated with the perceived adequacy of fuel tax revenues and it has been used for expensive facilities that were expected to be particularly attractive to users, thus making up for their higher cost. In the 1950s toll financing was used extensively for financing controlled-access highways in the East and Midwest. In the US the construction of toll roads declined during 1950 -1990 because the availability of generous federal funding for development of the interstate system. However the practice was maintained as Kentucky, for instance, developed toll roads during this period. Further by 1990 it was widely perceived that revenues from fuel tax would not be adequate to keep up with highway development needs and this led to a revival of interest in toll roads. (James, 1998)

Valerie (2016) observed that the public and private sectors play complementary roles in improving the infrastructure network. Therefore, it is critical to strengthen public investment management processes as well as the regulatory framework, including to ensure an appropriate mix of financing and funding for projects and to address environmental concerns.

Ronald et al. (1999) stated the importance of maintenance is increasingly recognized and continued in the 21st century. With the Interstate highway system essentially in place, the focus of transportation programs is shifting from capital investment to maintenance and operation. Senior executives, legislators, and the public consider maintenance key to not only protecting the nation's multibillion-dollar highway investment but also continuing to provide a safe, efficient transportation system. Funding for new highways on the scale of the Interstate program is not likely to be allocated again in the foreseeable

future. The challenge for maintenance managers is to achieve maximum performance from the existing system, which will continue to be paramount for the foreseeable future. In this document, the members of TRB Maintenance and Operations Management Committee (AHD10) identify the major trends that affect maintenance; cite current and emerging innovations in management systems, technology, and intelligent transportation systems (ITS) and examine the key maintenance challenges of this century. The authors envision that careful planning combined with focused maintenance research and implementation will help the nation overcome the highway transportation and environmental challenges of the coming decades.

Infrastructure indicators in the region compare, on average, reasonably well with those in the group of emerging markets at large, and Asia in particular. However, a comparison of each country against the group of its rivals in export markets suggests that competitiveness is compromised in many LAC countries by the state of their infrastructure. Unless progress continues, there is a risk that the observed infrastructure shortfalls, relative to rivals and what might be expected given LAC countries' development levels, may increasingly hamper the region's growth potential. Fiscal policy and fiscal institutions play a critical role in improving the infrastructure network. The extent of fiscal space, and the level and composition of public financing instruments matter significantly for infrastructure stock accumulations.

Nabil et al. (2011) presented the concept of Privatized Roads in South Africa, delivery of road user services and key performance indicators reflecting certain performance areas of operational toll roads. South African National Roads Agency Ltd. (SANRAL) is developing an extensive freeway network in their country. It promoted the "User pay" principle which requires eligible road users to pay for the use of designated toll roads and

tolled facilities in South Africa. Tolls collected help finance the development, operation and maintenance of tolled road network and delivery of related services to road users. It plans to implement Electronic toll collection systems. It mentioned that the performance of the system need be measured before doing some management. Complex projects like toll roads require the operating contractor to be a multi-disciplinarian, and orchestrate the provision of services in everything-from billing to onsite security and from customer relationship management to debt collection and enforcement. The success of projects depends on many factors including achieving levels of public compliance, meeting financial targets, economic empowerment goals, and a delivery of a high level of operational performance. The next step is to identify key performance indicators (KPI) reflecting performance areas. The measurement framework requires score card approach The Open Road Tolling is suggested better than the plaza based system of toll collection as the commuters are not forced to wait.

2.2 Toll Road System in India

Road transport is vital to India's economy. It enables the country's transportation sector to contribute 4.7 percent towards India's GDP, in comparison to railways that contributed 1 per cent, in 2009–2010. The government of India considers road network as critical to the country's development, social integration and security needs. India's road network carries over 65 percent of its freight and about 85 percent of passenger traffic. The road network in India is administered by various government authorities as a part of federal form of government.

The total road length in India increased more than 11 times during the 60 years between 1951 and 2011. From 3.99 lakhs kilometer as on 31st March 1951, the road length increased to 46.90 lakhs kilometers as on 31st March 2011. The length of surfaced roads

which was 1.57 lakh kilometers (39.35 percent of total road length) as on 31st March 1951 increased to 25.25 lakh kilometers (53.83 percent of total road length) as on 31st March 2011.

India inherited a poor road network infrastructure at the time of its independence in 1947. Beyond that, between 1947 and 1988, India witnessed no new major projects, and the roads were poorly maintained. Predominantly all roads were single lane, and most were unpaved, no expressways, and less than 200 kilometers of four lane highways. In 1988, an autonomous entity called the National Highways Authority of India was established by an Act of Parliament, and came into existence on 15 June 1989. The Act empowered this entity to develop, maintain and manage India's road network through National Highways. However, even though the Authority was created in 1988, not much progress was there till India introduced widespread economic liberalization in the early 1990s. Since 1995, the authority has privatized road network development in India, and by the year 2015 delivered a state wise length of over 97,135 kilometers of National Highways, of which 22,757 kilometers are four lane or six lane modern highways (Agarwal, 2013). Besides India has massive primary system of roads such as the National highways and Expressways (Nagarjuna, 2011**).** In 1999, the first initiative for the development of modern road system was taken by the Government of India the Government of India has formulated a seven-phase programme, 'National Highway Development Project (NHDP)', vested with National Highways Authority of India (NHAI), for the development of National Highways in the country (MoRTH). Table 1 presents various summaries of the NH projects taken up by the Govt.

Table 2.1: Various Phases of NHDP, 31 May, 2017			
NHDP Phase	**Particulars**	**Total Length (in km)**	**Investment (Aprx.) Rs. in Crore**
Phases I & II	GQ, EW-NS corridors and Port connectivity	13,413	2,68,260
Phase III	4-laning	11,809	2,36,180
Phase IV	Upgradation/Strengthening of National Highways to 2/4 lanes	13,203	2,64,060
Phase V	6-laning of selected stretches	6,500	1,30,000
Phase VI	Development of expressways	1,000	20,680
Phase VII	Ring roads, Bypasses, Grade Separators, Service roads etc.	700	14,000
SARDP-NE	Accelerated Road Development Project for North-East region	110	2,200
Misc.	Others (Phase I, II & Misc.)	2048	40,960
Total		48,783	11,55.660

Source: www.nhai.org/whatitis.asp, May 2017

2.2.1 Highway Sector Privatization and Toll Policy

The National Highway Act, 1956 was amended to enable the government to levy tolls. The first tolling policy was drafted in 1997 as the National Highways rules (rate of fee), 1997 for both public and private funded highway projects (Arora, 2006).The policy prescribes the user fee for various toll stretches on which toll / user fee is levied. The important features are: (i) Capping rates per km for different types of vehicles (ii) The mechanism to compute toll rates for projects taken up on BOT basis (iii) Concessions to be given to local and frequent users and (iv) Revision of toll rates etc. Tolling in India began with the imposition of tolls on the Ajmer (Jaipur) – Kotputli section of NH-8,

from March 30, 1998. The unit rates for toll fee based on per kilometer were fixed by this policy (CRISIL Research, 2016).

However, the toll fee for the project would be inflation linked and has been fixed by the union cabinet at 1997 prices on the basis of recommendation for the development of four lane national highways. On an average the fee would be increased by about 6 percent per annum.

Haldia et al. (2007) mentioned that the Govt. made it mandatory for the NHAI to use MCA to bid out highway projects post Jan 1, 2007. It protects the revenue interest of the concessionaire. It includes land acquisition clause, target traffic clause, VGF, tolling policy etc. The target traffic clause applies to the projects during operational stage. This particular clause decides extension, reduction and termination of the concession based on the growth potential of the traffic on the toll road stretches. The MCA proposes a reduction in concession if toll revenues are higher than estimates. And there will be an extension in the period of concession if the actual toll revenues are found lower than estimates made during the project feasibility study. At the same time the stretches of high traffic growth potential run the risk of termination or reduction in the concession period.

Shi (2006) defined in brief all the forms of privatization in road sector and the role of the concessionaire. 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. The concessionaire has to keep the road and other assets in a specified condition throughout

the period of concession, as the concession agreement prescribes the design, construction, and maintenance standards.

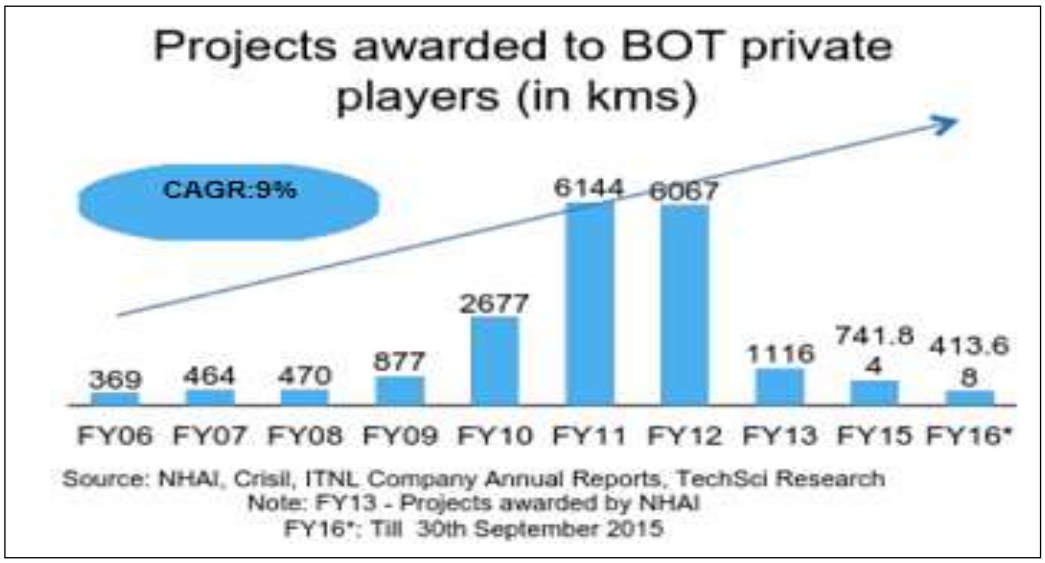
Qamar (2010) pointed that in order to bring private investment into the road sector, the Ministry of Road Transport and Highways (MoRTH) aims to award over 85 percent of National highways and expressways projects on a Built Operate Transfer (BOT) toll basis. While this will result in a large number of 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. 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 (Chandrasekhar, 2010).

Ramnani (2009) In the study it is summarized that Tamil Nadu Road Development Corporation is JV Company between TNIDC and ILFS with the objective to capitalize private sector participation and investment in the road sector and to initiate commercialization of Operations and Maintenance of Road assets. Shubhara (2014) observes the toll collection across the country is improving on the account of the higher traffic volumes generated on some major roadway corridors in the country particularly with high percentage of commercial vehicles.

2.2.2 Private Participation in Toll Road Projects

The private sector emerged as a key player in the development of road infrastructure in India. Increased industrial activities, along with increasing number of vehicles have supported the growth in the road transport infrastructure projects. The government's policy, at both central and state levels, to increase the private sector participation has proved to be a boon for the infrastructure industry with a large number of private players entering the business through the public-private partnership (PPP) model. As on March 2015, projects worth USD 32.69 billion have been awarded through PPP model, with as many as 165 PPP projects still under progress (NHAI Annual Report, 2014-15). During the next five years, investment through PPP is expected to be US$ 31 billion. With the government permitting 100 percent Foreign Direct Investment (FDI) in the road sector, several foreign companies have formed partnerships with Indian players to capitalize on the sector's growth.

The major infrastructure and construction companies like IRB, IL & FS, JAL, ITNL, Reliance Infra, etc. have been actively involved in the toll road building activity for a long time. The IL & FS and IRB are the specialized toll road development companies in India as their share is substantially high in this particular portfolio. IL & FS Transportation has grown into the largest BOT road asset owner in India with approximately 13,100 lane km in its portfolio (CRISIL, 2016). Overall, the number of projects through BOT model increased from year 2006 to 2012, and the number abruptly declined in the subsequent years as it is shown in Figure 2.1.



Source: NHAI, CRISIL, ITNL Company Annual Reports

Figure 2.1: BOT Projects Awarded by NHAI to Private Players

Shubra, (1999) articulated that Road development in India was faced with public funding constraints, thus the sector witnessed the emergence of PPP in the early 1990s. While the National Highway Authority of India (NHAI) continues to carry out regulatory functions including monitoring the projects, setting up quality norms, etc. the operators operate and maintain the infrastructure created during the specified period. Further, Operate, Maintain and Transfer Concept was introduced with an objective to assure road users of adequate quality of roadway services and safety and security standards while undertaking journeys on the toll way stretches and paying the toll.

The NHAI, an implementing agency, was set up in the year 1995. During the period, 1995—97 it worked on practically one project i.e. widening of 330 km. long National Highway (NH) project covering five states. The NHAI has the first toll road in the country – an 80 km long stretch from Jaipur to Kotputli in Rajasthan on which it started toll since March, 1998

2.2.3Toll Revenue Trends

The practice of tolling roads has slowly but steadily gained acceptance. This has reflected in the marked increase in toll collection at both the national and state levels and it has prompted the decision to implement more projects. Toll revenues from national highways have increased consistently. Toll collections for 2006-07 are estimated at Rs 10.3 billion, an increase of about 30 percent over 2005-06. Of this, 80 percent of the collections are from public-funded projects and the remaining 20 percent from private projects. Prior to this, collections witnessed growth rates of 76 percent in 2005-06 and 25 percent in 2004-05. The decline in 2006 and 2007 has been attributed to the delay in bringing eight new stretches under the toll net. The agency continued to collect INR1, 415 crores and INR 1,702 crores in the financial years 2007-08 and 2008-09 respectively. In the past two financial years i.e., 2013-14 and 2014-15 the yearly data shows the toll collection had been far higher than the projected revenues (Phadke, 2015**).** Experts suggest that the tolling potential of national highways can be further enhanced (Phadnis, 2015). Estimated toll collections for the Golden Quadrilateral (GQ) and the North-South-East-West (NSEW) projects are INR 5 million per km and INR 1.8 million per km respectively.

2. 2.4 Issues in Indian Toll Road System

The process of awarding PPP highway projects on BOT models has come to a near standstill for some time now. Today, there are hardly any bidders for highway based projects on BOT models. Most of the BOT projects have failed due to construction cost overruns and a number of them have landed in dire financial straits due to their anticipated toll collections falling way below the expected level. Most BOT project operators are companies that have evolved from EPC contractors into BOT

concessionaires just because of their experience in constructing mega road projects. However, these companies had either no knowledge or very basic knowledge of tolling when they entered the tolling business. Tolling operations were made into an extension of the finance department with a presumption that tolling is a simple activity of collecting the toll fee from road users and nothing more. This conjecture was based on the tolling experiences of developed countries where resistance to pay toll is very low and toll collections are duly supported by statutory regulations (Wadhwan, 2001). Quite a few BOT project concessionaires, even today, consider tolling as a secondary activity to construction.

Samra (2015) opined that lack of transparency and clarity on how the toll collection period and the amount of toll are decided. While the promoter or client of the road generally finalizes these parameters on the basis of traffic density studies, the commuters feel this is often flawed, there by leading to the toll collection contractors reaping huge benefits. They also feel that there should be a policy to make contracts more transparent- the provisions should include display of collection details at the booths, monitoring of traffic flows with digital meters and by Govt. staff and a police chowk at each booth. There are several companies for road development works but unfortunately the promoters of roads do not have the information about the amount of toll collected by the private agencies and how it is utilized.

Following benefits are expected by Toll Road Users in exchange for the toll fee paid by them.

Road User Facilities

Road user services are the advantages or privileges accruing to the vehicle drivers or owners or occupants through the features of road safety, comfort, and convenience, etc

(Khanna, 1993). For example, a group of services the toll road operators are expected to provide to the travelling public include patrolling services, ambulance facilities at the time of accidents, communication facilities, parking lots, restrooms along road side, motels etc. While a huge amount of money is being collected as toll, roadway maintenance and accidents prevention measures are far from adequate as opined by the observers or commuters and they also question the lack of maintenance and inadequate infrastructure on roads and highways, in-terms of clean toilets, parking bays, ambulance services, etc. despite toll being charged heavily.

Quality of Service

The government toll policy allows for a formula that permits annual increase in toll charges, but there are no tracking parameters that could measure the quality of service for travelers. It is mandated to ensure that the highway users get a certain level of quality services for the toll they pay. It is ensured that the road contractor and developers maintain the standards that they are supposed to according to the concession agreement between the contractors and NHAI as after all the commuter is levied toll for not just the highway usage but certain services as well. However, usually the trend is that once the road is ready for operation the tolling starts and everything else is forgotten. The concessionaire continues to collect toll from the ever increasing traffic and appears to have been neglecting the providing quality services to the commuters and deviate from the service deliveries as promised in the concession agreement (Das, 2010).

Waiting Time

Due to perpetual traffic jams reportedly occurring at toll plazas, lots of inconvenience is caused to travelers during peak hours thereby there has been repeated agitations among

the commuters, It has been observed that long delays at toll plazas are the overwhelming source of customer complaints. It is easy to understand why this is such a source of frustration. For most of the trip on a toll road facility motorists can drive in virtually free-flow conditions at 80 to 100 kmph. and feel that they are making good progress. When it comes to the traditional toll plaza, however, the contrast is striking. It is common to face long lines of sporadically moving vehicles that cost each patron delays of five to 15 minutes in peak hours. Time seems to move very slowly in such a situation. Idling and stop-and-start traffic generate high levels of tailpipe emissions, and contribute unnecessarily to air pollution levels (Das, 2012).

The NHAI imposes safety conditions to be implemented on the highways to ensure safety of commuters, but the developers seem to be apparently ignoring these aspects of safety, and the non-compliance to safety standards leads to highway accidents. The latest technologies and solutions are available in the advanced countries but they have not completely entered our country. So we are still following old practices and trying to make improvements (Rajaram subramaniam, 2012).

2.3 Toll Road Economic Advantages

As per Chakraborthy (1996), the primary objective of the investment in a road project is to generate benefits viz- user cost savings, reduction in travel time and accelerated economic development in the influence area of the road project. Prior to the private investment, when only the Govt. could invest in the projects the decision on investment was based on whether the project was economically viable. No infrastructure project could be undertaken if the economic benefits criteria were not met. For, the private sector, however, only the financial viability is relevant.

Khali (2005) presented PPP road infrastructure projects and discussed categorically various objectives of the Toll road projects. The article covers various economic benefits associated with the projects like adding road network capacity, increasing mobility, reducing congestion, increasing quality of road, economic development opportunities, etc. Some risks are traffic diversion, suppression of economic activity, public opposition to tolling and loss of political support. The Profit making potential of toll roads can be improved if toll contractors put in best practices for toll road operations which must be the Goal to satisfy all performance objectives of the toll road system.

Luis, W. (2013**)** reveals the fact that toll road travel has economic advantage particularly travel time saving due to fast ride and also covered the concept of Value of savings in Travel time as there is a relation between toll traffic generated , toll revenue and travel time savings.

Agrawal. M. L et.al (2008**),** in his study, did assessment of impacts on socio- economic attributes based on the perception of people in the influence area of road project. Variation of impact distance from the project corridor is measured and modeled. The indicators considered for the study were employment opportunities, education facilities, health facilities, demographic profile, per capita income, industrial activity and tourism. It was also mentioned in the study that several researchers have suggested the use of perception of people in the influence area of a project for carrying out social-economic impact assessment especially in developing countries where the post-project monitoring data is normally not available. The ADB suggested a questionnaire check list for assessing the socio-economic impacts of irrigation projects in developing countries.

The impacts of toll roads are, in many instances, similar to other highway facilities. However, the impacts of toll roads are differentiated by ongoing toll facility operations, more limited access points in most toll facility designs, and the pace of facility development. The nature and magnitude of any impacts are also affected by the location of the toll facility in urban, suburban, or rural settings. DeCorla-Souza and Kane (1992) discussed the economic reason for road pricing and impacts of peak period tolls on congestion, air quality, and economic development. Many urban areas face the problem of highway congestion that represents an obstacle to economic development. Although commercial traffic and business travelers will bear an extra production cost by paying for tolls, businesses will experience production efficiency and competitiveness through shorter travel time. Therefore, regions can expect business growth and economic development.

Marlon and Chalermpong (2001) studied the impact of the development of toll roads in Orange County, California, on housing prices. Using hedonic models the authors observed that homebuyers are willing to pay for improved access created by toll roads. Homebuyers exhibit a willingness to pay for improved access, which impacts residential development patterns and induced traffic. Parasibu (2005) discussed the impact of toll roads on regional development in the case study of Jabotabek, the largest urban area in Indonesia. The study emphasized the importance of private capital in developing toll roads in Jabotabek. Since government fiscal capacity is limited, private capital increased the opportunity for the area to invest in road development. The author found that the development of industry, creation and expansion of residential areas, and environmental improvements were especially noticeable in toll road areas. Significant improvements in

the transportation system led to increased land values. Further, the toll road system has increased private investment and stimulated socio-economic and regional development.

Weisbrod and Gupta (2003) in their study observed that when transportation network improvements enhance a business's access to markets, that business can realize cost advantages from new economies of scale, just-in-time inventory management, and improved logistical efficiencies. While illustrating the role of transportation infrastructure on economic development, the report reviews road facility development programs supported with state funding that are undertaken specifically to attract or enhance business development activities. The metrics reported in their study as evidence of economic development include the number of new jobs and private capital investment and other measures attributed to the studied road improvements. Kalmanje and Kockelman (2005) assessed the impact of toll roads in the Austin, Dallas/Fort Worth, and El Paso metropolitan planning areas. The authors emphasized differences in network configuration, spatial and temporal variations in demand, and road rider characteristics between these regions. A regional response to toll roads is affected by the enumerated differences determining the real character of impacts on a region's aspects, such as traffic, land use, economic structure, and residents' welfare. Results, which varied by region, showed that there are positive impacts on the regions' in the areas near toll roads.

The report titled Guidebook (Forkenbrock et al. 2001) for assessing the social and economic effects of transportation projects offers methods, tools, and techniques to assess the social and economic effects of transportation projects on neighboring communities, and it provides a review of relevant legislation. This report summarizes 11 general types of social and economic impacts such as safety, changes in vehicle

operating costs, changes in travel time, transportation choice, accessibility, community cohesion, economic development, traffic noise, visual quality, property values, and quality of life. The author recommends the following steps when undertaking a comprehensive impact assessment of a transportation project: assessment of need for the project, feasibility analysis of alternatives, analysis of social and economic effects, analysis of effects of natural system, and communication of results in ways that are easily understood by residents, stakeholders, and decision makers. The effects of transportation projects are divided into two general clusters: transportation system effects, and social and economic effects.

Ramie *et al.* (1999) investigated the willingness to pay attitude for car users and factors affecting the willingness and ability to pay local tolls. The factors include travel time, cost, trip purpose, socio-economic characteristics etc.

Tapan *et al.* (2006**)** covered economics associate with toll road of the Transport Corridor Agency (TCA) toll Road system. The data on various parameters on road segments are collected and analysed segment wise.

2.4 Toll Road Operations and Performance indicators

As per Moody (2006), Operational toll roads are the roads that have exited the construction phase and able to demonstrate its intended function for toll traffic (Moody, 2006). In this study a methodology was developed for analyzing and rating six operational toll roads in US based on mostly assets type and financial metrics.

Atul (2013**)** defined and described toll operations in Indian scenario and narrated various factors affecting tolling operations particularly toll revenue in our country. The factors include willingness to pay toll, toll leakage, local support, parallel routes, plaza design

and location, technology, incidents management etc. However the strategies are mechanisms are not mentioned to overcome these issues that are impediments in tolling operations.

John. (2002**)** examined the operating phase of the city link toll road over the first full year of the post construction period. It was analysed that the observed traffic is less than the forecast made in 1996. The toll road started operational from 2000. Risk analysis and risk allocation framework was covered. The economic benefits based on the travel time savings on toll roads were estimated

PBSJ (2009) presented five toll plaza operational characteristics are briefed and their performance is analysed through mostly financial and output indicators

Prill (2009) addressed the evaluation of performance factors for the commercial buildings in the area of operation and maintenance. The factors identified and evaluated are Energy usage, heating and ventilation, occupant's satisfaction and operation and maintenance. Score cards are developed for rating purpose.

Opoku et al (2013) evaluated the performance of toll plazas equipped with manual and electronic operations. The key performance indicators studied are service time, service rates, vehicle headways, etc. The models are developed based on these key indicators in order to predict the system performance under various traffic scenarios.

Franni H et al. (1994) developed a framework of performance indicators for managing road infrastructure projects across major areas. It was stated that performance indicators were basic inputs to a variety of decision processes and activities in the infrastructure management. The stakeholders such as the network supplies, regulators, service providers and users can use the PIs for analysing performance at various levels.

Ginger et al. (2010) measured performance of Texas toll roads by devising a framework of performance indicators and described performance framework and Goals and objectives of the toll road concessions (PI).

Hass et al. (2009) explained the role of Performance indicators (PIs) in modern road infrastructure asset management for current and future state of road system. The term key PI was originated in Australia for the performance specified road contracts. 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). In the study it was mentioned that in total 72 PIs in 10 categories were selected to represent the economic, social, safety and environmental performance of the road sector. The PIs are to be practical and useable by a transport agency, they should be linked to realistic policy objectives of the road agencies. It is suggested that the policy objectives should be based on or fit with the agency's mission statement. An example set of realistic policy objectives and associated PIs is provided in the study.

Yong et al. (2013) developed Key Competitiveness Indicators (KCI) for evaluating the contractors in the Hong Kong construction industry. Relative importance value is calculated with some mathematical formula for selecting the indicators. The questionnaire is made to collect the judgmental opinion from contractors about the value of relative significance of each competiveness indicator. The indicator with relative importance value indicates that the indicator as a higher effect on contractors' competitiveness.

Praveen et al. (2010) studied the performance of pavement structure of rural roads in state of Uttarakhand and developed prediction models of performance. In the study the Present Serviceability Rating (PSR), Condition and indication is described for various sections of the roads. Severity levels–low, medium and high of different pavement distress like cracking, potholes, raveling and roughness was given based on visual inspection. Performance Index is developed.

Loannis et al. l (2011) covered the performance measures for traffic management like intelligent transport systems (ITS). It is also mentioned that in the absence of specific measures, it is difficult to assess the programmes and policies objectively. The evaluation of the performance of ITS with respect to pollution reduction can be done. The performance measures (PMs) are generated with help of analytical method and PMs are applied in the process of evaluations, decision making support and ongoing monitoring project performance. Goals and objectives are clearly defined with examples-Goal: accessibility and mobility and Related objectives: to abandon private traffic and to provide cycling lanes and walk ways.

Robinson et al. (1998) mentioned that the road administration is supposed to be aware of commuters' needs and is led to develop performance measures or indicators that reflect the policy framework of administration. In fact the most important objectives from the policy framework should be highlighted and adopted as key indicators. They need to be reviewed periodically, and action taken on significant deviations from targets. They are useful for serving number of objectives-Tracking and monitoring toll.

Jolanda *et al.* (2009) toll traffic forecast was studied through various case studies and analysed demand for toll roads in the city Texas. Jack (2006)Used PIs for evaluation of

Para transit system in New York. From sources data elements are used to calculate indicators, and mentioned that the Performance evaluation framework should be workable using readily available or easily collectable information.

Tarrel (2003) Performance measures are defined as quantitative and qualitative. For example, surface unevenness that can be measured directly is quantitative parameter where as customer satisfaction which can be measured through survey / feedback is qualitative. The study defined precisely the "the highway system" and various components. Quantitative variables are important to the operators. However, for analysing quality of travelling experience toll paying customers are targeted for feedback on the service or the facilities of the system.

2.5 Toll Road Services

Gitesh (2016) stated that there are clearly marked 'rest houses" on all major roads and highways in Australia.

NHAI initiated a survey in 2006 to measure satisfaction and capture expectation of various road users. It was the first ever national road user survey designed and conducted by MDRA, a consulting company. The findings helped NHAI to focus its efforts on various concerns of stakeholders. The survey served as a bench mark to track stakeholders' expectations and satisfaction with various initiatives around to improve highway.

Neelima. (2013) carried out a study among drivers for the purpose of ascertaining knowledge of road rules and regulation system level of awareness and mitigation measures through education and enforcement has increased among drivers.

Jill et al (1996) mentioned Road users include motorists and other motor carriers who utilise highway transportation system. The objective of the study was to assess rural road users and perception of road needs. Different rural road user groups were identified to obtain a representative sample of users. User groups targeted in the study included commuters, drivers, staff on vehicles, owners of vehicles. An attitudinal survey was developed and administered to these groups travelling on these roads. Analysis was performed on responses for road services and features. A significant difference is found between several of the road and service features.

The primary objective of a road operator should be customer satisfaction. It is important to provide good quality road infrastructure as well as other amenities to road users with focus on enhancing the safety measures (Kataria, 2014). The performance of a toll road is basically concerned with the Operation, Maintenance and Tolling Segment (OMT) and it is like any other industry where the user pays the toll and expects a certain level of service with regard to roadway safety, security, road way assistance services, etc. (Dubey,2013). A study on road user satisfaction on the completed toll roads of the golden quadrilateral project was conducted and submitted to the National Highways Authority of India (NHAI), highlighting the drivers of user satisfaction like safety, quality service, travel time savings, etc. The study attempted to capture and collect the data on the users' perception on various road user service parameters at the operational level of the road projects and the findings thereby reportedly helped the NHAI to focus its efforts on various concerns of stakeholders.

Quamar (2012) noted broadly various features of the Model Concession Agreement (MCA), a landmark policy initiated by the Govt. of India a decade ago, and for the use of

NHAI for preparing guidelines for awarding and operating the road projects in India. The policy has an important feature of Road User Services and user satisfaction. In the transport industry, the quality of efficient service can be summarized as the service consisting of speed, safety, frequency, regularity, comfort and acceptable cost. These indicators of quality of service rendered by the transport system can be measured by the statistics developed by user opinion scores on the service quality indicators (Rao, 1994). At the same time the performance indicator can be defined as a value that refers to either a metric or a textual description that is used to measure system performance outcomes (Jyoti, 2004). Despite the payment of toll, the condition of the roads on large chunks of highway is quite dismal. Mandalozis (2010) analysed the risk of noncompliance to toll and suggested a mechanism in which the developers could offer to the road users the services that are worth their toll money and thereby providing high level of service to the users. And also defined level of service as effectiveness (quality) of transportation, quality in safety, mobility and convenience are key factors affecting the users' behaviour. High level of service is ensured by the development and application of an integrated monitoring/measuring system of operations performance of various operational objectives. There is a need to provide services as they are value for money for users, and hence the performance targets set for implementing innovative services that include broadly, safety of users, incident management, roadway maintenance, Electronic Tolling, etc. for overall commuters satisfaction.

A highway project creates services all along its route in various forms such as hotels, service and repair, rest houses, toll plazas etc. In the project every user is a client of the operator. Achieving customer satisfaction becomes a tiresome and difficult affair given the diversity of perception and expectation of customers of various social strata. A large

number of studies show that the users of toll roads are not happy with the current services offered by the operators and not willing to pay hefty toll charges and in other words the customers are willing to pay higher charges for better services. In the field of urban transportation, the services of para-transit modes and the deluxe bus services are a direct indication of the willingness to pay for better services in terms of comfort, security and punctuality (Kapshe, Anatharamaiah, 1996).

The study by Renuka Devi and Meenakshi (2011) concentrates on various services provided by the transport corporations and the commuter's perception on the quality of services. It is a cross sectional study with sample size of 100 commuters. The study considered the parameters such as service frequency, punctuality, safety, vehicle condition and cleanliness and fare system. The authors used descriptive statistics for analysis of the parameters.

Toll roads are nothing but the Govt. initiatives aimed at improving public services which are the advantages of building new highway facilities. Otherwise the objectives may be lost if the asset is not well maintained or the traffic is routinely delayed at toll plazas or by accidents. By building a toll roadway, it is possible to provide a list of improved services to the road users and it can also be measured in order to ensure that they deliver the outcomes that are envisaged (Bax, 2011). It is apparent that productivity and efficiency of the operator must be synchronized with satisfaction of the user. The transportation system depends on actions and interactions of four agencies; namely, operators, users, society and the Government. Striking a balance between the various agencies and running the system smoothly and efficiently requires managerial skills of a

high order. There are both external as well as internal factors which govern the quality of service offered to the users or passengers in the system (Patankar, 1994).

Another study by Jetli and Sethi (2007) discusses the maintenance and management of highways through various safety measures and amenities. The study emphasizes that facility to be provided for traffic, including providing relief to the accident victims and ensuring removal of bottlenecks in traffic movement, should also feature in the highway management. The authors have outlined the definition of corridor management as the technique of managing the highways to deliver maximum throughput in terms of speed and traffic volume, while minimizing operational cost and enhancing road safety. O & M contracts are given to achieve these objectives. The broad scope of O & M is road maintenance, road property management, incident management, traffic management and engineering improvements. The study highlighted the various safety measures being adopted as a part of corridor management. They are: (i) Usage of road safety furniture such as; crash barriers, road signage, delineators, road studs, median railing, thermoplastic road marking, and plantation of shrubs in central median to reduce glare of light of vehicles from the opposite direction, (ii) Deployment of round the clock route patrol vehicles, ambulance for immediate rescue of accident victims and tow-away cranes for rapid clearance of the highway, and (iii) Development of wayside amenities to reduce the fatigue of long distance driving. Road user services are the advantages or privileges accruing to the vehicle driver or owner through features of safety, comfort, and convenience, etc. (Khanna and Justo, 1993). Kadyan (2014) is of the opinion that the concessionaire should comply with quality standards and provide user facilities like 24x7 emergency services.

A study was conducted in the state of Himachal Pradesh to compute road user satisfaction index by taking into account 24 variables for all categories of roads such as NHs, SHs, MDRs, etc. The toll stretches are analysed and overall scores, parameters and road segments are obtained after analysing roadways in service performance based on categorization of road users across various socio-economic factors like age, education, income, gender, occupation etc. (MDRA, 2006, 2007 and 2012).

Akbiyinkli and Eaton (2006) in their study described O & M as the most important and longest phase of the project as the services and payment is created. Primarily the O & M focuses on delivery of services and maximising the quality of services and satisfying the end users' needs with minimum costs. The road user satisfaction is tested with services provided. The primary parameters in O & M framework are physical performance and functional performance of a road to satisfy the end users. The physical performance covers maintenance, durability and pavement strengthening etc. whereas functional performance is related to the proper functioning of the constructed asset in operation and covers parameters like driving comfort, safety, easy access etc.

Toll Road Projects have specific economic objectives like expansion of roadway network, increasing mobility, quality of service and other socio-economic development in the region etc. as well as reducing traffic congestion and rate of accidents (Khali, 2005). In other words, from a Toll Road, travelers derive a whole lot of benefits in terms of savings of time and cost than that of with the use of non-toll road. These benefits are measured in terms of the decrease in road user costs and the increase in road user services. Road user services are nothing but the advantages accruing to the passengers through features such as, safety, comfort, and convenience (Khanna et al., 1993). 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. Any new highway project, in the beginning, should specify the project objectives in terms of tangible outcomes such as reduced journey times and improved road safety. In India, the operating agency, typically the concessionaire is responsible for designing of the project and delivering operational services using associated technology (Chris bax 2011) thus the primary objective of a road operator should be customer satisfaction. It is important to provide good quality road infrastructure as well as other required amenities to road users with focus on enhancing the safety measures (Kataria, 2014).

Performance of toll road is basically concerned with the Operation, Maintenance and Tolling Segment (OMT) and like in any other service industry; the user pays the toll and expects a certain level of service with regard to roadway safety, security and road way assistance services (Dubey, 2013). A study on road user satisfaction on the completed toll roads of the golden quadrilateral project was conducted and submitted to the National Highways Authority of India (NHAI), highlighting the drivers of user satisfaction like safety, quality of service, and travel time savings. The study attempted to capture and collect data on the users' perception on various road user service parameters at the operational level of the road projects and the findings thereby reportedly helped the NHAI to focus its efforts on various concerns of stakeholders. Thomas (2007) presented value added services associated with roadway corridors which are broadly classified as public services and commercial services. Jetli et al. (2007) stated corridor management services that are considered as various safety, security and other roadway assistance services.

An attempt has been made in this study to compute road user satisfaction index by taking into account 24 variables for different categories of roads such as National Highways (NHs), State Highways (SHs), and Major District Roads (MDRs). The Toll stretches are analysed and road-wise overall scores and parameters are obtained after analysing roadways in service performance based on survey of road users across various socio-economic factors like age, education, income, gender, and occupation (MDRA, 2006, 2007 and 2012).

Quamar (2012) noted broadly various features of the Model Concession Agreement (MCA), a landmark policy initiated by the Govt. of India about a decade ago, for the use of NHAI for preparing guidelines for awarding and operating the road projects in India. The policy has an important feature of Road User Services (RUS) and user satisfaction. In the transport industry, the quality of efficient service should be summarized as the service consisting of speed, safety, frequency, regularity, comfort and acceptable cost. These indicators of quality of service rendered by the transport system can be measured by the statistics developed by user opinion scores on the service quality indicators (Rao, 1994). The performance indicator can be defined as a value that refers to either a metric or a textual description that is used to measure system performance outcomes (Jyoti, 2004). Oza (2014) opined that despite the collection of toll, the condition of the roads on large chunks of highway is quite dismal. Dimitris (2010) analysed the risk of objecting paying toll, and suggested to offer those services to the road users that are worth their money and provide high level of service. Defined level of services such as effectiveness (quality) of transportation, quality in safety, mobility and convenience are key factors affecting the users' behaviour. High level of service is ensured by the development and application of an integrated monitoring / measuring system of operations performance of various operational objectives. Performance covers financial, operational and

technological perspectives, with each area having a set of parameters to be assessed. Parameters broadly cover areas like safety of users, incident management, maintenance, ETC operations and overall performance and overall customer satisfaction. Toll collection at the majority of toll plazas is done manually. This results in inefficiencies, including traffic bottlenecks and revenue leakages. It has been estimated that a vehicle needs to wait for 5-10 minutes in the queue before leaving the toll plazas. As an efficient measure the toll payment on the operational toll lanes at the plazas can be made by cash, credit or debit card or electronic tolling. By means of the state-of-the- art technologies like debit or credit card the transaction time at the toll plaza is considerably reduced to somewhere between 0 and 15 seconds and the toll lanes can process 12,000 -16,000 vehicles per hour. Three payment modes are available viz. onboard unit, smart cards and cash at the plazas. While cash payment requires 30-40 seconds, swipe card transaction takes 20-25 seconds.

2.6 Modern Tolling Methods and Technology for Efficiency Enhancement

ITS on inter urban roads such as Delhi-Jaipur and Delhi-Mumbai involves precisely the Electronic Toll Collection (ETC) that emerged as an alternative to manual toll collection. The system removes the limitations of manual toll systems and helps in reducing waiting time by automatically deducting the fare from the user account. With the use of ETC, vehicles can pass through toll booths without stopping making it a more convenient and effective method of toll collection. The roadways are served by the state-of-the-art tolling equipment with automatic vehicle classification to prevent toll leakage. However, an open tolling system is used with multi-lane toll plazas at pre-selected points. The stoppage time is less than 10 seconds for cars.

According to a joint study by the Transport Corporation of India and the Indian Institute of Management Calcutta, the implementation of a pan-India electronic toll collection

system on national highways may help save INR 87,000 Crore. The length of time at toll points adds up to a cost of INR 27,000 Crore a year and the extra fuel spent on slowing down and stopping at checkpoints amounts to an additional INR 60,000 Crore. The ETC will also benefit toll operators as faster toll collection will lead to higher throughput which would translate in to increased revenue generation and reduced operating costs. Cost of managing manual toll collection booths is in the range of $150,000 to $180,000 per year as compared to $5,000 per year for ETC lanes.

Figure 2.2: Electronic Toll Collection System

Source:http://www.smartcube.co/INDUSTRIES/TransportationTraffic/ElectronicTollCollection.aspx

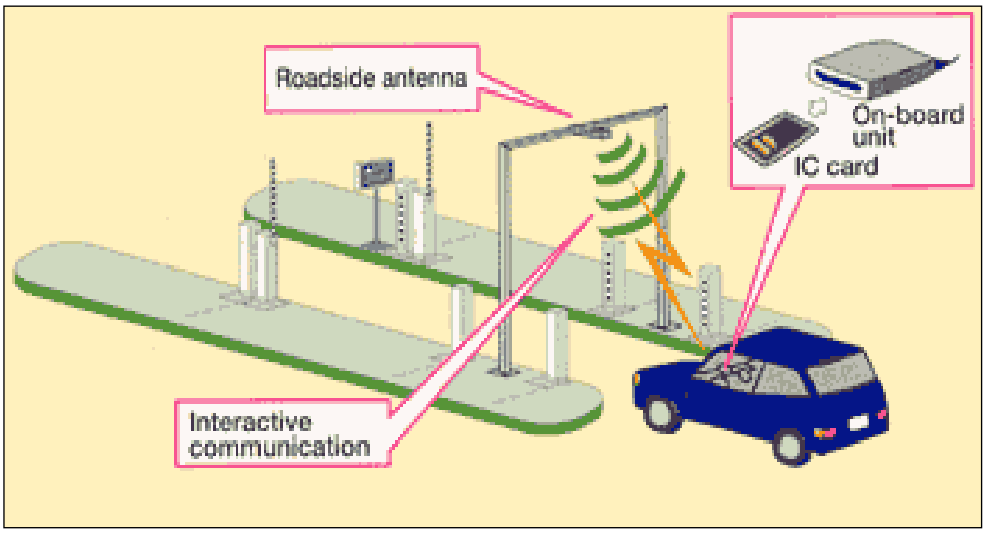


Figure 2.3: Electronic Toll Collection Lane System

Source:http://www.mlit.go.jp/road/ITS/2000HBook/chapter4/4-8e.html

On Board Unit (OBU); It allows vehicles to pass through the toll plaza unhindered by means of an on board electronic unit, called RFID device, which debits their account on each passage.

Figure 2.4: On Board Unit Devices

Source:https://www.google.co.in/search?q=electronic+toll+collection+system&espv=2&biw=1366&bih=638&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjEktD45vPRAhVBQY8KHdHACtgQ_AUIBigB#imgrc

Smart Cards: Smart cards are issued to those who make a minimum of 50 trips a month and Rs. 100 will be collected as administration charges.

Figure 2.5: Smart Cards

Source:https://www.google.co.in/search?q=electronic+toll+collection+system&espv=2&biw=1366&bih=638&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjEktD45vPRAhVBQY8KHdHACtgQ_AUIBigB#imgrc=_

Smart Tag: It involves attaching an e-tag to the vehicle. The tag transmits radio waves as the vehicle approaches the toll station and the amount is debited from the commuter's bank account, thus allowing the commuter to move without stopping.

The research gap analysis has been carried out through studying various relevant literatures and the respective contributions by various authors**.** The process involves thorough reading of literature in terms of the domain knowledge, factors associated with

the study, highlighting the various authors' contributions and identifying the factors which are not particularly covered in their studies. So a big table comprising elements like title of the study, name of the author, source of publication or article, year of publication or presentation and gist of contributions, is constructed and the similar process is followed for all relevant studies and presented in a particular order in Table No. 2.2: summary of relevant literature survey followed by a section of "Research Gap", section no. 2.7 .

2.2 Summary of Relevant Literature Survey Conducted In Chronological Order of Research Articles Relevant To This Research

Sl. No.	Title of the paper	Publication	Author/s	Publishing Year	Contribution
01	Framework of Performance Indicators., international conference on Managing pavement	3rd International Conference On Managing Pavements	Franne Humlic	1994	Developed a framework of performance indicators for managing road infrastructure projects. The performance was measured at five major levels by identifying and defining various indicators at each level. It was stated that the performance measures are the basic input to a variety of decision processes and activities in an infrastructure management. The parties such as road users, service suppliers, road network suppliers and regulating agencies can use the performance indicators for analysing the performance of the network of infrastructure.
02	BOT projects- The risk and the operator Magazine: infrastructure of the future-theme: transportation	Book Chapter, International Symposium on Infrastructure of the Future	Kapshe S	1996	A Transport project creates services all along its route in various forms such as hotels, service and repair, rest houses, toll plazas. Etc., which are to be used at that place only. In the project every user is a client of the operator. Achieving customer satisfaction becomes a tiresome and difficult affair given the diversity of perception and expectation of customers of various social strata.

Sl. No.	Title of the paper	Publication	Author/s	Publishing Year	Contribution
					A large number of studies show that the users of toll roads are not happy with the current services offered by the operators and not willing to pay hefty toll charges and in other words the customers are willing to pay higher charges for better services. In the field of urban transportation, the services of Para-transit modes and the deluxe bus services is a direct indication of the willingness to pay for better services in terms of comfort security and punctuality.

Sl. No.	Title of the paper	Publication	Author/s	Publishing Year	Contribution
03	"Willingness-to pay attitude of car users on toll charges" , Journal Of The Eastern Asia Society For Transportation Studies	Research Journal Of The Eastern Asia Society For Transportation Studies 3 (4)	Ramie	1999	Investigated the willingness to pay attitude for car users and factors affecting the willingness and ability to pay local tolls. The factors include travel time, cost, trip purpose, socio-economic characteristics etc.
04	An initial Performance review of Melbourne's City link toll Road., Australasian Transport Research Forum	Research presented in 25th Australasian Transport Research Forum. 2002	John F	2002	The study examined the operating phase of the city link toll road over the first full year of the post construction period. It was analysed that the observed traffic is less than the forecast made in 1996. The toll road started operational from 2000. Risk analysis and risk allocation framework was covered. The economic benefits based on the travel time savings on toll roads were estimated.

05	Performance measures of operational effectiveness for highway segments and systems	Transportation Research Board, National Cooperative Highway Research Program Synthesis 311	Terrel Shaw P. E	2003	Performance measures are defined as quantitative and qualitative. For example, surface unevenness that can be measured directly is quantitative parameter where as customer satisfaction which can be measured through survey / feedback is qualitative. The study defined precisely the "the highway system" and various components. Quantitative variables are important to the operators. However, for analysing quality of travelling experience toll paying customers are targeted for feedback on the service or the facilities of the system.
06	Linking Performance to budget., Indian infrastructure	Article, Presented in Indian Infrastructure. 6, 43-45	Akash Deep	2004	Performance indicator is a specific value used to measure output or outcome. The parameters selected are based on service quality, efficiency, effectiveness and financial strength. Performance incentive is the tool for efficiency in service delivery at the individual levels. So the Process of performance management is as follows : 1. Review 2. Evaluate the toll road system 3. Analyse 4. Remove deficiencies 5. Make plans and proposals and mechanisms 6. Evaluate plans 7. Recommendations. Example for PIs are average rating score etc.

07	Economic benefits of toll roads operated by the transport corridor agencies, LECG	Research	Tapan Munroe	2006	Covered economics associated with toll road of the Transport Corridor Agency (TCA) toll Road system. The data on various parameters on road segments are collected and analysed segment wise. The study analyzed economic aspects of projects during development stage; however it did not cover operational features of the toll road projects and performance measurement of the performance indicators during operations stage.
08	Transit Performance Measurement	Research Published in ,H:\Projects\ Transit course\ performance sec-2 doc	Jack Reilly	2006	Used PIs for evaluation of Para transit system in New York. From sources data elements are used to calculate indicators , and mentioned that the Performance evaluation framework should be workable using readily available or easily collectable information.

09	Measuring performance indicators for Roads: Canadian and international practice	Paper presented in Annual conference of the transportation association of Canada, pp. 1-22, 2009.	Ralph Haas	2009	Explained the role of Performance indicators (PIs) in modern road infrastructure asset management for current and future state of the road system. The term key PI was originated in Australia for the performance specified road contracts. 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). In the study it was mentioned that in total 72 PIs in 10 categories were selected to represent the economic, social, safety and environmental performance of the road sector. The PIs are to be practical and useable by a transport agency and they should be linked to realistic policy objectives of the road agencies. It is suggested that the policy objectives should be based on or fit with the agency's mission statement. An example set of realistic policy objectives and associated PIs is provided in the study. The Study has not addressed toll way service indicators measurement process.

Sl. No.	Title of the paper	Publication	Author/s	Publishing Year	Contribution
10	Actual –Vs- Forecasted Toll Usage: A Case Study Review", Centre For Transportation Research- The University Of Texas At Austin	Research article in A Case Study Review", Centre for Transportation Research- the University of Texas At Austin, 2009.	Jolanda Prozz	2009	Toll traffic forecast was studied through various case studies and analysed demand for toll roads in the city Texas.
11	Electronic Toll Collection beginning towards Seamless Travel	Article, Indian Infrastructure, 13(5): 22-24	Sharif	2010	It is also described the manual tolling, unattended tolling,, ETC, Open road tolling (ORT) and GPS systems. The first two methods may be used for low and moderate traffic volumes and the remaining three are used for high and very high volumes with the technology support. GAP; unattended tolling method can be tried for low volume roads in India.
12	Policy Reforms Towards Increasing Private Sector	Article-Indian Infrastructure	Chandrasekhar M.	2010	Mentioned National highway fee rules, 2008: this policy prescribed the stretches on which 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.

13	Made To Measure Performance Management On South African Toll Roads., Traffic Infratech	Article presented in Traffic Infra Tech., pp 34-39, September, 2011	Nabilabou	2011	South African National roads agency Ltd (SANRAL) is developing an extensive freeway network in their country. It promoted the 'User pay "principle which requires eligible road users to pay for the use of designated toll roads and tolled facilities in South Africa. Tolls collected help finance the development, operation and maintenance of tolled road network and delivery of related services to road users. It plans to implement Electronic toll collection systems. It mentioned that the performance of the system need be measured before doing some management. Complex projects like toll roads require the operating contractor to be a multi-disciplinarian, and orchestrate the provision of services in everything-from billing to onsite security and from customer relationship management to debt collection and enforcement. The success of projects depends on many factors including achieving levels of public compliance, meeting financial targets, economic empowerment goals, and a delivery of a high level of operational performance. The next step is to identify key performance indicators (KPI) reflecting

Sl. No.	Title of the paper	Publication	Author/s	Publishing Year	Contribution
					Performance areas. The measurement framework requires score card approach The OPEN ROAD TOLLING is suggested better than the plaza based one.
14	Assessment of OMT and Toll collection market for road projects in India	Research Report	CRISIL	2013	Covered the overview of the infrastructure development in Indian roads and Highways, PPP framework, MCA and overview of new toll policy. Further covered are key trends in tolling business and OMT business. Also covered toll act; Central govt. is authorised levy a fee (toll) under section of NH, Act, 1956 for public funded projects and under section 8A of the said act for private investment projects. Two lane roads with cost perkm more than Rs. O. 25 billions will be toll able. O 7 m was introduced in India for the first time in 2009.
15	Performance evaluation of two toll plazas on The Accra- Tema motorway	International Journal of Engineering and Science,	Richter Opoku-Boahen,	2013	Evaluated the performance of toll plazas both manual and e- zone lanes. The performance indicators studied were service time, service rates, headway etc. The models were developed based on these indicators for the prediction of the system performance under different traffic scenarios. The study defined the performance indicators very briefly. Seven levels of services were defined based on 85 th

Sl. No.	Title of the paper	Publication	Author/s	Publishing Year	Contribution
					percentile delay of traffic at the plazas. The traffic flow through toll lanes were observed by video recording system and viewed on desk top computers.
16	Performance evaluation of two toll plazas on the Accra-tema motorway., international reference journal of engineering and science	Research Paper in International Reference Journal of Engineering and Science. 2(5): 16-25.	Opoku-Boahen	2013	Evaluated the performance of toll plazas both manual and e- zone lanes. The performance indicators studied were service time, service rates, headway etc. The model was developed based on these indicators for the prediction of the system performance under different traffic scenarios. The study defined the performance indicators very briefly. Seven level of services were defined based on 85th percentile delay. The traffic flow through toll lanes were observed by video recording system and viewed on desk top computers.
17	Importance Of Developing And Using Analytical Models In Forecasting., Traffic Infratech	Article in Traffic Infratech, 3, 68-70.	Luis Willium	2013	A successful toll road must provide a useful advantage over the use of alternative, unrolled, routes. The most important of these is a saving in time spent travelling. Drivers will then consider this time saving and compare it against the cost of the toll and decide whether they are willing to pay for it. Some drivers will have a high willingness to pay where others will prefer to save the money and incur in additional travel time. Willingness to pay is closely linked to two factors: how

					important it is to save time and personal family income. The more valuable the time saving or the higher the income, the greater the willingness to pay. The Value of Travel Time savings (VTTS) is described as monetary units per minutes or per hour. The VTTs deserve careful attention and it can be computed for different socio-economic groups and trip purposes. It can be further analysed in Short and long trips and free and forced flow conditions (traffic light, roundabouts, congestion etc.)Angles. And also a relation can be made between traffic flow, revenue for a toll road and VTTS.
18	Survey On Vehicle And Toll Plaza For National Highways In India International Journal Engineering And Computer Science	Research International Journal Engineering And Computer Science, pp. 2823-2837, 2013	Satya, V. Abdul Samanth J	2013	Investigated the different operational systems of collecting tolls along the toll plazas through the measurement of service rate of vehicles. Analysed E-lanes and manual lanes and found that E lanes work more efficiently. Described various methods of tolling in India along with advantages and disadvantages.

Sl. No.	Title of the paper	Publication	Author/s	Publishing Year	Contribution
19.	BOT toll Road projects in India	ICRA Report on Rating Methodology	ICRA	March 2015	The ICRA rating agency examined various toll projects in India particularly during project development stage. The factors considered in the rating system are delay of projects due to land acquisition, environmental clearances, issues with developers funding risks and cost and time over run of the projects. Also considered factors like risks associated with key components of projects such as funding of the project, land, contractual obligations etc. The key factors required for operational phase assessment, like roadway services, toll plaza operations are not covered.
20	Assessment of Operation- Maintenance-Transfer (OMT) and Toll collection market for road projects in India	CRISIL Report	CRISIL	2016	CRISIL carried out assessment based on very broad parameters associated with toll road project development and market models. Mentioned overall trends in road sector particularly in OMT segment in determining some drivers of OMT market in India. The Research question of addressing operational performance and the factors required in the process not covered.
21	Road accidents in India	International journal of Advanced and Integrated Medical sciences	Sharma S M	April-June 2016 1 (2) 57-64	The article highlighted the tremendous rise of road accidents in India, impact on societies and causal factors. Poor traffic control, bad roads, lack of public awareness, incompetent authorities and lack of implementation of

					existing laws and rules are attributed the alarming rise in accidents. Factors l such as street lighting, car and vehicle parks, ambulance and trauma care centers are key factors represent road ways quality services dealing with minimizing rate of accidents.
22	Studying and forecasting tolls is inefficient, unproductive and expensive	ATFI Report	Alliance for Toll free Interstates	2016	This paper describes the financial performance of toll projects and states that some toll roads have attack record of failure. Case studies dealing with financial indicators are covered and the performance gaps in terms of predicted revenue and actual revenue are observed in some case studies.
23	Report of the Working Group on Central Roads Sector	Government of India, Ministry of road transport and highways, 12^{th} Five Year Plan (2012-17)	MoRTH	2016	The state of Indian highway network is described along with development trends across various phases of highway development in India. Responsibilities of various key stakeholders are also defined in this report. Roadway services are specially mentioned as key component of operational highways and role contractors in maintaining and operating this service along with the highway assets.

2.7 Research Gaps

In addition to the traffic count and toll collection figures for every toll road, it is important to display measurable service parameters such as waiting time, accident-response time, road roughness near the toll plaza and on the road, commuters' feedback, etc, but this kind of information is always missing. In India there is hardly any mechanism devised for measuring toll road performance unlike other countries. Attica toll ways in Greece handles over 3 lack vehicles on average every day and the toll operators conduct customer satisfaction surveys from time to time to measure the performance of toll ways. In India, in absence of such programmes virtually the road project owners are not in a position to identify and incentives/penalise good performers/poor performers. Evaluation and service quality monitoring systems are not widely implemented across the toll sector particularly during operational phase. At the same time, few studies were carried out for depicting the condition of toll roads across various functional factors, and also studies are not available to address the broad research question – the holistic performance of tollways during the operational stage undertaken for this study. And though it is believed that roadways service levels can vary widely in the region there are not yet passenger's ratings of individual roadways. Hence this research study will address this problem. It was found that there has been no comprehensive evaluation system and assessment tools for measuring operational performance of toll roads holistically so broad tools for the performance measurement were devised as a part of the study-Tools - i. Toll road traffic data and Toll revenue, ii. Observation of toll operations processing and, iii. Road user survey technique for collecting opinion variables.

2.8 Summary

This chapter presented the literature related to the concept of operational performance of toll roads. The performance framework across various performance dimensions comprising relevant quantitative and qualitative variables is illustrated. The research reviews are systematically carried out in order to identify the research gap in the selected domain of research. The relevant articles published in various journals, resources available in library and on line are read to develop the knowledge base in the subject and to identify the factors for the study. The articles are analysed across the dimensions of the research problem to find out the prioritized research gaps, thereby the gap of research is described at the end.

CHAPTER 3

PERFORMANCE OF TOLL ROAD SYSTEM: CONCEPTUAL FRAMEWORK

3.1 Introduction

The toll road planning process starts with the decision to adopt planning as a tool for achieving certain desired goals and objectives. After the Goals and objectives are defined, solutions are generated taking due cognizance of problems and constraints. These solutions are evaluated after thorough analysis. The best amongst them is chosen for implementation. After implementation the system is studied in operation and its performance is assessed. Based on this assessment it may be necessary to go back certain stages of planning and repeat the sequence. (Kadiyali 2010)

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 (comprehensive list is given in section 3.2) of each business area forming the project. Further, it can be equal to actual results on the standard expected results. Performance 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 as 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 operated 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 data provided by the systematic observations in the field. The data, either internal or external, can be further ordered into statistical / textual information and presented into 'indicators' that are believed to express structure or change of the operational condition of the system. The term key PI was originated in Australia for the performance specified road contracts. 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.

3.2 Operational Objectives of Functional Toll Roads

The comprehensive list of objectives in all performance related areas of toll road projects during operation period is presented below (Chakraborthy 1996, John 2002**,** Ginger et al. 2010, Loannis et al. 2011):

i. To determine actual flow of traffic on the project road
ii. To demand and collect road user fee from users
iii. To revise the toll fee annually
iv. To make provisions for toll exemption for local users
v. To provide toll pass to the frequent users
vi. To check over-loading of goods vehicles by setting up weigh-in- Motion bridge at toll plaza
vii. To display toll fee rates for one km. before toll plaza and at the toll plaza
viii. To maintain a public relations office at each of toll plaza
ix. To keep a complaint register open to public access at all times for recording of complaints by any person
x. To inspect the complaint register every day and take prompt and reasonable action for redressal of each complaint.
xi. To provide emergency medical aid post at the toll plazas.
xii. To provide ambulance service round the clock
xiii. To provide traffic aid post round the clock with patrolling services
xiv. To prepare toll fee statement monthly and submit to the Authority
xv. To co-ordinate with the safety audit of project highway

xvi. To develop, implement and administer a surveillance and safety program for providing a safe environment on the project road

xvii. To provide materials and equipment

xviii. To train employees

xix. To provide road user amenities

3.3 Defining Performance Indicators

Performance Indicators (PIs) can be defined in a variety of ways:

i. PI is a measure, usually quantitative, which reveals information about certain characteristics of a service as it remains in both statistics and textual form.

ii. PI is a variable that indicates functional performance of a system either at processing level or output level. The indicators that are used to measure company's objectives are called output indicators.

iii. PIs are powerful tools for monitoring and improving system services. The system may be business, manufacturing, transit, etc.

iv. Performance Measures / Indicators (PIs) are nothing but a basic input for a variety of decision processes and activities in infrastructure management (Frannie, 1994)

v. It is the result of the comparative analysis of a performance measurement out come to the corresponding performance goal. These measurements give an indication of performance

vi. PIs form the criteria for assessment of the performance of the system. For example, 'Profit' is a PI parameter that the firm / business is interested in, where as the 'customer satisfaction' is another PI parameter that can be obtained by customer ratings through customer satisfaction survey.

3.4 Performance Indicators and Performance Index

When we have too many indications to consider as it is necessary to present information from several related areas simultaneously, performance indexing becomes a useful performance management tool. Simply put the index combines indicators of all the performance areas. The philosophy behind using performance indexes is simple: they condense a great deal of information into one number- a statistical measure of how a variable, or a set of variables, changes over time.

3.5 Application of Performance Indicators

The stakeholders relevant to the sector use the PIs depending on the requirement and interest. For example, quantitative variables such as "Toll Traffic" and "Toll Revenue" are important to the operators and agencies as they measure the output of the system as it is mentioned in the company's objectives framework. While the indicators used to measure a company's objectives are called output indicators, the variables used to tap the concept of user satisfaction on various dimensions of quality of road user services are called process indicators. The list of indicators with the corresponding application area is given in the *Table 3.1***.**

3.6 How to Obtain PIs

Some of the PIs readily available in most systems, and others can be collected and analysed as conditions warrant. Some PIs can be measured objectively at individual facility level, e.g. "Toll Fare Processing Time (in seconds) at the Toll Booth". However, some PIs need to be derived through other simple and readily available variables or statistics. Example, for analysing quality of travelling experience toll paying customers is targeted for feedback on the service or the facilities of the system (Shaw, 2003). For analysing a complex system like transport, one could probably

devise much number of PIs. However, experience has shown that in many situations a relatively small number of measures can be used effectively. In a particular study, it was mentioned that a total of 72 PIs in 10 categories were selected to represent the economic, social, safety and environmental performance of the road sector (Ralph Haas *et al.2009).*

3.7 Classification Based On the Nature of PIs

For the sake of computational convenience, the PIs can be categorized as Simple, Composite and Complex.

Simple PIs: It can be measured and recorded by direct observation.

Example: 'Traffic Density', this variable can be measured in number of vehicles per time (such as an hour or a day) as low, medium and high volumes of a particular road.

Composite PIs: It can be calculated by using minimum two simple variables

Example: Delay on Toll Road Segment:

Segment Delay (sec.) = [Actual Travel Time – Acceptable Travel Time] x Vehicle Volume

The acceptable travel time is the total travel time it would take to travel a segment during expected conditions, normally less than actual travel time. Such model calculation deriving PIs are presented in *Table 3.1***.**

Complex PIs: It is an abstract concept multidimensional in character. As such it cannot be measured directly, they are measured indirectly by indicators - in this case items in Likert scale and such indicators are manifesting variables.

Example: Road user satisfaction or travelling experience that has several dimensions with various elements in each dimension. In order to measure this type of PIs scale are required to be designed. In short, the PIs are analysed to determine if the system's performance is satisfactory relative to the goals set for the system, or with respect to an external norm. The method of determining the performance score with multiple variables is explained in the subsequent paragraph – 'Method of Calculation of PIs'.

Table 3.2 presents the relevant Key Performance Areas such as traffic and toll, road user's services, financial and operational and toll infrastructure related ones etc. and specific Performance Indicators under these areas generally considered for the study.

Table 3.1: Model Calculation for Select Indicators

S. No.	Name of the Indicator	Nature	Measure	Data Source	Method of Calculation	Application / User
1	Category of roadway	Textual	NH / SH	Toll office	N.A	Road building agency
2	Length of stretch	Simple statistic	Kms.	Toll office	N.A	Road -building agency
3	Number of lanes	Simple statistic	Number	Toll office	N.A	Road -building agency
4	Project cost	Simple statistic	Rs.	Toll office	N.A	Road- building agency/toll contractor
5	Traffic density	Simple statistic	Number of vehicles per day	Toll office	Traffic volume counts	Govt. and Contractor
6	Volume / Capacity (V/C)	Simple statistics	Number.	Toll office	Ratio between traffic volume and Capacity	Utilisation of roadway
7	Speed on the toll way	Simple statistic	Km/ph	Toll office	N.A	Road user
8	Delay on toll road	Simple statistics	Minutes	Field survey	Delay on toll way=(Actual travel time -acceptable travel time) x traffic volume	Road user
9	User satisfaction on safety	Abstract variable	Opinion /attitude	User survey	Performance index = average score of all safety elements	For decision on improvement
10	User security	Abstract variable	Opinion /attitude	User survey	PI= average score of all security elements	For decision on improvement

Source: Compiled by the researcher from various sources

3.8 Model of Performance Measurement: The Key-Area / Performance Indicator Framework

Step 1 : **Job Purpose** (Be concise and precise. *In this case, it is O & M of Toll Road*)

Step 2 : **Key Areas** (Aspects of the job vital to success. *In this case Operational, Financial, Safety, Security, User Amenities, etc*.)

Step 3 : **Performance Indicators** (How performance is evident, generally as many as possible include subjective indicators, *In this case, Toll Traffic, Toll Revenue, Road Way Signs, Signals, Markings, and Quality of Services etc.*)

Step 4 : **Objectives and Standards** (review performance indicators, select most useful, write SMART objectives and /or standards, *In this case Comprehensive list of Objectives are mentioned above*)

Key Area 1	Key Area 2	Key Area 3	Key area 4
*	*	*	*
*	*	*	*
*	*	*	*

(*: Performance Indicator)

Table 3.2: Key Performance Areas and Indicators Framework

KEY PERFORMANCE AREAS				
Provision Of Infrastructure	**Traffic and Toll**	**Road Users (commuters and drivers) - Services and Safety Measures**	**Financial**	**Operational**
Category of Road Length of project road Number of lanes Project cost Number of toll plazas on the toll road Number of toll lanes Type of technology Toll collection system	. Traffic composition . Traffic estimate . Toll exempted vehicles . Local commuters / pass holders	Communication facilities Rest rooms Repair and service centers Road fencing Road marking Sign posts Signaling system Lighting facilities Safety devices). Parking lay-byes . Emergency medical aid posts 2. Ambulance services	1. Gross Toll receipts 2. Net revenue 3. Operation & Maintenance expenses 4. Profit/ Loss 5.Toll leakage	Toll fee processing time Toll plaza outfit (equipment and staff) engagement Number of vehicles processed per hour or a day Average Travel time saved by commuter in one way trip Journey experience (excellent/ good/ bad) Users satisfaction on the wayside an amenities Percentage of traffic that by passing toll road (Toll road should capture maximum traffic with few vehicles on the alternative road is allowable)

Source: Compiled by the researcher from various sources

It is to ensure that the objectives are clear as per the version of the SMART format as below.

1) **S**pecific indicators should be identified
2) **M**easurable outputs should be prioritised
3) **A**ccountability to public should be upheld
4) **R**eporting on periodic basis should be undertaken
5) **T**ransparency and training should be pursued.

3. 9 Method to Calculate PIs

For measuring the parameters like 'Quality of Service' or 'User Experience' on the quality of services delivered by the road contractors, Likert Scale is designed to collect user opinion on the series of the items (statements) of various dimensions of the services like safety, security, information technology, general amenities etc. The opinion is collected on 5-point numeric rating scale. The series of statements - the rating questions or descriptions are combined to measure a wide variety of concepts such as customer loyalty, service quality and job satisfaction. For each of these concepts the resultant measure is represented by a scale score created by combining the scores for each of rating questions. Therefore, the 5 point numeric scale allocated to response categories (5 = Excellent, 4 = Good, 3 = Reasonable, 2 = Poor and 1 = Awful) will make it easier to aggregate responses using a computer to SATISFACTORY (Scores 5, 4 or 3) and UNSATISFACTORY (2 or 1). The underlying method of quantifying the data on the variables manifesting the concept of 'travel experience' through dummy variables, V_1, V_2 and V_3 is illustrated in *Table 3.3*.

Table 3.3: Sample Performance Index

Variables / Respondents	V1	V2	V3
1	3	3	4
2	4	2	3
3	4	2	2
4	2	3	3
5	3	2	4
6	4	2	3
7	3	3	4
8	5	3	3
9	4	2	4
10	4	2	4
Performance Scores	**3.6**	**2.4**	**3.4**

Performance Indicators include measures applicable to both users and non-users of toll road system, as well as measurement of roadway facility itself. The PIs are to be practical and usable by a transport agency and they should be linked to realistic policy objectives of the road agencies. It is suggested that the policy objectives should be based on or fit with the agency's mission statement. A set of realistic policy objectives and associated PIs is provided in the study as an example. It should be easily available from the sources, easily collectable and be calculated using readily available data. It should reflect the objectives of clients / organisation, (example: 'travel time') as a key indicator and recommended for use as it has the strongest fundamental link between user perception and the mobility provided.

3.10 Summary

This chapter established theoretical framework for the study and presented concepts and key terms in the research domain. The Model Framework comprising key performance areas and the related indicators is designed and presented. The performance framework design is based on the interest of various stakeholders involved in the operational domain of the toll roads. The performance measurement of abstract concept like "quality of road services" is described and process of measurement is presented.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 Overview

In this study, the researcher intends to devise a framework to evaluate performance of operational toll roads in Pune Region through select performance indicators in key performance areas. As the researcher intends to analyse the operational performance of a toll road system, select toll road sections in neighborhood of Pune region were studied for various performance parameters. Since the study contemplates managerial issues of toll roads in operational stage, detailed data was required to understand and analyse the problem holistically across all the performance areas. Suitable criteria for measurement of performance are used. This is precisely, an appropriate framework for information fitting into the study and corresponding factors involved, was developed and detailed data collection methods were devised. Data collection is a multi-pronged approach as it covers a comprehensive search of secondary literature available in the public domain, to determine the efforts of all stakeholders and current-state of work in the sector, followed by primary research.

The primary data collection techniques broadly include 'toll and traffic' information, a structured study based on observation and a questionnaire survey for capturing user experience. Data on the selected factors are collected across toll road segments and it is partly quantitative and partly qualitative- for example, quantitative data is traffic and financial indicators data and qualitative data is toll operations indicators and Roadway Services indicators. Thus, the selected roads are evaluated on some quantitative parameters such as toll traffic, toll revenue, the indicators representing operational aspects of toll plazas, as well as qualitative perception-based parameters

such as road user services and economic factors. The data collection process involved the following aspects broadly.

i. Data on Toll traffic and Toll Revenue,

ii. Observation of toll booth sites and process of toll collection,

iii. Road user survey through questionnaires.

The data collection methods are explained in subsequent paragraphs.

4.2 Research Questions

Questions were framed by first identifying the main question, followed by sub questions under it.

Main Question:

How to assess performance of operational toll road system and what are the key indicators of performance?

Sub Questions:

- What are the factors affecting performance
- How to assess toll booth operational performance and what are the parameters?
- What is the performance of Toll traffic and Toll Revenue?
- How does the public view the system performance?
- What are the issues the toll road system has during its functioning?

4.3 Research Objectives

1. To identify specific indicators to evaluate performance of toll roads

2. To develop evaluation criteria to measure performance of toll roads
3. To check deviation in performance factors and suggest measures for improvement

4.4 Data Collection Methods

4.4.1 Traffic Data collection method

The objective of this particular survey is to collect and analyze data on various 'traffic and toll' collection performance factors and comparing the toll roads on the corresponding indicators. The primary factor in this regard is toll traffic comprising vehicles passing through toll booths; the categories include Car, Jeep, Bus, Truck, MAV, 3-Axle vehicles, etc. The other details of data include the toll rates of different class of vehicles, Toll plaza name, number of lanes, number of toll gates, the toll stretch length for which the toll is collected at the toll plaza, starting year of operation and name of the operator. *Toll Traffic Data Collection Procedure*: A schedule was prepared for paying visits to various toll plazas around Pune region. At the toll plaza, requisite permissions to gather the data were taken from the toll plaza officials. With the toll operator's permission, Data on toll traffic for various types of vehicles was extracted from records maintained in toll office. Subsequently the traffic figures in the records were verified by conducting field studies and random sampling through the standard methods of traffic volume counts –Average Daily Traffic (ADT) and Average Annual Daily Traffic (AADT)(Kkadiyali,2010). However some useful data related to project information was also required, which was collected from the secondary sources like the project's concessionaire documents, for the study. Some other statistics such as vehicle growth rate on the project roads, toll fee revision, operation and maintenance cost unit rates, etc. was collected from National Highway Authority of India (NHAI) website, detailed project reports of various road contractor

firms, annual reports of various toll operators and so on. This information is presented in the subsequent chapters. Other important financial indicators, such as toll revenue, etc. are derived from the primary data, the analyses of which are presented in data analyses chapter. The data collection instrument for this particular study is given in Appendix I, page no. 253.

4.4.2 Toll Plaza Operational Data

Pune Region has eight toll plazas on all six tollways under study. Thousands of vehicles pass through these toll booths every day. Some of the toll plazas are multi-lane systems and they are expected to be maintained on par with standards. But the toll booths set up on the tollways do not seem to be maintaining some basic tolling operational facilities such as traffic management, technology for toll transaction, complaint register, etc., thereby providing poor operational service to the vehicles crossing toll posts. So in this regard evaluation of the toll plazas working almost under similar conditions is conducted. The evaluation is done on standard operational service parameters. This particular study involves extensive field surveys across the toll booth sites, where toll booths are operational under similar physical and technical environment. The information was collected around working environment of toll booths with an objective to compare various plazas on operational efficiency parameters through mapping the condition of the present system. The method of data collection adopted in this case is “site observation method”. The observation study involves a field visit at the toll plazas with a prepared observation sheet with clearly defined format for capturing various aspects or elements of the toll operational zone along with approach roads. The observation sheet is a kind of stock verification check list. The aspects to be observed are clearly listed as in an audit form or they could be

indicative areas on which the observation is to be made. For example, the sheet has the names of the items like plaza computer, lane barrier, Weigh in Motion equipment, etc. That way the performance indicators can be measured objectively at an individual facility level. The intensity of the feature is measured on 0-1 scale, where 0 score is assigned to feature when it is absent in system and score 1 is given when the feature is present in the system. However in some cases where features are not quantitatively measured, subjective opinion is sought. All the features are measured like this process and based on total scores, toll plazas are ranked. The Instrument for this particular study is given in Appendix II, page no.254.

4.4.3 The Road User Satisfaction Survey (RUS)

The toll roads are meant to provide service quality in various supplementary facilities created along road side. The services broadly include improving quality of roads, safety standards, putting up help-lines along the way etc. The road user survey is aimed to capture perceptions and expectations of travelers on specific service parameters as mentioned below (Table No. 4.1). It was designed to elicit views and gather feedback on road attributes and other concerns of various stakeholders, particularly vehicle users or vehicle operators. The Questionnaire Survey was employed for gathering the data on the road users' perception in 18 road service indicators (Table 4.1), as it was a way of assessing the system performances in terms of user service quality and bringing in improvement in the system. The structure questionnaire for eliciting response was administered through a sample of toll paying customers ranging from commercial transporters to regular commuters travelling on the toll roads. While the analysis of observation study was mostly textual and less statistical, the questionnaire survey responses were analyzed through quantitative

methods like ANOVA and Factor Analyses and hypotheses testing. The hypotheses proposed are presented in the subsequent section (No.4.6).

Table 4.1: Road User Service Indicators

Road Service Parameters (Constructs)	Service Indicators
Quality of Road (*Construct 1*)	1.Smoothness
	2.Roadway markings
	3.Shoulder condition
Safety of Road (*Construct 2*)	4.Pedestrian crossing facilities
	5.Signs and signals
	6.Lighting at the Junctions
Security and emergency services on the road (*Construct 3*)	7.Highway Police patrolling
	8.Ambulance for accidents victims
	9.Crane facility for vehicle breakdown
	10.Telephone booth for emergency calls
Road user amenities (*Construct 4*)	11.Restaurants
	12.Canteen
	13.Petrol pumps
	14.Auto Service Centers
	15.Medical aid
	16.Parking lots
	17.Public Toilets
	18Rest house for drivers or Travelers

4.4.3.1 Questionnaire Design

The survey was conducted among over 336 road users across all toll plazas in the region. The instrument used for the RUS was a structured questionnaire. The instrument thus prepared was based on various factors including study objectives, pilot study ensuring internal validity. The questionnaire was so designed that time required for filling the questionnaire should not exceed 20-30 minutes. The questionnaire is designed in sections which include some peripheral questions on the toll way operational systems to evaluate tollways - General system performance indicators, key driving factors influencing toll road journey, complaints on the system,

toll road economic indicators, and the most important one is Road User Service indicators.

The sets of questions covering various aspects are as follows:

Q.1 to Q. 9- The general system performance

Q.10- Factors the commuters prefer for Toll road journey

Q.11- The complaints people have on toll roads

Q.12- The economic contribution of toll Roads in the region

Q.13- Road user service performance indicators

However question No.13 is the main section, which is considered as study variables representing the roadway service indicators that are measured by opinion of commuters as perceived – quality of tollways, safety, security services and road user amenities. The road user survey questionnaire is attached in the Appendix III, page no.255.

4.4.3.2 Administering the Questionnaire

Conduct of the surveys required a good deal of planning and organization, such as identification of locations along road side, intercepting commuters, handing over the questionnaire or asking the set of questions, etc.

Road user survey involved asking a sample of road users such as drivers, staff in vehicle, passengers, etc. (viz. cars, LCVs, buses, public transport, goods vehicles). The commuters were contacted and the structured questionnaires were given to the road users or commuters at various points along the roads such as road side dhabas, bus stops, checkpoints, etc. During face to face interview, the respondents were asked to give their personal attributes such as mode of travel, category of user (for toll exemptions / pass holders), etc. where as in the other section of questionnaire, data on

respondents' opinion on various services were measured on a five point numeric scale, popularly known as "Likert Scale" or service quality scale in this particular study. Survey team comprised adequate number of interviewers and a well trained supervisor.

4.4.3.3 Sampling Process

Sampling Frame: Vehicles covered by the study included passenger and commercial vehicles, the toll roads under study cater to the travel needs of rural and urban population across the region. The vehicles travelling on the highways include goods vehicles such as trucks, lorries, tempos and other Light Commercial Vehicles (LCV), and passenger transport vehicles like buses, cars, vans, jeeps auto rickshaws, etc. Categories of road users such as passengers, drivers, owners (in case of cars and some LMVs), staff in the vehicle, are the sampling unit in this study.

***Sampling Size*:** The sample size is a representation of travelling population through all these roads and it is a proportion of a traffic volume measured as Average Daily Traffic (ADT). The sample size depends on the number of vehicles / travelers passing through. Thousands of people travelling across the region, using these roads by different travel modes, depending upon the length and purpose of the journey, are the population for the study. Roughly 5.25 lakh people travel in various transport modes everyday on all the toll routes (as per the break-up given in table 4.2), the sampling size is calculated for 95 % confidence level, as follows:

Sample size, $n = N/1+ N e^2$ where N = population = 5, 25,000, e = 0.05 (at 95% confidence level)

The ‘n’ comes out to be 400. However, due to several practical issues, data could be collected only from 336 respondents. For this sample size, confidence level works out to be 94.55 %, as per following calculation.

$$336 = \frac{N}{1+Ne^2}$$

Where ‘e’ is level of significance (revised for sample size 336)

‘N’ is the population = 5, 25,000

e^2 =0.0029742857

$e = \sqrt{0.0029742857}$

=0.054537 (5.45%)

So, the Confidence level (revised) is 94.55 (100-5.45), which means the accuracy of results are compromised to 94.55 % confidence level against 95%.The survey was conducted randomly among travelers of these stretches of which the category of users include bus passengers, car riders, truck and heavy commercial vehicles and light commercial vehicle operators. However, the relevant population for survey is estimated as 5, 25,000 across the toll ways, as presented in the Table 4.2. The relevant population does not cover two-wheelers, child travelers, and illiterate people in the road user survey process. The size of sample road wise is shown in the Table 4.2.

Table 4.2: Sample Size in Study Area-Toll Road Wise

Sr. No.	Tollway Stretch and Designation	Sample Size	Estimate of Passengers Per Day	% of Sample Size
1	Pune-Ahmednagar Highway (PA)	50	55,000	0.09
2	Pune-Nashik Highway (PN)	64	75,000	0.085
3	Pune-Satara Highway (PS)	63	80,000	0.078
4	Pune-Solapur Highway (PSo)	50	1,25,000	0.04
5	Pune-Mumbai Old Highway (PM)	59	90,000	0.065
6	Pune-Mumbai Expressway (PEx)	50	1,00, 000	0.05
	Total	**336**	**5,25,000**	**0.064**

Method Of Sampling: The sample for the study is represented by the toll way users like, passengers, drivers, driver-cum-owners (owners of vehicles) and staff in vehicles. A simple random sample method is used for the study as the study objective is to acquire representative sample and it is expected to see some variations in road-user service indicators within the population of the road-users.

Sample Location: All six Toll Road segments of Primary Roads-Mumbai-Pune Expressway, NH 4 (Pune-Mumbai), NH 9 (Pune-Solapur), NH 50 (Pune-Nashik) and State Highway SH 27(Pune-Ahmednagar*),* passing around Pune region. Except NH 4 all other highways have one toll road each. The NH 4 has two toll stretches - one from Pune to Satara and the other, Pune to Mumbai (other than express highway). In short, the study locations are:

i. Four National highways

ii. One major State Highway

iii. One Expressway

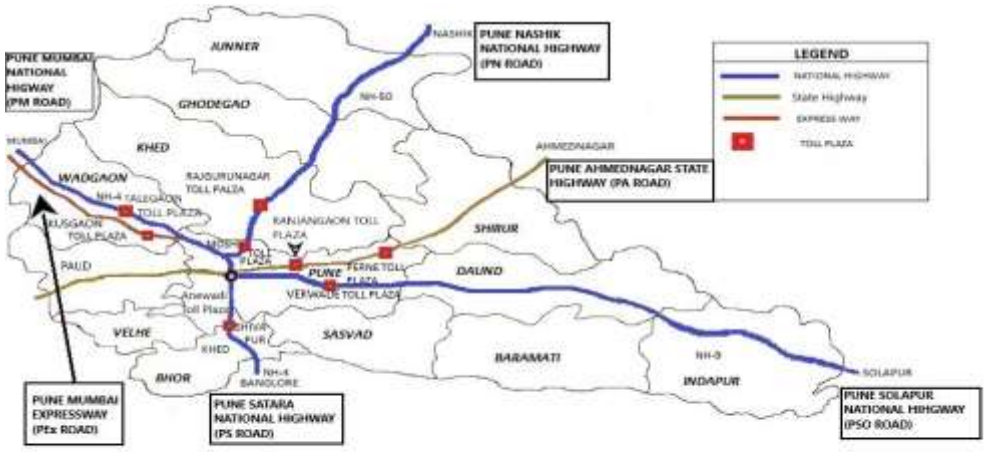
The study location layout is presented in Figure 4.1

4.5 Analysis Techniques

Based on the type of data–quantitative or qualitative, different analyses techniques were used to analyze and interpret the data - The analysis was carried out by using standard analysis techniques-descriptive and inferential statistics. For example, Traffic and Toll revenue data is analyzed and results are presented through mostly descriptive statistical techniques like tables, bars and line charts whereas the toll plaza operational data is analyzed through specifically devised score card method. .At the same time Road user service indicators are analyzed by means of descriptive as well as inferential statistics. Precisely 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 (Version15.1 for Windows).

Figure 4.1: Study Area Lay out of the Toll Roads and Toll Plazas (2014-16)



4. 6 Study Hypotheses

Null hypothesis H0: Mean Scores in service indicator (**µ1 to µ6**) are the same across the six cases of tollways.

Alternate Hypothesis Ha: Mean Scores are not same across the six cases of Tollways.

1. **Hypothesis for Indicator 1 : Smoothness of tollway**

   H0: µ1= µ2= µ3= µ4= µ5= µ6
   Ha: µ1≠ µ2 ≠µ3≠ µ4 ≠ µ5≠ µ6

2. **Hypothesis for Indicator 2 : Roadway markings**

   H0: µ1= µ2= µ3= µ4= µ5= µ6
   Ha: µ1≠ µ2 ≠µ3≠ µ4 ≠ µ5≠ µ6

3. **Hypothesis for Indicator 3 : Shoulder condition**

   H0: µ1= µ2= µ3= µ4= µ5= µ6
   Ha: µ1≠ µ2 ≠µ3≠ µ4 ≠ µ5≠ µ6

4. **Hypothesis for Indicator 4 : Pedestrian crossing facilities**

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

5. **Hypothesis for Indicator 5 : Signs and signals**

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

6. **Hypothesis for Indicator 6 : Lighting at the Junctions**

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

7. **Hypothesis for Indicator 7 : Highway Police patrolling**

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

8. **Hypothesis for Indicator 8 : Ambulance for accidents victims**

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

9. **Hypothesis for Indicator 9 : Crane facility for vehicle breakdown**

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

10. **Hypothesis for Indicator 10 : Telephone booth for emergency calls**

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

11. **Hypothesis for Indicator 11 : Restaurants**

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

12. **Hypothesis for Indicator 12 : Canteen**

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

13. **Hypothesis for Indicator 13 : Petrol pumps**

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

14. Hypothesis for Indicator 14 : Auto Service Centers

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

15. Hypothesis for Indicator 15 : Medical aid

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

16. Hypothesis for Indicator 16 : Parking lots

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

17. Hypothesis for Indicator 17 : Public Toilets

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

18. Hypothesis for Indicator 18 : Rest house for drivers or Travelers

H0: μ1= μ2= μ3= μ4= μ5= μ6
Ha: μ1≠ μ2 ≠μ3≠ μ4 ≠ μ5≠ μ6

4.7 Summary

The data for the study is financial and non –financial and quantitative and qualitative. In this particular chapter, various studies carried out to achieve the research objectives are described. The corresponding methodologies are explained. The analyses techniques are also discussed in brief. The hypothesis structures for various road user service indicators are presented

CHAPTER 5

PILOT STUDY

Road User Study on Two Toll Roads in Pune Region

5.1 Purpose of the Study

A small scale preliminary has been conducted in order to evaluate feasibility, time cost and adverse events associated with the final study. This is conducted prior to the full scale research study and the study process is improved including finalizing the research tools, factors considered in the final study of road user study of six roads in the region based on the experience gained through the pilot study.

5.2 Methodology

The study is mostly a primary research based on a field survey which has used a structured questionnaire for collecting empirical data and is focused on understanding the travelers' perception about various roadway services provided by the toll road operators. The service factors that are likely to affect the road user satisfaction selected for the study are broadly as follows:

- Road User Safety
- Highway Security
- User Amenities

The corresponding 14 manifesting indicators that are grouped into the above factors identified and presented in *Table 5.1*.

Table 5.1: Roadway Services

Sr. No.	Road User Service Category	Service Elements/ Parameters
1	Roadway Safety Measures	Signs and Signals
		Traffic Control
		Ambulance Service
		Crash Barriers
		Recovery Vans
2	Security Measures	Police Patrolling
		CCTV
		Emergency Telephone
3	User Amenities	Parking Area
		Rest House
		Toile Facilities
		Filling Stations
		Repair Facilities
		Pick Up Bus Stops

5.3 Data Collection Process

The Road User Satisfaction Survey: It was planned to elicit views and gather feedback on road attributes and other concerns of various stakeholders particularly vehicle users or vehicle operators. The Road User Satisfaction (RUS) survey aimed to capture perceptions and expectations of travelers on above mentioned service parameters employed. It has two parts: the first part deals with personal details / attributes of the travelers and the second part covers the questions on the subject of the study. In the first part of the survey, the questions deal with the data variables mostly related to mode of travel, purpose of travel, willingness to pay toll etc. as these characteristics are expected to influence the commuters' assessment of roadway services. The second part of the questionnaire deals with the evaluation of the service parameters with the help of data which are measured by devising an appropriate scale for seeking users' opinion variables.

5.3.1 Administering the Questionnaire

The commuters were contacted and the structured questionnaires were given to the road users or commuters at various points along the road such as road side dhabas, bus stops, checkpoints, etc. During face to face interview, the respondents were asked to give their personal attributes such as mode of travel, purpose of travel, category of user (for toll exemptions / pass holders), etc. where as in the other section of questionnaire data on respondents' opinion on various services are measured on a five point numeric scale, popularly known as "likert Scale" or service quality scale in this particular study.

5.3.2 Sampling

Sampling unit: A commuter is the respondent and a sampling unit in our study.

***Sample size*:** the sample size is about 100, that means a total sample of 100 respondents are covered with almost an equal sample (about 50 respondents) from each toll road segment in order to ensure uniformity in the data processing, analysis and result outcomes. The survey was conducted among the 100 random travelers of these stretches of which the category of users include bus passengers, car riders, truck and heavy commercial vehicles and light commercial vehicle operators. The profile of sampling is shown in the *Table 5.2.*

Table 5.2: Sample Profile Road Segment Wise

Sample Profile - Road Segment-wise				
Category	**Pune-Mumbai Road**		**Pune-Satara Road**	
	Road 1	**%**	**Road 2**	**%**
Cars	25	50	23	46
Buses	17	34	16	32
LCV	4	8	10	20
HCV	4	8	1	2
Total	**50**	**100**	**50**	**100**

Sample Locations

i. The road way segment approximately of about 15 kilometers on National Highway 4 connecting Mumbai and Pune passing through toll plaza at Dehu road near Pune.

ii. The road way segment approximately of about 15 kilometers on National Highway 4 connecting Mumbai and Chennai passing through toll plaza, Khed-Shivapur near Pune.

A Sample Question Is Cited As Follows:

How do you rate the 'Quality of Patrolling Service' on the toll road Segment?

(Please tick the appropriate option based on your experience on the 5 – band scale below)

1. Highly Dissatisfied
2. Somewhat dissatisfied
3. Neither satisfied / Nor dissatisfied
4. Somewhat satisfied
5. Highly satisfied

The above question is likely to give data at an ordinal level. However since the numerical, 1 to 5 are given to each descriptor it will yield data on interval level that is meant for quantitative analysis. The relative weightage placed by the respondent in regard to various service parameters and the average parameter score out of 5 are key statistics reflecting present Quality Service Indicators (QSI). Certainly higher the number more satisfied the commuters are with that particular service.

5.4 Data Analysis

i. Analysis of Travel Characteristics

a. *Purpose of Travel:* The raw frequency of respondents (commuters) for various trip purposes are converted into percentages as they are more meaningful in

presenting various categories. From overall analysis of the two corridors it is revealed that a 34 per cent of total commuters are business class travelers, 25 per cent are education 17 per cent office goers, 14 per cent are for recreation and the rest 10 per cent conduct trips for social purpose. *Table 5.3* presents analysis of purpose of travel.

Table 5.3: Purpose of Travel

Categories	Pune-Mumbai Road	Pune-Satara Road
Business	38%	30%
Office	16%	18%
Education	24%	26%
Recreation	12%	16%
Social	10%	10%

b. *Duration of Travel:* As far as factor is concerned as can be seen in the *Table 5.4*, on Pune-Satara Road, it is found that a about one-half (48 per cent) of the respondents travel between past 1 and 3 years, a 16 per cent lie between 3 to 5 years band and 36 per cent of them travel the stretch for 5 years. Whereas on the other stretch Pune-Mumbai road about 45 per cent of users are found travelling between 3 and 5 years, 32 per cent more than 5 years and the rest are travelling less than 3 years.

Table 5.4: Duration of Travel

Years	Pune-Mumbai Road	Pune-Satara Road
1 to 3	24%	48%
3 to 5	44%	16%
>5	32%	36%

c. *Willingness to Pay Toll:* From this analysis it is found that an overwhelming 92 per cent of respondents on Pune- Mumbai Road and 84 per cent on Pune-Satara toll road were of the opinion that they are willing to pay toll as the toll road generally are seen to have delivered several economic benefits like fuel savings, reduction in travel time, etc. This perception is very strong at almost 100 per cent among Car riders and commercial vehicle operators. The analysis is presented in *Table 5.5*.

Table 5.5: Willingness to Pay Toll if Road is Well Maintained

Opinion	Pune-Mumbai Road	Pune-Satara Road
Yes	92%	84%
No	8%	16%

ii. Analysis of Roadway Segment Based on Service Parameter Scores

It is basically the analysis of data on respondents' opinion about various service elements. As it is already mentioned in the above section during field survey, the respondents are asked to specify their perception about various category of services on 5 point numeric scale, popularly known as "Likert Scale", since the aim was to workout aggregate score on each parameter for each roadway segment and compare the segments based on the grand average score. The consolidated data – the aggregate score parameter wise and grand average is shown below at *Table 5.6* and *Fig. 5.1*.

Table 5.6: Average Parameters Scores – Road-wise

Parameter	Road 1	Road 2
Signs/ signals	3.84	3.6
Traffic control	3.44	3.16
Ambulance service	3.08	2.14
Crash barrier	3.64	2.94
recovery cranes	3.36	1.72
Highway police / patrolling	3.28	1.64
CCTV	2.88	1.28
Emergency telephone	2.9	1.3
Parking Area	3.3	1.32
rest houses	3.6	2.78
toilet facilities	3.5	2.92
Filling stations	3.66	3.5
repair stations	3.42	3
pick-up- bus stops	3.5	2.94
Food courts	3.76	3.7
Grand Average Score	**3.41067**	**2.52933**

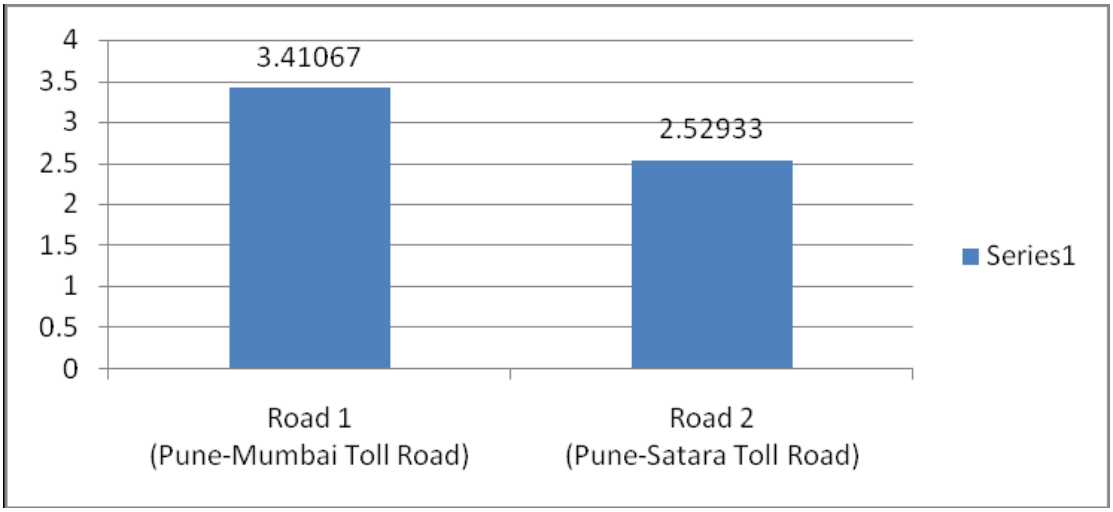


Fig. 5.1: Satisfaction Scores on Segments

Overall, the road users on Pune- Satara highway (Road 2) are least satisfied with an average rating of 2.53 which is less than the minimum expected score of 3 points, while those travelling on Pune–Mumbai (Road 1) segment showed higher satisfaction levels with an average rating of 3.41, just 0.59 more than expected minimum points of 3 on 1-5 scale across 13 service parameters. The deeper analysis found that the average perception scores are moderately good on some of the service parameters such as food courts, filling stations, traffic control devices that might have positively influenced the overall perception of commuters using Pune- Mumbai toll corridor.

iii. Analysis of User Satisfaction Levels in Terms of Percentage :

It was tried to have parameter wise satisfaction level scores in terms of proportion of respondents indicating *highly satisfied, satisfied, not satisfied, etc.* - the various options for the respondents to choose or simply the level of data measurement for each service variable. During the field survey the respondents were probed about the availability of restaurant food, water, parking facilities, tow vehicle services condition of toilets attached mostly with restaurants, clarity and placement of traffic sign posts, etc. The data obtained on the perceptions of respondents are analysed and presented in simple 'Percentage' through bar charts for all parameters considered in the study. To

have little ambiguity while presenting responses in terms of percentage score the five bands on the rating scale are combined to give only three levels of opinion data. In other words, the first and second points on the scale - 'highly dissatisfied' and 'somewhat dissatisfied' are combined to give 'POOR' opinion, the third point- 'neither satisfied nor dissatisfied' will represent 'AVERAGE' opinion and fourth and fifth points - 'somewhat satisfied' and 'highly satisfied' are combined to give 'GOOD' opinion. In nutshell, the road way services are evaluated as GOOD, AVERAGE and POOR and the comprehensive evaluation is presented in *Table 5.7*. The proportions of respondents indicating satisfaction levels are presented in *Table 5.7* and explained in the corresponding bar-charts (*Fig. 5.2 to Fig. 5.15*)**.**

i. *Perception on signs and Signal*s: The equal proportions of respondents (50 per cent) are happy with the adequacy, visibility and placement of the Sign posts in both the corridors and at the same time around 40 per cent respondents on each corridor said it was average *(Refer Fig. 5.2).*

ii. Traffic control refer at this stage refers to guiding vehicles through various toll lanes at toll plaza, checking with traffic violations, monitoring toll exempted vehicles and giving quick clearance, etc. Over all people are considerably satisfied with this aspect. (*Refer Fig.5.3*)

iii. *Ambulance Facility*: Higher percentage of respondents (overall 66 per cent) interviewed in both the roads are dissatisfied with the provision of ambulance service *(Refer Fig. 5.4).*

iv. *Crash barriers***:** About 40 per cent of the respondents on Pune-Satara Road are of the opinion that the maintenance of this component is poor and this feeling is more prominent (46 per cent) among the users of Pune- Mumbai stretch (*Refer Fig. 5.5*)**.**

v. *Recovery Vans* Among all the parameters the satisfaction level worst with this facility as no single respondent said this particular facility is good. Over all a little less than 12 per cent said it was average and the rest of the respondents (about 90 per cent) have given poor opinion at this service (*Refer Fig.5.6*).

vi. *Police patrolling*: Very high percentage of respondents (over 80 per cent) are dissatisfied with aspect and a little over 10 per cent have said it is Average and Poor (*Refer Fig.5.7*).

vii. *CCTV and Emergency phone*: The dissatisfaction level is overwhelming at these facilities as almost all the users rated them Poor (*Refer Fig. 5.8 and Fig. 5.9*)**.**

viii. *Satisfaction with the availability of Parking Facilities is not very high (about 35 per cent). This is especially low in Pune-Mumbai segment (Refer Fig. 5.10).*

ix. The respondents are not satisfied with road side rest houses as this perception is very high among the commercial vehicle operators who deserve intermittent breaks after long hours of driving. *(Refer Fig.5.11).*

x. *Toilet facility:* a significantly high percentage (70 per cent) of commuters travelling on Pune-Mumbai Highway feel that this facility is poorly maintained where as about 60 per cent said the facilities average and good on Pune-Satara road (*Refer Fig.5.12*)**.**

xi. *Filling stations*: Overall, less than half of the respondents said the stations are available on these roads. However, availability on Pune-Satara is much better probably because of high traffic density (*Refer Fig. 5.13*).

xii. *Repair shops***:** The repair shops are available across these roads, however, if we look at the Pune-Mumbai stretch the dissatisfaction considerably at 40 per cent (*Refer Fig. 5.14*).

xiii. Pick up bus stops; while majority of respondents (about 60 per cent) are satisfied with this facility, around 35 per cent feel lots of improvement is need on this front. (*Refer Fig. 5.15*)

Table 5.7: Proportion of Satisfaction with the Toll Roads

S. No.	Service Parameter	Pune-Mumbai Road	Description of Evaluation	Pune Satara Road
1	Signs and signals	50	Good	50
		44	Average	38
		6	Poor	12
2	Traffic Control	45	Good	55
		30	Average	25
		25	Poor	20
3	Ambulance Services	4	Good	4
		52	Average	28
		64	Poor	68
4	Crash Barriers	36	Good	28
		26	Average	26
		38	Poor	46
5	Recovery Vans	0	Good	0
		8	Average	14
		92	Poor	86
6	Police Patrolling	4	Good	4
		8	Average	14
		88	Poor	82
7	CCTV	0	Good	0
		2	Average	2
		98	Poor	98
8	Emergency Phone	0	good	0
		2	Average	2
		98	Poor	98
9	Parking Areas	2	Good	7
		34	Average	28
		64	Poor	64
10	Rest Houses	18	Good	20
		40	Average	30
		42	Poor	50
11	Toilet facility	24	Good	14
		44	Average	16
		32	Poor	70
12	Filling Stations	50	Good	40
		38	Average	30
		12	Poor	30
13	Repair stations	32	Good	20
		40	Average	40
		28	Poor	40
14	Pick up bus stops	30	Good	30
		36	Average	30
		34	Poor	40

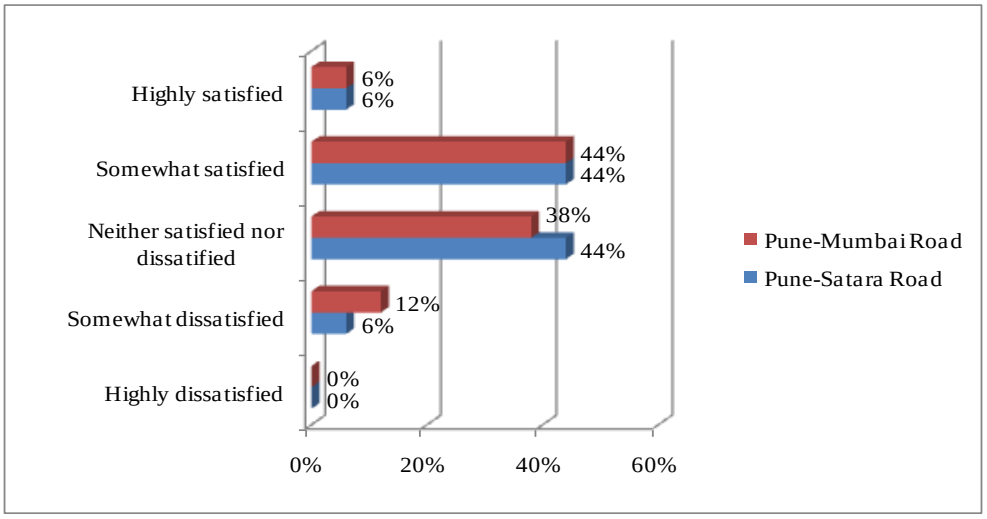


Fig. 5.2: Satisfaction w.r.t Signs and Signals

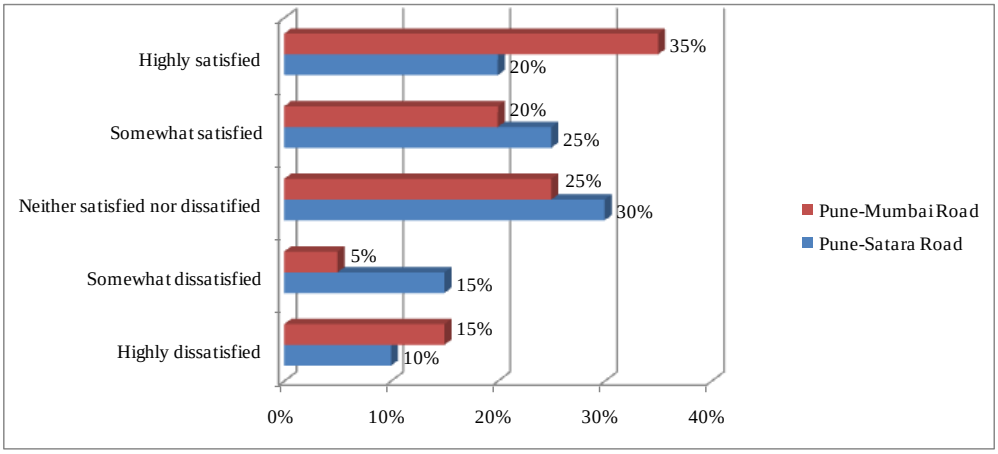


Fig. 5.3: Satisfaction w.r.t. Traffic Control

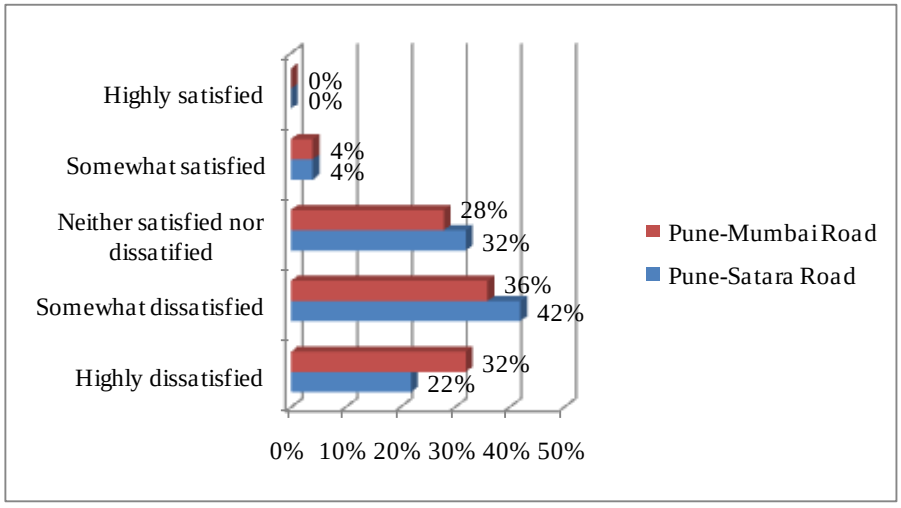


Fig. 5.4: Satisfaction w.r.t Ambulance Service

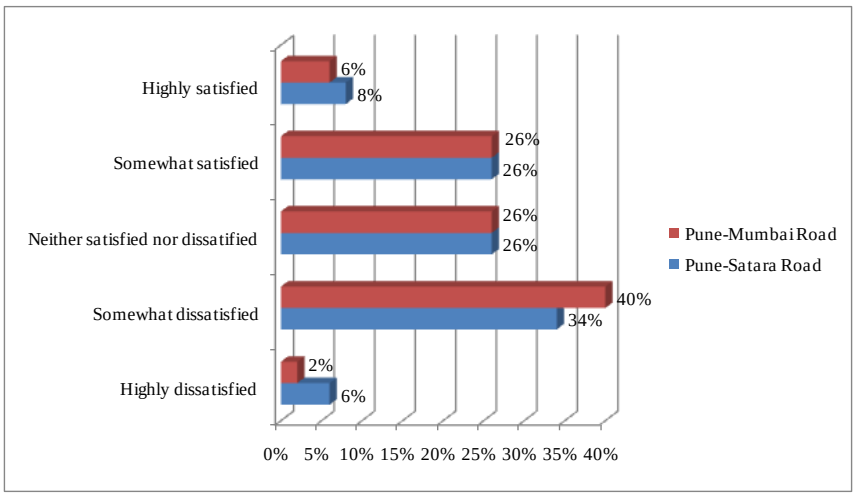


Fig. 5.5: Satisfaction w.r.t Crash Barriers

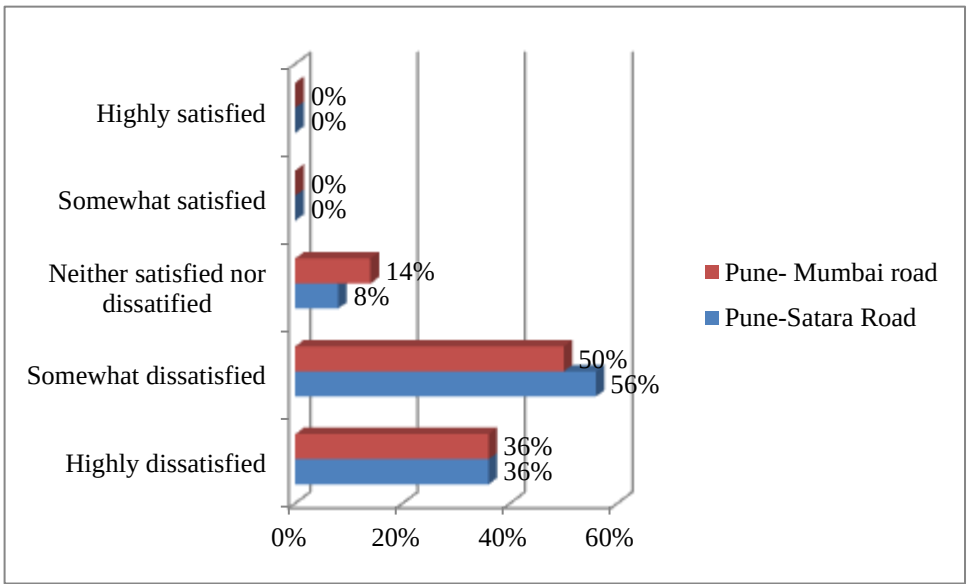


Fig. 5.6: Satisfaction w.r.t Recovery Vans

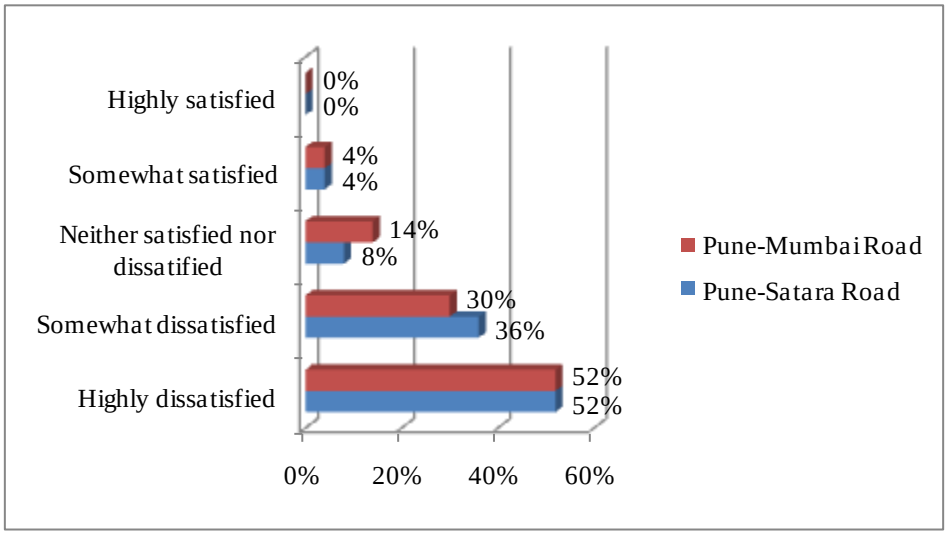


Fig. 5.7: Satisfaction w.r.t Police Patrolling

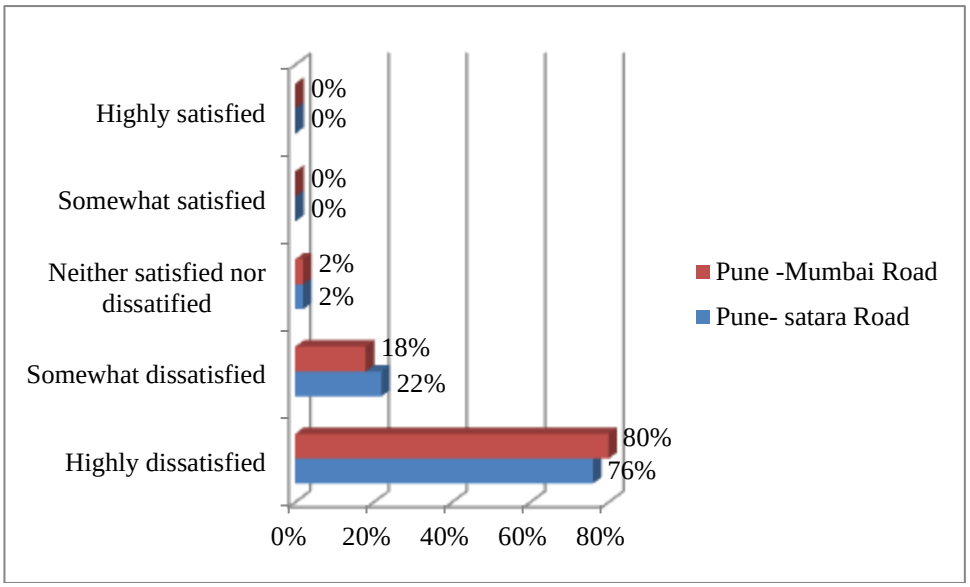


Fig. 5.8: Satisfaction w.r.t CCTV

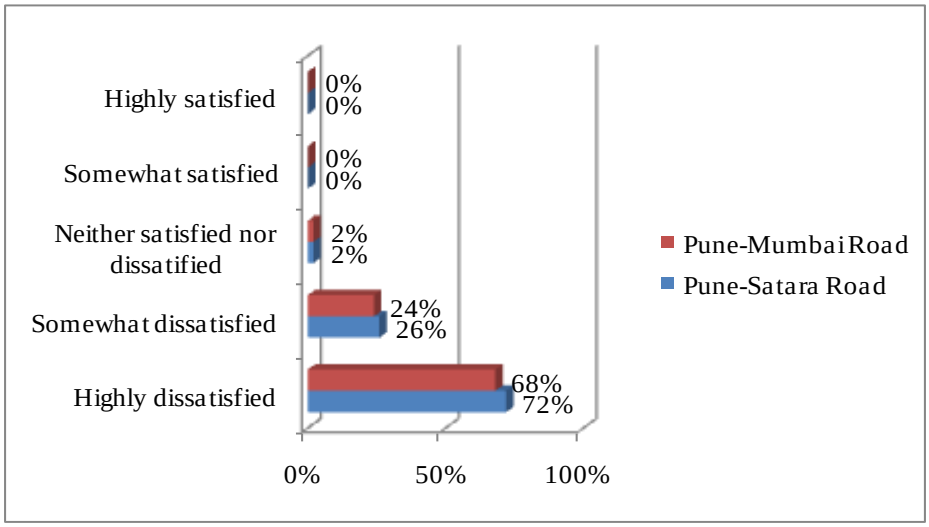


Fig. 5.9: Satisfaction w.r.t Emergency Phone

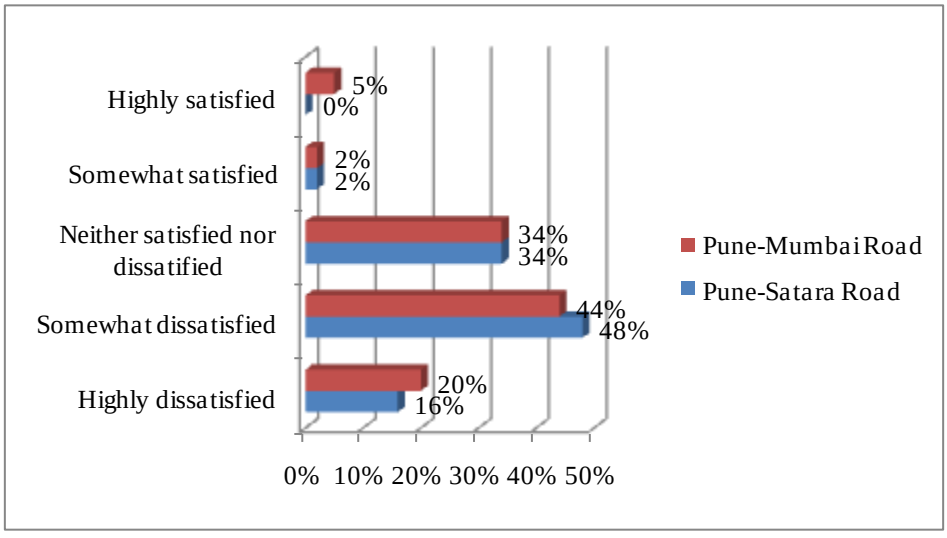


Fig. 5.10: Satisfaction w.r.t Parking Facilities

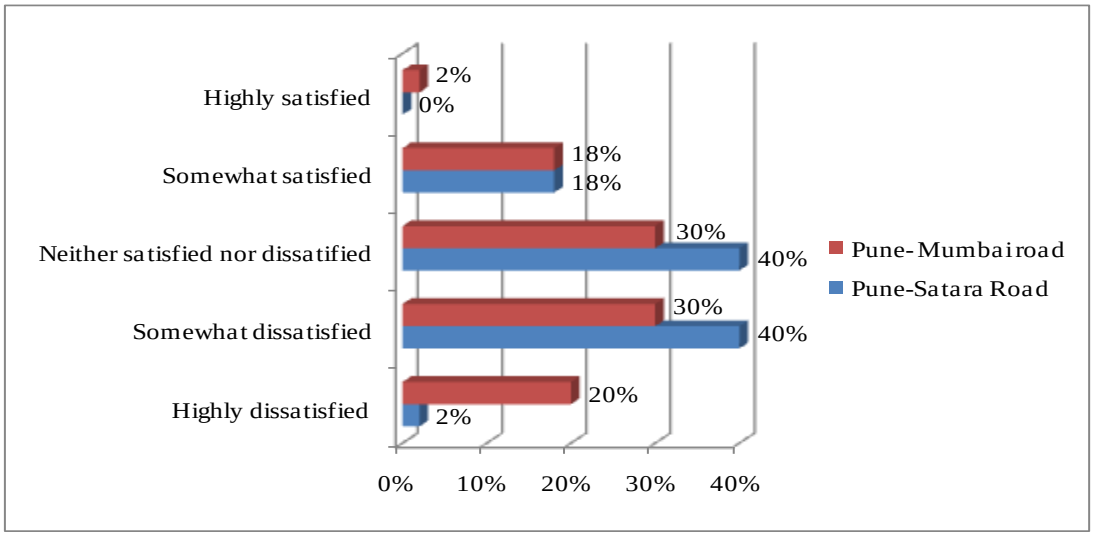


Fig. 5.11: Satisfaction w.r.t Rest Houses along Road Side

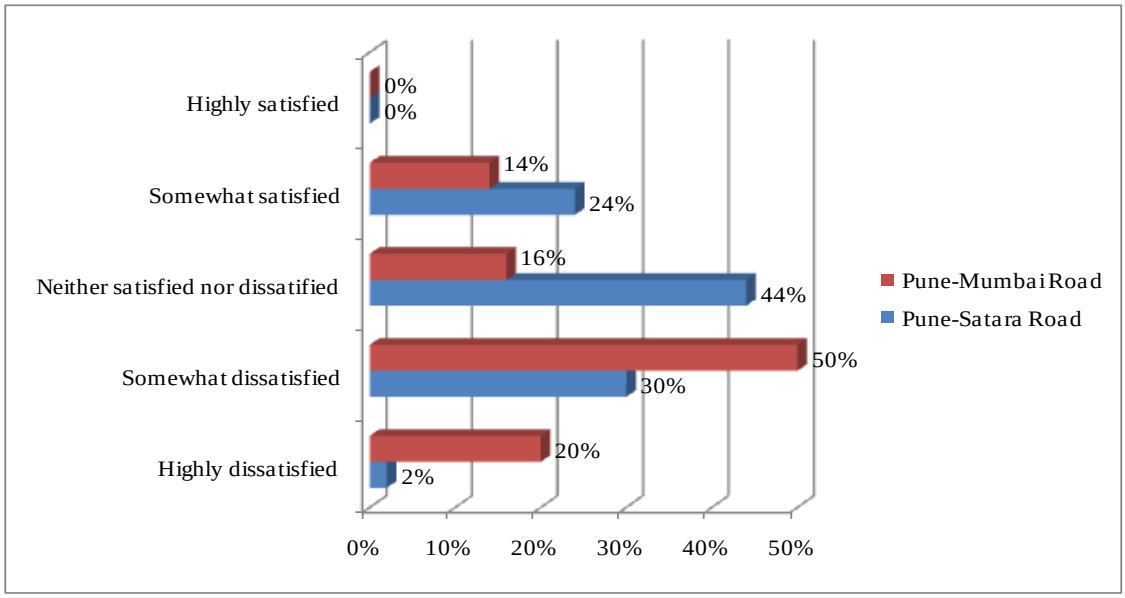


Fig. 5.12: Satisfaction w.r.t Toilet facilities along Road Side

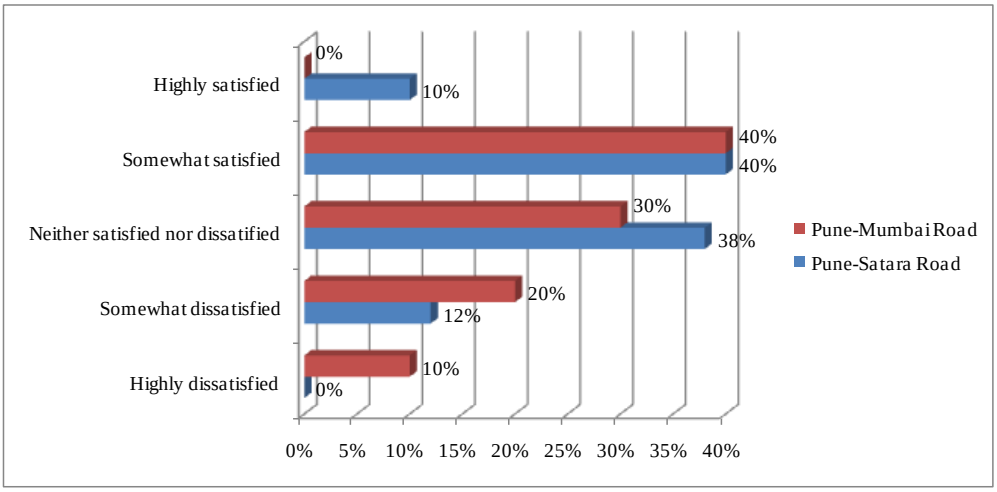


Fig. 5.13: Satisfaction w.r.t Road Side Filling Stations

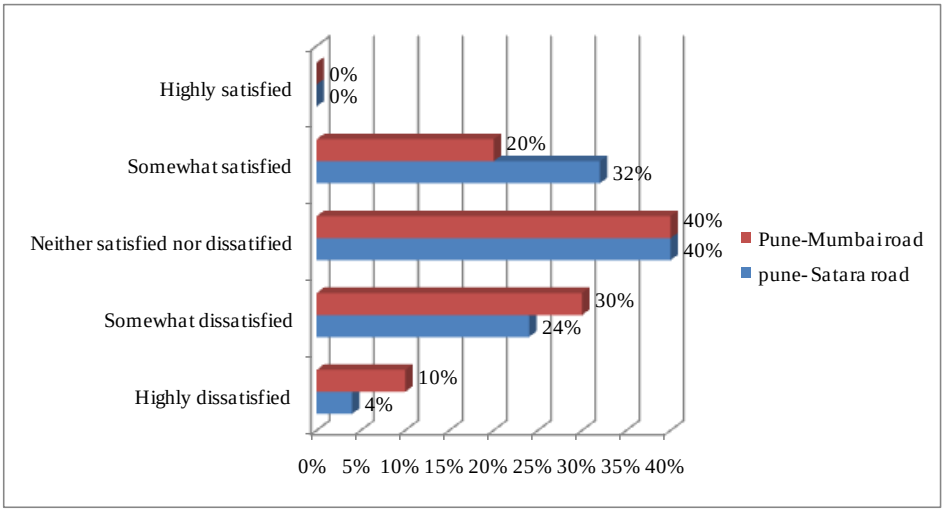


Fig. 5.14: Satisfaction w.r.t Road-Side Small Repair Shops

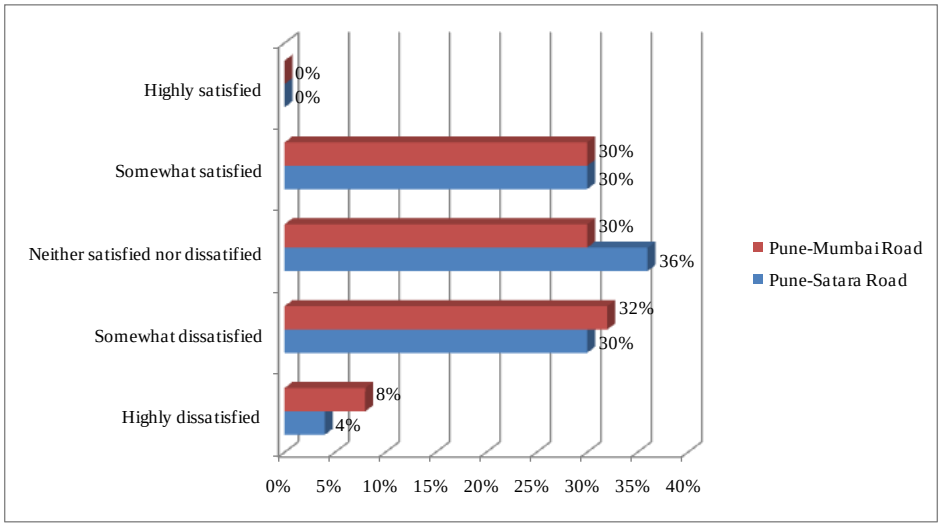


Fig. 5.15: Satisfaction w.r.t Road Side Pick-Up Bus Stops

5.5 Summary of Pilot Study Findings

Overall, 48 per cent cars, 33 per cent buses, 14 per cent LCVs and 5 per cent HCVs use these two national highways. Overall 34 per cent travel for business, 17 per cent are office goers, 25 per cent for education and remaining 17 per cent travel for recreation purpose. Satisfaction levels are higher among some road user groups like social purpose trip makers due to fewer expectations, however, from the further analysis of opinion scores given by different trip makers - education and business purpose trip makers have higher expectations due to more exposure and hence lower

satisfaction levels. Other casual factors could be huge difference expectations from the highway projects of high standards envisaged and existing practices or conditions. Passengers who travel the roads for long time are more satisfied than those who travel for few years. So, more the exposure to the travel on highways less is the satisfaction levels. Overall assessment is made on the aspects like Roadway safety, security and user amenities for the two roads with help of the compiled opinion statistics presented at the *Table 5.7*.

Road 1 (Pune-Mumbai)

About 54 per cent of the total sample has rated the safety systems on the road as average to good and remaining 46 per cent are less satisfied with this factor. As far as security is concerned only 12 per cent rated as Average to Good and 88 per cent of respondents are dissatisfied due to frequent thefts and with accessibility to the highway police posts. On road user amenities front, about 55 per cent of respondents are satisfied with several of road side amenities as they rated this aspect as average to good.

Road 2 (Pune-Satara)

Of all the respondents who responded to the survey about 60 per cent rated the safety feature on an average as good. About a few respondents (7 per cent) rated the security factor on an average as good, and 93 per cent said that the security system is poorly maintained. And about 66 per cent rated the factor of user amenities in the range of Average to Good with 34 per cent saying that the amenities are not up to the mark.

Based on the sample length of the toll road segment, the study found that the two roads are falling short of performance expected from them. Based on the data on opinion variables, the service index was calculated and it was found that none of the roads could achieve the minimum target value of 4 out of 5. The analysis found the road Pune-Mumbai secured highest service level index value of 3.41, followed by

Pune-Satara road 2.53, ranking first and second respectively in terms of their performance standards. However the ranks given to them on computation of service index are relative and no tollway would be considered perfect. Pune-Mumbai roadway offering comparatively better services with first position in Service Level rankings though there are shortcomings in the important services like balance, two way vehicle, emergency telephone, etc. The other roadway, Pune-Satara stretch, considered as average performer with second position as the areas where the roadway scored overall better, are signs and signals, Filling stations, food courts etc. The areas where the roads were found lacking are patrolling services, emergency telephones, parking areas, Crash barriers. It is required to upgrade services for the benefit of commuters as there are several indications that the dissatisfaction is very high among commuters in availing the mandatory road user services. It is therefore recommended to have similar surveys frequently for assessing passenger satisfaction at the facilities.

CHAPTER 6
ANALYSIS OF DATA, RESULTS AND DISCUSSIONS

6.1 Analysis Techniques

Based on the type of data–quantitative or qualitative, different analysis techniques were used to analyse and interpret the data- The analysis was carried out by using standard analysis techniques-descriptive and inferential statistics. The key analysis techniques used are frequency distribution, ranking, one way ANOVA, factor analysis etc. The software tools primarily used for Analyses are MS-Excel and SPSS (Version 15.1 for Windows).

6.2 Toll Traffic and Toll Financial Data Analysis

Traffic studies were carried out during the period 2014-2016 to determine the traffic volume, composition of traffic stream on toll roads, daily Toll collection and revenue, etc. The traffic data thus collected comprised a large number of cars, buses, trucks, LCV and other commercial vehicles. The data thus collected from the location is compiled and presented in Tables 6.1 to 6.5. The compiled data gives the understanding of prevailing heterogeneity of traffic at the study locations. The computed toll traffic, revenue and other parameters in consolidated form are presented in Table 6.6 to 6.11.

The traffic volume survey gave the profile of the usage of the road by different types of vehicles, shown in Table no.6.1. One of the major data required for analyzing operational performances is volume of traffic prevailing on roadways. From collection of this primary data, the composite indicators derived are Toll revenue, operation and maintenance cost for each tollway and for each Toll Plaza and the annual operating ratio for those Toll Plazas. For analysis, the Traffic density data

collected for all categories of vehicles at the toll sections were converted into a frequency distribution table for each category of vehicle.

This part of the analysis, thereby, addresses two fundamental questions – (i) To find out whether the operator has been able to achieve an increase in average daily traffic, and (ii) To find out an increase in daily toll collection against the projected traffic and revenue figures. Thereby the study addresses the questions precisely: how much toll revenue and toll traffic, the toll plaza records annually, after a certain period of implementation of the project.

Six toll organizations on the Toll Road system comprising six roads in the region are analysed with financial and traffic data. More than 1, 50,000 vehicles in all categories pass through these Toll plazas every day making it the busiest Toll sector in the western region. The toll projects have been top grosser and have earned huge toll revenue over years, in the Region, since they became operational. The traffic and toll revenue rise more than expected throughout operational period. After the Projects were put into operational mode, the traffic across various categories increased at a CAGR of 3-15% depending on the mode of vehicle. The observed traffic for the study period based on the assumed traffic in the first year of operation across various categories is given in the below section, No.6.2.1. Toll rates increase once in every three years across modes of vehicles are presented in the same section, as follows.

6.2.1 Toll Revenue

The traffic volume that is observed is multiplied with the appropriate toll rate in order to determine the total gross revenue per year. Operation and maintenance cost of toll ways is based on yearly operational and road maintenance activities related to toll way organization's establishment and physical maintenance of road. Finally,

operating revenue indicator is derived from expenditure involved in maintenance and annual revenues.

Table 6.1: Toll Traffic at Toll Ways

SR. NO.	TOLL ROAD	YEAR	CARS	LCV'S	HCV'S	MAV'S	TOTAL
1	PA	2014	18,31,935	10,65,600	48,74,264	4,69,028	82,40,827
		2015	20,15,128	11,82,816	52,15,462	4,830,99	88,96,505
		% annual increase	10%	11%	7%	3%	7.95%
		2016	22,56,943	13,36,582	57,37,008	5,07,254	98,37,787
		% annual increase	12%	13%	10%	5%	10.58%
2	PN	2014	34,12,000	9,87,429	49,58,700	4,49,900	98,08,029
		2015	36,84,960	10,76,298	54,04,983	4,63,397	1,06,29,638
		% annual increase	8%	9%	9%	3%	8.31%
		2016	40,53,456	11,94,691	59,45,481	4,81,933	1,16,75,561
		% annual increase	10%	11%	10%	4%	9.83%
3	PM	2014	33,33,283	11,06,743	43,98,800	3,99,828	92,38,654
		2015	36,33,278	12,39,552	46,62,728	4,15,821	99,51,379
		% annual increase	9%	12%	6%	4%	7.70%
		2016	40,32,939	14,13,089	50,82,374	4,40,770	1,09,69,172
		% annual increase	11%	14%	9%	6%	10.22%
4	PS	2014	21,60,000	11,12,832	33,38,496	5,04,000	71,15,328
		2015	23,54,400	12,46,372	36,38,961	5,24,160	77,63,893
		% annual increase	9%	12%	9%	4%	9.11%
		2016	26,13,384	14,20,864	40,02,857	5,50,368	85,87,473
		% annual increase	11%	14%	10%	5%	10.61%
5	PSo	2014	20,16,772	8,51,760	26,89,160	5,93,124	61,50,816
		2015	22,38,617	9,71,006	29,04,293	6,16,849	67,30,765
		% annual increase	11%	14%	8%	4.40%	9.42%
		2016	25,07,251	11,16,656	31,94,722	6,44,607	74,63,263
		% annual increase	12%	15%	10%	4.50%	10.88%
6	PExp	2014	2,01,49,397	34,09,559	43,39,785	27,89,832	3,06,88,573
		2015	2,23,65,831	38,18,706	46,43,570	29,29,324	3,37,57,431
		% annual increase	11%	11%	7%	5%	10%
		2016	2,50,49,731	43,91,512	51,07,928	30,17,204	3,75,66,375
		% annual increase	12%	15%	10%	3%	11.28%

PA: Pune – Ahmednagar Road,
PN: Pune- Nashik Road,
PS: Pune- Satara Road,
PSo: Pune- Solapur Road,
PM: Pune -Mumbai Road,
PEx: Pune- Expressway Road

Table 6.2: Toll Rates at Various Toll Plazas (in Rs. Per trip)						
SR. NO.	**TOLL ROAD**	**YEAR**	**CARS**	**LCV**	**HCV**	**MAV**
1	PA	2014	40	65	120	210
		2015	40	65	120	210
		2016	40	65	120	210
2	PN	2014	28	47	94	200
		2015	28	47	94	200
		2016	28	47	94	200
3	PM	2014	101	179	355	763
		2015	101	179	355	763
		2016	101	179	355	763
4	PS	2014	25	43	85	182
		2015	25	43	85	182
		2016	25	43	85	182
5	PSo	2014	45	69	149	214
		2015	45	69	149	214
		2016	45	69	149	214
6	PExp	2014	165	255	300	1116
		2015	165	255	300	1116
		2016	165	255	300	1116

Source: Primary data collected by the researcher

Table 6.3: Toll Revenue (in Rs. Lakh)							
SR. NO.	**TOLL ROAD**	**YEAR**	**CARS**	**LCV'S**	**HCV'S**	**MAV'S**	**TOTAL**
1	PA	2014	732	692	5,849	984	8,257
		2015	806	768	6,258	1,014	8,846
		% annual increase	10%	11%	7%	3%	7.10%
		2016	902	868	6884	1,065	9,719
		% annual increase	12%	13%	10%	5%	9.80%
2	PN	2014	955	464	4,667	900	6,986
		2015	1,030	506	5,080	927	7,543
		% annual increase	7.85%	9.05%	8.85%	3%	8%
		2016	1,135	561	5,588	963	8,247
		% annual increase	10.19%	10.87%	10%	3.88%	9.30%
3	PM	2014	3,366	1,981	15,615	3,050	24,012
		2015	3,669	2,218	16,552	3,172	25,611
		% annual increase	9%	12%	6%	4%	6.60%
		2016	4,073	2,529	18,042	3,363	28,007
		% annual increase	11%	14%	9%	6%	9.70%
4	PS	2014	540	479	2,837	917	4,773
		2015	590	536	3,090	954	5,173
		% annual increase	10.70%	11.90%	8.90%	4%	7.73%
		2016	653	611	3402	1,002	5,668
		% annual increase	9.26%	14%	10%	5%	9.56%
5	PSo	2014	907	587	4,006	1,270	6,770
		2015	1,007	670	4,327	1,320	7,324
		% annual increase	11%	14%	8%	4%	8%
		2016	1,128	770	4,760	1,379	8,037
		% annual increase	12%	15%	10%	4.50%	9.70%
6	PExp	2014	33,266	8,694	13,019	31,134	86,113
		2015	36,903	9,737	13,930	32,691	93,261
		% annual increase	11%	12%	7%	5%	8.30%
		2016	41,332	11,198	15,323	33,672	1,01,525
		% annual increase	12%	15%	10%	3%	9%

Source: Primary data collected by the researcher

Table 6.4: Comparative Operating Ratios over the last 3 years					
TOLL ROAD	**YEAR**	**TOTAL TRAFFIC**	**TOTAL REVENUE (Rs. In Lakhs)**	**O&M EXPENDITURE (Rs. In Lakhs)**	**OPERATING RATIO (%)**
PA	2014	82,40,827	8,257	375	4.5
	2015	88,96,505	8,846	394	4.45
	2016	98,37,787	9,719	418	4.3
PN	2014	98,08,029	6,986	278	3.98
	2015	1,06,29,638	7,543	292	3.87
	2016	1,16,75,561	8,247	310	3.76
PM	2014	92,38,654	24,012	665	2.76
	2015	99,51,379	25,611	698	2.72
	2016	1,09,69,172	28,007	740	2.64
PS	2014	71,15,328	4,773	497	10.41
	2015	77,63,893	5,173	522	10.09
	2016	85,87,473	5,668	553	9.75
PS0	2014	61,50,816	6,770	695	10.26
	2015	67,30,765	7,324	730	9.96
	2016	74,63,263	8,037	774	9.63
P Exp	2014	3,06,88,573	86,113	1040	1.21
	2015	3,37,57,431	93,261	1092	1.17
	2016	3,75,66,375	1,01,525	1158	1.14

Source: Analysis of primary data by the researcher

Table 6.5: Toll Revenue Grand Total Year Wise (Rs. In Lakhs)									
Sr. No.	**Vehicles/ Toll Road**	**Year**	**PA**	**PN**	**PM**	**PS**	**PSo**	**PExp**	**Total**
1	**CAR**	2014	732	955	3,366	540	907	33,266	39,766
		2015	806	1,030	3,669	590	1,007	36,903	44,005
		2016	902	1,135	4,073	653	1,128	41,332	49,223
2	**LCV'S**	2014	692	464	1,981	479	587	8,694	12,897
		2015	768	506	2,218	536	670	9,737	14,435
		2016	868	561	2,529	611	770	11,198	16,537
3	**HCV'S**	2014	5849	4667	15,615	2837	4,006	13,019	45,993
		2015	6258	5080	16,552	3090	4,327	13,930	49,237
		2016	6884	5588	18,042	3402	4,760	15,323	53,999
4	**MAV'S**	2014	984	900	3,050	917	1,270	31,134	38,255
		2015	1,014	927	3,172	954	1,320	32,691	40,078
		2016	1,065	963	3,363	1,002	1,379	33,672	41,444

Source: Analysis of primary data by the researcher

6.2.2 Summary of Statistics of Six Toll Roads

Table 6.6: Summary of Statistics: Pune-Ahmed Nagar Road

YEAR	TOTAL TRAFFIC	TOTAL REVENUE (Rs. In Lakhs)	O&M EXPENDITURE (Rs. In Lakhs)	O&M EXPENDITURE TO REVENUE (%)
2014	82,40,827	8,257	375	4.5
2015	88,96,505	8,846	394	4.45
2016	98,37,787	9,719	418	4.30

Source: Analysis of primary data by the researcher

Table 6.7: Summary of Statistics: Pune-Nashik Road

YEAR	TOTAL TRAFFIC	TOTAL REVENUE (Rs. In Lakhs)	O&M EXPENDITURE (Rs. In Lakhs)	O&M EXPENDITURE TO REVENUE (%)
2014	98,08,029	6,986	278	3.98
2015	1,06,29,638	7,543	292	3.87
2016	1,16,75,561	8,247	310	3.76

Source: Analysis of primary data by the researcher

Table 6.8: Summary of Statistics: Pune-Mumbai Road

YEAR	TOTAL TRAFFIC	TOTAL REVENUE (Rs. In Lakhs)	O&M EXPENDITURE (Rs. In Lakhs)	O&M EXPENDITURE TO REVENUE (%)
2014	92,38,654	24,012	665	2.76
2015	99,51,379	25,611	698	2.72
2016	1,09,69,172	28,007	740	2.64

Source: Analysis of primary data by the researcher

Table 6.9: Summary of Statistics: Pune-Satara Road

YEAR	TOTAL TRAFFIC	TOTAL REVENUE (Rs. In Lakhs)	O&M EXPENDITURE (Rs. In Lakhs)	O&M EXPENDITURE TO REVENUE (%)
2014	71,15,328	4,773	497	10.41
2015	77,63,893	5,173	522	10.09
2016	85,87,473	5,668	553	9.75

Source: Analysis of primary data by the researcher

Table 6.10: Summary of Statistics: Pune-Solapur Road

YEAR	TOTAL TRAFFIC	TOTAL REVENUE (Rs. In Lakhs)	O&M EXPENDITURE (Rs. In Lakhs)	O&M EXPENDITURE TO REVENUE (%)
2014	61,50,816	6,770	695	10.26
2015	67,30,765	7,324	730	9.96
2016	74,63,263	8,037	774	9.63

Source: Analysis of primary data by the researcher

Table 6.11: Summary of Statistics: Pune-Mumbai Expressway

YEAR	TOTAL TRAFFIC	TOTAL REVENUE (Rs. In Lakhs)	O&M EXPENDITURE (Rs. In Lakhs)	O&M EXPENDITURE TO REVENUE (%)
2014	3,06,88,573	86,113	1040	1.21
2015	3,37,57,431	93,261	1092	1.17
2016	3,75,66,375	1,01,525	1158	1.14

Source: Analysis of primary data by the researcher

6.2.3 Graphical Representation of Trends

The statistics are presented graphically for interpretation convenience for all toll roads as follows (Fig 6.1 to 6.18)

a) Pune-Ahmednagar Road

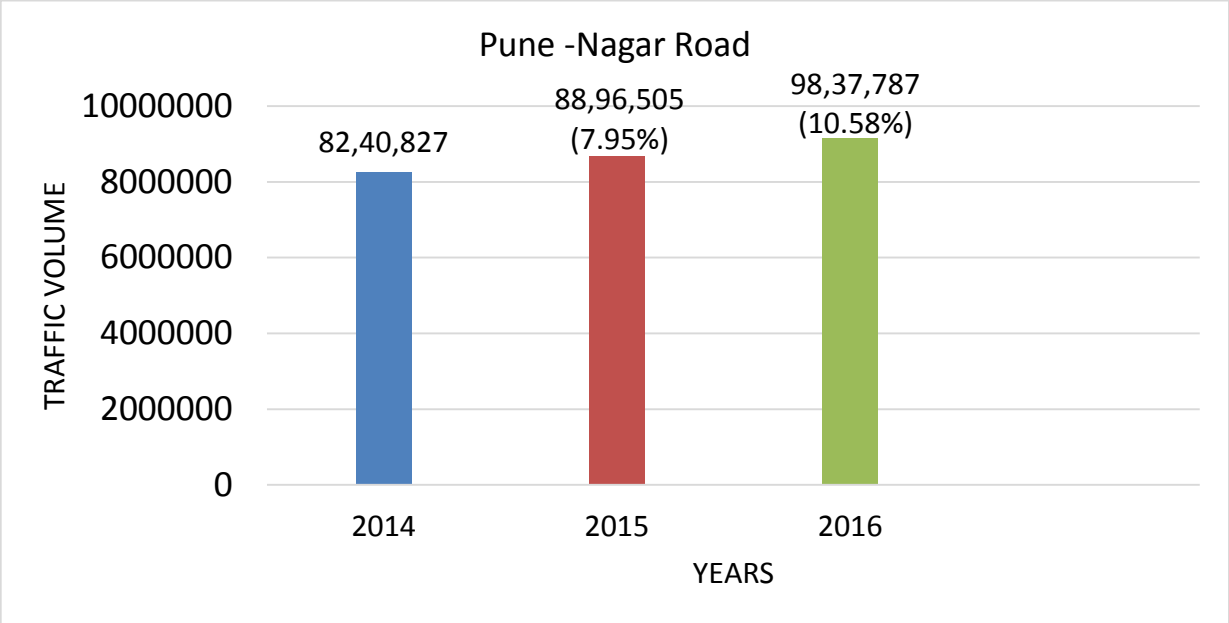


Figure 6.1: Toll Traffic Trend

It can be observed in 2015 that there is a **7.95%** increase in traffic volume from the base year of 2014. And similarly **10.58%** increase is observed in 2016.

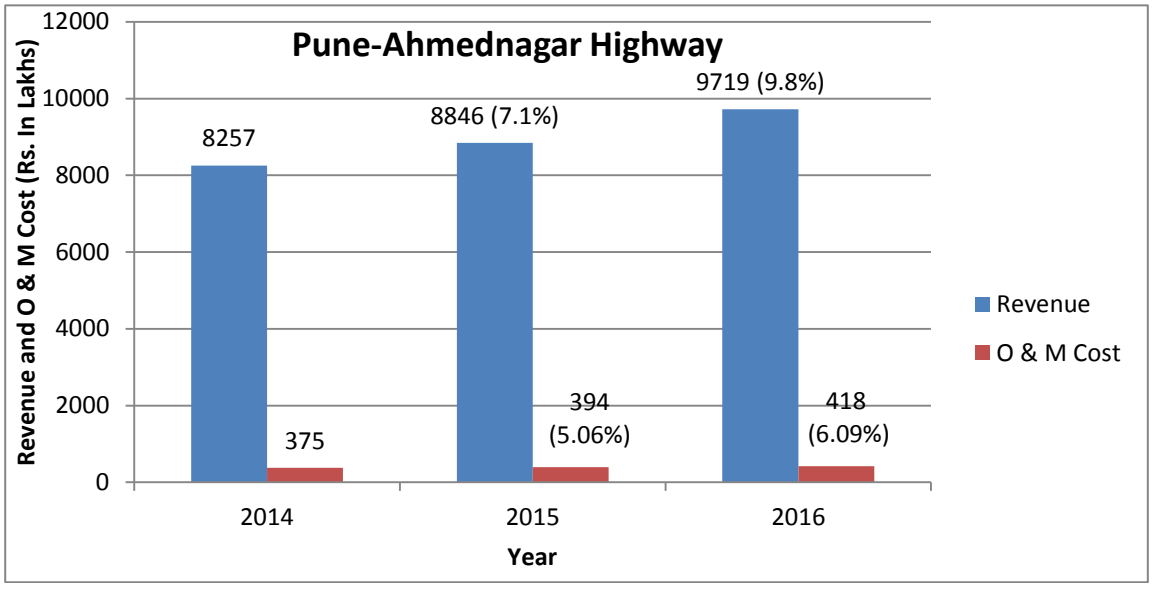


Figure 6.2: Toll Revenue and O & M Cost (Rs. In Lakhs)

It can be observed in 2015 that there is a **7.1%** increase in total revenue from the base year of 2014. And similarly **9.8%** increase is observed in 2016. Also, it is observed that there is increase in operation and maintenance cost, 5.06% in the year 2015 and 6.09% in the year 2016.

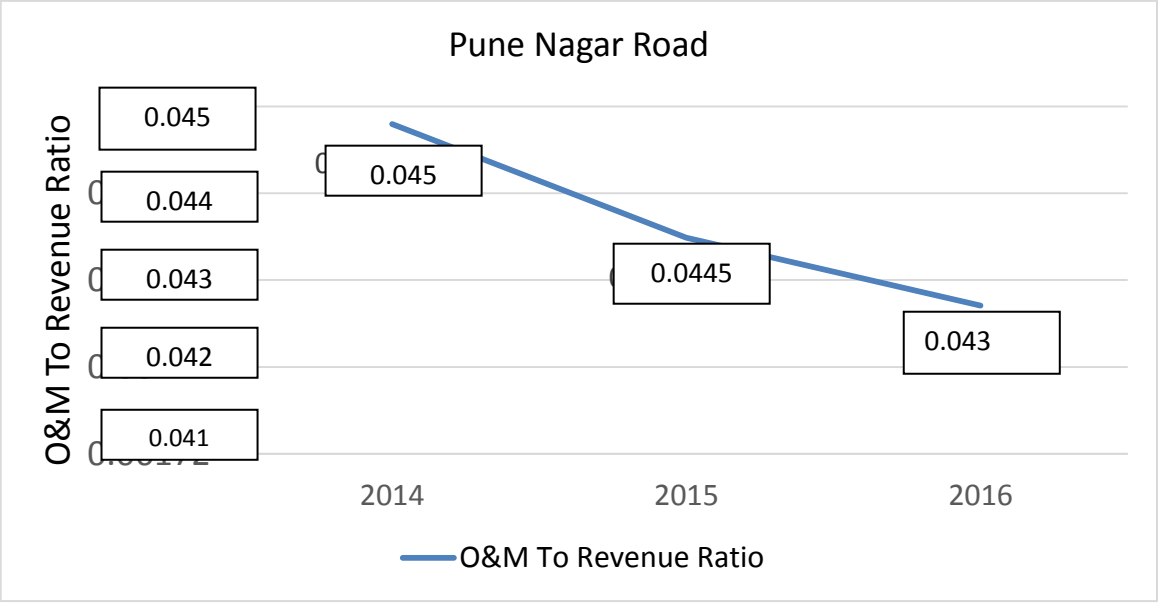


Figure 6.3: Operating Ratio Trend

The O&M to Revenue Ratio is decreasing during the period, 2014 -16.

1. In the year 2014 total traffic observed were **82, 40,827** while revenue generated was **Rs. 8,257 Lakhs.** The amount of money spent on operation and maintenance on this road was **Rs. 375 Lakhs** and the percentage of this amount to the revenue generated in the same year was **4.5 %.**
2. In the year 2015 total traffic observed were **88, 96,505** while revenue generated was **Rs. 8,846 Lakhs.** The amount of money spent on operation and management on this road was **Rs. 394 Lakhs** and the percentage of this amount to the revenue generated in the same year was **4.45%.**
3. In the year 2016 total traffic observed were **98, 37,787** while revenue generated was **Rs. 9,719 Lakhs.** The amount of money spent on operation and management on this road was **Rs. 418 Lakhs** and the percentage of this amount to the revenue generated in the same year was **4.30%.**

b) Pune-Nashik Road

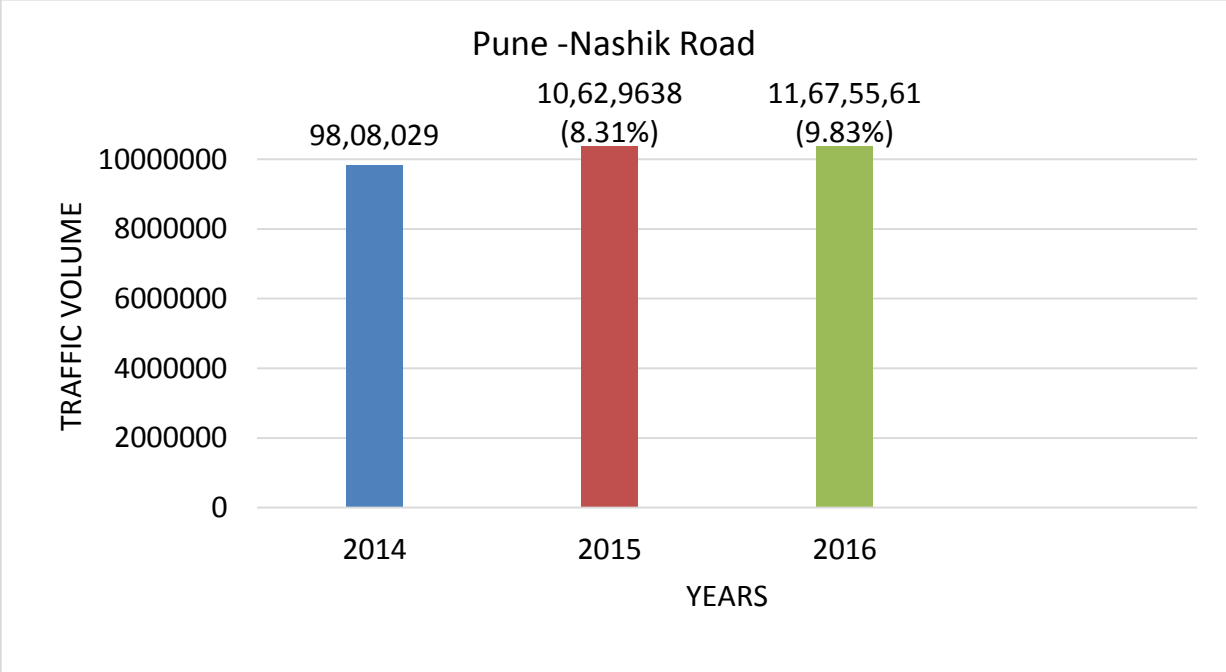


Figure 6.4: Toll Traffic Trend

It can be observed in 2015 that there is an **8.31%** increase in traffic volume from the base year of 2014. And similarly **9.83%** increase is observed in 2016. The X-axis represents the years and Y-axis represents traffic volume observed.

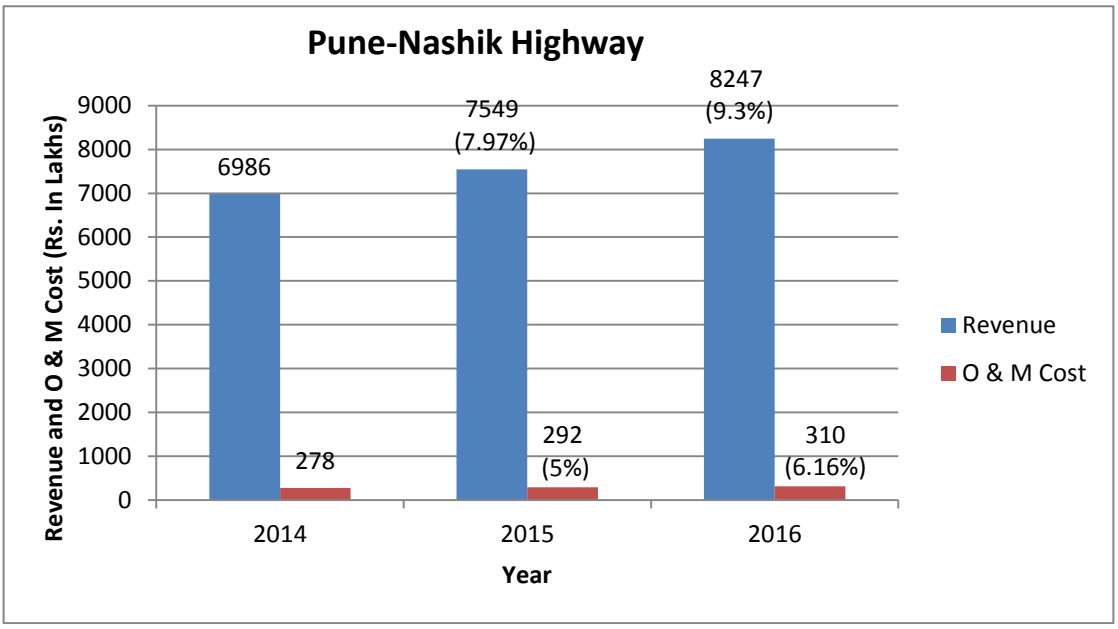


Figure 6.5: Toll Revenue and O & M Cost (Rs. In Lakhs)

It can be observed in 2015 that there is nearly **8%** increase in total revenue from the base year of 2014. And similarly **9.3%** increases is observed in 2016. Also, it is observed that

there is increase in operation and maintenance cost, 5% in the year 2015 and 6.16% in the year 2016.

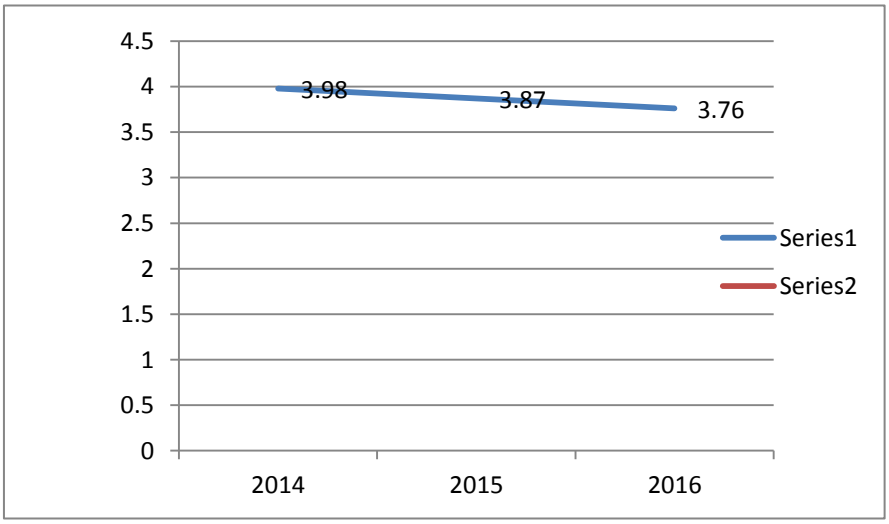


Figure 6.6: Operating Ratio Trend

The O&M to Revenue Ratio remain decreasing throughout the period 2015-16.

1. In the year 2014 total traffic observed were **98, 08,029** while revenue generated was **Rs. 6,986 Lakhs.** The amount of money spent on operation and maintenance on this road was **Rs. 278 Lakhs** and the percentage of this amount to the revenue generated in the same year was **3.98%.**
2. In the year 2015 total traffic observed were **1, 06, 29, 638** while revenue generated was **Rs. 7,543 Lakhs.** The amount of money spent on operation and management on this road was **Rs. 292 Lakhs** and the percentage of this amount to the revenue generated in the same year was **3.87%.**
3. In the year 2016 total traffic observed were **1, 16,75, 561** while revenue generated was **Rs. 8,247 Lakhs.** The amount of money spent on operation and management on this road was **Rs. 310 lakhs** and the percentage of this amount to the revenue generated in the same year was **3.76%.**

c) Pune-Mumbai Road

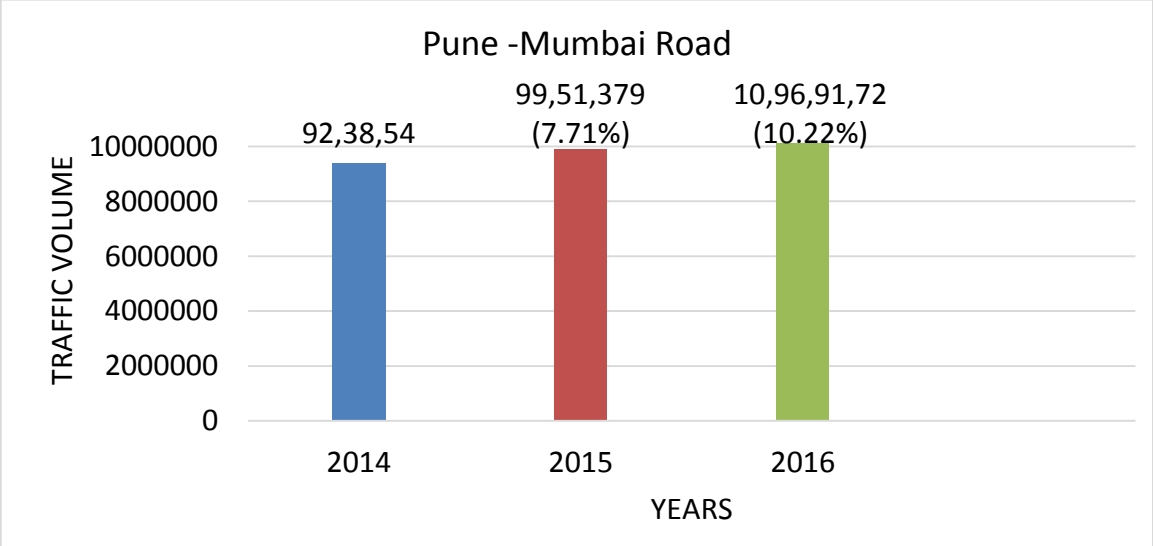


Figure 6.7: Toll Traffic Trend

It can be observed in 2015 that there is a **7.71%** increase in traffic volume from the base year of 2014. And similarly **10.22%** increase is observed in 2016. The X-axis represents the years and Y-axis represents traffic volume observed.

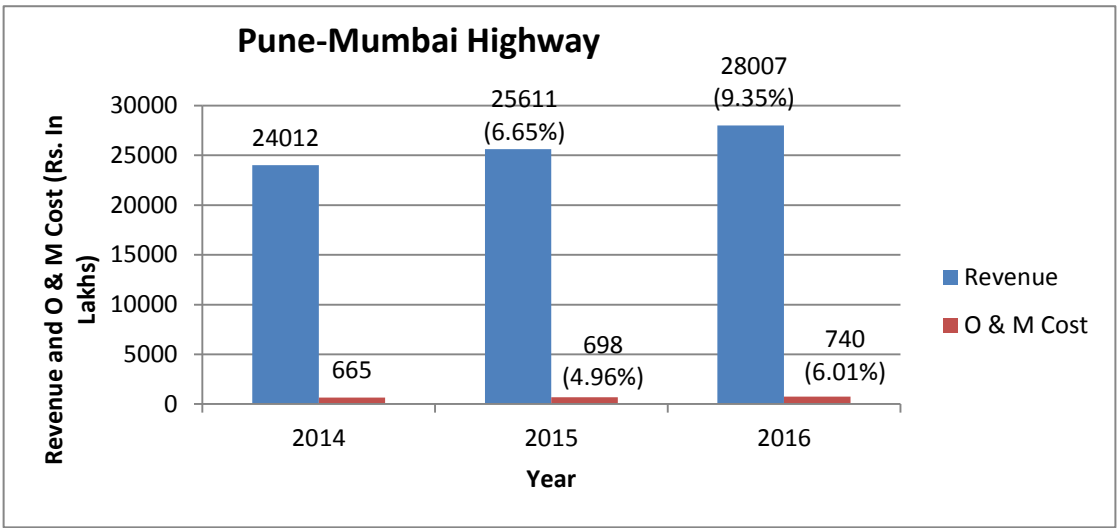


Figure 6.8: Toll Revenue and O & M Cost (Rs. In Lakhs)

It can be observed in 2015 that there is a6.6**%** increase in total revenue from the base year of 2014. And similarly **9.7%** increase is observed in 2016. Also, it is observed that there is increase in operation and maintenance cost, 4.96% in the year 2015 and 6.01% in the year 2016.

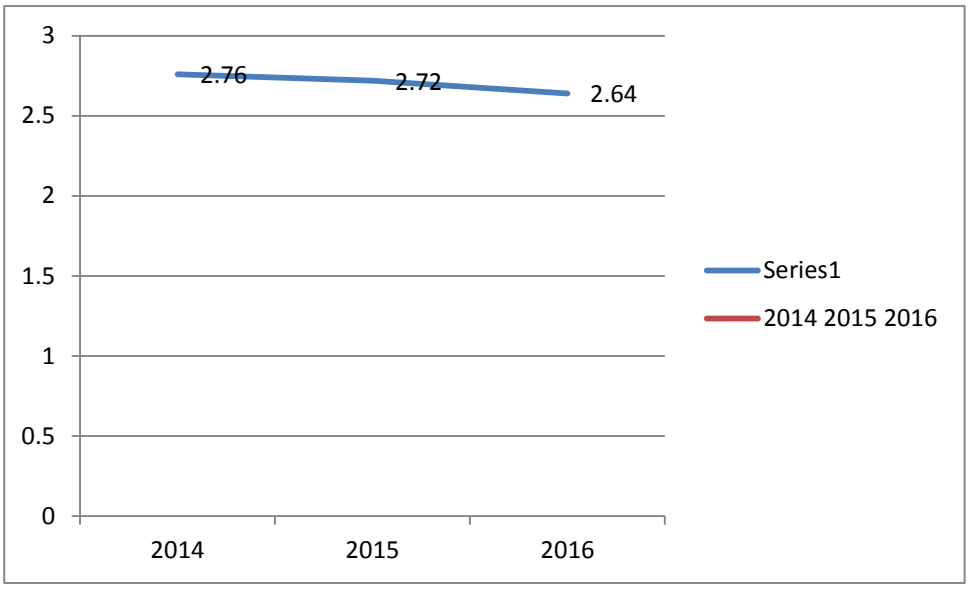


Figure 6.9: Operating Ratio Trend

The O&M to Revenue Ratio remain closely same through 2014-15 and decreases through 2015-16.

1. In the year 2014 total traffic observed were **92, 38,654** while revenue generated was **Rs. 24,012 Lakhs.** The amount of money spent on operation and maintenance on this road was **Rs.** 665 Lakhs and the percentage of this amount to the revenue generated in the same year was **2.76%.**
2. In the year 2015 total traffic observed were **99, 51,379** while revenue generated was **Rs.25, 611 Lakhs.** The amount of money spent on operation and management on this road was **Rs. 698 Lakhs** and the percentage of this amount to the revenue generated in the same year was **2.72%.**
3. In the year 2016 total traffic observed were **1, 09, 69, 172** while revenue generated was **Rs.28, 007 Lakhs.** The amount of money spent on operation and management on this road was **Rs. 740 Lakhs** and the percentage of this amount to the revenue generated in the same year was **2.64%.**

d) Pune-Satara Road

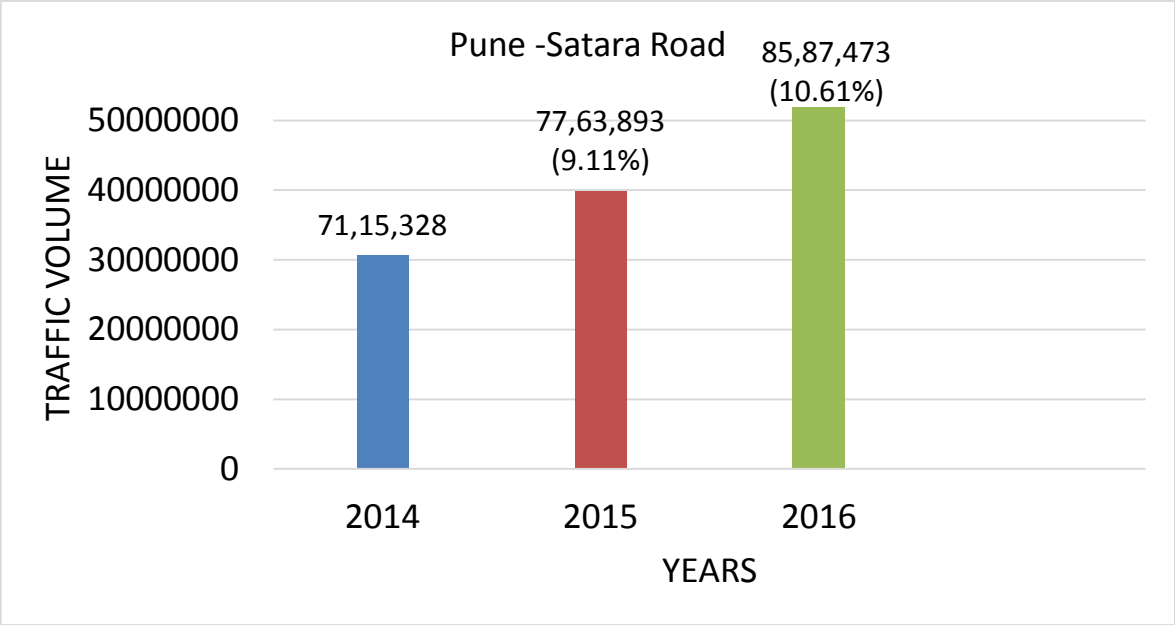


Figure 6.10: Toll Traffic Trend

It can be observed in 2015 that there is a **9.11%** increase in traffic volume from the base year of 2014. And similarly **10.61%** increase is observed in 2016. The X-axis represents the years and Y-axis represents traffic volume observed.

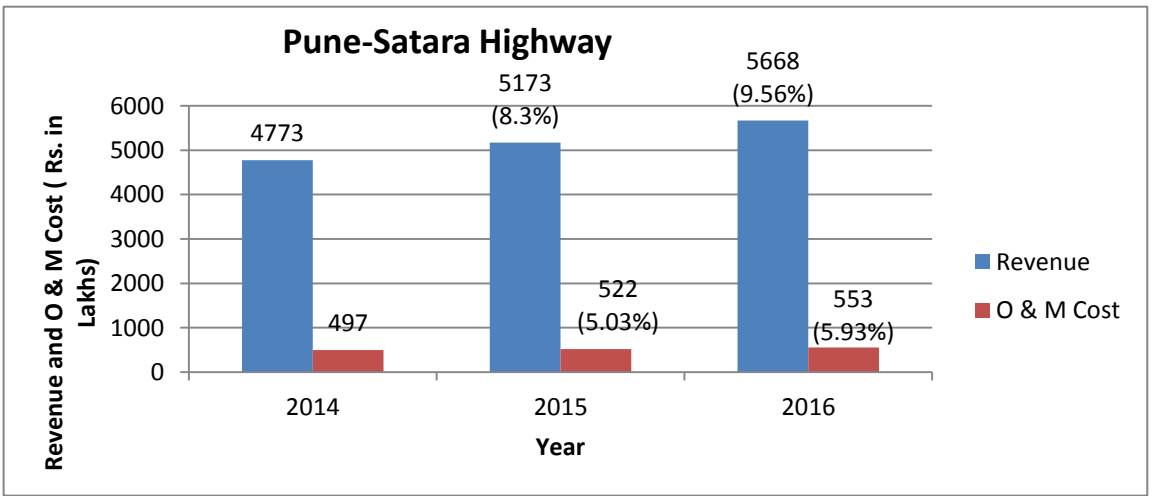


Figure 6.11: Toll Revenue and O & M Cost (Rs. In Lakhs)

It can be observed in 2015 that there is a **7.73%** increase in total revenue from the base year of 2014. And similarly **9.56%** increase is observed in 2016. Also, it is observed that there is increase in operation and maintenance cost, 5.03% in the year 2015 and 5.93% in the year 2016.

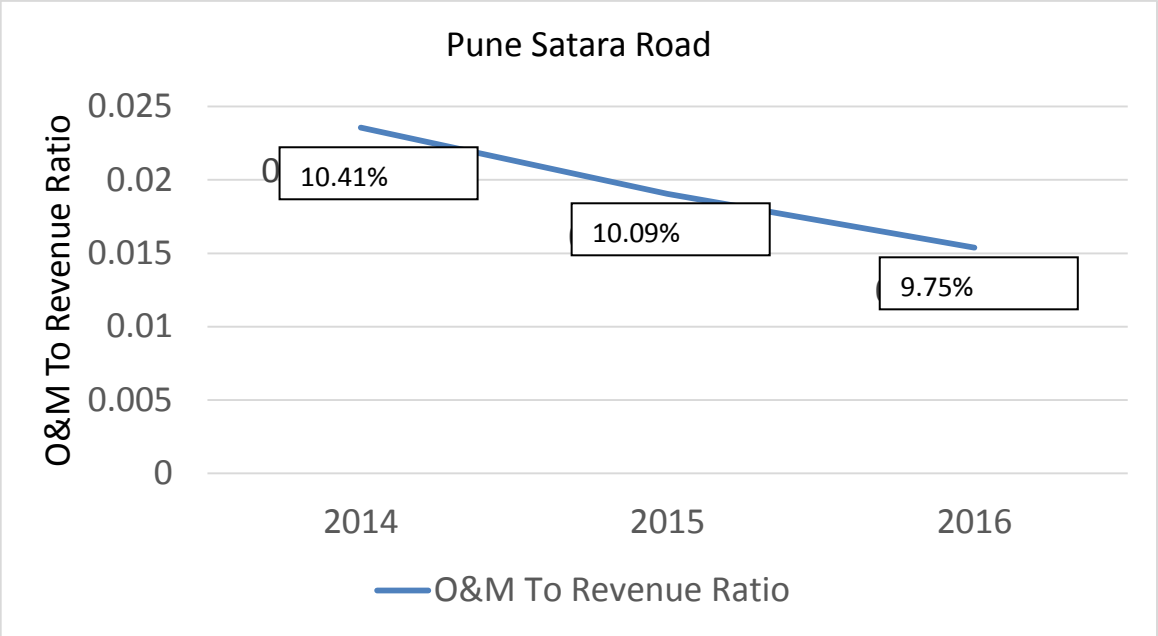


Figure 6.12: Operating Ratio Trend

The O&M to Revenue Ratio is decreasing throughout the period 2014-16.

1. In the year 2014 total traffic observed were **71, 15,328** while revenue generated was **Rs. 4,773 Lakhs** amount of money spent on operation and maintenance on this road was **Rs. 497 Lakhs** and the percentage of this amount to the revenue generated in the same year was **10.41%.**
2. In the year 2015 total traffic observed were **77,63,893** while revenue generated was **Rs.5,173 Lakhs** The amount of money spent on operation and management on this road was **Rs. 522 Lakhs** and the percentage of this amount to the revenue generated in the same year was **10.09%**
3. In the year 2016 total traffic observed were **85,87,473** while revenue generated was **Rs. 5,668 Lakhs** The amount of money spent on operation and management on this road was **Rs. 553 Lakhs** and the percentage of this amount to the revenue generated in the same year was **9.75%**

e) Pune-Solapur Road

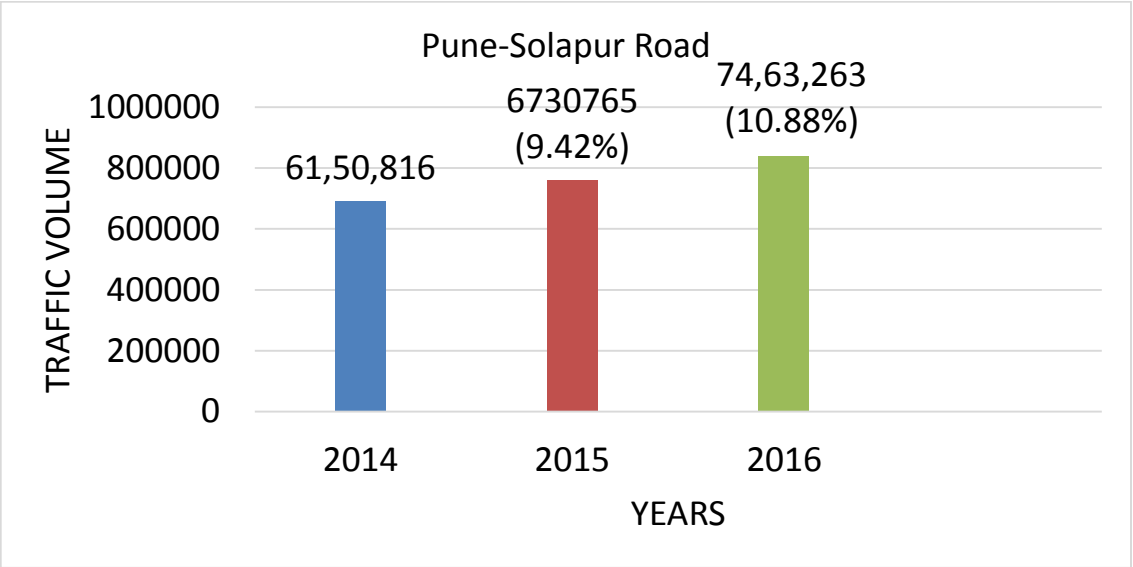


Figure 6.13: Toll Traffic Trend

It can be observed in 2015 that there is a **9.42%** increase in traffic volume from the base year of 2014. And similarly 1**0.88%** increase is observed in 2016. The X-axis represents the years and Y-axis represents traffic volume observed.

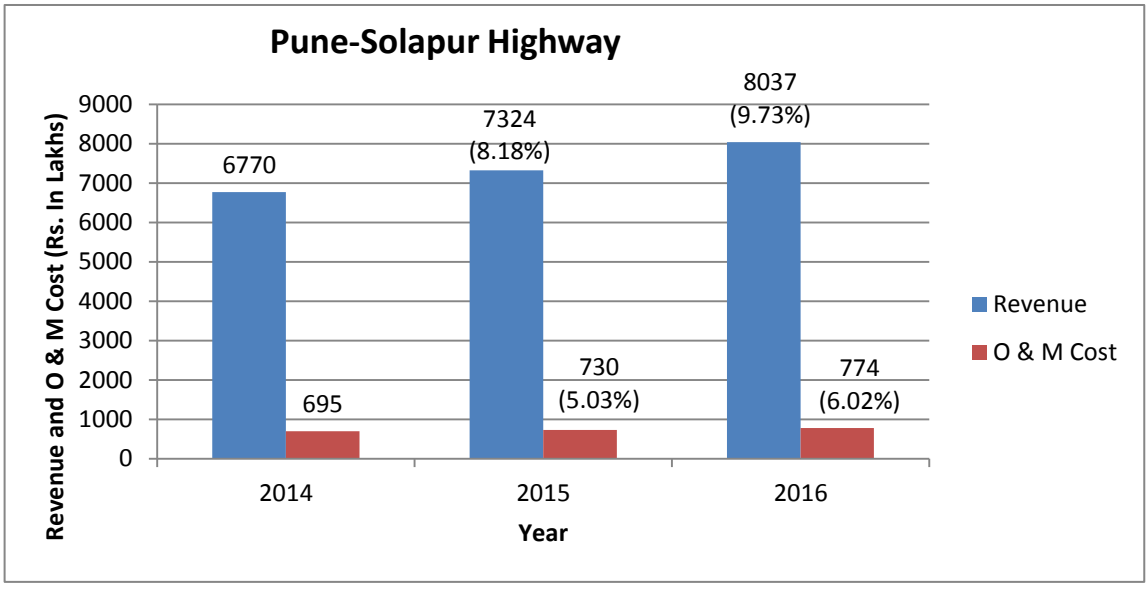


Figure 6.14: Toll Revenue and O & M Cost (Rs. In Lakhs)

It can be observed in 2015 that there is above 8**%** increase in total revenue from the base year of 2014. And similarly **9.7%** increase is observed in 2016. Also, it is observed that there is increase in operation and maintenance cost, 5.03% in the year 2015 and 6.02% in the year 2016.

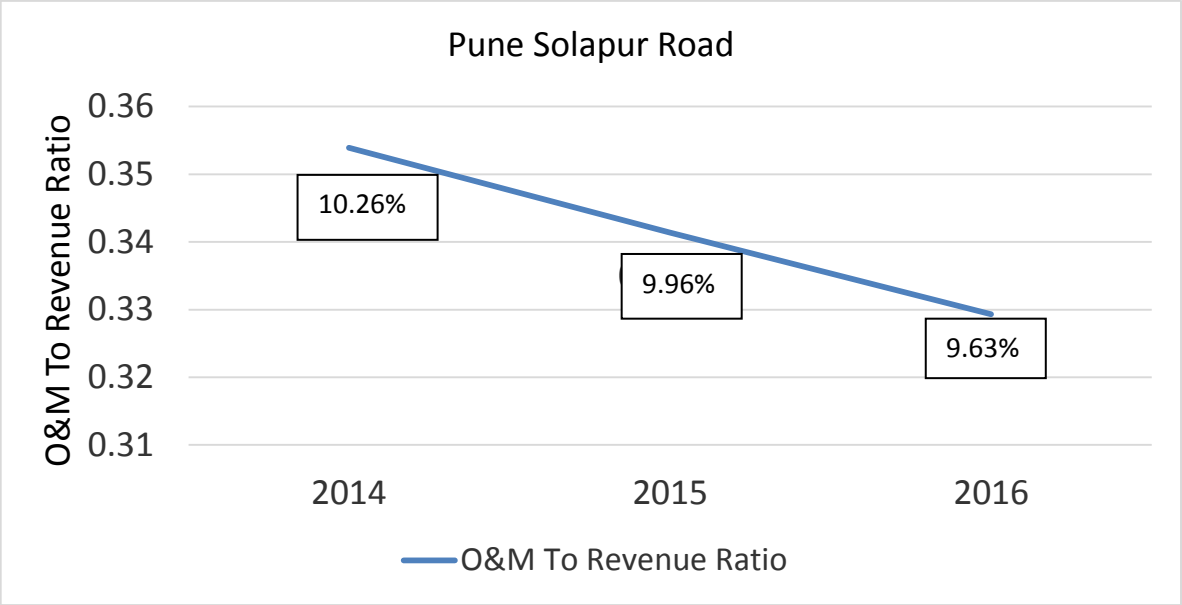


Figure 6.15: Operating Ratio Trend

The O&M to Revenue Ratio decreases in 2014-15 and 2015-16

1. In the year 2014 total traffic observed were Rs. **61, 50,816** while revenue generated was **Rs. 6,770 Lakhs..**The amount of money spent on operation and maintenance on this road was **Rs. 695 Lakhs** and the percentage of this amount to the revenue generated in the same year was **10.26 %.**
2. In the year 2015 total traffic observed were **67, 30,765** while revenue generated was **Rs.7,324 Lakhs** The amount of money spent on operation and management on this road was **Rs. 730 Lakhs** and the percentage of this amount to the revenue generated in the same year was **9.96 %.**
3. In the year 2016 total traffic observed were **74, 63,263** while revenue generated was **Rs. 8,037 Lakhs.** The amount of money spent on operation and management on this road was **Rs. 774 Lakhs** and the percentage of this amount to the revenue generated in the same year was **9.63 %.**

f) Pune-Mumbai Expressway

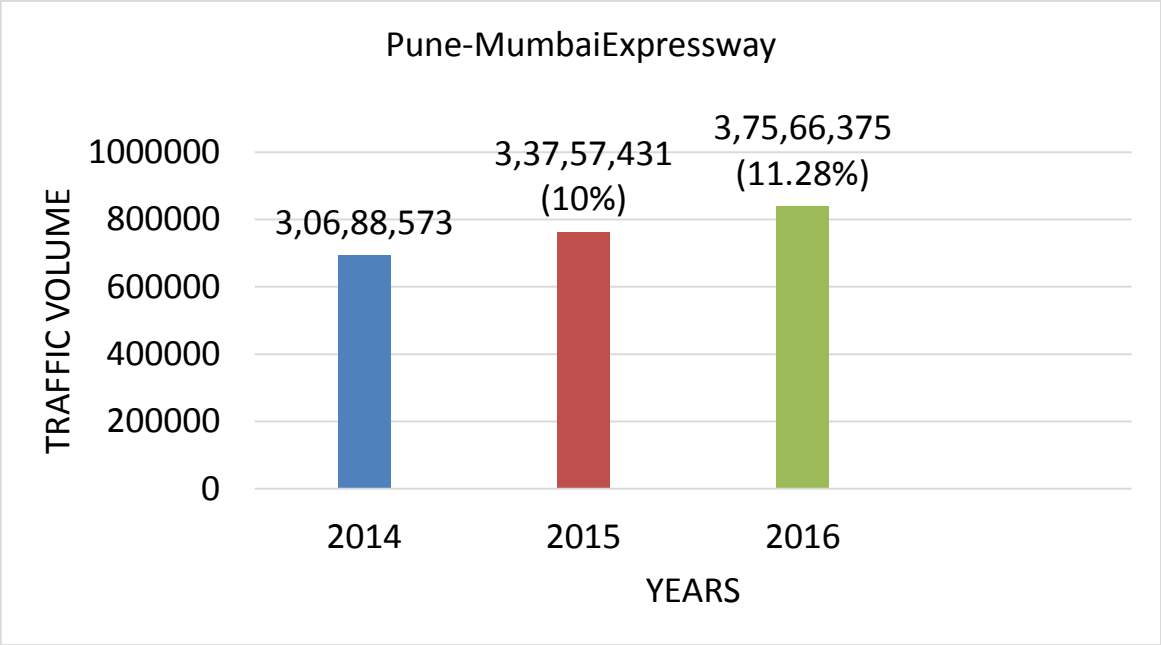


Figure 6.16: Toll Traffic Trend

It can be observed in 2015 that there is a **10%** increase in traffic volume from the base year of 2014. And similarly **11.28%** increase is observed in 2016. The X-axis represents the years and Y-axis represents traffic volume observed.

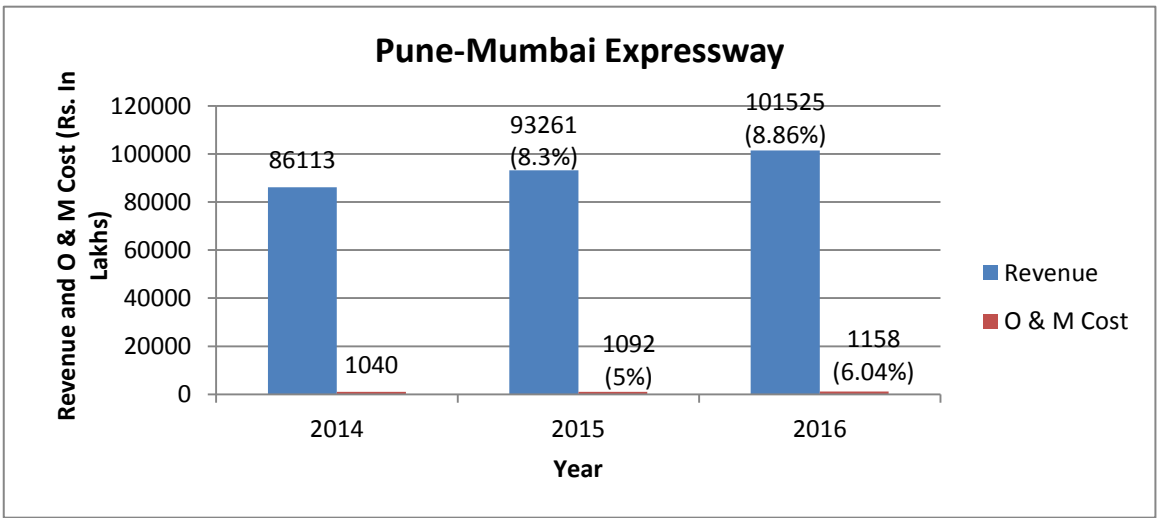


Figure 6.17: Toll Revenue Trend (Rs. In Lakhs)

It can be observed in 2015 that there is an **8.3%** increase in total revenue from the base year of 2014. And similarly **9%** increase is observed in 2016. Also, it is observed that there is increase in operation and maintenance cost, 5% in the year 2015 and 6.04% in the year 2016.

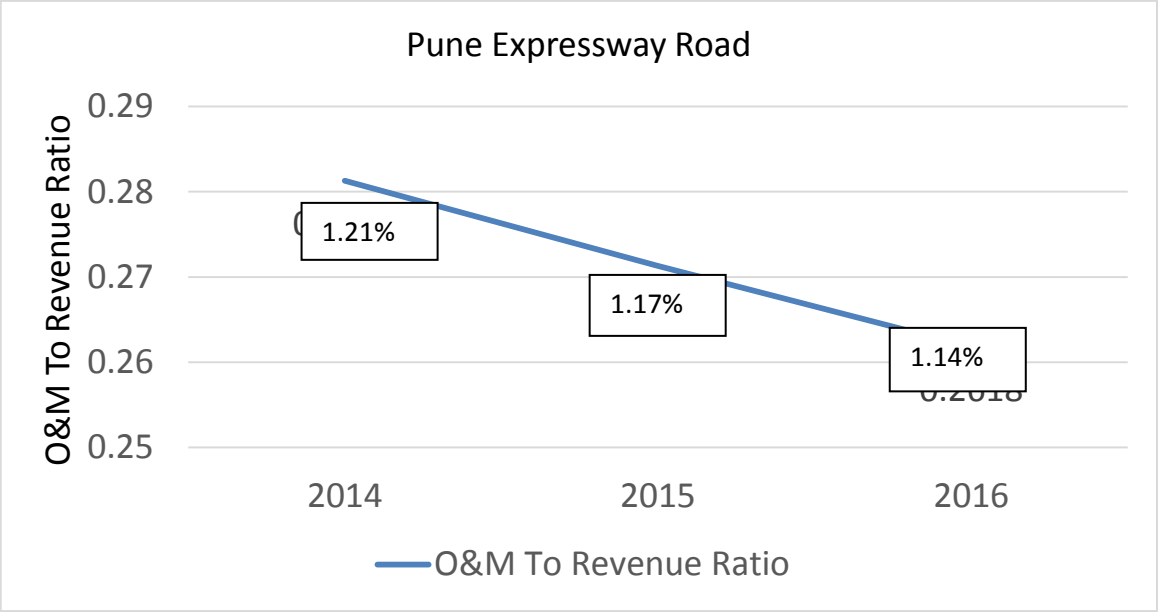


Figure 6.18: Operating Ratio Trend

The O&M to Revenue Ratio decreases in 2014-15 and 2015-16.

1. In the year 2014 total traffic observed were **3,06,88,573** while revenue generated was **Rs. 86,113 Lakhs.** The amount of money spent on operation and maintenance on this road was **Rs. 1040 Lakhs** and the percentage of this amount to the revenue generated in the same year was **1.21 %.**
2. In the year 2015 total traffic observed were **3, 37, 57,431** while revenue generated was **Rs.93,261 Lakhs.** The amount of money spent on operation and management on this road was **Rs. 1092 Lakhs** and the percentage of this amount to the revenue generated in the same year was **1.17 %.**
3. In the year 2016 total traffic observed were **3, 75, 66,375** while revenue generated was **Rs. 1, 01,525 Lakhs.** The amount of money spent on operation and management on this road was **Rs. 1,158 Lakhs** and the percentage of this amount to the revenue generated in the same year was **1.14%.**

6.2.4 Summary of the Comparison

It is found that all most all tollways are carrying near or above the roadway practical service traffic volumes (20,000 vehicles per day) for four lane highways. From the above analysis, it is observed that the top grosser projects are Pune-Mumbai expressway and Pune-Mumbai Old Highway which collected toll revenue Rs. 93,633 Lakhs and Rs.25, 877 Lakhs respectively on average during the period 2014-2015. Toll fares are higher thereby contractors generate a whopping revenue but is observed that the maintenance costs incurred on the roads are too low across the tollways. From the above analysis, it may be seen that, Pune-Satara Road has the highest operation and maintenance to revenue ratio with average of **10.41% (2014)** followed by Pune-Solapur road which has a average ratio of **10.26% (2014).**This can be attributed to less traffic which generates toll and more expenditure on maintenance which generates less profit and leads to less investment recovery.

Pune-Mumbai Expressway road has the least operation and maintenance to revenue ratio with average of **1.14% (2016).** This can be attributed to more income generated due to more traffic as compared to other roads and lower investment for maintenance expenditure.

Also from the analysis it can be inferred that although traffic is increasing every year and more revenue is being generated, the O&M to revenue ratio is decreasing every year. This could be due the fact that as the volume of traffic increases, the wear and tear of the road also increases which requires more maintenance and hence more money need to be spent.

6.3 Analysis of Data on Toll Plaza Operations

This particular study is based on the methodology explained at section No. 4.4.2 .The Toll Plazas are assessed on 4 broad parameters which include 24 specific indicators as mentioned in this section , to determine scoring so as to check deficiencies across

operational service factors and take necessary measures so as to improve operational efficiency. The questionnaire used for this study is enclosed at the Appendix II, page no.261

Collection technique: The categories observed in the field through this method are converted into binary form 0 and 1 for analysis. The Qualitative data collected in this technique consist of various variables which are recorded in Check-list, specifically formulated for the purpose. The check list data and analysis helps to observe the behaviour of the system, for example, as how it works for vehicles queues management through toll lanes, etc. The check-list is designed to map the features of the Tolling process and the features are measured on a scale of 0 to 1. It is assumed that all the parameters carry equal weight in ranking process and scoring system. Parameters are measured with a 'Yes' or 'No', based on Physical presence, wherein 'Yes' carries a weight of 1 (One), while 'No' carries 0 (zero) weight. However, for certain elements for which quantitative analysis is not applied, a subjective assessment is carried out, the process of which, is briefly mentioned herein. Corollary to above is that, it's a condition assessment process, where in, based on observation and data collected, the scores are assigned as follows:

1= Poor 2=Average 3=Good 4= Very Good 5=Excellent

Example: In case of public toilets, if present at Plaza, mention YES and simultaneously assess the condition of the same, on the above scale. Normally, it is observed that Toilets are assessed between poor and average and therefore, the scores between 1 and 2, are assigned by the respondent. The questionnaire, furnished in Annexure II provides a better picture and comprehensive information of the process involved. However, in short the toll plazas are assessed on Toll Plaza Information and Management Systems (TPIMS) with 8 elements for 8 points, Toll Technology and Surveillance System (TT

SS**)** with 5 elements for 5 points, Toll Office Amenities (TOA**)** for 4 points and Qualitative Service Parameters with 7 elements for 35 points (a maximum of 5 points for each Qualitative Service Parameter is given). Finally, each Toll Plaza is evaluated for Quantitative plus Qualitative scores, wherein the evaluation summates to a total of 52 points (8+5+4+35).

The Operational parameters, covering Quantitative (objective) and Qualitative (subjective) ones are listed below:

Toll Plaza Information and Management Systems (TPIMS) (for objective assessment)

- Display Of The Project information near The Toll Area
- Toll Rates Display
- Separate Lane for Oversized Vehicle
- Speed Restriction Sign at Plaza
- Lane Guidance for Vehicle
- Traffic Warden
- Bike Lane
- Boom Barrier

Toll Technology and Surveillance System (TT SS) (for objective assessment)

- Security Personnel
- CCTV in Toll cabin
- Electronic Toll Collection System
- WIM Bridge
- Automatic Vehicle Classifier

Toll Office Amenities (TOA) (for objective assessment)

- Toll Pass Office
- Parking Lots in emergency
- Commuter Complaint Register
- Toll Tag Recharge

Qualitative Service Parameters (QSP) (for subjective assessment)

- Public Toilets
- Plaza Lighting
- Lighting through approach areas
- Pavement condition at the approach area
- Vehicle queue length
- Appealing Environment around the premises
- Overall cleanliness

The Process involved for determining toll plaza operation service scores across 8 plazas are illustrated in the tables 6.12 to 6.14

Table 6.12: Quantitative Parameters										
Toll Plaza Information And Management System (TPIMS)			**Kusgaon**	**Shirur**	**Ranjangaon**	**Varwade**	**Talegoan**	**Anewadi**	**Moshi**	**Rajguru Nagar**
1	Display of Project Details Near The Plaza Area	Yes	1	1	1	1	1	1	1	1
		No								
2	Toll Rates Display	Yes	1	1	1	1	1	1	1	1
		No								
3	Separate Lane For Over Sized Vehicle	Yes	1	1	1	1	1	1	0	1
		No								
4	Speed Restriction Sign At Plaza	Yes	0	1	0	1	0	1	0	0
		No								
5	Lane Guidance For Vehicles (Over	Yes	0	1	1	1	1	1	0	0
		No								
6	Traffic Wardens/Marshals	Yes	1	1	0	1	1	1	0	0
		No								
7	Bike Lanes	Yes	0	1	1	0	1	1	0	1
		No								
8	Boom Barrier	Yes	1	1	1	1	0	1	1	1
		No								
Toll Technology And Surveillance System (TTSS)										
1	Security Personnel	Yes	1	1	0	0	1	1	1	0
		No								
2	CCTV in Toll Cabin	Yes	1	1	1	1	1	0	1	1
		No								
3	Electronic Toll Collection System	Manual	0	0	1	0	1	0	1	0
		Automatic								
4	WIM Bridge	Yes	0	0	0	0	1	0	1	0
		No								
5	Automatic Vehicle Classifier	Yes	0	0	1	0	0	0	0	0
		No								
Toll Office Amenities (TOA)										
1	Toll Pass Office	Yes	1	1	0	1	1	1	1	1
		No								
2	Parking Lots in Emergency	Yes	0	1	0	0	0	0	0	0
		No								
3	Commuter's Complaint Register	Yes	1	0	0	0	0	1	0	0
		No								
4	Toll Tag Recharge	Yes	0	0	0	0	0	0	0	0
		No								
Objective Total:			**9**	**12**	**9**	**9**	**11**	**11**	**8**	**7**

Source: Compiled by the researcher

Table 6.13: Qualitative Parameters

Qualitative Service Parameters (QSP)								Kushgaon	Shirur	Ranjangaon	Varwade	Talegoan	Anewadi	Moshi	Rajguru Nagar
1	Public Toilets	YES						0	3	0	2	2	1	0	0
		NO													
	IF YES THEN, LEVEL	1	2	3	4	5									
2	Plaza Lighting	YES						3	3	2	3	2	3	2	2
		NO													
	IF YES THEN, LEVEL	1	2	3	4	5									
3	Lighting Through Approach Areas	YES						2	3	2	2	2	2	1	0
		NO													
	IF YES THEN, LEVEL	1	2	3	4	5									
4	Pavement Condition At The Approach Area	YES						2	2	1	1	2	2	1	2
		NO													
	IF YES THEN, LEVEL	1	2	3	4	5									
5	Vehicle Queue Length	Negligible(**3**)						1	1	1	1	1	1	1	1
		Manageable(**2**)													
		Highly Non													
6	Appealing Environment Around Premises	YES						2	2	0	1	1	2	0	2
		NO													
	IF YES THEN, LEVEL	1	2	3	4	5									
7	Overall Cleanliness	YES						1	2	1	1	0	2	1	2
		NO													
	IF YES THEN, LEVEL	1	2	3	4	5									
SUBJECTIVE TOTAL								**11**	**16**	**7**	**11**	**10**	**13**	**6**	**9**
Grand Total (subjective +objective)								**20**	**28**	**16**	**20**	**21**	**24**	**14**	**16**

Source: Compiled by the researcher

Table 6.14: Ranking of Toll Plazas								
Ranking of Toll Plazas (RTP)	**Shirur**	**Anewadi**	**Talegoan**	**Kushgoan**	**Varwade**	**Ranjangonn**	**Rajgurunagar**	**Moshi**
Public Toilets	3	1	2	0	2	0	0	0
Plaza Lighting	3	3	2	2	3	2	2	2
Lighting Through Approach Area	3	2	2	0	2	2	0	1
Pavement At The Approach Area	2	2	2	2	1	1	2	1
Vehicle Qeue Length	1	1	1	1	1	1	1	2
Appealing Environment Around The Premises	2	2	1	2	1	0	2	0
Overall Cleanliness	2	2	1	2	1	1	2	1
SUBJECTIVE TOTAL (out of 35)	**16**	**13**	**11**	**9**	**11**	**7**	**9**	**8**
Objective Total (Out of 17)	**12**	**11**	**10**	**11**	**9**	**9**	**7**	**6**
Total (Out of 52)	**28**	**24**	**21**	**20**	**20**	**16**	**16**	**14**
Ranking	**1**	**2**	**3**	**4**	**4**	**5**	**5**	**6**

Source: Compiled by the researcher

1: Pune-Ahmednagar Road Toll Plaza (SHIRUR)

The Quantitative and Qualitative analysis was carried out for this Toll Plaza, and the observations are presented as follows. With respect to the TPIMS factor, this Toll Plaza maintains all the services such as project details, toll rates display, speed restriction sign at Plaza, lane guidance for vehicles, traffic wardens/marshals, bike lanes, etc. With respect to the TTSS factor, it has two facilities out of five which includes security personnel and CCTV in toll post cabins, Toll pass office and amenities at the plaza such as parking lots are existing under TOA factor. Facilities such as customer complaint

register and toll tag recharge facility are not provided under the same factor. For security reasons, surveillance system has provision for CCTV in Toll booths and presence of security personnel. Technological elements such as Toll collection system, automatic vehicle classifier, are found missing. From the process explained in the tables (6.12 to 6.13), it can be observed that the toll plaza at Shirur has been provided with comparatively good tolling service infrastructure leading to good operational efficiency. Further on QSP front it is observed that the element-vehicle queue length in lanes scored low points in 5-point scale, which co-relates to considerable vehicle queue and, therefore, proper management is required. The pavement at the approach area is provided at the moderate level, as is desired at a Toll Plaza. The other feature in evaluation process for the toll plaza is the "House Keeping". At Shirur Toll Plaza, the overall cleanliness is rated as "moderate", thereby necessitating greater focus with respect to this parameter. The appealing environment around the Toll Plaza is rated at "moderate" level. Finally the Shirur Toll Plaza scores a total of 28 points out of 52; by this, it can clearly be inferred that substantial attention is required with respect to various aspects, so as to increase the overall efficiency and effectiveness of the Toll Plaza.

2: Pune–Satara Toll Plaza (ANEWADI)

In TPIMS factor, it has all features as per expected standard- "Project Details" display near the Plaza Area as well as "Toll Rates" display. There are 10 lanes including a separate lane for oversized vehicles, lane guidance for vehicles, traffic wardens/marshals, bike lanes, violation enforcement system etc. Presence of physical features such as Toll pass office is observed. Amenities such as parking lots are not observed. Facilities such as customer complain register is provided under customer service parameter. For security purpose surveillance system has provision of security personnel. Technological elements

are found missing such as toll collection system, automatic vehicle classifier and Weigh in Motion bridge. With respect to the factor QSP, it is clear that this parameter attracts poor rating (public toilet rates abysmally low). However, the lighting at the Plaza scores quite well while the lighting at approach area is moderate. It is further observed that the vehicle queues feature scores very low, which infers that more emphasis should be laid on management of the queue so as to reduce queuing of vehicles at the Toll Plaza. The pavement at the approach area is rated as "moderate" with respect to quality, but considering the importance of good pavement at the approach area, quality has to be enhanced. Another element is the "House-keeping". The Anewadi Toll Plaza gets moderate rating in overall cleanliness as well as an appealing environment around the Toll Plaza. These two parameters can be the focus areas to improve the quality in this sector. Anewadi scores a total of 24 points in which special attention is needed at providing the public toilet, and also vehicle queue length can be area of focus to increase the score of this Toll Plaza.

3: Pune–Mumbai Highway Toll Plaza (Talegoan)

In compliance with the parameter of TPIMS this Toll Plaza has 6 facilities, namely, Display of Project details near the Plaza Area as well as the display of Toll Rates, separate lane for oversized vehicles, lane guidance for vehicles, traffic wardens/marshals, and bike lanes. The presence of physical parameters such as Toll-pass Office is observed. Amenities at Plaza like parking lots and facilities such as customer complaint register under customer service parameter are absent. For security purpose, the surveillance system has provision of CCTV in Toll booths and is manned by security personnel. Technology-elements such as Electronic Toll Collection system and

automatic vehicle classifier are absent. Whereas the roadway parameters that are available include highway patrolling, first aid and emergency phone.

It is seen further that the Toll Plaza at Talegoan has moderate level of amenities and in the near future the rating can be further enhanced by providing the amenities to the maximum level. With respect to the QSP it is observed that the vehicle queues through toll lanes has been rated as 1(one) thereby indicating an un manageable queues of vehicle. This emphasizes the need to improve queue management and thereby improve service. The Pavement at the approach area is provided with a moderate score and therefore, can be increased to ensure better accessibility. The other feature is House-keeping, in which the Talegoan Toll Plaza lacks in overall cleanliness as well as an appealing environment around the Toll Plaza. These two parameters should be the focus areas to improve the condition in this toll booth as the rating for both is 1(one) each. Talegoanr scores a total of 21 rating in which the prime areas of focus are vehicle queue length as well as sub-parameters of housekeeping to improve the score points of this Plaza.

4: Pune-Mumbai Expressway Toll Plaza (KUSHGAON)

Under TPIMS dimension this Toll Plaza has five service elements i.e., display of Project details near the Plaza area as well as Toll-Rates display, separate lane for oversized vehicles, lane guidance for vehicles, traffic wardens/marshals, bike lanes etc. Presence of physical parameter such as Toll pass office is observed. Amenities at Plaza like parking lots are absent. Facilities such as customer complaint register are also provided under the customer service parameter. For security purpose, surveillance system includes provision for CCTV in Toll booths and security personnel. Technological elements such as; Toll collection system, automatic vehicle classifier etc.

are not, present. it can be seen that the Toll Plaza at Kushgaon lacks in the parameter of amenities at the Toll Plaza, i.e. There are no public toilets available for the public. There is scope for improvement in lighting in approach area of Toll Plaza. The lighting for Plaza is provided at considerable level which means it is taken care adequately that this aspect might need some more attention.

On QSP front it is understood that the vehicle queues has also scored less in terms of rating which means that there is a queue of vehicles thereby emphasizing on the need of management's attention to solve this issue. At this Toll Plaza, it is observed that the pavement at the approach area is provided at the optimum level that is desired at the Toll Plaza. The next one is Housekeeping, in which the Kushgaon Toll Plaza lacks in overall cleanliness, while the appealing environment around the Toll Plaza is provided at the optimum level. Finally, the Kushgaon scores a total score of 20 points in which special attention is needed at providing the public toilet, improving cleanliness of Toll Plaza to further improve the condition of Toll Plaza operations.

5: Pune-Ahmednagar Road Toll Plaza (RANJANGOAN)

In TPIMS component this Toll Plaza has maximum facilities, i.e., Display of Project Details near the Plaza area, Toll Rates display, separate lane for oversized vehicles, lane guidance for vehicles, boom barrier, bike lanes, etc. It is not having speed restriction signs and traffic wardens In TOA component, no single facility is provided. For security purpose, surveillance system has CCTV in Toll booths but security personnel are missing. Technological elements such as ETC in few lanes, automatic vehicle classifier are seen existing. It is further observed that Toll Plaza at Ranjangaon lacks in the parameter of amenities at the Toll Plaza, i.e. there are no public toilets available to the public. There is scope of improvement in lighting in the approach area. The lighting for

Plaza is provided at the moderate level which means still there is a need to pay attention in amenities like lighting at Plaza and approach area.

In QSP aspect it is understood that the vehicle queue has scored low terms of rating. It means commuters suffer long queue of vehicle around the plaza. Thus emphasis must be on management of this issue to ensure little delay at toll booth. The pavement at the approach area is rated as 'Low' which means that a good quality pavement at the approach area is desired for better accessibility. The key element is House-keeping, in which the Rajangoan Toll Plaza lacks in overall cleanliness as well as the appealing environment around the Toll Plaza. These two parameters should be focused to improve the operational quality. So in all Rajangoan scores a total 16 out of 52 in both quantitative and qualitative service dimensions. It suggested that special attention is needed in providing public toilets as well as improving the house-keeping for overall cleanliness around the premises.

6: Pune-Solapur Toll Plaza (VARVADE)

At Varvade Toll Plaza, under TPIMS group of facilities has all facilities except bike lanes. It precisely has display of Project Details near the Plaza area as well as Toll Rates Display,

Separate lane for oversized vehicles, lane guidance for vehicles, speed restriction sign at Toll Plaza. Under TOA component toll pass office is available where as other amenities at Plaza like parking lots, complaint registrar and toll tag recharges are not found around. Security personnel are not deployed for security purpose but surveillance system provision of CCTV is installed in Toll booths. Technological elements such as ETC toll collection system, WIM bridge and automatic vehicle classifier are found missing. At this Varvade Toll Plaza, under the parameter of QSP toilets have been provided at the

basic level and the lighting at Plaza and approach road has been provided at just average level. It is also perceived that, the traffic queues are un manageable, thus proper traffic management is required to be put in place to reduce the traffic jams and to avoid delay at toll transaction. The cleanliness or housekeeping get low perception score since the appealing environment around the Toll Plaza is less attractive. Finally, Varvade scores a total score of 20 points out 52 which means it needs to improve in all aspects seriously.

7: Pune-Nashik Highway Toll Plaza (RAJGURUNAGAR)

The Rajgurunagar Toll Plaza has five facilities Under TPIMS group These facilities are Display of Project Details near the Plaza Area, Toll Rates Display, separate lane for oversized vehicles, bike lanes, boom barrier etc. Toll pass office is maintained and other amenities like parking lots, customer complaint register and toll tag recharge are also not provided under TOA component. The CCTV services in Toll booths are present where as other key technological elements such as Toll collection system, automatic vehicle classifier, etc, are found missing. While this Toll Plaza has no public toilets it has been perceived moderately good with respect to lighting of Plaza and the lighting at the approach area is totally nil. On QSP front it clear that the vehicle queues are un-manageable. This means that there is queue of vehicles thereby emphasizing on the need for better management, while the Pavement at the approach area is provided at moderate quality compared to expected quality of having a good pavement at the approach area for better accessibility. In overall cleanliness as well as the appealing environment around the Toll Plaza the commuters' perception is very low Rajgurunagar scores a total score of par below score of 16 points which emphasizes on the need for special attention in proving key facilities like public toilet, reducing vehicle queue length lighting of approach area,etc.

8: Pune-Nashik Highway Toll Plaza (Moshi)

The Moshi Toll Plaza provides only three facilities under TPIMS component as it precisely has Display of Project Details near The Plaza area, Toll Rates display boom barrier across toll lanes. At the same time it is devoid of five key elements such as traffic wardens, speed lanes for oversized vehicles, etc. Toll pass office maintained and other key elements like parking lots, customer complaint register, etc. under TOA are not observed. This plaza has almost all provisions under TTSS component such as f CCTV in Toll booths, security personnel, ETC, etc.

There are no public toilets available for the public. Also there is scope for improvement in lighting in the approach area. The lighting for Plaza is provided at a moderate level, which means that there is a need for more attention in amenities like lighting at Plaza and approach area. In the QSP component it is observed that the vehicle queue has low perception score which means that there is a long traffic line of vehicles thus emphasizing on the need for better management through toll lanes. The pavement at the approach area is not very well maintained which indicated a good pavement at the approach area is utmost important for smooth accessibility of approaching vehicles. The element of overall cleanliness well as the appealing environment around the Toll Plaza is rated as zero and perceived as not existing at all, thus emphasizing on the serious need for urgent improvement in these elements. The Toll Plaza at Moshi scores a total score of below par of 14 points out of 52, and this toll booth is in dire need for immediate improvement across all the operational dimensions.

Summary in short is that the evaluation of eight plazas on above mentioned parameters are conducted and outcome scores are considered for ranking eight toll plazas. The evaluation records the operational status of toll booths in the region and identifying strengths and opportunities for improvement in operational service performance. The

Shirur Toll Plaza was ranked “First” for having more number of tolling service facilities (28 points) and Anewadi with 24 points is ranked second. Talegoan is ranked third with 20 points. Kusgoan and Varvade toll plazas shared 4th position with 20 points each, Ranjangoan and Rajgurnagar are ranked 5 and Moshi is placed 6 position with very low score of 14 points.

6.4 Analysis of Road User Survey Data

The following sections present the analyses of Rod User data based on questionnaire survey. The questionnaire is attached at Appendix III at page no.255.

6.4.1 Analysis Of System Performance Indicators Are As Follows

Apart from Road user service indicators, some peripheral indicators (from Q. No.1 to Q. No. 12) are analyzed and findings are presented**.** While “the frequency distribution” technique of analysis is used from Q.No.1 to 10 the “method of ranking” is applied to derive the ranks of various driving factors and complaints in Q. No 10 - 11. Simple “Proportion Technique” is used to analyze Q. No. 12 for estimating the economic indicators in commuters’ perception and presented in graphs. For Q.13, being the most important part of the study, inferential statistics involving ANOVA, Factor analysis, etc. are carried out.

Category of vehicle

Thus a total sample size of 336 across all the Toll roads (under the study in the region) was carried out. The survey of 336 commuters includes various categories of vehicles such as buses, cars, trucks, heavy commercial vehicles and light commercial vehicles. Overall, the sample which covers passenger vehicles is 283 (84%) while that of goods vehicles is 53 (16%). This is because of the fact that the number of passengers travelling

in goods vehicles is substantially less in comparison with passengers travelling in passenger vehicles. Overall the percentage of total vehicle travelling on various Highways was surveyed and is as presented in *Table 6.15*.

Table 6.15: Sample Size in Various Cases of Toll Roads

Toll Road	Category of vehicle	Size of sample	% of sample
PA	PV	44	84
	GV	6	16
PN	PV	52	81
	GV	12	19
PS	PV	53	84
	GV	10	16
PSo	PV	36	72
	GV	14	28
PM	PV	55	93
	GV	4	7
PEx.	PV	43	86
	GV	7	14
Overall	PV	283	84%
	GV	53	16%
Total	-	**336**	**100%**

Source: Primary data Analysis

PA: Pune – Ahmednagar Road, PN: Pune- Nashik Road,
PS: Pune- Satara Road, PSo: Pune- Solapur Road,
PM: Pune -Mumbai Road, PEx: Pune- Expressway Road
PV: Passenger Vehicles, GV: Goods Vehicles

Category of Respondents (Respondent Profile) across Toll Road:

For PA road, over one-third (34%) of the commuters in vehicles are Drivers and Staff. About 40% commuters are vehicle owners and rests of them are passengers. For PN road, less than one fourth (24%) of those surveyed & interviewed are drivers and staff and over three fourth (76%) commuters belong to passengers and vehicle owners category particularly cars and LCVs. For PS, about 35 % of commuters surveyed & interviewed are drivers and staff and 66% are passengers and vehicle owners. For PSo

46% of those surveyed & interviewed are Drivers and staff and 54% are passengers and owners. For PM, Majority of respondents (78%) is passengers and vehicle owners and only 22 % are drivers and staff. For the Road PEx, 44 % are drivers and staff and 56 % are passengers and owners as interviewed on this road.

Percentage distribution of respondent profile is presented in the Table 6.16**.** A detailed analysis shows that those surveyed include Passengers travelling in buses and other vehicles (29%), Vehicle owners, particularly car and LMVs (39%), Drivers (28%) and Staff in vehicles (4%).

Table 6.16: Percentage Distribution of Respondent Profile

Road	Category of Respondents		Sample Size	%
PA	D		10	28
	S		4	4
	P		26	29
	O		10	39
		Total	**50**	**100**
PN	D		14	21
	S		2	3
	P		24	38
	O		24	38
		Total	**64**	**100**
PS	D		18	28
	S		4	6
	P		6	10
	O		35	56
		Total	**63**	**100**
PSo	D		20	40
	S		3	6
	P		11	22
	O		16	32
		Total	**50**	**100**
PM	D		12	20
	S		1	2
	P		25	42
	O		21	36
		Total	**59**	**100**
PEx.	D		20	40
	S		2	4
	P		5	10
	O		23	46
		Total	**50**	**100**
Overall	D		93	28
	S		16	4
	P		98	29
	O		129	39
		Total	**336**	**100**

Source: Primary data Analysis

D: Drivers S: Staff in Vehicle P: Passenger and O: Owner

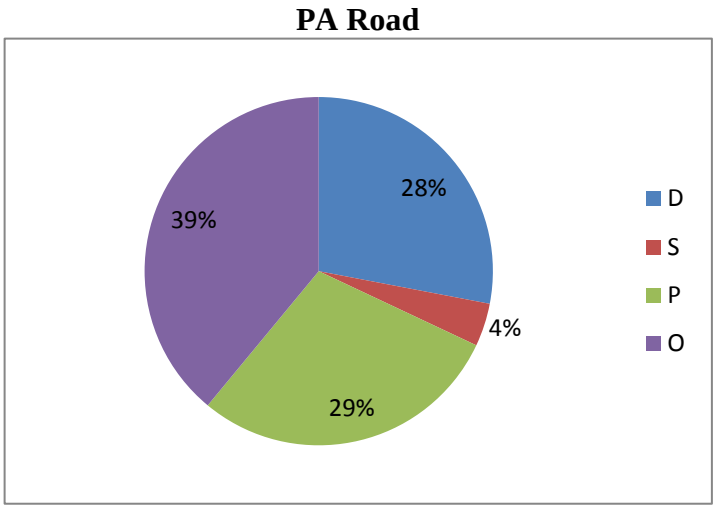


Figure 6.19: Respondent Profile – Pune-Ahmednagar Highway

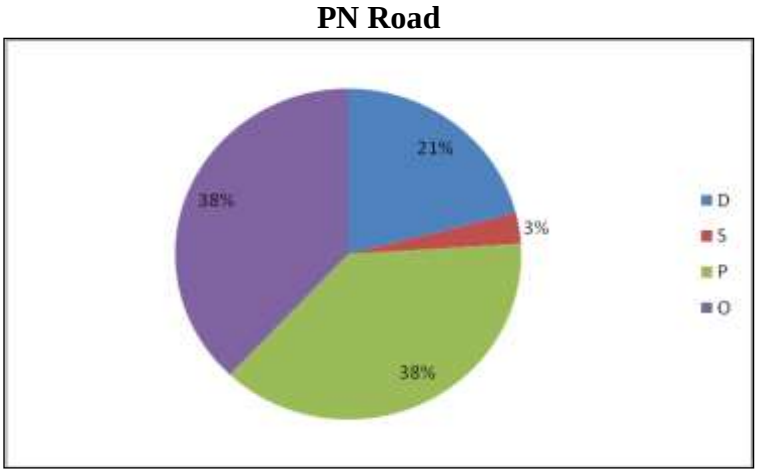


Figure 6.20: Respondent Profile – Pune-Nashik Highway

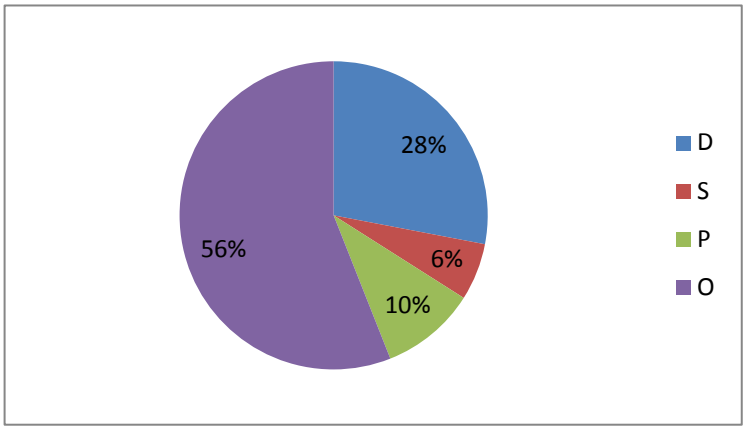


Figure 6.21: Respondent Profile – Pune-Satara Highway

PSo Road

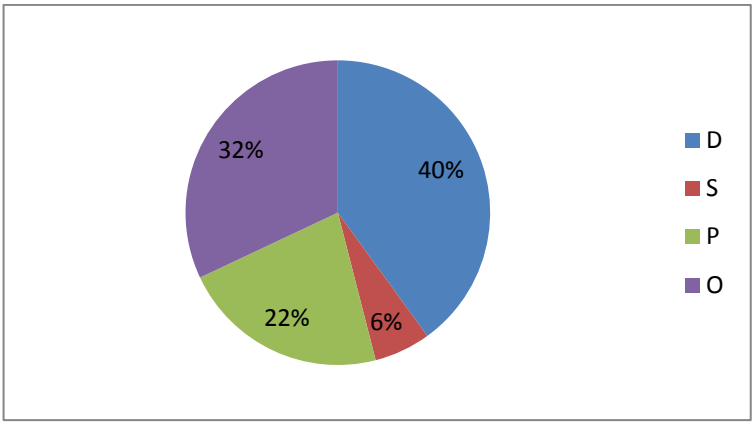


Figure 6.22: Respondent Profile – Pune-Solapur Highway

PM Road

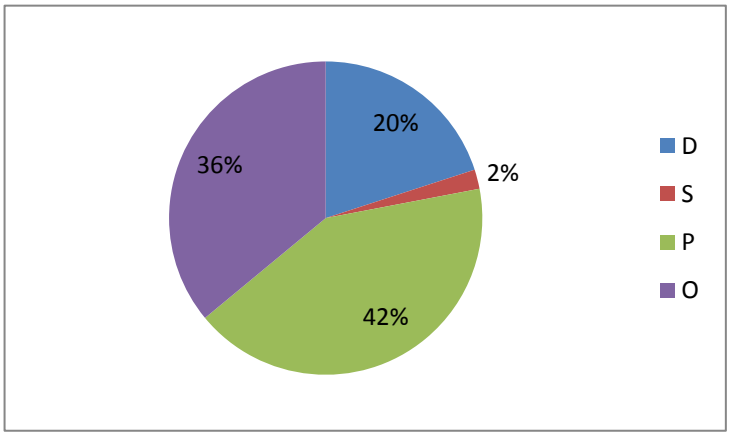


Figure 6.23: Respondent Profile – Pune-Mumbai Highway

PEx Road

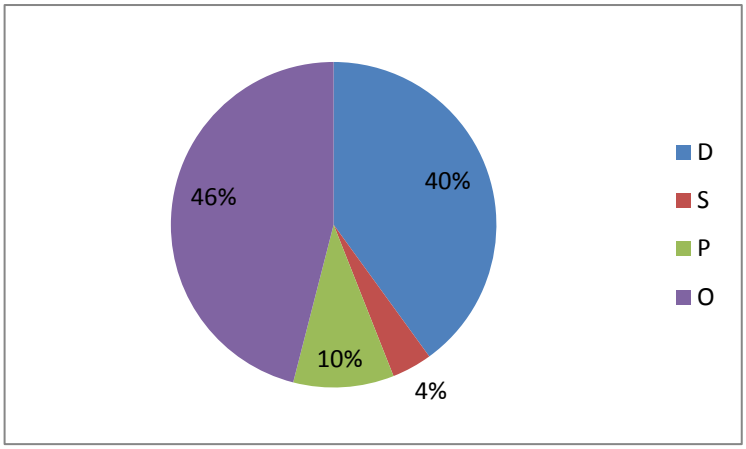


Figure 6.24: Respondent Profile – Pune-Mumbai Express Way

Overall

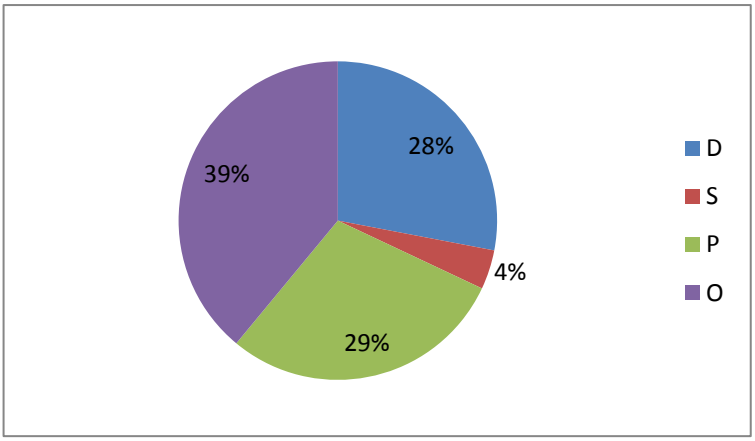


Figure 6.25: Respondent Profile – Overall

Commuters Paying Toll

Highest number of commuters on PEx (100%) pays Toll. Comparatively less number of commuters (86%) pay toll on PM and PSo roads respectively and rest of them fall under the toll-exempted category. A whopping 89% of commuters travelling on PA road, 91% on PN road, 95% on PS road confirmed that they pay toll. The over-all analysis of the Six roads revealed that 89% (=299*100/336) of total commuters pay toll at the toll booth as shown in Table 6.17. However the remaining 11% of total vehicles fall under various categories those are exempt from paying toll such as VVIP, ambulances, funeral vehicles etc.

(Ref: Toll Exemptions-http://deshgujarat.com/2011/11/28/who-are-exempted-from-toll-tax-on-national-highways-as-per-the-nhai-rules/)

Table 6.17: Percentage Distribution of Toll Payers across the Roads

Road	Category of Respondents (Toll paying?)	Sample Size	%
PA	Yes	38	89
	No	12	11
PN	Yes	58	91
	No	6	9
PS	Yes	60	95
	No	3	5
PSo	Yes	43	86
	No	7	14
PM	Yes	50	86
	No	9	14
PEx.	Yes	50	100
	No	0	0
Overall	Yes	299	89
	No	37	11
Total		**336**	**100**

Source: Primary Data Analysis

Analysis Of Data Pertaining To Toll Pass

As NHAI issues toll passes to regular commuters residing within a radius of 20 km from the plaza, commuters were asked whether they had Toll pass. It was found that the percentage of commuters having Toll pass is 6% each on PA, PS and PSo roads where as 2% each on PN and PM and Passengers travelling on Expressway (PEx) have no pass. Just to reiterate, Toll-pass is provided to those commuters who commute daily and are residing locally within a radius of 20km from the Toll-plaza. This is as per mandatory norms. However, the numbers in this Category are very small number (6 % overall) as is presented in Table 6.18**.**

Table 6.18: Percentage distribution of users of Toll passes

Road	Category of Respondents (using toll passes?)	Sample Size	%
PA	Yes	11	6
	No	39	94
PN	Yes	1	2
	No	63	98
PS	Yes	4	6
	No	59	94
PSo	Yes	3	6
	No	47	94
PM	Yes	1	2
	No	58	98
PEx	Yes	0	0
	No	50	100
Overall	Yes	20	6
	No	316	94
Total	-	**336**	**100**

Source: Primary Data Analysis

Level of Satisfaction over Toll Prices

On PA road, 78% of travelers said toll rates are high / very high where as 19% said they are moderate to low priced. Proportion of commuters who could not give any comment on this aspect is very small (3%).

On PN road, slightly more than 81% are of the opinion that toll rates are high / very high while 16% said toll-rates are low and moderate, and very small group (3%) were not able to comment.

On PS road, Nearly 78% of travelers said toll rates are high / very high and about 22% said they are moderate and low priced.

On PSo road nearly about 75 % of travelers said toll rates are high / very high where as about 22% said they are moderately low priced. A mere 4% could not give any comment on this aspect.

On PM road, about 70 % travelers said toll rates are high / very high and a little over 25% said they are moderate or low priced but 5% were reluctant to comment on this factor.

On Expressway a whopping 88% of commuters were not happy about toll prices as they are high / very high but for 8% of commuters the prices were moderate and 4% had no opinion about this.

Overall, about 80 % feel that the toll prices across all these roads are high / very high and nearly 20 % said there are low to moderate. This part of Analyses is presented in Table 6.19

Table 6.19: Opinion on Toll Prices (being high?)

Road	Toll Price	Sample size	%
PA	LP	1	1
	MP	10	18
	HP	28	48
	VHP	9	30
	CS	12	3
PN	LP	0	0
	MP	10	16
	HP	36	56
	VHP	16	25
	CS	2	3
PS	LP	1	2
	MP	13	20
	HP	19	30
	VHP	30	48
	CS	0	0
PSo	LP	1	2
	MP	10	20
	HP	24	48
	VHP	13	26
	CS	2	4
PM	LP	1	2
	MP	14	24
	HP	32	54
	VHP	9	15
	CS	3	5
PEx.	LP	0	0
	MP	4	8
	HP	20	40
	VHP	24	48
	CS	2	4
Overall	LP	4	1
	MP	61	18
	HP	159	48
	VHP	101	30
	CS	11	3
Total		**336**	**100**

Source: Primary Data analysis

LP: Low Priced, MP: Medium Priced, HP: High Priced,
VHP: Very High Priced, CS: Cannot Say

Mode of Toll Payment

About 47% of commuters (PA road), 30% (PN), 62% (PS), 44 % (PSo), 58% (PM) and 40% (PEx) have opined that general road tax is acceptable for usage of the Road, However, 53%, 70%, 30%, 56%, 42% and 60% of PA Road, PS road, PN Road , PSo Road, PM Road and PEx. road users respectively said they were not interested to pay toll tax as additional fee for using the toll Road. Analysis is presented in the Table 6.20. From this analysis, overall it is found that a considerable proportion of 53% of respondents were of the opinion that they are willing to pay toll as the toll road generally are seen to have delivered several economic benefits like fuel savings, reduction in travel time, comfortable ride etc. This perception is very strong at almost 70% on Pune-Nashik Road among Car riders and commercial vehicle operators. However around 47 % feel that road taxes are adequate and there is no need of separate tax like Toll. The analysis is presented in *Table 6.20.*

Table 6.20: Mode of Toll Payment

Road	Category	Size	%
PA	General Road tax	23	47
	Toll Tax	27	53
PN	General Road tax	19	30
	Toll Tax	45	70
PS	General Road tax	39	62
	Toll Tax	24	38
PSo	General Road tax	22	44
	Toll Tax	28	56
PM	General Road tax	34	58
	Toll Tax	25	42
PEx.	General Road tax	20	40
	Toll Tax	30	60
Overall	General Road tax	157	47
	Toll Tax	179	53
Total		336	100

Source: Primary data analysis

Toll Awareness and Source of Awareness

Less than 30% of commuters on PA road said they have attended the awareness programme where as a whopping 73% of commuters reported having no knowledge about toll awareness programme. On PN road about 60% have attended or know about the toll awareness programme but a little more than (41%) said they have not come across any such programmes. On PS road, few commuters (3%) are aware / attended awareness programmes on toll but a large number of users i.e., 97% had no knowledge of the program. Nearly (24%) travelling on PSo Road knew about / experiences the programme benefits whereas over 75% are not aware or 'seen' any such facility. On Mumbai Road almost all the commuters said they have either seen or were aware about the programmes on toll awareness. 42% commuters on E-way saw the progrmme and about 60 % were not aware of the same. It is observed that around 27% of the people are aware of the existence of the toll system and the rest (73%) are not aware of it. The sources of awareness were analysed and are as presented in Table.6.21. The analysis also reveals the extent of media exposure that these Road users have about Toll roads awareness and various other benefits. This information helped in understanding the channel of communication available for Road users' awareness on usage of the Toll Road. The data indicates a higher level of exposure to news papers as the news papers happen to be the best source (66%) followed by various magazines (17%) covering the toll news from time to time.

Table 6.21: Awareness about Toll Payment

Road	Category	Size	%
PA	Yes	15	27
	No	35	73
PN	Yes	38	59
	No	26	41
PS	Yes	2	3
	No	61	97
PSo	Yes	12	24
	No	38	76
PM	Yes	1	2
	No	58	98
PEx.	Yes	21	42
	No	29	58
Overall	Yes	89	27
	No	247	73
Total		336	100

Source: Data Analysis compiled by the author

Commuter Satisfaction about Complaint Redressal System

Satisfaction regarding complaint redressal system is analyzed and presented as follows. Around (41%) of commuters on PA road are somewhat and slightly satisfied, where as about 60% are dissatisfied / highly dissatisfied. Nearly 33% of respondents on Nashik Road are happy with the redressal system but 57% are not happy about the redressal system. While 30% show satisfaction, 70% are not satisfied about redressal system on Satara toll Road. Nearly 50% are not satisfied and 50% are satisfied on the Solapur Road. More than (43%) are satisfied and nearly 60% show dissatisfaction on Mumbai Road. About 60 % are satisfied where as more than 40 % are dissatisfied on PEx. Overall, nearly 60 % of total road users across these toll ways are not satisfied with redressal system of complaints at the same time a little over 40% said they were somewhat satisfied, with only few highly satisfied. Table 6.22 provides analyses for the above factor.

Table 6.22: Opinion on Complaint Redressal System

Road	Category	Frequency	%
PA	High satisfaction	1	4
	somewhat satisfaction	17	37
	Somewhat dissatisfaction	26	40
	Highly dissatisfaction	6	19
PN	High satisfaction	0	0
	somewhat satisfaction	21	33
	Somewhat dissatisfaction	25	39
	Highly dissatisfaction	18	28
PS	High satisfaction	0	0
	somewhat satisfaction	19	30
	Somewhat dissatisfaction	28	45
	Highly dissatisfaction	16	25
PSo	High satisfaction	3	6
	Somewhat satisfaction	21	42
	Somewhat dissatisfaction	20	40
	Highly dissatisfaction	6	12
PM	High satisfaction	4	7
	Somewhat satisfaction	21	36
	Somewhat dissatisfaction	19	32
	Highly dissatisfaction	15	25
PEx.	High satisfaction	4	8
	Somewhat satisfaction	24	48
	Somewhat dissatisfaction	16	32
	Highly dissatisfaction	6	12
Overall	High Satisfaction	12	4
	somewhat satisfaction	123	37
	Somewhat dissatisfaction	134	40
	Highly dissatisfaction	67	19
	Total	**336**	**100**

Source: Primary Data analysis

Driving factors for Toll Road Journey

With reference to Factors affecting the Toll Road journey, respondents were allowed to select preferences that were listed from top to bottom, as follows:

- Value for Time
- Safety on Road
- Travel comfort

- Value for Money
- Travel amenities
- Visual appeal

People's preferences were ranked and the analysed data is presented as follows with Table 6.23.

1. Pune-Ahmednagar:

"Value for time" is the most preferred factor, followed by Safety on roads, travel comfort, value for money, travel amenities and visual appeal.

2. Pune-Nashik:

"Value for time" is the most preferred factor, followed by safety on roads, travel comfort, value for money, travel amenities and visual appeal.

3. Pune-Satara:

Commuters gave importance to "Value for time" and money as they rank 1 and 2 in the preference list.

4. Pune-Solapur:

Commuters gave the same factors, as above, more importance as compared to other factors.

5. Pune-Mumbai:

In this case travel time remains on top and safety on the road was given second priority and other factors are given importance as listed above.

6. Pune Expressway:

Safety is the top most priority for commuters travelling on Expressway, followed by travel comfort.

Table 6.23: Analysis of Driving Factors for Travel

Pune-Ahmednagar		Pune-Nashik		Pune-Satara		Pune-Solapur		Pune-Mumbai		Pune-Express Way	
Rank	**Factor**	**Rank**	**Factor**	**Rank**	**Factor**	**Rank**	**Factor**	**Rank**	**Factor**	**Rank**	**Factor**
1	Value for time	1	Value for time	1	value for time	1	value for time	1	value for time	1	Safety on the road
2	safety on Road	2	safety on Road	2	Value for money	2	value for money	2	safety on the road	2	Travel comfort
3	Travel comfort	3	Travel comfort	3	safety on road	3	Safety on the road	3	Travel comfort	3	Value for Time
4	Value for Money	4	Value for Money	4	Travel comfort	4	Travel comfort	4	value for money	4	Value for Money
5	Travel amenities	5	Travel amenities	5	Travel Amenities	5	Travel amenities	5	Travel amenities	5	Travel amenities
6	Visual appeal	6	Visual appeal	6	Visual appeal	6	Visual appeal	6	visual appeal	6	visual appeal

Overall analysis of factors affecting travel presents from highest priority factor to lowest one so far as commuters' choice for toll road journey the abstract of which is given in Table 6.24.

Expressway safety norms are more stringent as compared to other norms on the other highways. . The following safety measures are broadly observed on Expressways thereby commuters travelling the Expressway are made to care more seriously the traffic rules; the commuters are fined for halting at unauthorized stops as it is designed for non-stop high speed road with high level of access control. Highway Police patrol is deployed for highway safety and take stern action against passengers who flout the safety norms. These measure are therefore expected to reduce the rate of accidents on the expressway, there by people must prefer safety as an important element while travelling on expressway.

Table 6.24: Analysis of Overall Driving Factors Affecting Travel

Rank	Factor
1	Value for time
2	Safety on Road
3	Value for money
4	Travel comfort
5	Travel amenities
6	Visual appeal

Complaints on Toll Road

In this particular section, the factors are selected based on the concerns about issues related to Toll Roads. The complaints are on aspects like Government Policy on Toll, Road maintenance, long queues at plazas etc. Complaints about these aspects are being received on regular basis. The complaints regarding these problems from commuters have been on rise on these Toll Roads. The pressing complaint from users is road way maintenance (1), delay at plazas (2), etc. There are even complaints

about Government's flawed Toll policy. Commuters said that the biggest problem they face is regarding the poor Roadway maintenance (1). The region recorded a wide range of problems such as issues with Government Toll policy, poor Roadway maintenance, delay at Toll Plazas, etc. Across the region, from 2016 to 2017,Roadway maintenance problems and skewed toll policy emerged as the top reasons for Toll Roads facing a short-fall in delivering services of standard quality.

1. **Pune-Ahmednagar**

The most pressing issues are delay at toll plaza, biased toll revenue, Government policy on Toll Roads as is observed from the complaint category list.

2. **Pune-Nashik**

The most pressing issues are delay at toll plaza, biased toll revenue, Government policy on Toll roads as is observed from the complaint category list.

3. **Pune-Satara**

In this case the travelers' concerns are delay at toll plaza, Road way maintenance, biased toll revenue etc. The other complaints ranking 4, 5 and 6, seem to be not as important

4. **Pune-Solapur**

In this case the travelers' concerns are delay at toll plaza, Road way maintenance, Government Toll policy etc. The other complaints ranking 4, 5 and 6 seem to be not very important.

5. **Pune-Mumbai**

Commuters are not happy with Road way maintenance, Toll revenue projections and Govt. Policy as they emerged as the top 3 most pressing issues in these cases.

6. **Pune-Expressway**

In this case the travelers' concerns are delay at Toll plaza, Road way maintenance, biased toll revenue etc. The others complaints ranking 4, 5 and 6, seem to be not very important.

Table 6.25: Analysis of Complaints Affecting Travel

Pune-Ahmednagar		Pune-Nashik		Pune-Satara		Pune-Solapur		Pune-Mumbai		Pune-Express Way	
Rank	**Factor**	**Rank**	**Factor**	**Rank**	**Factor**	**Rank**	**Factor**	**Rank**	**Factor**	**Rank**	**Factor**
1	Poor Roadway maintenance	1	delay at Toll Plaza	1	delay at toll Plaza	1	delay at toll Plaza	1	Poor Roadway maintenance	1	delay at Toll Plaza
2	delay at Toll Plaza	2	Biased revenue and toll Projection	2	Poor Roadway maintenance	2	Poor Roadway maintenance	2	Biased revenue and toll Projection	2	Poor Roadway maintenance
3	Biased revenue and toll Projection	3	Govt. policy on toll roads	3	Biased revenue and toll Projection	3	Govt. policy on toll roads	3	Govt. policy on toll roads	3	Biased revenue and toll Projection
4	Govt. policy on toll roads	4	Poor Roadway maintenance	4	Govt. policy on toll roads	4	Biased revenue and toll Projection	4	delay at Toll Plaza	4	Govt. policy on toll roads
5	bad signage on roads	5	robbery / Theft on highway	5	bad signage on roads	5	bad signage on roads	5	robbery / Theft on highway	5	bad signage on roads
6	robbery / Theft on highway	6	bad signage on roads	6	robbery / Theft on highway	6	robbery / Theft on highway	6	bad signage on roads	6	robbery / Theft on highway
7	Not Revealed	7	Not Revealed	7	Not Revealed	7	Not Revealed	7	Not Revealed	7	Not Revealed

Overall analysis of complaints across roads affecting travel presents from the most pressing complaint to small one so far as commuters' problems in toll road journey the abstract of which is given in Table 6.26.

Table 6.26: Overall Summary of Complaints

Rank	Complaint Category
1	Poor Roadway maintenance
2	Delay at Toll Plaza
3	Govt. Policy on toll roads
4	Biased revenue and toll Projection
5	Robbery / Theft on highway
6	Bad signage on roads
7	Any Other

People using the toll roads, i.e. the commuters were asked to point out driving factors in terms of six parameters that they consider important while using the roads. These parameters are:

- Value for time
- Safety on Road
- Travel Comfort
- Value for Money
- Travel Amenities
- Visual Appeal

The commuters also shared their complaints in terms of using the road-ways as presented in the above sections. The following sub-section explains the differences among the six toll ways (road ways), viz. Pune-Ahmednagar, Pune-Nashik, Pune-Satara, Pune-Solapur, Pune-Mumbai, and Pune-Express Way, with respect to commuter's preferences in using the road-ways and their complaints. The commuters travelling on these six roadways are of differing nature and they have different

perceptions about the travel preferences and the experiences. This section provides a holistic view of people perceptions – both positive (in terms of preferences) and negative (in terms of complaints).

First, we will study the differences for each of the above-mentioned toll ways (road ways) individually:

1. Pune-Ahmednagar Highway

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 the parameters, 'Poor roadway maintenance' tops the complaints list followed by 'delay at Toll Plaza'.

2. Pune-Nashik Highway

The nature of commuters on Pune-Nashik road is similar to that of the travelers on Pune-Ahmednagar road, both being busy industrial traffic belts. So, it is not surprising

that the commuters traveling 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 travelers 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 Highway

The survey of the people traveling 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 Highway

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 travelers, 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 Highway

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 travelers 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-Mumbai 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 traveler category, rather than primarily business travelers. It is not that there are no business travelers on Pune Expressway; just that there is higher proportion of people travelling for personal and leisure reasons that 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.

Economic Indicators

The survey questionnaire included socio-economic factors to ascertain the contribution of Region’s Toll Roads on socio-economic aspects. The commuters’ opinions are gathered through an appropriate scale mentioned in question No. 12. The results are presented through graphical representations across various roads.

i. Increase in Speed

On Pune-Ahmednagar Road 68% of commuters agree or strongly agree that there has been improvement in the commute speed on the road. While 24% of respondents remained neutral only. 8% do not agree on this factor. On Pune-Nashik Road 35% of commuters agree or strongly agree that there has been improvement in the commute speed on the road. While 30% of respondents remained neutral. 35% do not agree with this factor. On Pune-Satara Road a small proportion i.e., 14% agreed that there has been increase in commute speed on the Road whereas a whopping proportion (76%) did not agree with it. About 10% maintained neutral opinion about the parameter. On Pune-Solapur Road 28% of commuters agree that there has been improvement in the commute speed on the Road. While 38 % of respondents remained neutral. 34% do not agree on this. On Pune-Mumbai Road 37% of commuters agree that there has been improvement in the commute speed on the Road, while 37% of respondents remained neutral. 26% do not agree on this. On Pune-Express highway Road 70% of commuters agreed that there has been improvement in the commute speed on the road. While 26 % of respondents remained neutral 4% did not agree on this.

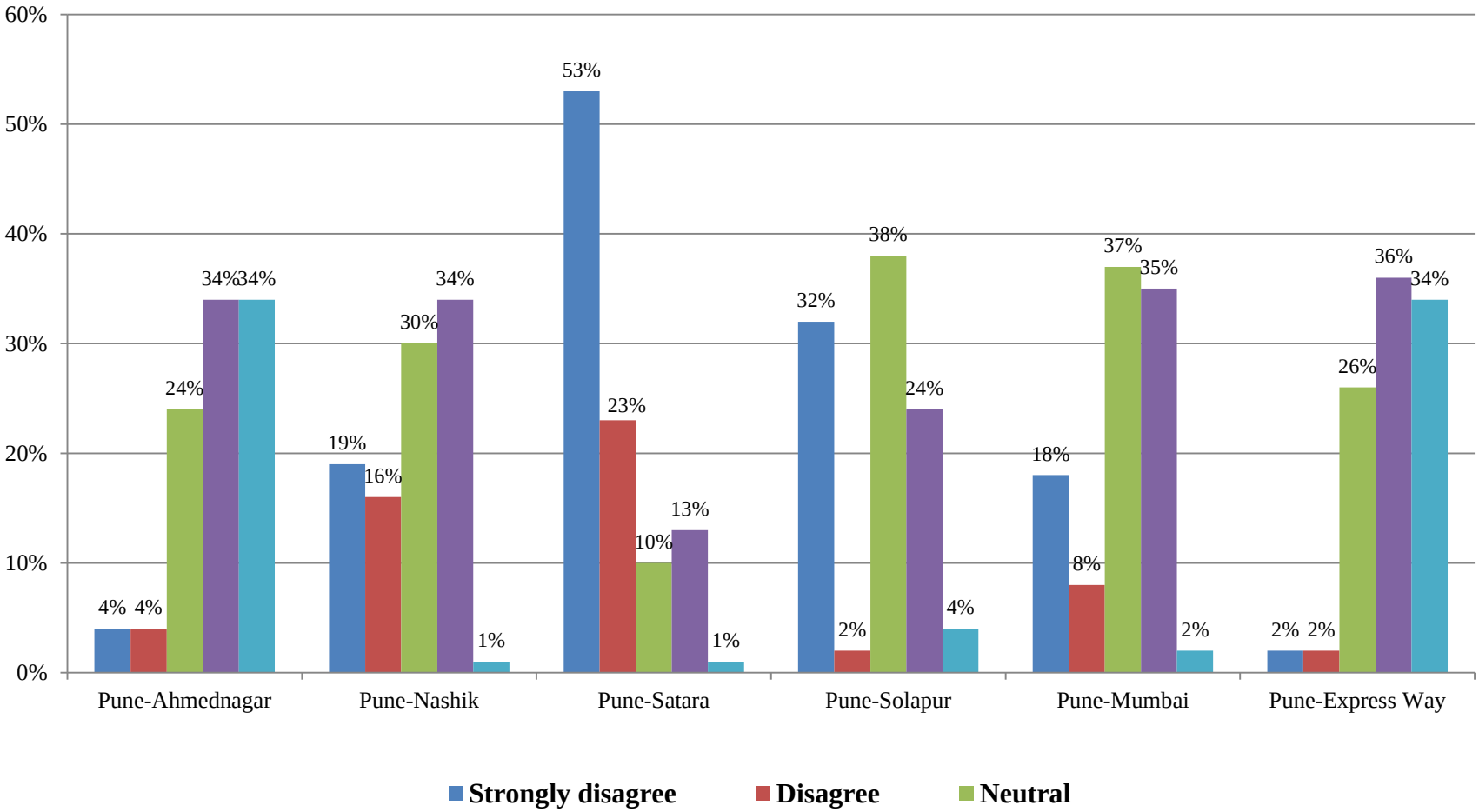


Figure 6.26: Opinion about Increasing Travel Speed Limits across toll Roads

ii. Reduced Commuting Time

On Pune-Ahmednagar Road with the reduction in commuting time, a whopping 83% were highly satisfied or satisfied. However only 8% did not agree with this and 9% remained neutral.

On Pune-Nashik Road with the reduction of commuting time, 50% are highly satisfied or satisfied while about 17 % are neutral. 33% did not agree with this.

On Pune-Satara Road with the reduction of commuting time, 13% are highly satisfied or satisfied. However, about 78% did not agree with this and 9% were neutral about this.

On Pune-Solapur Road with the reduction of commuting time, 42% are highly satisfied or satisfied. However about 38% are not agree with this and 20% remained neutral on this.

On Pune-Mumbai Road with the reduction of commuting time, 54% are highly satisfied or satisfied. However 27% did not agree with this and 19% expressed a neutral opinion.

On Pune-Express Highway with the reduction of commuting time massive number of 84% were highly satisfied or satisfied, while 14% remained neutral and a mere 2% did not agree with this.

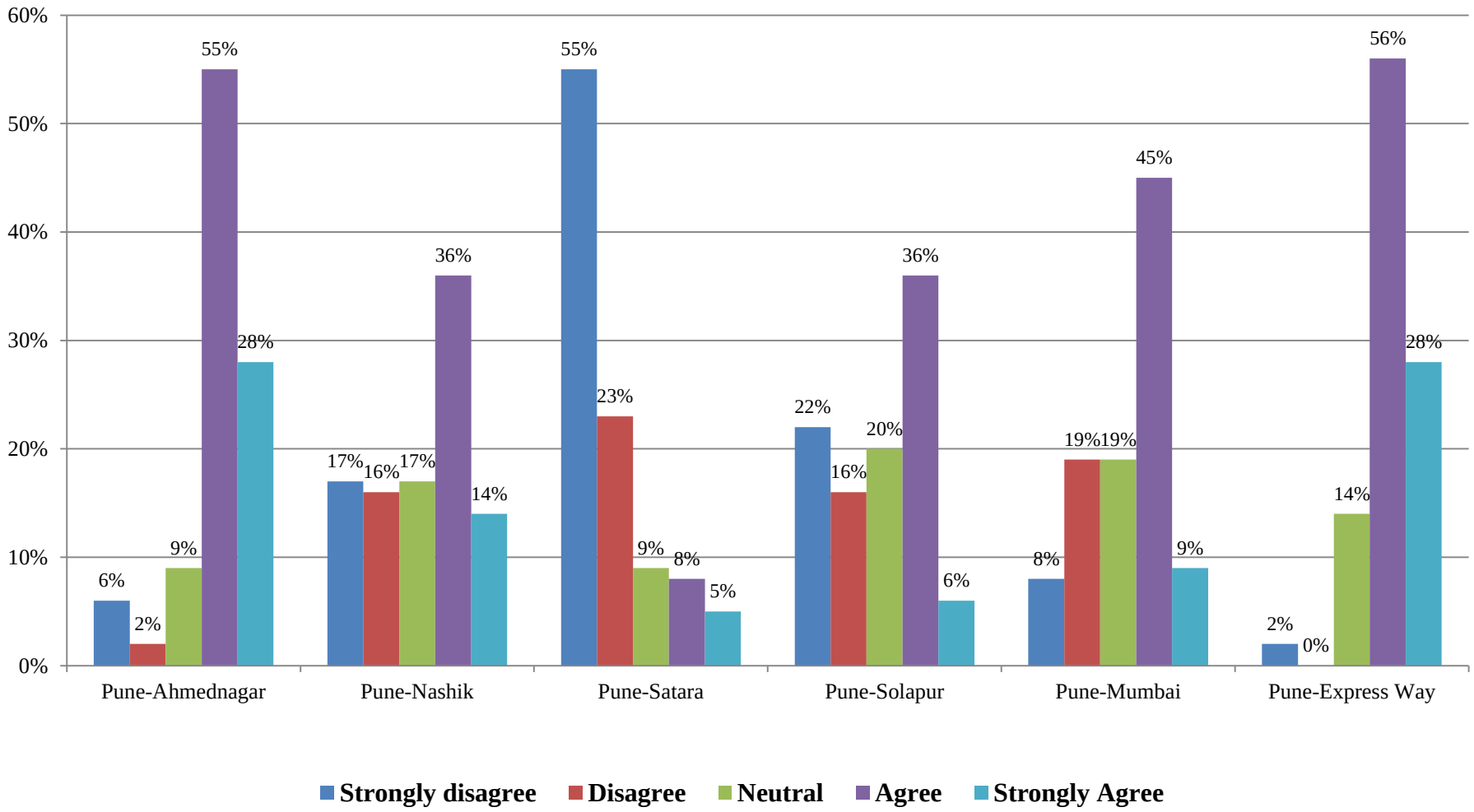


Figure 6.27: Opinion about Increasing Reduced Commuting Time across Toll Roads

iii. Savings in Fuel expenses

On Pune-Ahmednagar about 58% of the respondents are satisfied or highly satisfied with savings in fuel expenses. 30 % of them are neutral. About 12 % did not agree with it.

On Pune-Nashik Road 40% of the respondents are satisfied or highly satisfied with savings in fuel expenses. 20% are neutral. About 40 % did not agree with it.

On Pune-Satara Road 10% of the respondents are satisfied or highly satisfied with savings in fuel expenses. 16% are neutral and 74% did not agree with it.

On Pune-Solapur Road 34% of the respondents are satisfied or highly satisfied with savings in fuel expenses. 26% of them are neutral and 40 % did not agree with it.

On Pune-Mumbai Road 60% of the respondents are satisfied or highly satisfied with savings in fuel expenses. 10% are neutral and 30 % did not agree with it.

On Pune-Express highway Road 58% of the respondents are satisfied or highly satisfied with savings in fuel expenses. 36% of them are neutral and 6 % did not agree with it.

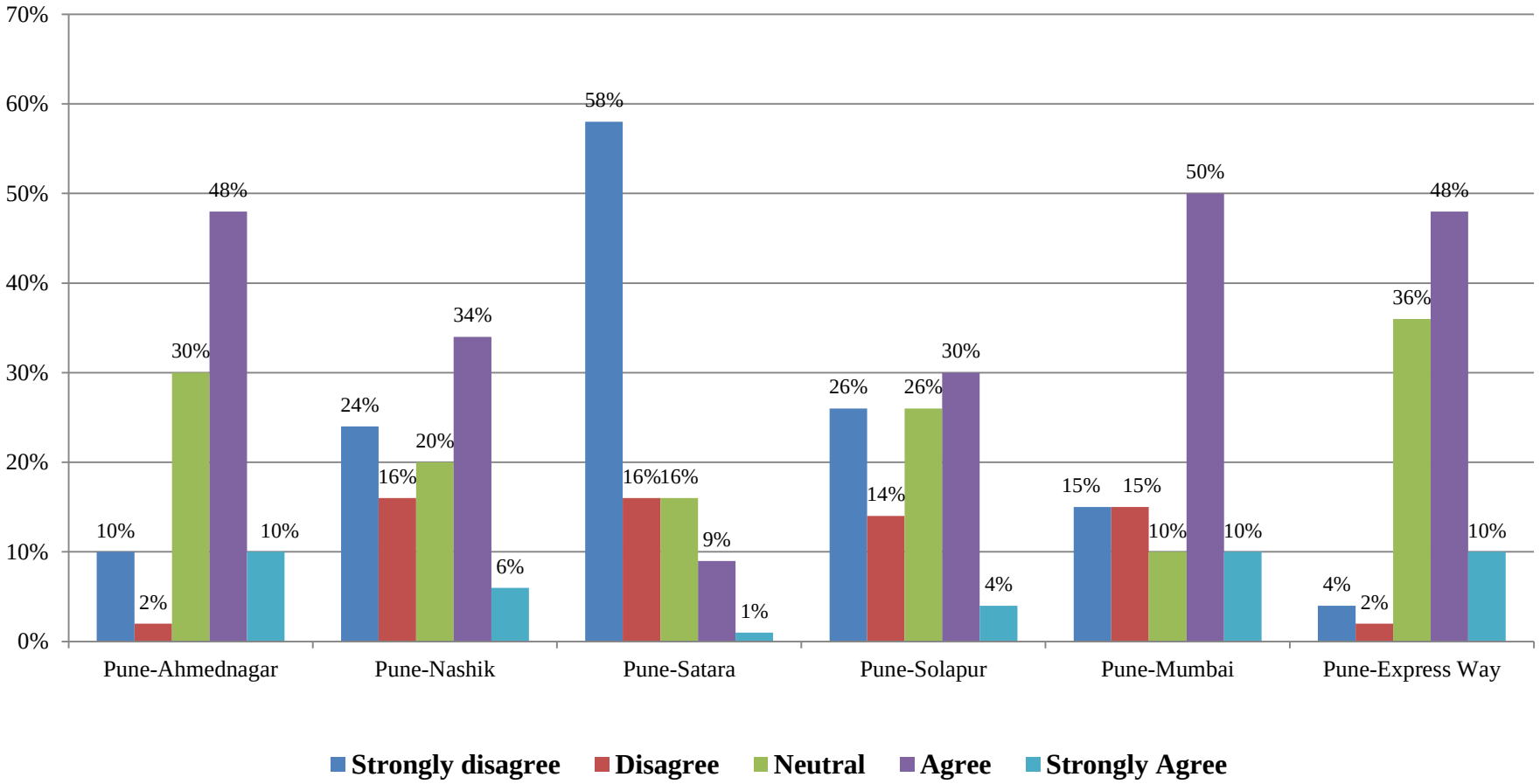


Figure 6.28: Opinion about Increasing Savings in Fuel expenses across toll Roads

iv. Reduced Environmental Pollution

On Pune-Ahmednagar Road About 42% of the respondents are satisfied or highly satisfied with reduction in environmental pollution. However, 38% of them are neutral and 20% either disagree or strongly disagree with it.

On Pune-Nashik about 34% of the respondents are satisfied or highly satisfied with reduction in environmental pollution. However, 20% are neutral and 36% of them either disagree or strongly disagree with it.

On Pune-Satara about 10% of the respondents are satisfied or highly satisfied with reduction in environmental pollution. However, about 5% are neutral and 85% either disagree or strongly disagree with it.

On Pune-Solapur 31% of the respondents are satisfied or highly satisfied with reduction in environmental pollution. However, 23% are neutral and 46% either disagree or strongly disagree with it.

On Pune-Mumbai 48% of the respondents are satisfied or highly satisfied with reduction in environmental pollution. However, 12% are neutral and 40% either disagree or strongly disagree with it.

On Pune-Express highway about 42% of the respondents are satisfied or highly satisfied with reduction in environmental pollution. However, 38% are neutral and 20% either disagree or strongly disagree with it.

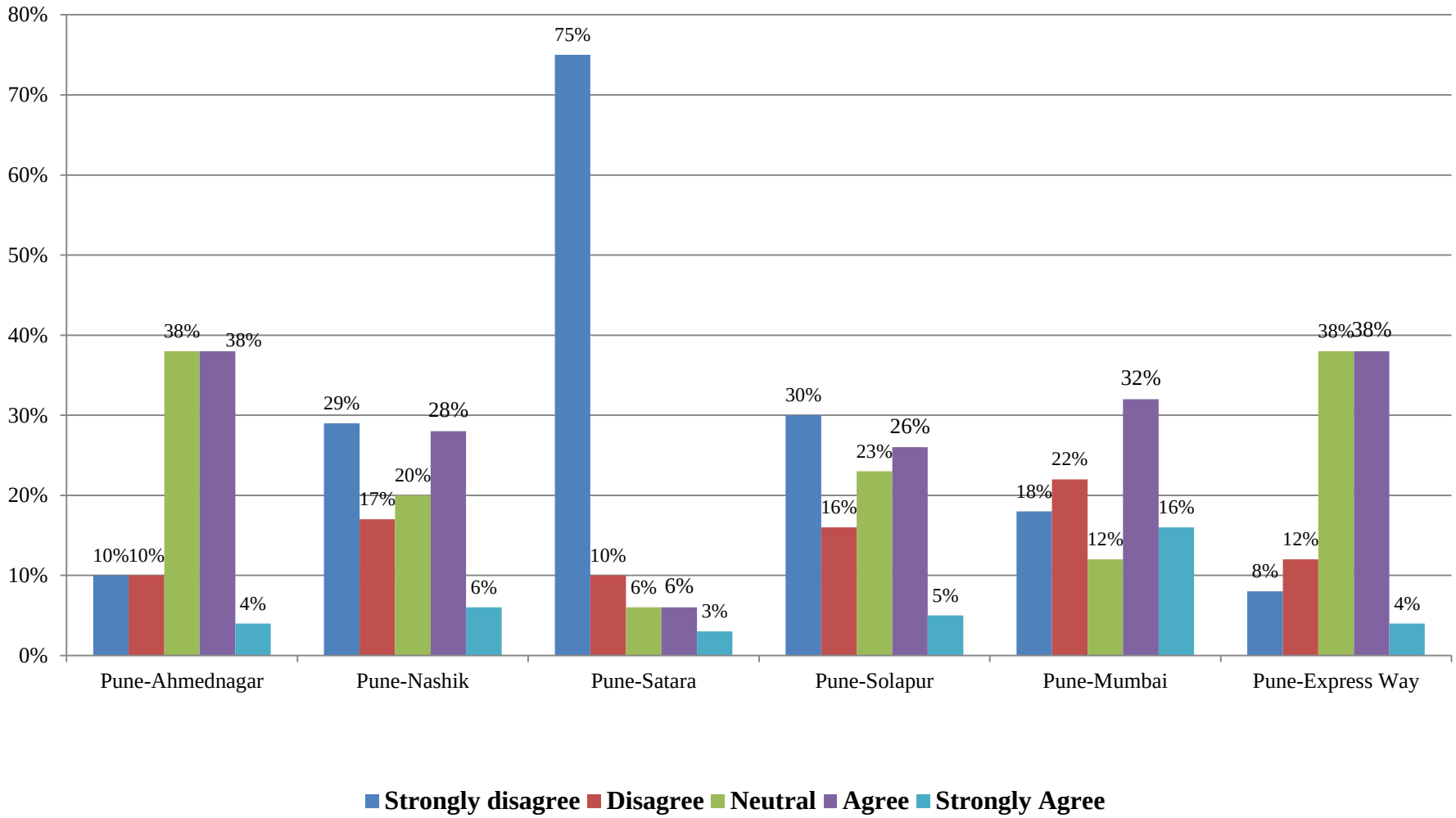


Figure 6.29: Opinion about Reduced Environmental Pollution across toll Roads

v. Decreased Road accidents

On Pune-Ahmednagar about decreased road accidents, 38% are highly satisfied / satisfied,14% are neutral and 48% of commuters do not agree with it.

On Pune-Nashik 44% are highly satisfied or satisfied. About 40% are in strong disagreement. Only 17 % expressed neutral opinion.

On Pune-Satara only 8% strongly agree or agree on this factor, about a massive 90% show disagreement / strong disagreement. Only 4% are neutral about it.

On Pune-Solapur 32%strongly agree or agree on this factor; about 40% are in disagreement or strong disagreement. And only 18 % are at neutral position.

On Pune-Mumbai 40 % are highly satisfied or satisfied with it. While 42% are showing agreement or strong disagreement only 18 % gave neutral opinion.

On Pune-Express Highway 38% are strongly agreed or agreed on this factor while 48% are in disagreement or strong disagreement. 14 % of commuters are neutral about this factor.

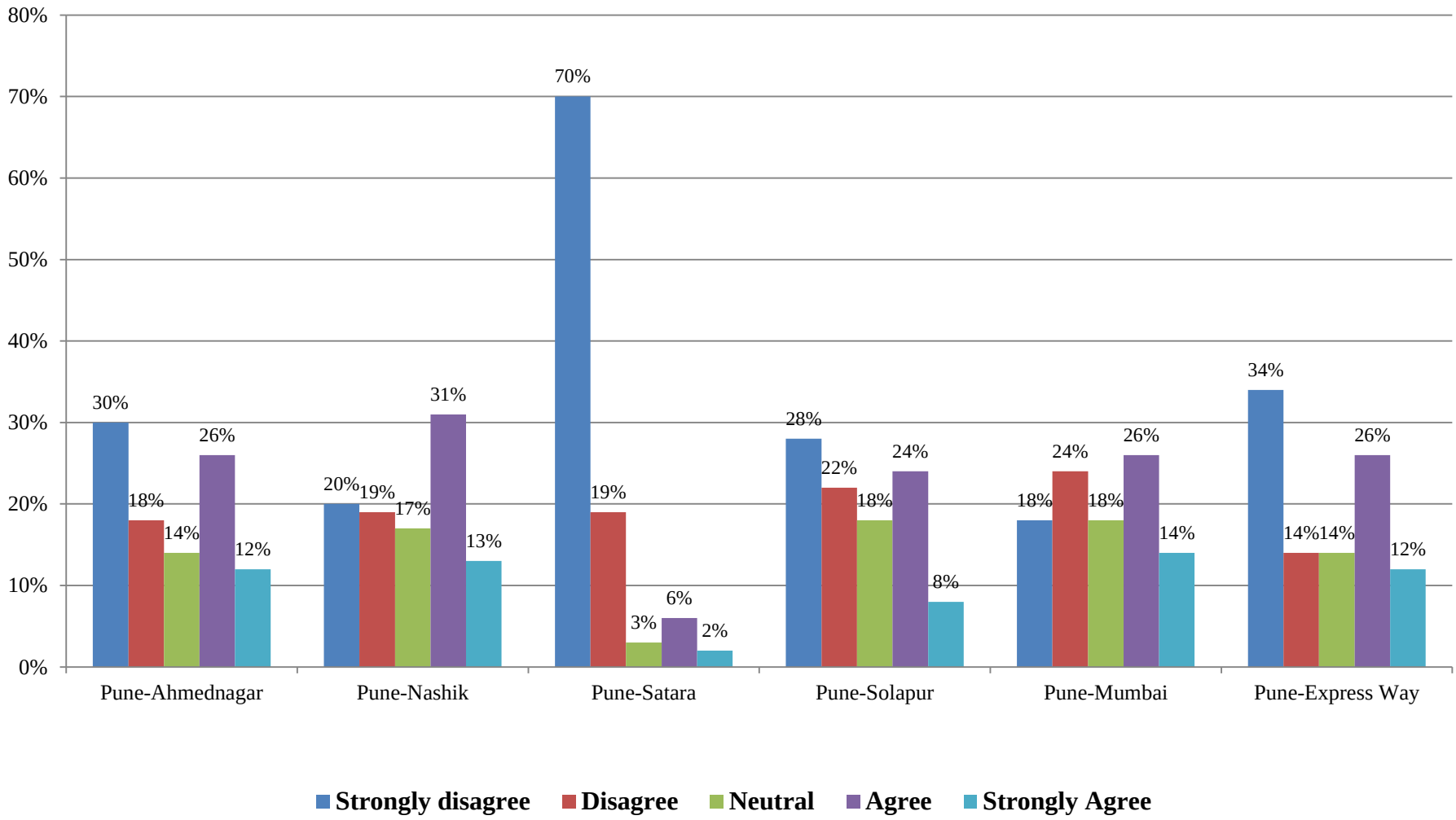


Figure 6.30: Opinion about Decreased Road accidents Across toll Roads

vi. Industrial Township development

On Pune-Ahmednagar 22% are either highly satisfied or satisfied. 36% have neutral opinion and 42% either strongly agreed or agreed with it.

On Pune-Nashik 42 % of commuters agree that there has been improvement in industrial township development, while 55 % are dissatisfied or highly dissatisfied and only 13 % remained neutral about it.

On Pune-Satara 42% agreed that there has been development around the road whereas a substantial proportion (71%) does not agree with it. Only 17% maintained neutral opinion about the parameter.

On Pune-Solapur 28% agreed that there has been development around the road whereas a substantial proportion (50%) does not agree with it. Only 22 % maintained neutral opinion about the parameter.

On Pune-Mumbai 53% agreed that there has been development around the road whereas a proportion (25.46%) does not agree with it. Only 22 % maintained neutral opinion about the parameter**.**

On Pune-Express Highway 42% agreed that there has been development around the road whereas a proportion (20%) does not agree with It. 38 % maintained neutral opinion about the parameter.

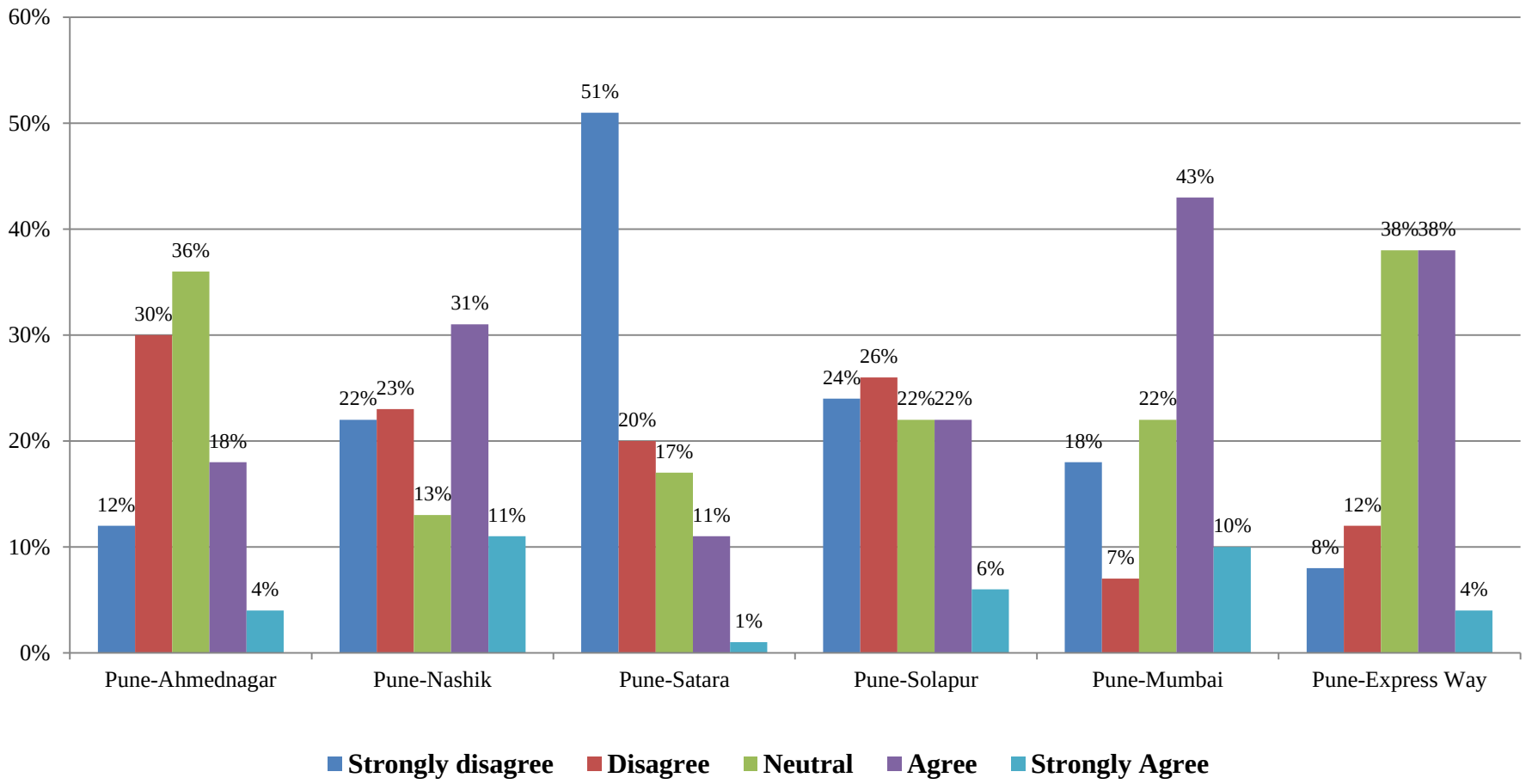


Figure 6.31: Opinion about Industrial Township Development across toll Roads

Overall Analysis of Economic Indicators

i. **Increase in speed:** With regard to this parameter, overall 32 % have agreed or strongly agreed. While 34% remained neutral, 34% have disagreed.

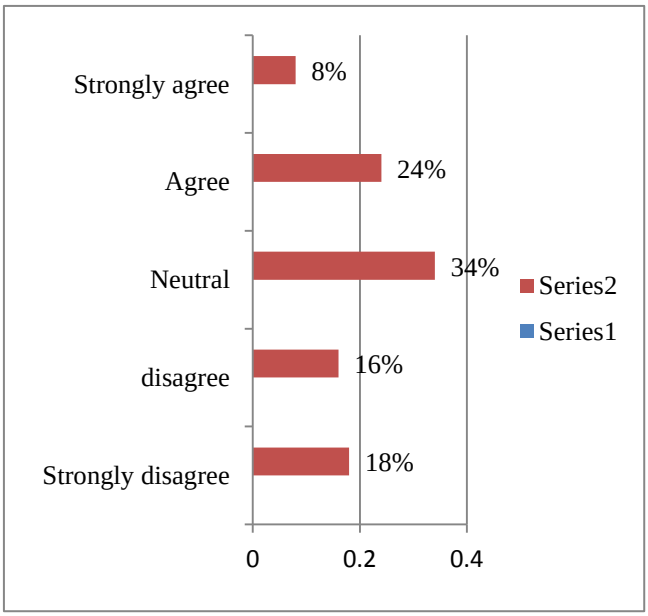


Figure 6.32: Percentage of Respondents on increase in speed

ii. **Reduced commuting time:** 36% of the commuters are happy with this where as 43% are not happy with this aspect. 21% maintain neutral position.

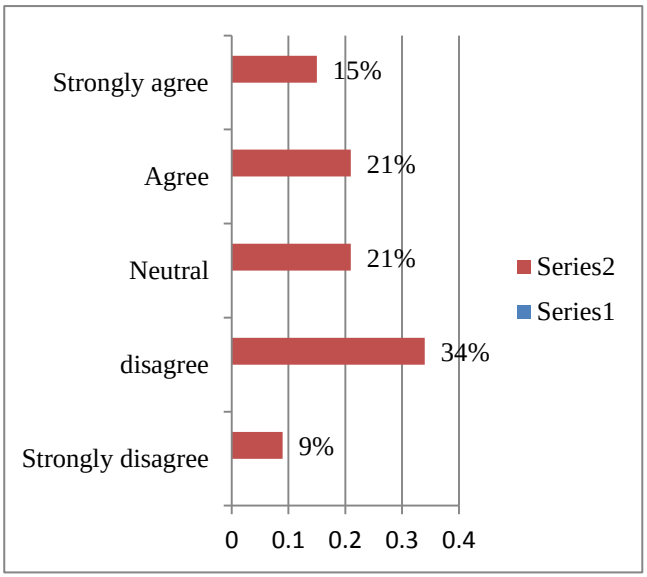


Figure 6.33: Percentage of Respondents on Reduced Commuting Time

iii. **Savings in Fuel Expense**: 38 % commuters are very happy with this aspect, and nearly 31 % are not satisfied with this and 31% of commuters are neutral about this.

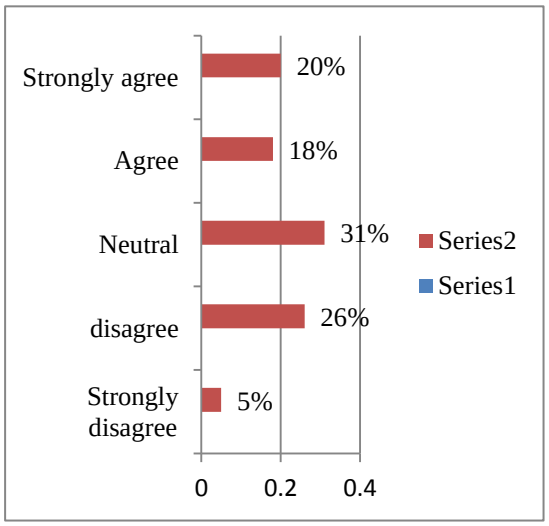


Figure 6.34: Percentage of Respondents on Saving in Fuel Expense

iv. **Reduced Environmental Pollution:** 45% commuters are of the opinion that the environmental pollution is on a higher side. While 30% do not agree with it, 25% are neutral about it.

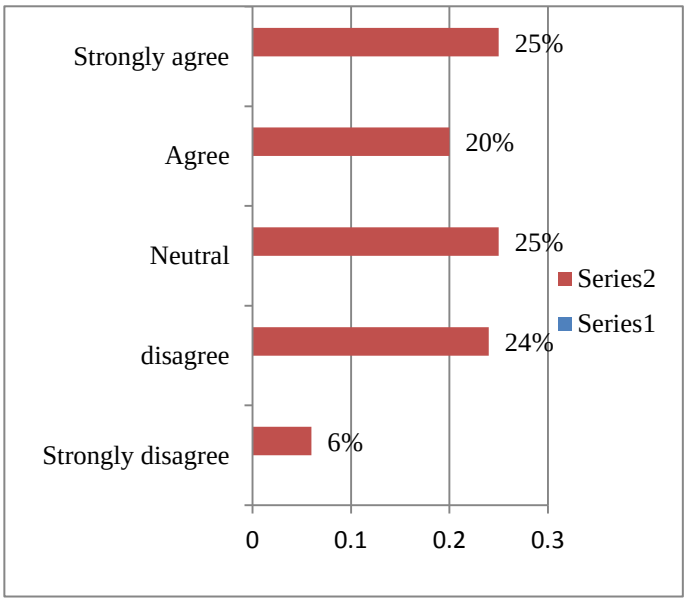


Figure 6.35: Percentage of Respondents Reduced environmental pollution

v. **Decreased Road Accidents**: nearly 50% commuters do agree that there is decrease in accidents on the road, where as 23% commuters are of the opinion that accidents have reduced. 28% are neutral about it.

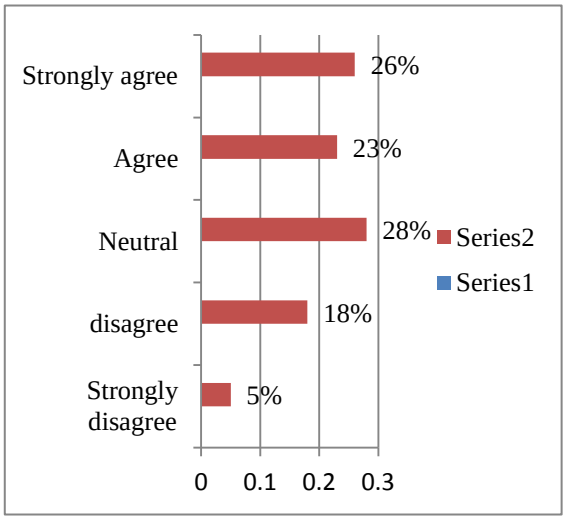


Figure 6.36: Percentage of Respondents on Decreased Road Accidents

vi. **Industrial Township Development**: 45% of commuters agreed about industrial and township development, whereas 33% do not agree with it and 23% are neutral about it.

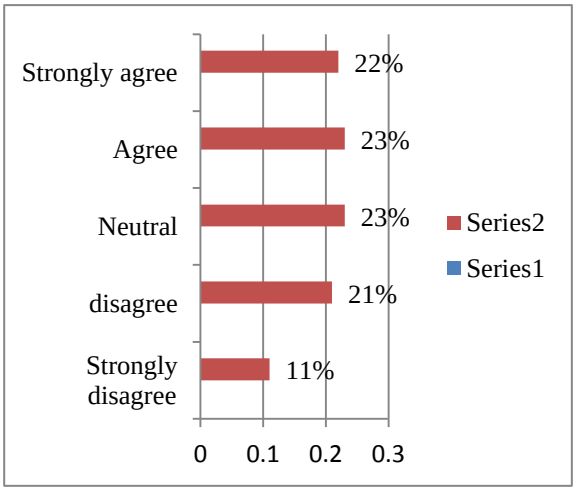


Figure 6.37: Percentage of Respondents on Industrial Township Development

6.4.2 Road User Services Data Analysis

The study is based on a field survey, using a structured questionnaire for collecting empirical data among users of the road and it is focused on understanding the travelers' perception of various roadway services provided by the Toll road operators. The service factors (which were identified from literature survey), that are likely to affect the Road-user satisfaction, are as follows:

- Quality of Road
- Safety of Road
- Security and Emergency Services on the road
- Road User Amenities

Eighteen service indicators that are grouped into the above factors are as follows, in Table 6.27.

Table 6.27: Roadway Service indicators

Road Service Parameters (Constructs)	Service Indicators
Quality of Road (*Construct 1*)	. Smoothness
	. Roadway markings
	. Shoulder condition
Safety of Road (*Construct 2*)	. Pedestrian crossing facilities
	. Signs and signals
	. Lighting at the Junctions
Security and emergency services on the road (*Construct 3*)	. Highway Police patrolling
	. Ambulance for accidents victims
	. Crane facility for vehicle breakdown
	. Telephone booth for emergency calls
Road user amenities (*Construct 4*)	. Restaurants
	. Canteen
	. Petrol pumps
	. Auto Service Centers
	. Medical aid
	. Parking lots
	. Public Toilets
	. Rest house for drivers or Travelers

Source: Compiled from literature review

Validity and Reliability of Data

The data on the above roadway service performance indicators are considered to be valid and reliable because:

i. The questionnaire was finalised based on the opinion of experts and covers various relevant factors. A pilot study was conducted with a sample size of 100 in order establish the external validity. The Internal validity was tested using hypothesis testing through inferential statistics through tests of significance.

ii. The data is reliable as the 'Cronebach Alpha' is calculated and found to be more than 0.75 for every factor.

The indicators under various categories were coded for easy analysis. Responses from survey were entered into a spread sheet and then imported into statistical package SPSS and analysis was performed on responses for road service parameters. F-test was conducted to identify difference in mean perception scores across the Roads for a single service.

Calculating Roads' Services Indices (RSI)

A five point Likert Scale was used to record the satisfaction level of commuters in terms of their opinion on various road way service parameters. Any respondent can rate his / her satisfaction level based on judgment on a scale of 1 to 5, (5=Excellent; 4=Very Good; 3=Good; 2=Average; 1=Poor).

The relative weightage placed by the respondent in regard to various service parameters and the average parameter score out of 5 reflect present Quality Service Indicators (QSI). The higher the number, the more satisfied the commuters are, with respect to that particular service.

Analysis of Overall Scores –Segments wise

A set of 18 indicators have been used in computing the Indices which are grouped into Four sub-groups – Quality of Roadway, Safety, Security and Road way amenities. As many as six roads imparting toll service are covered by the researcher for computation of RSI on the basis of data collected through primary survey. It is found that most of the roads falling short of attaining the level of performance expected of them. It is stipulated that they should provide infrastructure and facilities needed for quality service. Based on the data through primary survey, the performance indices were calculated for all 18 parameters. It was found that none of the Roads could achieve the RSI value of 5. The highway, Pune-Ahmednagar (PA) secured the highest overall performance index value of 2.57, followed by Pune-Mumbai Expressway (PEx) 2.47 and Pune-Nashik Highway (PN) 2.43. The Pune-Satara (PS) came out to be the worst performing road in sixth position preceded by the Pune-Solapur (PSo) ranking five and Pune-Mumbai (PM) in fourth position (Table 6.28).

Table 6.28: Comparative Segmental Average Scores of Six Roadways

	Road Service Indicators	PA	PN	PS	PSo	PM	PEx
Construct 1	1	2.83	2.59	1.9	2.6	2.57	3.6
	2	2.87	2.92	2.06	2.6	2.77	3.58
	3	2.65	2.64	1.96	2.46	2.42	3.1
	Construct (Quality of Road) Average	**2.78**	**2.71**	**1.9**	**2.58**	**2.58**	**3.42**
Construct 2	4	2.34	2.06	1.9	2.08	2.06	2.38
	5	2.77	2.78	2	2.5	2.71	2.76
	6	2.83	2.58	2.11	2.52	2.54	2.98
	Avg.	**2.64**	**2.47**	**2**	**2.36**	**2.43**	**2.7**
Construct 3	7	2.48	1.97	1.46	2.08	2.38	2.34
	8	2.44	2.27	1.46	2.12	2.33	2.22
	9	2.28	2.33	1.42	2.1	2.35	1.82
	10	2.53	2.16	1.44	2	2.08	2.28
	Avg.	**2.43**	**2.18**	**1.44**	**2.07**	**2.28**	**2.16**
Construct 4	11	2.61	2.93	2.77	2.52	2.79	2.68
	12	2.75	2.79	2.07	2.36	2.61	2.44
	13	2.95	2.81	2.04	2.46	3.06	2.58
	14	2.53	2.39	1.41	1.86	2.13	1.98
	15	2.3	2.22	1.34	1.82	2.1	1.92
	16	2.44	2.09	1.31	1.78	2.11	2
	17	2.28	2.05	1.38	1.72	1.91	1.94
	18	2.48	2.29	1.42	1.86	1.86	1.94
	Avg.	**2.54**	**2.44**	**1.71**	**2.04**	**2.32**	**2.67**
	Average of all constructs	**2.57**	**2.43**	**1.74**	**2.19**	**2.37**	**2.47**

Source: Compilation of Primary Data based on Questionnaire Survey

Note: Column 1 represent 18 roadway service indicators Mentioned in Table No.1

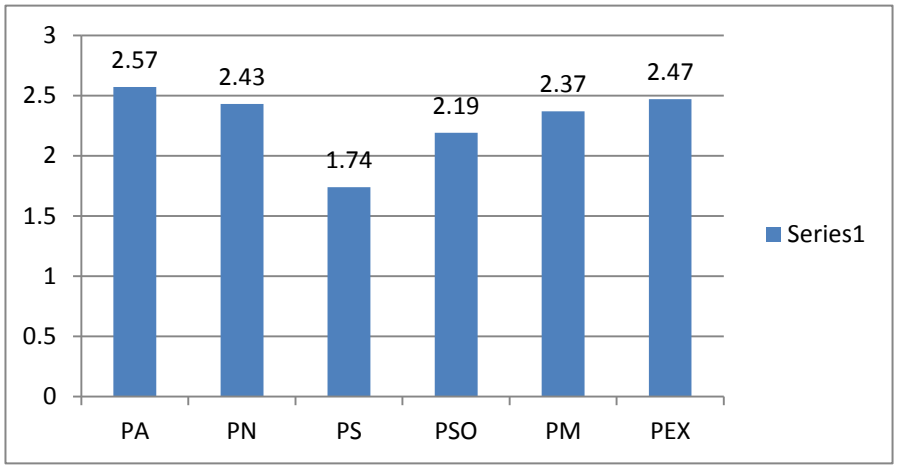


Figure 6.38: Road wise average road service performance scores (across all parameters)

Toll Roadway Service Constructs and Performance indicator-wise Analysis

Quality of Road (Construct 1)

Roadway Surface quality is the prime concern of Road users who judge it with regard to smoothness or riding comfort that they experience while driving their vehicles**.** The quality of Road is assessed through three indicators - Smoothness, Roadway markings and Shoulder condition. PEx is in the top slot on this parameter with average score of 3.42, followed by PA (2.78), PN (2.71), PM (2.58), PSo (2.58) and PS (1.9). However individual indicators under this construct were analysed as follows:

1. **Smoothness**

Except PEx, none of the other five roads averages more than 2.83. PS's lowest score of 1.9 is preceded by PM's 2.57. PA is slightly ahead with a score of 2.83, where as the other two roads PN and PSo have almost same score of 2.60.

2. **Roadway marking**

In roadway marking practices, PEx tops the list with 3.58 points out of 5. PN came second (2.92) and PA a close third (2.87), while PM (2.77), PSo (2.6) and PS (2.06) are fourth, fifth and sixth respectively**.**

3. **Shoulder Condition**

The condition for all the roads except PEx is not good. The condition of PS is below par, with a low score of 1.96. However, other roads seem to fare marginally better.

Roadway Safety (Construct 2)

There are several factors contributing to the safety of commuters. However, only three key indicators are considered for assessing the safety condition of Roadways viz. Pedestrian crossing facilities, Road signs and signals and Lighting at junctions. The respondents rated PEx as best with top score of 2.7, followed by PA (2.64), PN (2.47),

PM (2.43), PSo (2.36) and PS (2.00). However individual indicators under this construct are analyzed and discussed as follows:

4. Pedestrian Crossing Facility

Unfortunately this is a category in which no Road scored particularly well, baring PEx and PA, which scored above average at 2.38 and 2.34 respectively.

5. Signs and Signals

Respondents rated Nashik Road as nearly good road in this category with a score of 2. 78 ahead of other roads, PA stands second in the chart with a score of 2.77, PEx third (2.76), PM fourth (2.71), PSo fifth (2.5) and PS sixth (2.0).

6. Lighting at Junctions

The survey had PEx in the top slot with a score of 2.98, followed by PA (2.83), PN (2.58), PM (2.54), PSo (2.52), and PS (2.11) which is too below good score.

Security and Emergency Services on Road (Construct 3)

Four indicators are considered for defining this particular construct, viz, highway Police patrol, Ambulance services, Crane facility and Telephone booth. The PA toll Road is rated as best in terms of average indicator score of 2.43, followed by PM (2.28), PN (2.18), PEx (2.16), PSo (2.07) and PS (1.44). However individual indicators under this construct are analysed and discussed as follows:

7. Highway Police Patrolling

PA emerged as top performer with a score of 2.48, closely followed by PM (2.38); PEx (2.34), PSo (2.08) and the worst performers are PN and PS with low scores of 1.97 and 1.46 respectively.

8. Ambulance for Accident Victims

When it comes to this service, except PS road all other roads performed just above average at scores more than 2 out of 5. PS has emerged as poor performer with a score of 1.46.

9. Crane facility for vehicle break down

Scores on this parameter across all the roads are between about 1.5 to about 2.5 which is not in acceptable range.

10. Telephone booths for Emergency calls

When it comes to this service, except PS road all other roads performed just above average at scores more than 2 out of 5. However, the PS road emerged as poor performer with a score of 1.44.

Road User Amenities (Construct 4)

This is a major construct, wherein ten indicators are used to define it. As per average indicators, score PEx remains on top, followed by PA (2.54), PN (2.44), PM (2.32), PSo (2.04), PS (1.71). However individual indicators under this construct are analysed and discussed as follows.

11. Restaurant Facilities

Among Eight Toll Roads in the region, PN obtained the highest score of 2.93. The Roads PA and PSo have remained at the bottom with scores at 2.61 and 2.52 respectively.

12. Canteens

Among the roads, PN was able to score a moderate score of 2.79 and remained at top position, and it was followed by PA with a score of 2.75 points, while that of PM, PEx, PSo and PS were 2.61, 2.64, 2.36 and 2.07 points respectively.

13. Petrol Pumps

In this particular service, parameter PM topped the list by scoring 3.06 points and it was closely followed by PA with score of 2.95 points.PN is the third best by scoring 2.58, while that of PEx, PSo and PS are 2.58, 2.46 and 2.04 respectively.

14. Auto Service Centers

When it comes to performance of this particular parameter, PA is the number one in the chart, with a score of 2.53 points, while PN stood second, PM third, PEx fourth, PSo fifth, and PS sixth , with scores of 2.39, 2.13, 1.98, 1.86 and 1.41 respectively.

15. Medical Aid

PA road is number one with 2.3 points and it is followed by the Road PN (2.22), PM (2.1), PEx (1.92), PSo (1.82) and PS Road (1.34).

16. Parking Lots

PA leads with 2.44 points, followed by PM (2.11), PN (2.09), PEx (2), PSo (1.78) and PS (1.31).

17. Public Toilets

When it comes to performance of this particular parameter, no Road performed well, but PA is number one in the chart with a score of 2.28 points while PN comes second, PEx third, PM fourth, PSo fifth, and PS sixth , with scores of 2.05, 1.94, 1.91, 1.72 and 1.38 respectively.

18. Rest Houses for Drivers / Travelers

Among the roads, PA was able to score average score of 2.48 and remained at top position, and it was followed by PN with a score of 2.29 points, while that of PEx, PM, PSo and PS were 1.94, 1.86, 1.86 and 1.42 points respectively.

6.5: Road user Study Statistical Analysis (Inferential Statistics)

Validity of Results (ANOVA Test)

It is observed that quality of service defined by these indicators varies across the segments. For analysing this aspect, an attempt is made to find how an individual indicator remains different from Road to Road. The above findings are tested for statistical significance through F-test since multiple cases are involved. In the present study, most of the results, out of 18 parameters, are found statistically significant at error rates ranging from 1% to 5% (99% and 95% confidence level) thereby; it is believed that most of the results are not due to randomness in sampling process.

F- Test

Through this test we are interested to compare the average scores of various roadway services provided to commuters travelling on the study area toll roads, and want to see if the aggregate mean scores, for all these Six populations (Total passengers on Six Toll roads) from where samples are drawn, are equal.

Null hypothesis: Mean Scores of various indicators across cases (Six Toll Roads) are same.

Alternate Hypothesis: Mean Scores of various indicators across cases (Six Toll Roads) are same.

Hypotheses Structure

Null Hypothesis, H0: $\mu1 = \mu2 = \mu3 = \mu4 = \mu5 = \mu6$

Alternate Hypothesis, Ha: $\mu1 \neq \mu2 \neq \mu3 \neq \mu4 \neq \mu5 \neq \mu6$

As we are working with more than two samples, we can test for the equality of means at once using the analysis of variance, F-test (Anova). The Anova procedure tests null hypothesis in each service category, that the samples were from population whose means is equal. If null is true, samples drawn from such populations will have means roughly equal in value. In case of data on 18 roadway service parameters analyses the samples will have roughly similar means, if the null is correct. Of course, we do not expect the sample means to be equal even if the population means are same, since random variation will affect the sample process. Consider the hypothetical sample results for six toll roads and mean scores of each service variable are presented with a couple of significance test results. Here, only one indicator (Indicator 1) analysis is given for model calculation.

Significance Test Process for Indicator 1

Table 6.29: Descriptive Statistics for Road Service Scores (smoothness)

Roadway	PA	PN	PS	PSo	PM	PEx
Smoothness (S) service mean score	2.83	2.59	1.9	2.6	2.57	3.6

We can see that there is a good deal of variation among the means of the six samples in each service category. F-Statistics results are as shown in Table 6.30.

Table 6.30: ANOVA Results

ANOVA						
		Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
S	Between Groups	82.567	5	16.513	20.183	.000
	Within Groups	269.993	330	0.818		
	Total	**352.560**	**335**			

Looking at the SPSS output, we can see the results as sum of squares between groups, sum of squares with in and total sum of squares are in the first column of ANOVA Table together with relevant degree of freedom in third column. For these, the F-ratio is 20.183 and the corresponding probability is printed as .000 as SPSS rounds-off the probability to 3 decimal places. We have found that the p-score is so low that it (result) is 'statistically significant' at 1% level of significance and hence null hypothesis (the samples come from populations with the same mean) is rejected and we have decided that at least one of these populations has mean that is not equal to the others. In other words at least one population differs from the rest.

However in order to find out as to which of the populations differ from others, some follow up information is provided which is called post hoc comparison (Table 6.31). The multiple comparison tables provide a comparison of means for each road against other road. For the variable Smoothness, the first row compares mean score on smoothness in PA Road with each of PN, PS PSo, PM and PEx. The second set of rows compares the score in PN Road with each of the other five roads and so on. For example, in the first set of rows we can see that the difference between the means when comparing PA Road with PN Road is .24625 and in the second set of rows when comparing PN Road with PA Road the mean difference is -.24625, as this is the same comparison as looked at from the other way.

Table 6.31: POST HOC TEST for the Variable Smoothness of the road (S)

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
S	PA	PN	.24625	.17072	.150	-.0896	.5821
		PS	.93524*	.17132	.000	.5982	1.2723
		PSO	.24000	.18090	.186	-.1159	.5959
		PM	.26373	.17387	.130	-.0783	.6058
		PEX	-.76000*	.18090	.000	-1.1159	-.4041
	PN	PA	-.24625	.17072	.150	-.5821	.0896
		PS	.68899*	.16053	.000	.3732	1.0048
		PSO	-.00625	.17072	.971	-.3421	.3296
		PM	.01748	.16325	.915	-.3037	.3386
		PEX	-1.00625*	.17072	.000	-1.3421	-.6704
	PS	PA	-.93524*	.17132	.000	-1.2723	-.5982
		PN	-.68899*	.16053	.000	-1.0048	-.3732
		PSO	-.69524*	.17132	.000	-1.0323	-.3582
		PM	-.67151*	.16387	.000	-.9939	-.3491
		PEX	-1.69524*	.17132	.000	-2.0323	-1.3582
	PSO	PA	-.24000	.18090	.186	-.5959	.1159
		PN	.00625	.17072	.971	-.3296	.3421
		PS	.69524*	.17132	.000	.3582	1.0323
		PM	.02373	.17387	.892	-.3183	.3658
		PEX	-1.00000*	.18090	.000	-1.3559	-.6441
	PM	PA	-.26373	.17387	.130	-.6058	.0783
		PN	-.01748	.16325	.915	-.3386	.3037
		PS	.67151*	.16387	.000	.3491	.9939
		PSO	-.02373	.17387	.892	-.3658	.3183
		PEX	-1.02373*	.17387	.000	-1.3658	-.6817
	PEX	PA	.76000*	.18090	.000	.4041	1.1159
		PN	1.00625*	.17072	.000	.6704	1.3421
		PS	1.69524*	.17132	.000	1.3582	2.0323
		PSO	1.00000*	.18090	.000	.6441	1.3559
		PM	1.02373*	.17387	.000	.6817	1.3658

The important aspect of Table-5 is the "significance" column that indicates the significance for difference between any two means. Where the p value is less than 0.05 SPSS places (*) next to the value in the mean difference column, it indicates a significant difference between the means of the two samples being compared. Collecting these (*) together we can see that a significant difference exists between the means for each of the following pair wise comparison so far as the mean score of

smoothness in all roads, thereby the alternate hypothesis (means are not equal) is proved. In other words, for each of these combinations, we can reject the null hypothesis by stating 'the mean score of smoothness of Road are the same'.

PA Road by PS Road

PA Road by PEx Road

PN Road mean score differs by PS Road

PN Road by PEx Road

PS Road by all other Roads

PSo Road by PS Road

PSo Road by PEx Road

PM Road by PS Road

PM Road by PEx Road

PEx Road by all other Roads

The same procedure was followed for the rest of 17 variables and summarised in Table 6.44. However in case of variable at S.No.4 and 11 below, the result is not statistically significant and hence the null hypotheses are 'accepted' in these cases. Here, only one indicator (Indicator 4) analysis is presented as follows:

Table 6.32: Analysis of Pedestrian Facilities (Indicator 4)

Roadway	PA	PN	PS	PSo	PM	PEx
Pedestrian facilities Score(PCF)	2.34	2.06	1.9	2.08	2.06	2.38

Table 6.33: ANOVA Results (Indicator 4)

		Sum of Squares	Df	Mean Square	F	Sig.
PCF	Between Groups	9.163	5	1.833	2.179	0.056
	Within Groups	277.587	330	0.841		
	Total	286.750	335			

From ANOVA results of indicator 4, the F-ratio is 2.179 and the corresponding probability is 0.056. Since p value is more than 5%, result is statistically not significant. In this case it is concluded that the means of six road vehicular population do not differ across toll Roads and the result is attributed to randomness in sampling process. Similar process is followed for indicator 11 for which the result is statistically not significant. The comprehensive statistics for all indicators is presented in Table 6.34.

Table 6.34: F Test Analysis

S. No.	Factor	Abbreviation	F-value	Significance	Result
1	Smoothness	S	20.183	0	H0 =Rejected
2	Roadway markings	RM	16.666	0	H0 =Rejected
3	Shoulder Condition	SC	8.941	0	H0 =Rejected
4	Pedestrian crossing facilities	PCF	2.179	0.056	Ho =Accepted
5	Signs and Signals	SAS	7,010	0	H0 =Rejected
6	Lighting at junctions	LATJ	5.632	0	Ho= Rejected
7	Highway Police patrolling	HPP	10.109	0	Ho=Rejected
8	Ambulance for accidents victims	AFCV	8.629	0	Ho=Rejected
9	Crane facility for Vehicle breakdown	CFVBD	9.969	0	Ho=Rejected
10	Telephone booths for emergency calls	TBFEC	8.41	0	Ho=Rejected
11	Restaurants	R	1.187	0.315	Ho=Accepted
12	Canteens	C	4.947	0	Ho=Rejected
13	Petrol Pumps	PP	7.629	0	Ho=Rejected
14	Auto service Centers	ASC	12.397	0	Ho=Rejected
15	Medical aid	MA	10.255	0	Ho=Rejected
16	Parking lots	PL	10.932	0	Ho=Rejected
17	Public Toilets	PT	6.469	0	Ho=Rejected
18	Rest houses for Drivers / Travelers	RHFDT	10.522	0	Ho=Rejected

Similar Statistical Analysis process as followed above, for remaining 17 road user indicators has been carried out along with other relevant analyses - reliability and the factor analysis in the subsequent article no. 6.5, Road user study statistical analyses.

RELIABILITY

/VARIABLES=S RM SC PCF SAS LATJ HPP AFCV FFVBD TBFEC R C PP ASC MA PL PT RHFDT

/SCALE (ALL VARIABLES) ALL

/MODEL=ALPHA

/STATISTICS=DESCRIPTIVE SCALE CORR

/SUMMARY=TOTAL.

Table 6.35: Reliability Notes

Notes		
Comments		
Input	Data	C:\Users\owner\Desktop\Q13.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	336
	Matrix Input	
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the procedure.
Syntax		RELIABILITY /VARIABLES=S RM SC PCF SAS LATJ HPP AFCV FFVBD TBFEC R C PP ASC MA PL PT RHFDT /SCALE ('ALL VARIABLES') ALL /MODEL=ALPHA /STATISTICS=DESCRIPTIVE SCALE CORR /SUMMARY=TOTAL.
Resources	Processor Time	00:00:00.00
	Elapsed Time	00:00:00.00

SCALE: ALL VARIABLES

Table 6.36: Case Processing Summary

		N	%
Cases	Valid	336	100.0
	Excluded	0	0.0
	Total	336	100.0

a. List wise deletion based on all variables in the procedure.

Table 6.37: Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.921	.921	18

Table 6.38: Item Statistics

	Mean	Std. Deviation	N
S	2.6488	1.02587	336
RM	2.7827	1.00319	336
SC	2.5208	.98322	336
PCF	2.1250	.92519	336
SAS	2.5804	.95234	336
LATJ	2.5744	.98366	336
HPP	2.0982	.98004	336
AFCV	2.1280	.98874	336
FFVBD	2.0506	.96218	336
TBFEC	2.0625	1.00993	336
R	2.7321	1.02490	336
C	2.5060	.97121	336
PP	2.6488	1.09621	336
ASC	2.0446	.94684	336
MA	1.9464	.89948	336
PL	1.9464	.94795	336
PT	1.8720	.96428	336
RHFDT	1.9702	.93952	336

Table 6.39: Inter-Item Correlation Matrix

	S	RM	SC	PCF	SAS	LATJ	HPP	AFCV	FFVBD	TBFEC	R	C	PP	ASC	MA	PL	PT	RHFDT
S	1.000	.706	.726	.380	.469	.493	.409	.398	.323	.361	.174	.335	.384	.268	.300	.300	.292	.308
RM	.706	1.000	.657	.367	.560	.547	.435	.410	.370	.411	.286	.361	.424	.372	.318	.317	.292	.281
SC	.726	.657	1.000	.401	.470	.483	.377	.404	.417	.388	.219	.445	.425	.424	.400	.334	.382	.372
PCF	.380	.367	.401	1.000	.541	.524	.411	.508	.375	.397	.187	.268	.226	.297	.313	.222	.286	.221
SAS	.469	.560	.470	.541	1.000	.602	.393	.431	.414	.428	.209	.401	.470	.362	.360	.263	.374	.280
LATJ	.493	.547	.483	.524	.602	1.000	.384	.385	.351	.451	.272	.357	.376	.338	.349	.273	.307	.309
HPP	.409	.435	.377	.411	.393	.384	1.000	.711	.546	.467	.246	.399	.380	.375	.470	.394	.323	.178
AFCV	.398	.410	.404	.508	.431	.385	.711	1.000	.649	.446	.175	.408	.369	.408	.494	.466	.405	.297
FFVBD	.323	.370	.417	.375	.414	.351	.546	.649	1.000	.501	.147	.359	.311	.479	.438	.373	.342	.319
TBFEC	.361	.411	.388	.397	.428	.451	.467	.446	.501	1.000	.146	.439	.300	.468	.388	.350	.361	.339
R	.174	.286	.219	.187	.209	.272	.246	.175	.147	.146	1.000	.571	.453	.354	.230	.274	.189	.178
C	.335	.361	.445	.268	.401	.357	.399	.408	.359	.439	.571	1.000	.540	.501	.424	.393	.292	.321
PP	.384	.424	.425	.226	.470	.376	.380	.369	.311	.300	.453	.540	1.000	.504	.459	.473	.395	.375
ASC	.268	.372	.424	.297	.362	.338	.375	.408	.479	.468	.354	.501	.504	1.000	.627	.585	.533	.515
MA	.300	.318	.400	.313	.360	.349	.470	.494	.438	.388	.230	.424	.459	.627	1.000	.630	.622	.549
PL	.300	.317	.334	.222	.263	.273	.394	.466	.373	.350	.274	.393	.473	.585	.630	1.000	.606	.504
PT	.292	.292	.382	.286	.374	.307	.323	.405	.342	.361	.189	.292	.395	.533	.622	.606	1.000	.595
RHFDT	.308	.281	.372	.221	.280	.309	.178	.297	.319	.339	.178	.321	.375	.515	.549	.504	.595	1.000

Table 6.40: Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
S	38.5893	117.992	.596	.651	.917
RM	38.4554	117.329	.644	.635	.915
SC	38.7173	117.254	.663	.646	.915
PCF	39.1131	120.739	.528	.469	.918
SAS	38.6577	118.291	.634	.572	.916
LATJ	38.6637	118.278	.612	.507	.916
HPP	39.1399	118.156	.620	.595	.916
AFCV	39.1101	117.179	.662	.668	.915
FFVBD	39.1875	118.804	.601	.530	.916
TBFEC	39.1756	118.271	.594	.461	.917
R	38.5060	122.627	.382	.443	.922
C	38.7321	118.382	.616	.574	.916
PP	38.5893	116.523	.617	.501	.916
ASC	39.1935	117.733	.667	.589	.915
MA	39.2917	118.548	.663	.604	.915
PL	39.2917	118.930	.605	.557	.916
PT	39.3661	119.045	.588	.559	.917
RHFDT	39.2679	120.567	.528	.481	.918

Table 6.41: Scale Statistics

Mean	Variance	Std. Deviation	N of Items
41.2381	132.337	11.50379	18

```
ONEWAY S RM SC PCF SAS LATJ HPP AFCV FFVBD TBFEC R C PP ASC MA
PL PT RHFDT BY Group
/MISSING ANALYSIS
/POSTHOC=LSD ALPHA (0.05).
```

One-way

Table 6.42: One-way Anova Notes

Comments		
Input	Data	C:\Users\owner\Desktop\Q13.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	336
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each analysis are based on cases with no missing data for any variable in the analysis.
Syntax		ONEWAY S RM SC PCF SAS LATJ HPP AFCV FFVBD TBFEC R C PP ASC MA PL PT RHFDT BY Group /MISSING ANALYSIS /POSTHOC=LSD ALPHA (0.05).
Resources	Processor Time	00:00:00.09
	Elapsed Time	00:00:00.10

Table 6.43: ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
S	Between Groups	82.567	5	16.513	20.183	.000
	Within Groups	269.993	330	.818		
	Total	352.560	335			
RM	Between Groups	67.969	5	13.594	16.666	.000
	Within Groups	269.171	330	.816		
	Total	337.140	335			
SC	Between Groups	38.637	5	7.727	8.941	.000
	Within Groups	285.218	330	.864		
	Total	323.854	335			
PCF	Between Groups	9.163	5	1.833	2.179	.056
	Within Groups	277.587	330	.841		
	Total	286.750	335			
SAS	Between Groups	29.171	5	5.834	7.010	.000
	Within Groups	274.659	330	.832		
	Total	303.830	335			
LATJ	Between Groups	25.484	5	5.097	5.632	.000
	Within Groups	298.656	330	.905		
	Total	324.140	335			
HPP	Between Groups	42.737	5	8.547	10.109	.000
	Within Groups	279.022	330	.846		
	Total	321.759	335			
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
AFCV	Between Groups	37.862	5	7.572	8.628	.000
	Within Groups	289.636	330	.878		
	Total	327.497	335			
FFVBD	Between Groups	40.697	5	8.139	9.969	.000
	Within Groups	269.443	330	.816		
	Total	310.140	335			
TBFEC	Between Groups	38.618	5	7.724	8.410	.000
	Within Groups	303.069	330	.918		
	Total	341.688	335			
R	Between Groups	6.215	5	1.243	1.187	.315
	Within Groups	345.678	330	1.048		
	Total	351.893	335			

C	Between Groups	22.032	5	4.406	4.947	.000
	Within Groups	293.956	330	.891		
	Total	315.988	335			
PP	Between Groups	41.704	5	8.341	7.628	.000
	Within Groups	360.856	330	1.094		
	Total	402.560	335			
ASC	Between Groups	47.491	5	9.498	12.397	.000
	Within Groups	252.839	330	.766		
	Total	300.330	335			
		Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
MA	Between Groups	36.451	5	7.290	10.255	.000
	Within Groups	234.585	330	.711		
	Total	271.036	335			
PL	Between Groups	42.778	5	8.556	10.932	.000
	Within Groups	258.258	330	.783		
	Total	301.036	335			
PT	Between Groups	27.804	5	5.561	6.469	.000
	Within Groups	283.693	330	.860		
	Total	311.497	335			
RHFDT	Between Groups	40.659	5	8.132	10.522	.000
	Within Groups	255.043	330	.773		
	Total	295.702	335			

Post Hoc Tests

Table 6.44: Multiple Comparisons

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
S	PA	PN	0.24625	0.17072	0.15	-0.0896	0.5821
		PS	.93524*	0.17132	0	0.5982	1.2723
		PSO	0.24	0.1809	0.186	-0.1159	0.5959
		PM	0.26373	0.17387	0.13	-0.0783	0.6058
		PEX	-.76000*	0.1809	0	-1.1159	-0.4041
	PN	PA	-0.24625	0.17072	0.15	-0.5821	0.0896
		PS	.68899*	0.16053	0	0.3732	1.0048
		PSO	-0.00625	0.17072	0.971	-0.3421	0.3296
		PM	0.01748	0.16325	0.915	-0.3037	0.3386
		PEX	-1.00625*	0.17072	0	-1.3421	-0.6704
	PS	PA	-.93524*	0.17132	0	-1.2723	-0.5982
		PN	-.68899*	0.16053	0	-1.0048	-0.3732
		PSO	-.69524*	0.17132	0	-1.0323	-0.3582
		PM	-.67151*	0.16387	0	-0.9939	-0.3491
		PEX	-1.69524*	0.17132	0	-2.0323	-1.3582
	PSO	PA	-0.24	0.1809	0.186	-0.5959	0.1159
		PN	0.00625	0.17072	0.971	-0.3296	0.3421
		PS	.69524*	0.17132	0	0.3582	1.0323
		PM	0.02373	0.17387	0.892	-0.3183	0.3658
		PEX	-1.00000*	0.1809	0	-1.3559	-0.6441
	PM	PA	-0.26373	0.17387	0.13	-0.6058	0.0783
		PN	-0.01748	0.16325	0.915	-0.3386	0.3037
		PS	.67151*	0.16387	0	0.3491	0.9939
		PSO	-0.02373	0.17387	0.892	-0.3658	0.3183
		PEX	-1.02373*	0.17387	0	-1.3658	-0.6817
	PEX	PA	.76000*	0.1809	0	0.4041	1.1159
		PN	1.00625*	0.17072	0	0.6704	1.3421
		PS	1.69524*	0.17132	0	1.3582	2.0323
		PSO	1.00000*	0.1809	0	0.6441	1.3559
		PM	1.02373*	0.17387	0	0.6817	1.3658

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
RM	PA	PN	-0.02188	0.17046	0.898	-0.3572	0.3135
		PS	.83651*	0.17106	0	0.5	1.173
		PSO	0.3	0.18063	0.098	-0.0553	0.6553
		PM	0.12034	0.1736	0.489	-0.2212	0.4618
		PEX	-.68000*	0.18063	0	-1.0353	-0.3247
	PN	PA	0.02188	0.17046	0.898	-0.3135	0.3572
		PS	.85838*	0.16029	0	0.5431	1.1737
		PSO	0.32188	0.17046	0.06	-0.0135	0.6572
		PM	0.14221	0.163	0.384	-0.1784	0.4629
		PEX	-.65813*	0.17046	0	-0.9935	-0.3228
	PS	PA	-.83651*	0.17106	0	-1.173	-0.5
		PN	-.85838*	0.16029	0	-1.1737	-0.5431
		PSO	-.53651*	0.17106	0.002	-0.873	-0.2
		PM	-.71617*	0.16362	0	-1.038	-0.3943
		PEX	-1.51651*	0.17106	0	-1.853	-1.18
	PSO	PA	-0.3	0.18063	0.098	-0.6553	0.0553
		PN	-0.32188	0.17046	0.06	-0.6572	0.0135
		PS	.53651*	0.17106	0.002	0.2	0.873
		PM	-0.17966	0.1736	0.301	-0.5212	0.1618
		PEX	-.98000*	0.18063	0	-1.3353	-0.6247
	PM	PA	-0.12034	0.1736	0.489	-0.4618	0.2212
		PN	-0.14221	0.163	0.384	-0.4629	0.1784
		PS	.71617*	0.16362	0	0.3943	1.038
		PSO	0.17966	0.1736	0.301	-0.1618	0.5212
		PEX	-.80034*	0.1736	0	-1.1418	-0.4588
	PEX	PA	.68000*	0.18063	0	0.3247	1.0353
		PN	.65813*	0.17046	0	0.3228	0.9935
		PS	1.51651*	0.17106	0	1.18	1.853
		PSO	.98000*	0.18063	0	0.6247	1.3353
		PM	.80034*	0.1736	0	0.4588	1.1418

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
SC	PA	PN	0.01938	0.17547	0.912	-0.3258	0.3646
		PS	.69175*	0.17608	0	0.3454	1.0381
		PSO	0.2	0.18594	0.283	-0.1658	0.5658
		PM	0.23627	0.1787	0.187	-0.1153	0.5878
		PEX	-.44000*	0.18594	0.019	-0.8058	-0.0742
	PN	PA	-0.01938	0.17547	0.912	-0.3646	0.3258
		PS	.67237*	0.165	0	0.3478	0.9969
		PSO	0.18063	0.17547	0.304	-0.1646	0.5258
		PM	0.2169	0.16779	0.197	-0.1132	0.547
		PEX	-.45938*	0.17547	0.009	-0.8046	-0.1142
	PS	PA	-.69175*	0.17608	0	-1.0381	-0.3454
		PN	-.67237*	0.165	0	-0.9969	-0.3478
		PSO	-.49175*	0.17608	0.006	-0.8381	-0.1454
		PM	-.45547*	0.16843	0.007	-0.7868	-0.1241
		PEX	-1.13175*	0.17608	0	-1.4781	-0.7854
	PSO	PA	-0.2	0.18594	0.283	-0.5658	0.1658
		PN	-0.18063	0.17547	0.304	-0.5258	0.1646
		PS	.49175*	0.17608	0.006	0.1454	0.8381
		PM	0.03627	0.1787	0.839	-0.3153	0.3878
		PEX	-.64000*	0.18594	0.001	-1.0058	-0.2742
	PM	PA	-0.23627	0.1787	0.187	-0.5878	0.1153
		PN	-0.2169	0.16779	0.197	-0.547	0.1132
		PS	.45547*	0.16843	0.007	0.1241	0.7868
		PSO	-0.03627	0.1787	0.839	-0.3878	0.3153
		PEX	-.67627*	0.1787	0	-1.0278	-0.3247
	PEX	PA	.44000*	0.18594	0.019	0.0742	0.8058
		PN	.45938*	0.17547	0.009	0.1142	0.8046
		PS	1.13175*	0.17608	0	0.7854	1.4781
		PSO	.64000*	0.18594	0.001	0.2742	1.0058
		PM	.67627*	0.1787	0	0.3247	1.0278

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
PCF	PA	PN	0.2775	0.17311	0.11	-0.063	0.618
		PS	.43524*	0.17371	0.013	0.0935	0.777
		PSO	0.26	0.18343	0.157	-0.1008	0.6208
		PM	0.2722	0.1763	0.124	-0.0746	0.619
		PEX	-0.04	0.18343	0.828	-0.4008	0.3208
	PN	PA	-0.2775	0.17311	0.11	-0.618	0.063
		PS	0.15774	0.16277	0.333	-0.1625	0.4779
		PSO	-0.0175	0.17311	0.92	-0.358	0.323
		PM	-0.0053	0.16553	0.974	-0.3309	0.3203
		PEX	-0.3175	0.17311	0.068	-0.658	0.023
	PS	PA	-.43524*	0.17371	0.013	-0.777	-0.0935
		PN	-0.15774	0.16277	0.333	-0.4779	0.1625
		PSO	-0.17524	0.17371	0.314	-0.517	0.1665
		PM	-0.16303	0.16616	0.327	-0.4899	0.1638
		PEX	-.47524*	0.17371	0.007	-0.817	-0.1335
	PSO	PA	-0.26	0.18343	0.157	-0.6208	0.1008
		PN	0.0175	0.17311	0.92	-0.323	0.358
		PS	0.17524	0.17371	0.314	-0.1665	0.517
		PM	0.0122	0.1763	0.945	-0.3346	0.359
		PEX	-0.3	0.18343	0.103	-0.6608	0.0608
	PM	PA	-0.2722	0.1763	0.124	-0.619	0.0746
		PN	0.0053	0.16553	0.974	-0.3203	0.3309
		PS	0.16303	0.16616	0.327	-0.1638	0.4899
		PSO	-0.0122	0.1763	0.945	-0.359	0.3346
		PEX	-0.3122	0.1763	0.078	-0.659	0.0346
	PEX	PA	0.04	0.18343	0.828	-0.3208	0.4008
		PN	0.3175	0.17311	0.068	-0.023	0.658
		PS	.47524*	0.17371	0.007	0.1335	0.817
		PSO	0.3	0.18343	0.103	-0.0608	0.6608
		PM	0.3122	0.1763	0.078	-0.0346	0.659

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
SAS	PA	PN	0.01875	0.17219	0.913	-0.32	0.3575
		PS	.80000*	0.17279	0	0.4601	1.1399
		PSO	0.3	0.18246	0.101	-0.0589	0.6589
		PM	0.08814	0.17536	0.616	-0.2568	0.4331
		PEX	0.04	0.18246	0.827	-0.3189	0.3989
	PN	PA	-0.01875	0.17219	0.913	-0.3575	0.32
		PS	.78125*	0.16191	0	0.4627	1.0998
		PSO	0.28125	0.17219	0.103	-0.0575	0.62
		PM	0.06939	0.16466	0.674	-0.2545	0.3933
		PEX	0.02125	0.17219	0.902	-0.3175	0.36
	PS	PA	-.80000*	0.17279	0	-1.1399	-0.4601
		PN	-.78125*	0.16191	0	-1.0998	-0.4627
		PSO	-.50000*	0.17279	0.004	-0.8399	-0.1601
		PM	-.71186*	0.16528	0	-1.037	-0.3867
		PEX	-.76000*	0.17279	0	-1.0999	-0.4201
	PSO	PA	-0.3	0.18246	0.101	-0.6589	0.0589
		PN	-0.28125	0.17219	0.103	-0.62	0.0575
		PS	.50000*	0.17279	0.004	0.1601	0.8399
		PM	-0.21186	0.17536	0.228	-0.5568	0.1331
		PEX	-0.26	0.18246	0.155	-0.6189	0.0989
	PM	PA	-0.08814	0.17536	0.616	-0.4331	0.2568
		PN	-0.06939	0.16466	0.674	-0.3933	0.2545
		PS	.71186*	0.16528	0	0.3867	1.037
		PSO	0.21186	0.17536	0.228	-0.1331	0.5568
		PEX	-0.04814	0.17536	0.784	-0.3931	0.2968
	PEX	PA	-0.04	0.18246	0.827	-0.3989	0.3189
		PN	-0.02125	0.17219	0.902	-0.36	0.3175
		PS	.76000*	0.17279	0	0.4201	1.0999
		PSO	0.26	0.18246	0.155	-0.0989	0.6189
		PM	0.04814	0.17536	0.784	-0.2968	0.3931

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LATJ	PA	PN	0.26188	0.17956	0.146	-0.0913	0.6151
		PS	.72889*	0.18018	0	0.3744	1.0833
		PSO	0.32	0.19026	0.094	-0.0543	0.6943
		PM	0.29763	0.18287	0.105	-0.0621	0.6574
		PEX	-0.14	0.19026	0.462	-0.5143	0.2343
	PN	PA	-0.26188	0.17956	0.146	-0.6151	0.0913
		PS	.46701*	0.16884	0.006	0.1349	0.7991
		PSO	0.05813	0.17956	0.746	-0.2951	0.4113
		PM	0.03575	0.1717	0.835	-0.302	0.3735
		PEX	-.40188*	0.17956	0.026	-0.7551	-0.0487
	PS	PA	-.72889*	0.18018	0	-1.0833	-0.3744
		PN	-.46701*	0.16884	0.006	-0.7991	-0.1349
		PSO	-.40889*	0.18018	0.024	-0.7633	-0.0544
		PM	-.43126*	0.17235	0.013	-0.7703	-0.0922
		PEX	-.86889*	0.18018	0	-1.2233	-0.5144
	PSO	PA	-0.32	0.19026	0.094	-0.6943	0.0543
		PN	-0.05813	0.17956	0.746	-0.4113	0.2951
		PS	.40889*	0.18018	0.024	0.0544	0.7633
		PM	-0.02237	0.18287	0.903	-0.3821	0.3374
		PEX	-.46000*	0.19026	0.016	-0.8343	-0.0857
	PM	PA	-0.29763	0.18287	0.105	-0.6574	0.0621
		PN	-0.03575	0.1717	0.835	-0.3735	0.302
		PS	.43126*	0.17235	0.013	0.0922	0.7703
		PSO	0.02237	0.18287	0.903	-0.3374	0.3821
		PEX	-.43763*	0.18287	0.017	-0.7974	-0.0779
	PEX	PA	0.14	0.19026	0.462	-0.2343	0.5143
		PN	.40188*	0.17956	0.026	0.0487	0.7551
		PS	.86889*	0.18018	0	0.5144	1.2233
		PSO	.46000*	0.19026	0.016	0.0857	0.8343
		PM	.43763*	0.18287	0.017	0.0779	0.7974

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
HPP	PA	PN	.53125*	0.17356	0.002	0.1898	0.8727
		PS	1.03968*	0.17416	0	0.6971	1.3823
		PSO	.42000*	0.1839	0.023	0.0582	0.7818
		PM	0.11017	0.17675	0.534	-0.2375	0.4579
		PEX	0.16	0.1839	0.385	-0.2018	0.5218
	PN	PA	-.53125*	0.17356	0.002	-0.8727	-0.1898
		PS	.50843*	0.16319	0.002	0.1874	0.8295
		PSO	-0.11125	0.17356	0.522	-0.4527	0.2302
		PM	-.42108*	0.16596	0.012	-0.7476	-0.0946
		PEX	-.37125*	0.17356	0.033	-0.7127	-0.0298
	PS	PA	-1.03968*	0.17416	0	-1.3823	-0.6971
		PN	-.50843*	0.16319	0.002	-0.8295	-0.1874
		PSO	-.61968*	0.17416	0	-0.9623	-0.2771
		PM	-.92951*	0.16659	0	-1.2572	-0.6018
		PEX	-.87968*	0.17416	0	-1.2223	-0.5371
	PSO	PA	-.42000*	0.1839	0.023	-0.7818	-0.0582
		PN	0.11125	0.17356	0.522	-0.2302	0.4527
		PS	.61968*	0.17416	0	0.2771	0.9623
		PM	-0.30983	0.17675	0.081	-0.6575	0.0379
		PEX	-0.26	0.1839	0.158	-0.6218	0.1018
	PM	PA	-0.11017	0.17675	0.534	-0.4579	0.2375
		PN	.42108*	0.16596	0.012	0.0946	0.7476
		PS	.92951*	0.16659	0	0.6018	1.2572
		PSO	0.30983	0.17675	0.081	-0.0379	0.6575
		PEX	0.04983	0.17675	0.778	-0.2979	0.3975
	PEX	PA	-0.16	0.1839	0.385	-0.5218	0.2018
		PN	.37125*	0.17356	0.033	0.0298	0.7127
		PS	.87968*	0.17416	0	0.5371	1.2223
		PSO	0.26	0.1839	0.158	-0.1018	0.6218
		PM	-0.04983	0.17675	0.778	-0.3975	0.2979

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
AFCV	PA	PN	0.19438	0.17683	0.272	-0.1535	0.5422
		PS	.99968*	0.17744	0	0.6506	1.3487
		PSO	0.34	0.18737	0.07	-0.0286	0.7086
		PM	0.12102	0.18008	0.502	-0.2332	0.4753
		PEX	0.24	0.18737	0.201	-0.1286	0.6086
	PN	PA	-0.19438	0.17683	0.272	-0.5422	0.1535
		PS	.80531*	0.16627	0	0.4782	1.1324
		PSO	0.14563	0.17683	0.411	-0.2022	0.4935
		PM	-0.07336	0.16909	0.665	-0.406	0.2593
		PEX	0.04562	0.17683	0.797	-0.3022	0.3935
	PS	PA	-.99968*	0.17744	0	-1.3487	-0.6506
		PN	-.80531*	0.16627	0	-1.1324	-0.4782
		PSO	-.65968*	0.17744	0	-1.0087	-0.3106
		PM	-.87867*	0.16973	0	-1.2126	-0.5448
		PEX	-.75968*	0.17744	0	-1.1087	-0.4106
	PSO	PA	-0.34	0.18737	0.07	-0.7086	0.0286
		PN	-0.14563	0.17683	0.411	-0.4935	0.2022
		PS	.65968*	0.17744	0	0.3106	1.0087
		PM	-0.21898	0.18008	0.225	-0.5732	0.1353
		PEX	-0.1	0.18737	0.594	-0.4686	0.2686
	PM	PA	-0.12102	0.18008	0.502	-0.4753	0.2332
		PN	0.07336	0.16909	0.665	-0.2593	0.406
		PS	.87867*	0.16973	0	0.5448	1.2126
		PSO	0.21898	0.18008	0.225	-0.1353	0.5732
		PEX	0.11898	0.18008	0.509	-0.2353	0.4732
	PEX	PA	-0.24	0.18737	0.201	-0.6086	0.1286
		PN	-0.04562	0.17683	0.797	-0.3935	0.3022
		PS	.75968*	0.17744	0	0.4106	1.1087
		PSO	0.1	0.18737	0.594	-0.2686	0.4686
		PM	-0.11898	0.18008	0.509	-0.4732	0.2353

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
FFVBD	PA	PN	-0.02813	0.17055	0.869	-0.3636	0.3074
		PS	.87143*	0.17114	0	0.5348	1.2081
		PSO	0.2	0.18072	0.269	-0.1555	0.5555
		PM	-0.05593	0.17369	0.748	-0.3976	0.2858
		PEX	.48000*	0.18072	0.008	0.1245	0.8355
	PN	PA	0.02813	0.17055	0.869	-0.3074	0.3636
		PS	.89955*	0.16037	0	0.5841	1.215
		PSO	0.22813	0.17055	0.182	-0.1074	0.5636
		PM	-0.02781	0.16308	0.865	-0.3486	0.293
		PEX	.50812*	0.17055	0.003	0.1726	0.8436
	PS	PA	-.87143*	0.17114	0	-1.2081	-0.5348
		PN	-.89955*	0.16037	0	-1.215	-0.5841
		PSO	-.67143*	0.17114	0	-1.0081	-0.3348
		PM	-.92736*	0.1637	0	-1.2494	-0.6053
		PEX	-.39143*	0.17114	0.023	-0.7281	-0.0548
	PSO	PA	-0.2	0.18072	0.269	-0.5555	0.1555
		PN	-0.22813	0.17055	0.182	-0.5636	0.1074
		PS	.67143*	0.17114	0	0.3348	1.0081
		PM	-0.25593	0.17369	0.142	-0.5976	0.0858
		PEX	0.28	0.18072	0.122	-0.0755	0.6355
	PM	PA	0.05593	0.17369	0.748	-0.2858	0.3976
		PN	0.02781	0.16308	0.865	-0.293	0.3486
		PS	.92736*	0.1637	0	0.6053	1.2494
		PSO	0.25593	0.17369	0.142	-0.0858	0.5976
		PEX	.53593*	0.17369	0.002	0.1942	0.8776
	PEX	PA	-.48000*	0.18072	0.008	-0.8355	-0.1245
		PN	-.50812*	0.17055	0.003	-0.8436	-0.1726
		PS	.39143*	0.17114	0.023	0.0548	0.7281
		PSO	-0.28	0.18072	0.122	-0.6355	0.0755
		PM	-.53593*	0.17369	0.002	-0.8776	-0.1942

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
TBFEC	PA	PN	.38375*	0.18088	0.035	0.0279	0.7396
		PS	1.09556*	0.18151	0	0.7385	1.4526
		PSO	.54000*	0.19167	0.005	0.163	0.917
		PM	.45525*	0.18421	0.014	0.0929	0.8176
		PEX	0.26	0.19167	0.176	-0.117	0.637
	PN	PA	-.38375*	0.18088	0.035	-0.7396	-0.0279
		PS	.71181*	0.17008	0	0.3772	1.0464
		PSO	0.15625	0.18088	0.388	-0.1996	0.5121
		PM	0.0715	0.17296	0.68	-0.2687	0.4118
		PEX	-0.12375	0.18088	0.494	-0.4796	0.2321
	PS	PA	-1.09556*	0.18151	0	-1.4526	-0.7385
		PN	-.71181*	0.17008	0	-1.0464	-0.3772
		PSO	-.55556*	0.18151	0.002	-0.9126	-0.1985
		PM	-.64030*	0.17362	0	-0.9818	-0.2988
		PEX	-.83556*	0.18151	0	-1.1926	-0.4785
	PSO	PA	-.54000*	0.19167	0.005	-0.917	-0.163
		PN	-0.15625	0.18088	0.388	-0.5121	0.1996
		PS	.55556*	0.18151	0.002	0.1985	0.9126
		PM	-0.08475	0.18421	0.646	-0.4471	0.2776
		PEX	-0.28	0.19167	0.145	-0.657	0.097
	PM	PA	-.45525*	0.18421	0.014	-0.8176	-0.0929
		PN	-0.0715	0.17296	0.68	-0.4118	0.2687
		PS	.64030*	0.17362	0	0.2988	0.9818
		PSO	0.08475	0.18421	0.646	-0.2776	0.4471
		PEX	-0.19525	0.18421	0.29	-0.5576	0.1671
	PEX	PA	-0.26	0.19167	0.176	-0.637	0.117
		PN	0.12375	0.18088	0.494	-0.2321	0.4796
		PS	.83556*	0.18151	0	0.4785	1.1926
		PSO	0.28	0.19167	0.145	-0.097	0.657
		PM	0.19525	0.18421	0.29	-0.1671	0.5576

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
R	PA	PN	-0.3175	0.19318	0.101	-0.6975	0.0625
		PS	-0.15778	0.19385	0.416	-0.5391	0.2236
		PSO	0.1	0.2047	0.625	-0.3027	0.5027
		PM	-0.17661	0.19673	0.37	-0.5636	0.2104
		PEX	-0.04	0.2047	0.845	-0.4427	0.3627
	PN	PA	0.3175	0.19318	0.101	-0.0625	0.6975
		PS	0.15972	0.18164	0.38	-0.1976	0.517
		PSO	.41750*	0.19318	0.031	0.0375	0.7975
		PM	0.14089	0.18472	0.446	-0.2225	0.5043
		PEX	0.2775	0.19318	0.152	-0.1025	0.6575
	PS	PA	0.15778	0.19385	0.416	-0.2236	0.5391
		PN	-0.15972	0.18164	0.38	-0.517	0.1976
		PSO	0.25778	0.19385	0.185	-0.1236	0.6391
		PM	-0.01883	0.18542	0.919	-0.3836	0.3459
		PEX	0.11778	0.19385	0.544	-0.2636	0.4991
	PSO	PA	-0.1	0.2047	0.625	-0.5027	0.3027
		PN	-.41750*	0.19318	0.031	-0.7975	-0.0375
		PS	-0.25778	0.19385	0.185	-0.6391	0.1236
		PM	-0.27661	0.19673	0.161	-0.6636	0.1104
		PEX	-0.14	0.2047	0.494	-0.5427	0.2627
	PM	PA	0.17661	0.19673	0.37	-0.2104	0.5636
		PN	-0.14089	0.18472	0.446	-0.5043	0.2225
		PS	0.01883	0.18542	0.919	-0.3459	0.3836
		PSO	0.27661	0.19673	0.161	-0.1104	0.6636
		PEX	0.13661	0.19673	0.488	-0.2504	0.5236
	PEX	PA	0.04	0.2047	0.845	-0.3627	0.4427
		PN	-0.2775	0.19318	0.152	-0.6575	0.1025
		PS	-0.11778	0.19385	0.544	-0.4991	0.2636
		PSO	0.14	0.2047	0.494	-0.2627	0.5427
		PM	-0.13661	0.19673	0.488	-0.5236	0.2504

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
C	PA	PN	-0.03688	0.17814	0.836	-0.3873	0.3136
		PS	.68063*	0.17876	0	0.329	1.0323
		PSO	.40000*	0.18876	0.035	0.0287	0.7713
		PM	0.14983	0.18142	0.409	-0.2071	0.5067
		PEX	0.32	0.18876	0.091	-0.0513	0.6913
	PN	PA	0.03688	0.17814	0.836	-0.3136	0.3873
		PS	.71751*	0.1675	0	0.388	1.047
		PSO	.43688*	0.17814	0.015	0.0864	0.7873
		PM	0.18671	0.17034	0.274	-0.1484	0.5218
		PEX	.35688*	0.17814	0.046	0.0064	0.7073
	PS	PA	-.68063*	0.17876	0	-1.0323	-0.329
		PN	-.71751*	0.1675	0	-1.047	-0.388
		PSO	-0.28063	0.17876	0.117	-0.6323	0.071
		PM	-.53080*	0.17099	0.002	-0.8672	-0.1944
		PEX	-.36063*	0.17876	0.044	-0.7123	-0.009
	PSO	PA	-.40000*	0.18876	0.035	-0.7713	-0.0287
		PN	-.43688*	0.17814	0.015	-0.7873	-0.0864
		PS	0.28063	0.17876	0.117	-0.071	0.6323
		PM	-0.25017	0.18142	0.169	-0.6071	0.1067
		PEX	-0.08	0.18876	0.672	-0.4513	0.2913
	PM	PA	-0.14983	0.18142	0.409	-0.5067	0.2071
		PN	-0.18671	0.17034	0.274	-0.5218	0.1484
		PS	.53080*	0.17099	0.002	0.1944	0.8672
		PSO	0.25017	0.18142	0.169	-0.1067	0.6071
		PEX	0.17017	0.18142	0.349	-0.1867	0.5271
	PEX	PA	-0.32	0.18876	0.091	-0.6913	0.0513
		PN	-.35688*	0.17814	0.046	-0.7073	-0.0064
		PS	.36063*	0.17876	0.044	0.009	0.7123
		PSO	0.08	0.18876	0.672	-0.2913	0.4513
		PM	-0.17017	0.18142	0.349	-0.5271	0.1867

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
PP	PA	PN	0.1475	0.19737	0.455	-0.2408	0.5358
		PS	.91238*	0.19806	0	0.5228	1.302
		PSO	.50000*	0.20914	0.017	0.0886	0.9114
		PM	-0.1078	0.20101	0.592	-0.5032	0.2876
		PEX	0.38	0.20914	0.07	-0.0314	0.7914
	PN	PA	-0.1475	0.19737	0.455	-0.5358	0.2408
		PS	.76488*	0.18559	0	0.3998	1.13
		PSO	0.3525	0.19737	0.075	-0.0358	0.7408
		PM	-0.2553	0.18873	0.177	-0.6266	0.116
		PEX	0.2325	0.19737	0.24	-0.1558	0.6208
	PS	PA	-.91238*	0.19806	0	-1.302	-0.5228
		PN	-.76488*	0.18559	0	-1.13	-0.3998
		PSO	-.41238*	0.19806	0.038	-0.802	-0.0228
		PM	-1.02018*	0.18945	0	-1.3929	-0.6475
		PEX	-.53238*	0.19806	0.008	-0.922	-0.1428
	PSO	PA	-.50000*	0.20914	0.017	-0.9114	-0.0886
		PN	-0.3525	0.19737	0.075	-0.7408	0.0358
		PS	.41238*	0.19806	0.038	0.0228	0.802
		PM	-.60780*	0.20101	0.003	-1.0032	-0.2124
		PEX	-0.12	0.20914	0.567	-0.5314	0.2914
	PM	PA	0.1078	0.20101	0.592	-0.2876	0.5032
		PN	0.2553	0.18873	0.177	-0.116	0.6266
		PS	1.02018*	0.18945	0	0.6475	1.3929
		PSO	.60780*	0.20101	0.003	0.2124	1.0032
		PEX	.48780*	0.20101	0.016	0.0924	0.8832
	PEX	PA	-0.38	0.20914	0.07	-0.7914	0.0314
		PN	-0.2325	0.19737	0.24	-0.6208	0.1558
		PS	.53238*	0.19806	0.008	0.1428	0.922
		PSO	0.12	0.20914	0.567	-0.2914	0.5314
		PM	-.48780*	0.20101	0.016	-0.8832	-0.0924

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
ASC	PA	PN	0.14938	0.16521	0.367	-0.1756	0.4744
		PS	1.12730*	0.16579	0	0.8012	1.4534
		PSO	.68000*	0.17506	0	0.3356	1.0244
		PM	.40441*	0.16825	0.017	0.0734	0.7354
		PEX	.56000*	0.17506	0.002	0.2156	0.9044
	PN	PA	-0.14938	0.16521	0.367	-0.4744	0.1756
		PS	.97793*	0.15535	0	0.6723	1.2835
		PSO	.53062*	0.16521	0.001	0.2056	0.8556
		PM	0.25503	0.15798	0.107	-0.0557	0.5658
		PEX	.41063*	0.16521	0.013	0.0856	0.7356
	PS	PA	-1.12730*	0.16579	0	-1.4534	-0.8012
		PN	-.97793*	0.15535	0	-1.2835	-0.6723
		PSO	-.44730*	0.16579	0.007	-0.7734	-0.1212
		PM	-.72289*	0.15858	0	-1.0349	-0.4109
		PEX	-.56730*	0.16579	0.001	-0.8934	-0.2412
	PSO	PA	-.68000*	0.17506	0	-1.0244	-0.3356
		PN	-.53062*	0.16521	0.001	-0.8556	-0.2056
		PS	.44730*	0.16579	0.007	0.1212	0.7734
		PM	-0.27559	0.16825	0.102	-0.6066	0.0554
		PEX	-0.12	0.17506	0.494	-0.4644	0.2244
	PM	PA	-.40441*	0.16825	0.017	-0.7354	-0.0734
		PN	-0.25503	0.15798	0.107	-0.5658	0.0557
		PS	.72289*	0.15858	0	0.4109	1.0349
		PSO	0.27559	0.16825	0.102	-0.0554	0.6066
		PEX	0.15559	0.16825	0.356	-0.1754	0.4866
	PEX	PA	-.56000*	0.17506	0.002	-0.9044	-0.2156
		PN	-.41063*	0.16521	0.013	-0.7356	-0.0856
		PS	.56730*	0.16579	0.001	0.2412	0.8934
		PSO	0.12	0.17506	0.494	-0.2244	0.4644
		PM	-0.15559	0.16825	0.356	-0.4866	0.1754

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
MA	PA	PN	0.10125	0.15914	0.525	-0.2118	0.4143
		PS	.97079*	0.15969	0	0.6567	1.2849
		PSO	.50000*	0.16863	0.003	0.1683	0.8317
		PM	0.21831	0.16207	0.179	-0.1005	0.5371
		PEX	.40000*	0.16863	0.018	0.0683	0.7317
	PN	PA	-0.10125	0.15914	0.525	-0.4143	0.2118
		PS	.86954*	0.14964	0	0.5752	1.1639
		PSO	.39875*	0.15914	0.013	0.0857	0.7118
		PM	0.11706	0.15217	0.442	-0.1823	0.4164
		PEX	0.29875	0.15914	0.061	-0.0143	0.6118
	PS	PA	-.97079*	0.15969	0	-1.2849	-0.6567
		PN	-.86954*	0.14964	0	-1.1639	-0.5752
		PSO	-.47079*	0.15969	0.003	-0.7849	-0.1567
		PM	-.75249*	0.15275	0	-1.053	-0.452
		PEX	-.57079*	0.15969	0	-0.8849	-0.2567
	PSO	PA	-.50000*	0.16863	0.003	-0.8317	-0.1683
		PN	-.39875*	0.15914	0.013	-0.7118	-0.0857
		PS	.47079*	0.15969	0.003	0.1567	0.7849
		PM	-0.28169	0.16207	0.083	-0.6005	0.0371
		PEX	-0.1	0.16863	0.554	-0.4317	0.2317
	PM	PA	-0.21831	0.16207	0.179	-0.5371	0.1005
		PN	-0.11706	0.15217	0.442	-0.4164	0.1823
		PS	.75249*	0.15275	0	0.452	1.053
		PSO	0.28169	0.16207	0.083	-0.0371	0.6005
		PEX	0.18169	0.16207	0.263	-0.1371	0.5005
	PEX	PA	-.40000*	0.16863	0.018	-0.7317	-0.0683
		PN	-0.29875	0.15914	0.061	-0.6118	0.0143
		PS	.57079*	0.15969	0	0.2567	0.8849
		PSO	0.1	0.16863	0.554	-0.2317	0.4317
		PM	-0.18169	0.16207	0.263	-0.5005	0.1371

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
PL	PA	PN	.36625*	0.16697	0.029	0.0378	0.6947
		PS	1.14254*	0.16755	0	0.8129	1.4721
		PSO	.68000*	0.17693	0	0.3319	1.0281
		PM	.34136*	0.17005	0.046	0.0068	0.6759
		PEX	.46000*	0.17693	0.01	0.1119	0.8081
	PN	PA	-.36625*	0.16697	0.029	-0.6947	-0.0378
		PS	.77629*	0.157	0	0.4674	1.0851
		PSO	0.31375	0.16697	0.061	-0.0147	0.6422
		PM	-0.02489	0.15966	0.876	-0.339	0.2892
		PEX	0.09375	0.16697	0.575	-0.2347	0.4222
	PS	PA	-1.14254*	0.16755	0	-1.4721	-0.8129
		PN	-.77629*	0.157	0	-1.0851	-0.4674
		PSO	-.46254*	0.16755	0.006	-0.7921	-0.1329
		PM	-.80118*	0.16027	0	-1.1165	-0.4859
		PEX	-.68254*	0.16755	0	-1.0121	-0.3529
	PSO	PA	-.68000*	0.17693	0	-1.0281	-0.3319
		PN	-0.31375	0.16697	0.061	-0.6422	0.0147
		PS	.46254*	0.16755	0.006	0.1329	0.7921
		PM	-.33864*	0.17005	0.047	-0.6732	-0.0041
		PEX	-0.22	0.17693	0.215	-0.5681	0.1281
	PM	PA	-.34136*	0.17005	0.046	-0.6759	-0.0068
		PN	0.02489	0.15966	0.876	-0.2892	0.339
		PS	.80118*	0.16027	0	0.4859	1.1165
		PSO	.33864*	0.17005	0.047	0.0041	0.6732
		PEX	0.11864	0.17005	0.486	-0.2159	0.4532
	PEX	PA	-.46000*	0.17693	0.01	-0.8081	-0.1119
		PN	-0.09375	0.16697	0.575	-0.4222	0.2347
		PS	.68254*	0.16755	0	0.3529	1.0121
		PSO	0.22	0.17693	0.215	-0.1281	0.5681
		PM	-0.11864	0.17005	0.486	-0.4532	0.2159

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
PT	PA	PN	0.25313	0.175	0.149	-0.0911	0.5974
		PS	.91905*	0.17561	0	0.5736	1.2645
		PSO	.58000*	0.18544	0.002	0.2152	0.9448
		PM	.38475*	0.17823	0.032	0.0341	0.7353
		PEX	0.36	0.18544	0.053	-0.0048	0.7248
	PN	PA	-0.25313	0.175	0.149	-0.5974	0.0911
		PS	.66592*	0.16455	0	0.3422	0.9896
		PSO	0.32688	0.175	0.063	-0.0174	0.6711
		PM	0.13162	0.16734	0.432	-0.1976	0.4608
		PEX	0.10688	0.175	0.542	-0.2374	0.4511
	PS	PA	-.91905*	0.17561	0	-1.2645	-0.5736
		PN	-.66592*	0.16455	0	-0.9896	-0.3422
		PSO	-0.33905	0.17561	0.054	-0.6845	0.0064
		PM	-.53430*	0.16798	0.002	-0.8647	-0.2039
		PEX	-.55905*	0.17561	0.002	-0.9045	-0.2136
	PSO	PA	-.58000*	0.18544	0.002	-0.9448	-0.2152
		PN	-0.32688	0.175	0.063	-0.6711	0.0174
		PS	0.33905	0.17561	0.054	-0.0064	0.6845
		PM	-0.19525	0.17823	0.274	-0.5459	0.1553
		PEX	-0.22	0.18544	0.236	-0.5848	0.1448
	PM	PA	-.38475*	0.17823	0.032	-0.7353	-0.0341
		PN	-0.13162	0.16734	0.432	-0.4608	0.1976
		PS	.53430*	0.16798	0.002	0.2039	0.8647
		PSO	0.19525	0.17823	0.274	-0.1553	0.5459
		PEX	-0.02475	0.17823	0.89	-0.3753	0.3259
	PEX	PA	-0.36	0.18544	0.053	-0.7248	0.0048
		PN	-0.10688	0.175	0.542	-0.4511	0.2374
		PS	.55905*	0.17561	0.002	0.2136	0.9045
		PSO	0.22	0.18544	0.236	-0.1448	0.5848
		PM	0.02475	0.17823	0.89	-0.3259	0.3753

* The mean difference is significant at the 0.05 level.

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
RHFDT	PA	PN	0.20313	0.16593	0.222	-0.1233	0.5295
		PS	1.07143*	0.16651	0	0.7439	1.399
		PSO	.64000*	0.17582	0	0.2941	0.9859
		PM	.63559*	0.16899	0	0.3032	0.968
		PEX	.56000*	0.17582	0.002	0.2141	0.9059
	PN	PA	-0.20313	0.16593	0.222	-0.5295	0.1233
		PS	.86830*	0.15602	0	0.5614	1.1752
		PSO	.43687*	0.16593	0.009	0.1105	0.7633
		PM	.43247*	0.15867	0.007	0.1203	0.7446
		PEX	.35688*	0.16593	0.032	0.0305	0.6833
	PS	PA	-1.07143*	0.16651	0	-1.399	-0.7439
		PN	-.86830*	0.15602	0	-1.1752	-0.5614
		PSO	-.43143*	0.16651	0.01	-0.759	-0.1039
		PM	-.43584*	0.15927	0.007	-0.7491	-0.1225
		PEX	-.51143*	0.16651	0.002	-0.839	-0.1839
	PSO	PA	-.64000*	0.17582	0	-0.9859	-0.2941
		PN	-.43687*	0.16593	0.009	-0.7633	-0.1105
		PS	.43143*	0.16651	0.01	0.1039	0.759
		PM	-0.00441	0.16899	0.979	-0.3368	0.328
		PEX	-0.08	0.17582	0.649	-0.4259	0.2659
	PM	PA	-.63559*	0.16899	0	-0.968	-0.3032
		PN	-.43247*	0.15867	0.007	-0.7446	-0.1203
		PS	.43584*	0.15927	0.007	0.1225	0.7491
		PSO	0.00441	0.16899	0.979	-0.328	0.3368
		PEX	-0.07559	0.16899	0.655	-0.408	0.2568
	PEX	PA	-.56000*	0.17582	0.002	-0.9059	-0.2141
		PN	-.35688*	0.16593	0.032	-0.6833	-0.0305
		PS	.51143*	0.16651	0.002	0.1839	0.839
		PSO	0.08	0.17582	0.649	-0.2659	0.4259
		PM	0.07559	0.16899	0.655	-0.2568	0.408

* The mean difference is significant at the 0.05 level.

Significance (p-value):

Standard significance level: 5% (p-value = 0.05)

Null hypothesis is that the two data sets are similar whereas alternate hypothesis is that the two data sets differ significantly from each other. If the significance (or p-value) is less than 0.05 then we reject the null hypothesis and accept the alternate hypothesis that the two data sets are significantly different from each other. In other words, there is less than 5% chance that the difference is out of randomness. For example, the statistics related to one variable smoothness (S) of the road ways are computed and interpreted as follows: the mean difference between the ratings on smoothness indicator of PA Road and PN road is 0.24. The standard error between the mean ratings of PA and PN on average is 0.17, smaller the standard errors the closer are the two values. The upper and lower signifies the upper and lower limit of the 95% confidence interval of data distribution. This applies to the first line of statistics of smoothness indicator (S) in the above Table. The same explanation holds good for rest of the statistics across the indicators.

FACTOR AALYSIS

/VARIABLES S RM SC PCF SAS LATJ HPP AFCV FFVBD TBFEC R C PP ASC MA PL PT RHFDT

/MISSING LISTWISE

/ANALYSIS S RM SC PCF SAS LATJ HPP AFCV FFVBD TBFEC R C PP ASC MA PL PT RHFDT

/PRINT INITIAL EXTRACTION ROTATION

/PLOT EIGEN ROTATION

/CRITERIA MINEIGEN (1) ITERATE (25)

/EXTRACTION PC

/CRITERIA ITERATE (25)

/ROTATION VARIMAX

/METHOD=CORRELATION

Factor Analysis

Table 6.45: Factor Analysis Notes

Comments		
Input	Data	C:\Users\owner\Desktop\SPSS_Analysis Q13\Q13.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	336
Missing Value Handling	Definition of Missing	MISSING=EXCLUDE: User-defined missing values are treated as missing.
	Cases Used	LISTWISE: Statistics are based on cases with no missing values for any variable used.

Syntax		**FACTOR** /VARIABLES S RM SC PCF SAS LATJ HPP AFCV FFVBD TBFEC R C PP ASC MA PL PT RHFDT /MISSING LISTWISE /ANALYSIS S RM SC PCF SAS LATJ HPP AFCV FFVBD TBFEC R C PP ASC MA PL PT RHFDT /PRINT INITIAL EXTRACTION ROTATION /PLOT EIGEN ROTATION /CRITERIA MINEIGEN(1) ITERATE(25) /EXTRACTION PC /CRITERIA ITERATE(25) /ROTATION VARIMAX /METHOD=CORRELATION.
Resources	Processor Time	00:00:01.22
	Elapsed Time	00:00:01.54
	Maximum Memory Required	40024 (39.086K) bytes

Table 6.46: Communalities

	Initial	Extraction
S	1.000	.739
RM	1.000	.726
SC	1.000	.702
PCF	1.000	.517
SAS	1.000	.584
LATJ	1.000	.582
HPP	1.000	.706
AFCV	1.000	.768
FFVBD	1.000	.649
TBFEC	1.000	.488
R	1.000	.784
C	1.000	.724
PP	1.000	.627
ASC	1.000	.664
MA	1.000	.712
PL	1.000	.673
PT	1.000	.711
RHFDT	1.000	.690

Extraction Method: Principal Component Analysis.

Table 6.47: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.767	43.148	43.148	7.767	43.148	43.148	3.495	19.415	19.415
2	1.775	9.860	53.009	1.775	9.860	53.009	3.366	18.702	38.117
3	1.340	7.445	60.454	1.340	7.445	60.454	3.087	17.151	55.268
4	1.166	6.478	66.932	1.166	6.478	66.932	2.099	11.664	66.932
5	.858	4.767	71.699						
6	.705	3.915	75.614						
7	.571	3.172	78.786						
8	.520	2.887	81.672						
9	.457	2.538	84.210						
10	.447	2.482	86.692						
11	.406	2.254	88.945						
12	.386	2.146	91.092						
13	.359	1.996	93.087						
14	.329	1.826	94.913						
15	.275	1.529	96.443						
16	.239	1.325	97.768						
17	.217	1.204	98.972						
18	.185	1.028	100.000						

Extraction Method: Principal Component Analysis.

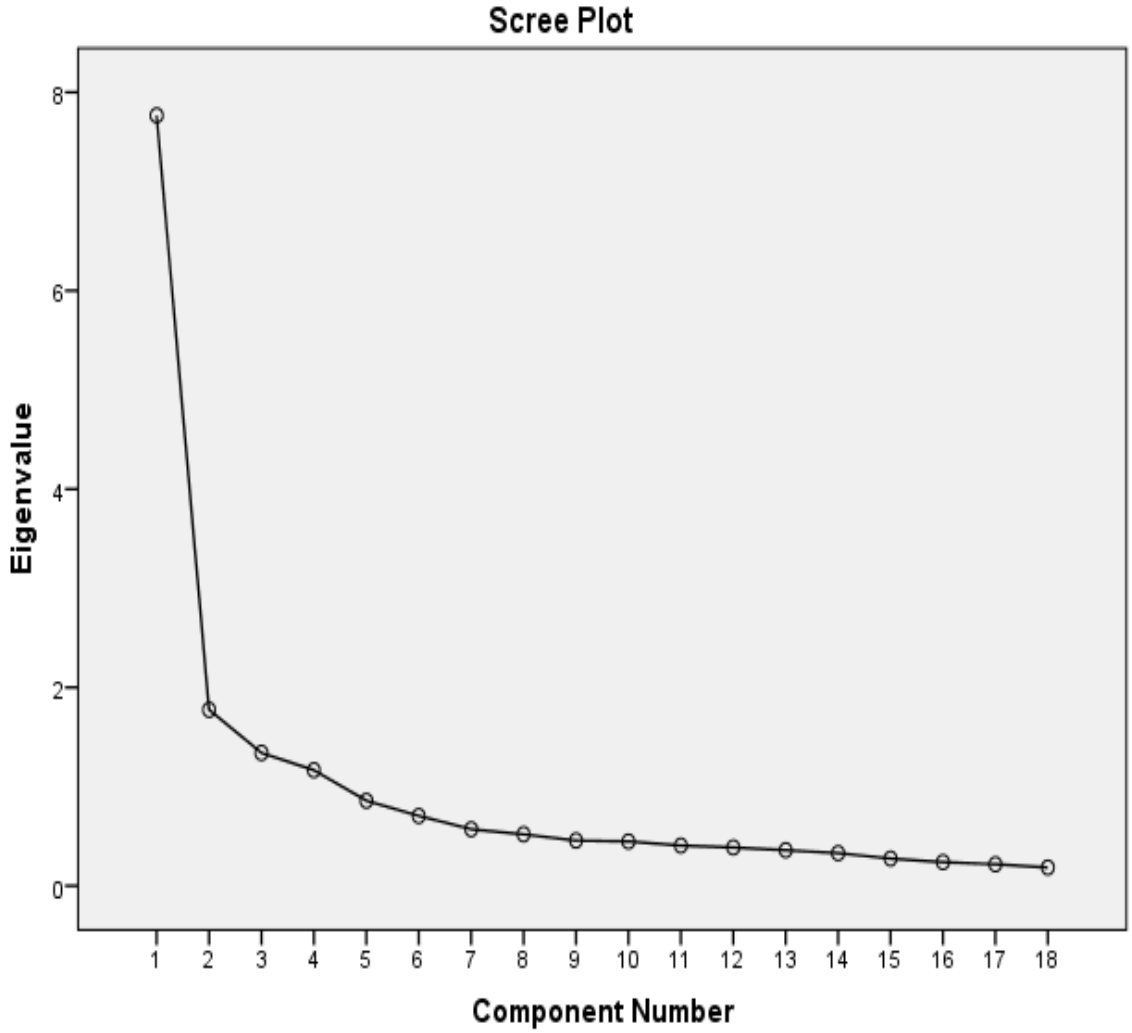


Figure 6.39: Scree Plot

Scree Plot

It is a simple line segment plot that shows the fraction of total variance in the date as explained or represented by each Principal component. This plot is drawn with descending order of magnitude of the Eigen values which are related to correlation factors. The scree test involves finding the place where the smooth decrease of Eigen values appears to level -off to the right of the plot. To the right of this point, presumably you find only "factorial scree "is the geological term referring to the debris that collects on the lower part of rocky slope. Thus no more than the number of factors to the left of this point should be retained. The significant underlying four

components which appear distinctly mostly on straight line part of the line of the scree plot, explained in details in the next section of principal component plot

Table 6.48: Component Matrix[a]

	Component			
	1	**2**	**3**	**4**
S	.652	-.429	.144	-.332
RM	.693	-.406	.198	-.206
SC	.712	-.281	.157	-.301
PCF	.585	-.349	-.219	.072
SAS	.684	-.333	.037	-.060
LATJ	.661	-.358	.082	-.099
HPP	.676	-.127	-.287	.388
AFCV	.717	-.066	-.403	.295
FFVBD	.661	-.032	-.393	.238
TBFEC	.652	-.081	-.216	.099
R	.426	.134	.635	.425
C	.656	.104	.391	.360
PP	.664	.155	.392	.091
ASC	.716	.388	.043	.020
MA	.716	.415	-.145	-.077
PL	.660	.479	-.054	-.076
PT	.646	.422	-.134	-.312
RHFDT	.586	.418	-.006	-.415

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Table 6.49: Component Transformation Matrix

Component	1	2	3	4
1	.559	.534	.527	.352
2	-.647	.721	-.166	.182
3	.240	-.115	-.627	.732
4	-.460	-.426	.549	.553

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

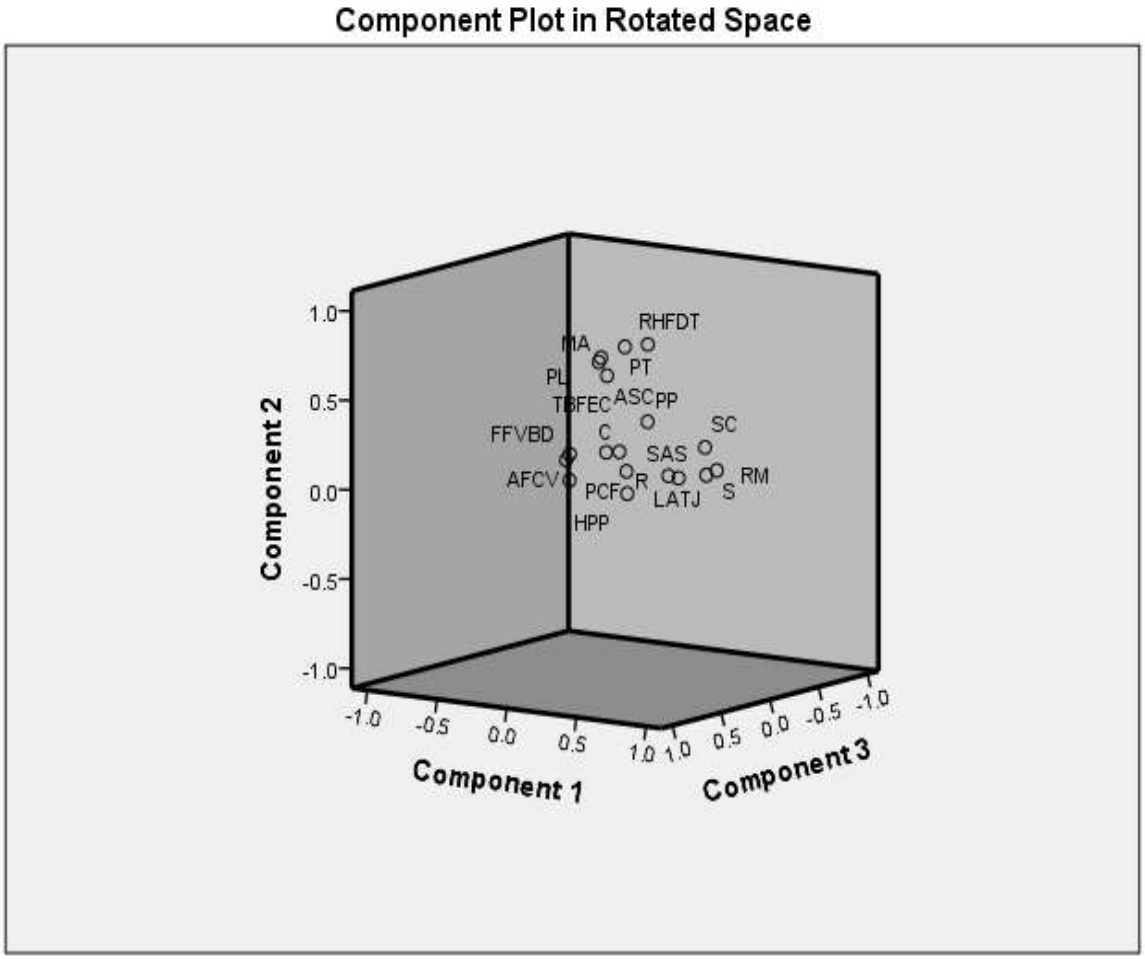


Figure 6.40: Component Plot in Rotated Space

18 Road user service variables selected in the study are finally grouped into 4 underlying factors which are called Principal components shown in the component plot which represent the largest factors loadings on the 4 principal components. The Four Principal components are extracted out of 18 variables of Road service Quality latent factor. The components are linear combinations of all these 18 variables with component 1 is defined by more variables, component 2 explained by some other variables and so on, as some variables contribute more in defining these principal components based on factor loadings or correlation coefficients (Given in the Table of component matrix). The component 1 is combination of most of the variables as they

are highly corrected with Component 1. Whereas component 2 is defined by variables such as MA, PL, PT and RHFDT with moderate positive association. At the same time component 3 is not having good correlation with many variables, but a few ones like “R” (0.635) and AFCV (-0.403) have shown some correlation. Component 4 is like the above mentioned one, as it too does have little association with most of the variables except a few like RHFDT (0.415) and R (0.425). The interpretation of Principal components analysis is based on findings when variables are most strongly correlated with each component. The correlation value above 0.5 deemed important for interpreting the four principal component results in this study. The first component is strongly correlated with almost all variables in all constructs. This component increases with increasing the scores of these variables. This follows that roadways with high values tending to have a lot of physical quality of road surface smoothness, roadway markings, etc., emergency services like highway patrol, ambulance for accident victims, etc., road user amenities with restaurants, petrol pumps, parking lots , etc. and so on. The second components increases with decreasing quality of road and increasing road user services that means the deteriorating roads can have amenities along road side to some extent. The third component is not a measure of many variables except road user facilities in terms of restaurants. The fourth component is not having significant correlation with many but slightly less significant with roadside restaurants (0.425) and negatively correlated to other road user amenity.

6.6 Linking Relative Performance of Toll ways – Overall Analysis of Performance Indicators

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.

Table 6.50: Inter Correlation among Parameters

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 miniscule percentage of the overall traffic. So, irrespective of the type of vehicle, the toll revenue is directly proportional to the toll road traffic.

- From the analysis of data, it is inferred that the operational cost is increasing with increase in toll road traffic density. Since the correlation statistics show (Table 6.51)

these two parameters are positively correlated (85%). 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 serviced 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.

The above mentioned six major operational parameters reflect 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.

Table 6.51: Co-Relation amongst Parameters

	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.

- Operational ratio is not correlated (-0.80) 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, Fig. 6.41. 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 PS are the least at 1.74.

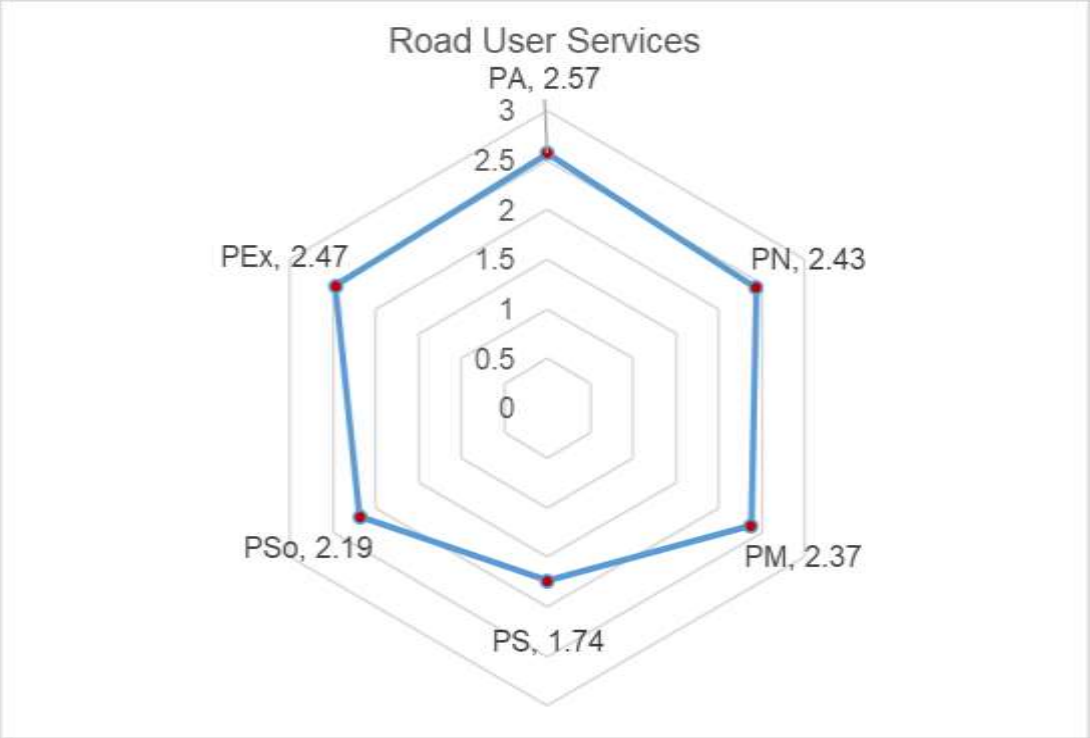


Figure 6.41: Radar-chart of road user services

6.7 Summary

Analyses of Three studies are presented in this chapter. The first study dealing with financial data across six toll roads are analysed and results in terms of various quantitative figures defining the intensity toll traffic, toll revenues, Operation and maintenance costs and derived quantities like Operating Ratios are explained in the form of descriptive statistics. The second study is carried out with an idea to recommend toll management to improve operational services and improvement of traffic flow, minimizing toll transaction time etc. The framework is developed and the efficiency of toll plazas are measured through field study performance scores, thereby the performance ranking is given to each toll plazas at various sites in the region. In the third study, tollways are assessed almost through the 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.

CHAPTER 7

SUMMARY AND CONCLUSIONS

The study focused on analyzing the performance of Toll Roads sector in Pune region, which consist of Six toll roads and more than 10 toll plazas. The operational system primarily comprises toll traffic, toll revenue, tolling infrastructure and roadway (tollway) services such as security, ambulance, and highway patrolling, etc.

During the study, critical performance factors were identified to assess the performance across all the operational components. Further, the study suggests ways for better performance in order to satisfy all stakeholders of the toll road system in the region. Appropriate Tools are developed for analysing the present status in operational elements. The operational performance across three major factors- Toll Traffic and Revenue, Tolling systems and Road services is studied and compared. It is found that the sector has been doing pretty well in traffic and revenue front and at the same time its performance is not up to the mark on service front.

Summary of performance and recommendations are presented as follows.

7.1 Summary of Performance of Roads Across various Indicators:

Financial Indicators

Comparison of six roads with respect to the total traffic, revenue, operation and maintenance (O &M) expenditure and O&M expenditure to revenue percentage.

Pune-Satara Road has the highest operation and maintenance to revenue ratio with average of **10.41% (2014)** followed by Pune-Solapur road which has a average ratio of **10.26% (2014).**This can be attributed to less traffic which generates toll and more expenditure on maintenance which generates less profit and leads to less investment

recovery. Pune-Mumbai Expressway road has the least operation and maintenance to revenue ratio with average of **1.14% (2016).** This can be attributed to less income generated due to more traffic as compared to other roads and high investment for maintenance. Also from the analysis it can be inferred that although traffic is increasing every year and more revenue is being generated, the O&M to revenue ratio is decreasing every year. This could be due to the fact that as the volume of traffic increases, the wear and tear of the road also increases which requires more maintenance and hence more money is spent. Operational cost is somewhat negatively correlated with operational ratio (-0.27) and road user services (-0.11). However, it is positively correlated with tolling operational efficiency (+0.25). This is because as the cost (and the cost base) increases, the efficiency increases a bit.

Recommendation for Traffic and Toll Revenue Performance improvement

During the feasibility phase, most of the projects are not precisely estimating the traffic demand which adversely affects the revenue generation. However some toll leakage also contributes to financial loss. In current scenario, the Government has to provide some extra concession period whenever it finds extra traffic is less than the projected traffic. Accurate traffic surveys are very important in correctly calculating toll revenue. In-house teams should be developed for collection of data to ensure future accountability instead of depending on the third parties to collect data. Senior level executives should personally get involved in the traffic surveys. Latest Traffic technologies like video traffic counters and CCTVs should be used. Auditing processes should be integrated in toll operation procedures. Regular offsite audits and third party audits should be conducted. The employer should be a multi disciplinarian, and orchestrate the provision of services in every form, from billing to on site security

and customer relation management to financial management and enforcement. It is also a requirement for cost control through delivering process and work flow efficiencies, safety control and risk reduction to make best use of toll collection. Thus the success can be achieved through revenue optimization and high level of public compliance, system health, operational performance and co-operative relation between employer and road user within hand use of modern technologies.

7.2 Tolling Operations Efficiency Ranking

It is observed that the Shirur toll plaza on Pune –Ahmednagar Road is the best in its operation since it gets the highest score of all the plazas. It excels in its housekeeping and has sufficient amenities for the users.

The Anewadi toll plaza and the Talegoan toll plaza set up on Pune- Satara highway and Pune-Mumbai Highway stand second and third of the eight plazas respectively. It is seen that they have a good toll plaza management system which is even better than the former plaza which ranks first. However the Talegoan toll plaza lags in a couple of amenities for customer services which make it stands second.

The Kushgoan Toll Plaza on Pune-Expressway and the Varwade toll plaza on Pune – Solapur Highway secured fourth position as they obtained equal scores. However they can have a better surveillance system and customer service as well. Still they are short of amenities like parking lots and toilets. However the plaza management system seems to be better as these plazas have number of functional components.

Ranjangaon toll plaza lying on Pune- Ahmednagar Road and Rajgurunagar Toll plaza have secured the fifth position with equal scores. However they lag in aspects like housekeeping and overall cleanliness, adequate surveillance system and customer service.

The Moshi toll plaza built on Pune-Nashik highway ranks sixth among all toll booths. It lags in police aid and customer service components. Except lighting at the premises during night time other amenities which add a value to the plaza seem to be absent. Toll plaza management system is not perfect in functional condition. It can be made better and performance score can be improved. Also there are hardly any amenities at the plaza which should be given an urgent priority.

Major factors Affecting Performance Efficiency

Competent employees are essential for the smooth functioning of the plaza. The staff should be polite and courteous but firm in dealing with the public. The employees working with toll plazas are not permanent and they work in 8 hrs. Shifts and 12 hr shift also. They are not well qualified as most of them are 10 or intermediate education and absorbed into the sector with little training background. However it is understood that they are absorbed in toll operation job with little experience. Though the tolling business is very lucrative with daily revenue running into lakhs the employees' salaries are not attractive, thereby they are less motivated. Not all toll plazas do provide good amount of security for employees. Manager of the toll plaza, who runs the entire toll plaza, should keep the focus on toll plaza objectives, all the time during day –to-day operations.

Technology plays an important role in making toll plazas minimize their waiting time and overall transaction time. There should be some combination lanes which should accept multiple form of toll payment. Modern technology is like electronic tolling collections are used in toll lanes maintained and operated in developed countries to

serve cash less customers which improves service and customer satisfaction. Very few electronic tolling collection systems are adopted by any toll operators in the region.

To deal with these types of issues, smart /tag /On Board Unit (OBU) should be made portable among the toll operators which in turn increase productivity in Toll management. The technology used for tolling systems should be reliable, accurate to capture all transactions with a high degree of vehicle classification accuracy. Lanes should be designed for peak hour traffic as variation in peak hour is very high and delayed users are potential risk to the projects as it sometimes lead to or incidents of mass forced toll gating, resulting in substantial toll revenue losses.

Untoward incidents are common at toll plazas and that would result invariably in the toll plaza staff being blamed. So use of CCTV and surveillance cameras can act as biggest asset and witness in such cases. Good quality CCTV network with good zoom and night view facilities to record activities occurring in lanes and plaza areas will also prove useful in providing the correct picture of the incident. Good relation with local administration, police and media must be maintained as these may come handy during such situations. In addition to this Government should give some incentives in order to promote cashless technologies and also nationwide automatic toll collection systems installation should be made compulsory. The accessibility to the facilities in some toll plazas are very poor, to improve this we have to provide emergency provisions like hospitals and ambulance facilities etc,

Throughput time of vehicles to be reduced to a minimum through training, technology and operational processes since courteous and polite tolling staff, with behavioral training at regular intervals can play an effective roll.

7.3 Toll Ways Services Performance

In the study of Road User Service parameters the aggregate performance of various factors (constructs) are compared across roads. The methodology in brief is that a score of 3 points on 5 point scale is taken as expected average score or par score for overall satisfaction. As per this figure the satisfaction score for roads can be above or below this cut-off. Higher scores than cut-off reflect quality roadway services, while trend towards lower scores call for discussion for additional quality in services, repairs, replacements and intervention of concerned agencies. Pune-Exp.way (PEx), Pune-Ahmednagar (PA) road, Pune- Nashik road (PN), Pune-Mumbai Road (PM), Pune-Solapur Road (PSo), Pune-Satara Road (PS) rank one (2.73), two (2.59), three(2.45), four(2.40), five (2.26) and six (1.76) respectively in road service factors group aggregate scores. Pune – Ahmednagar Road performed par below across all main service factors that averaged 2.78, 2.64, 2.43 and 2.54. Pune – Expressway is perceived relatively as best performing road though it scored 2.73 against the minimum targeted score of 3 points as it scored well in quality of road factor (3.42).

Pune – Solapur road is found to be poorly performing road with a score 1.76 against an expected par score of 3 points since it fared poorly on factors like security and emergency services (1.44) followed by quality of road (1.9). So far as performance of services based on average scores across the roads, " Quality of road " is ranked number one , "safety of Road " is ranked second . The other service factors such as "security and emergency services "and road user amenities rank third and fourth respectively.

7.4 Recommendations for Improving of Services

Compulsory road survey of state and national highways should be conducted once in every two months, reporting any damages immediately and rectifying the same within a month. Road projects should be given only to well proven infra companies, and be held responsible for certain minimum life of these roads Enforce and check overloading of trucks which damages the roads and reduces the life of roads. Plan better roads, truck bays, trucks bays, parking for trucks before toll plazas posts so that heavy vehicles like trucks, buses do not spill over the roads blocking highways by haphazard parking. Response to public grievances should be prompt and courteous. The road users complaints given in writing must always be followed up through written feedback. Road users feel that the facility should be provided free by the Government as they are already paying taxes. The road way conditions in terms of standards like surface of the road, roadway markings, etc. need to be drastically improved so as to minimize accidents rate and improve travel time.

7.5 Contribution of the Study

Based on the thorough literature review, it is believed that the study dealing with performance of tollways in a holistic way is the first of its kind. Few research studies have addressed this sort of problem comprehensively. The present study is precisely concerned with operational (post–construction) phase of toll roads which are operational in Pune Region. "The Toll Road System" is a study defined in terms of broad operational dimensions such as number of vehicles using the toll roads, toll revenues, operation costs of toll ways, etc. Some factors related to physical tolling operational process, and road user indicators like tollway quality, safety, etc. are part of evaluation framework. The analysis, based on the data collected from six tollways of the Pune Region gives an idea of the problems faced by the Users and what could

be their reasons and driving factors for tollway commutation. The opinions vary across commuters and tollway services.

7.6 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 good 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. In light of the above, there is scope for further study in this particular domain, as detailed in section 7.7.

7.7 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 bias.

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.

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. Toll Projects.

iv) Traffic and Revenue Risks - 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.

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.

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Appendix 1 – Traffic Study Format

CLASSIFIED VOLUME COUNT SURVEY

Name of Road: Pune-Satara NH4	**Direction:**	**To Satara**	**Day : 1**
Location: Km. 781.200	**Section : Near Khandala**		

Time Period		**PASSENGER TRAFFIC**									**GOODS TRAFFIC**									**NON MOTORISED TRAFFIC**			**GOVT EXEMPTED**			**Total Traffic**
							BUS				**TRUCKS**															
From	**To**	**2W**	**3W**	**Car/Jeep**	**Car (Yellow)**	**Tata Magic**	**RTC Bus**	**PVT Bus**	**Mini Bus**	**Sch Bus**	**2 Axle**	**3Axle**	**Multi Axle**	**HEM**	**LCV**	**Mini LCV**	**Tractor**	**Tractor with Trailer**	**3W Goods**	**Cycle**	**Cycle Rickshaw**	**Animal Drawn**	**Cars**	**Mini Bus**	**Trucks**	
8.00	**9.00**	152	0	315	89	0	13	81	20	0	91	16	21	0	8	26	0	0	0	0	0	0	0	0	0	832
9.00	**10.00**	68	1	320	60	0	25	8	25	0	122	31	49	0	4	28	0	0	0	0	0	0	0	0	0	741
10.00	**11.00**	157	1	330	49	0	36	12	7	0	94	25	33	0	9	16	0	0	0	5	0	0	2	1	7	784
11.00	**12.00**	126	1	285	44	0	34	6	7	0	61	38	25	0	10	35	0	0	1	0	0	7	0	0	0	680
12.00	**13.00**	72	0	255	30	0	23	10	7	0	97	46	31	0	11	25	0	0	4	1	0	0	0	0	0	612
13.00	**14.00**	125	0	260	20	0	37	5	8	0	63	44	44	0	8	36	0	0	1	1	0	0	0	0	0	652
14.00	**15.00**	148	0	229	28	0	39	5	1	0	71	37	29	0	10	35	0	0	3	2	1	0	0	0	0	638
15.00	**16.00**	173	1	312	17	0	31	5	3	0	102	67	41	1	20	14	0	0	3	2	1	0	0	0	0	793
16.00	**17.00**	202	2	390	19	0	23	3	0	0	60	36	37	0	10	35	0	0	1	0	0	0	0	0	0	818
17.00	**18.00**	237	3	423	30	0	30	14	6	0	76	35	26	0	12	29	0	0	1	0	0	0	0	0	0	922
18.00	**19.00**	188	2	435	33	0	29	15	0	0	55	26	37	0	13	24	0	0	1	0	1	0	0	0	0	859
19.00	**20.00**	111	5	342	16	0	16	10	4	0	69	19	22	0	4	23	0	0	1	0	0	0	0	0	0	642
20.00	**21.00**	81	0	325	13	0	15	8	3	6	77	17	13	0	7	6	0	1	4	0	0	0	0	0	0	576
21.00	**22.00**	83	0	162	10	0	13	12	0	0	79	22	5	2	4	13	0	0	4	0	0	0	0	0	0	409
22.00	**23.00**	16	0	142	0	1	20	55	1	0	86	19	8	0	4	13	0	0	5	0	0	0	0	0	0	370
23.00	**0.00**	15	0	213	5	8	11	64	6	0	104	32	1	0	6	17	0	0	1	0	0	0	0	0	0	483
0.00	**1.00**	23	0	239	13	3	7	21	8	0	75	26	16	0	0	23	0	0	0	0	0	0	0	0	0	454
1.00	**2.00**	3	0	132	9	5	5	58	1	0	52	13	14	0	1	9	0	0	0	0	0	0	0	0	0	302
2.00	**3.00**	0	0	83	4	0	7	61	3	0	91	26	16	0	0	1	0	0	0	0	0	0	0	0	0	292
3.00	**4.00**	4	0	71	4	0	11	19	1	0	52	13	14	0	0	6	0	0	0	0	0	0	0	0	0	195
4.00	**5.00**	11	0	76	2	0	18	81	4	0	204	61	35	0	0	5	0	0	0	0	0	0	0	0	0	497
5.00	**6.00**	6	0	186	5	0	26	28	5	0	176	76	80	0	0	32	0	0	0	0	0	0	0	0	0	620
6.00	**7.00**	35	0	318	20	0	25	17	14	0	153	57	36	0	2	27	0	0	0	0	0	0	0	0	0	704
7.00	**8.00**	114	7	356	60	0	9	5	26	0	75	13	12	0	0	18	0	0	0	0	0	0	0	0	0	695
Grand Total		**2150**	**23**	**6199**	**580**	**17**	**503**	**603**	**160**	**6**	**2185**	**795**	**645**	**3**	**143**	**496**	**0**	**1**	**30**	**11**	**3**	**7**	**2**	**1**	**7**	14570

Appendix II

Questionnaire For of Tolling Operations Efficiency Ranking

Name of the Toll Plaza location

Type of road: NH / SH / Expressway

TOLL PLAZA INFORMATION AND MANAGEMENT SYSTEM (TPIMS)								
1	Display of Project Details Near The Toll Plaza Area						Yes/No	Yes=1 No=0
2	Toll Rates Display						Yes/No	
3	Separate Lane For Over Sized Vehicle						Yes/No	
4	Speed Restriction Sign At Plaza						Yes/No	
5	Lane Guidance For Vehicles						Yes/No	
6	Traffic Wardens						Yes/No	
7	Bike Lane						Yes/No	
8	Boom Barrier						Yes/No	
TOLL TECHNOLOGY AND SURVEILLANCE SYSTEMS (TTSS)								
1	Security Personnel						Yes/No	
2	CCTV in Toll Cabin						Yes/No	
3	Electronic Toll Collection System						Yes/No	
4	WIM Bridge						Yes/No	
5	Automatic Vehicle Classifier						Yes/No	
TOLL OFFICE AMENITIES (TOA)								
1	Toll Pass Office						Yes/No	
2	Parking Lots in Emergency						Yes/No	
3	Commuter Complaint Register						Yes/No	
4	Toll Tag Recharge						Yes/No	
QUALITATIVE PARAMETERS								
1	Public Toilets						Yes/No	
	If Yes, the Level of Quality of Facility	5(E)	4	3	2	1(P)		
2	Plaza Lighting						Yes/No	
	If Yes, the Level of Quality of Facility	5	4	3	2	1		
3	Lighting Through Approach Areas						Yes/No	
	If Yes, the Level of Quality of Facility	5	4	3	2	1		
4	Pavement Condition At The Approach Area						Yes/No	
	If Yes, the Level of Quality of Facility	5	4	3	2	1		
5	Vehicle Queue Length						Yes/No	
	If Yes, the Level of Severity			3	2	1		
6	Appealing Environment Around Premises						Yes/No	
	If Yes, the Level of Quality of Facility	5	4	3	2	1		
7	Overall Cleanliness						Yes/No	
		5	4	3	2	1		

Appendix III

Questionnaire-Toll Road User Satisfaction Survey

This survey is meant for Ph.D. research work. The data of this survey will not be used in the interest of any individual or organization. I request you to kindly share the actual information for value addition in this academic pursuit.

Name of the Toll Plaza/Toll Stretch:

Type of the road: State Highway (SH) / National Highway (NH) / Expressway

From _____ to _____, _____kms.

A . Personal Details

1. Type of Vehicle Observed on the Road / mode of travel

a. *Passenger Vehicles* :

Car / Jeep /Van /Auto Rickshaw / Scooter /Motor bike / Mini Bus/ Standard Bus

b. *Goods Vehicle* :

Tempo / Light Commercial Vehicle (LCV) - Tractors / Heavy Commercial Vehicle (HCV) - 2-Axle Vehicles Truck / Multi Axle-truck/ Trailers /

c. Others – Specify_____

2. Category of respondent

a) Driver b) Staff on vehicle c) Passenger d) Owner

3. Have you ever paid toll fee (put √ mark) : ☐ Yes ☐ No ☐ Toll Exempted

4. Do you possess Toll pass : ☐ Yes ☐ No

If Yes

A. **Mention the type of pass?** ☐ Monthly ☐ Quarterly ☐ Other

B. **What is the cost of the buying the pass? Rs._____**

C. **Is it worthwhile?** ☐ Yes ☐ No

B. System Evaluation Indicators

5. **Given the present condition of the roadways, what do you think about the toll charges**

   a) Low priced b) Moderately priced c) High priced d) Very high priced e) Can't say

6. **How should the road users pay for travelling the highway stretch?**

   a) Through general road taxes b) Through toll taxes

7. **Have you attended any Toll road awareness programme (for understanding the benefits of toll road) by any Govt. or local authority or any NGO?**

   ☐ Yes ☐ No

8. **If Yes, What is the source of awareness**?

a) Road signs b) Newspapers c) Magazines d) Television e) Radio

9. **How satisfied are you with the complaint redressal system of road maintenance agencies**

a) Highly satisfied b) Somewhat satisfied c) Somewhat dissatisfied d) Highly dissatisfied

10. **Please Rank each of the driving factors listed below in order of importance to you while travelling on Toll Road. Number the Most Important Factor 1, The Next 2 And So On.**

	Factor	**Rank**
A	**Value for money** (Low fuel consumption, vehicle maintenance costs, etc.)	
B	**Value for Time** (Time taken in journey by toll road is less)	
C	**Comfort & convenience** (Condition of road, smooth ride, low congestion etc.)	
D	**Safety on the Road** (Signage, Police posts, Medical aid, Emergency telephone availability, towing vehicles, etc.)	
E	**Travel amenities** (Food, water, bath rooms, rest rooms, minor vehicle repairs etc.)	
F	**Visual appeal** (Road side plantations, greenery, landscaping, beautification, etc.)	

11. The below mentioned factors are related to complaints in the toll system. Number the most pressing problem 1, The Next 2, And So On.

	Factor	**Rank**
A	Govt. policy on toll roads	
B	Biased revenue / Toll projections by Toll contractors	
C	Poor Roadway maintenance	
D	Delay at toll plazas	
E	Robbery / Theft on highways	
F	Bad signage on the road	
G	Any Other (Please describe)	

12. Evaluation of the Economic Factors of the Road on 1 –5 Rating Scale

1	2	3	4	5
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly agree**

Economic indicators ↓	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
Increased vehicle speed					
Reduced commuting time					
Saving in fuel expense					
Reduced environmental pollution					
Decreased road accidents					
Encouraging industrial and township development					

13. Evaluate the condition of the Road Way on the following parameters On 1 - 5 Rating Scale

1	2	3	4	5
Poor	**Average**	**Good**	**Very Good**	**Excellent**

		Parameter	**Poor**	**Average**	**Good**	**Very good**	**Excellent**
A	**Quality of Road**						
1.	Smoothness						
2.	Roadway markings						
3.	Shoulder condition						
B	**Safety of Road**						
1.	Pedestrian crossing facilities						
2.	Signs and signals						
3.	Lighting at the Junctions						
C	**Security and Emergence service on the road**						
1.	Highway Police patrolling						
2.	Ambulance for accidents victims						
3.	Crane facility for vehicle break down						
4.	Telephone booths for emergency calls						
D	**Other road user amenities**						
1.	Restaurants						
2.	Canteens						
3.	Petrol pumps						
4.	Auto service centers						
5.	Medical aid						
6.	Parking lots						
7.	Public toilets						
8.	Rest houses for drivers /travelers						

You are free to give your opinion / suggestions: and how often you travel on this road in a year Or in a month

---

Thank you for your participation in the Survey and sparing your valuable time.

Name of Respondent: ***Contact no.***

Date: ***Time:*** ***Gender: Male / Female***

Qualification: ***10 / Diploma / Degree / P.G / Other***

Occupation: ***Student / Employee / Business / Others***

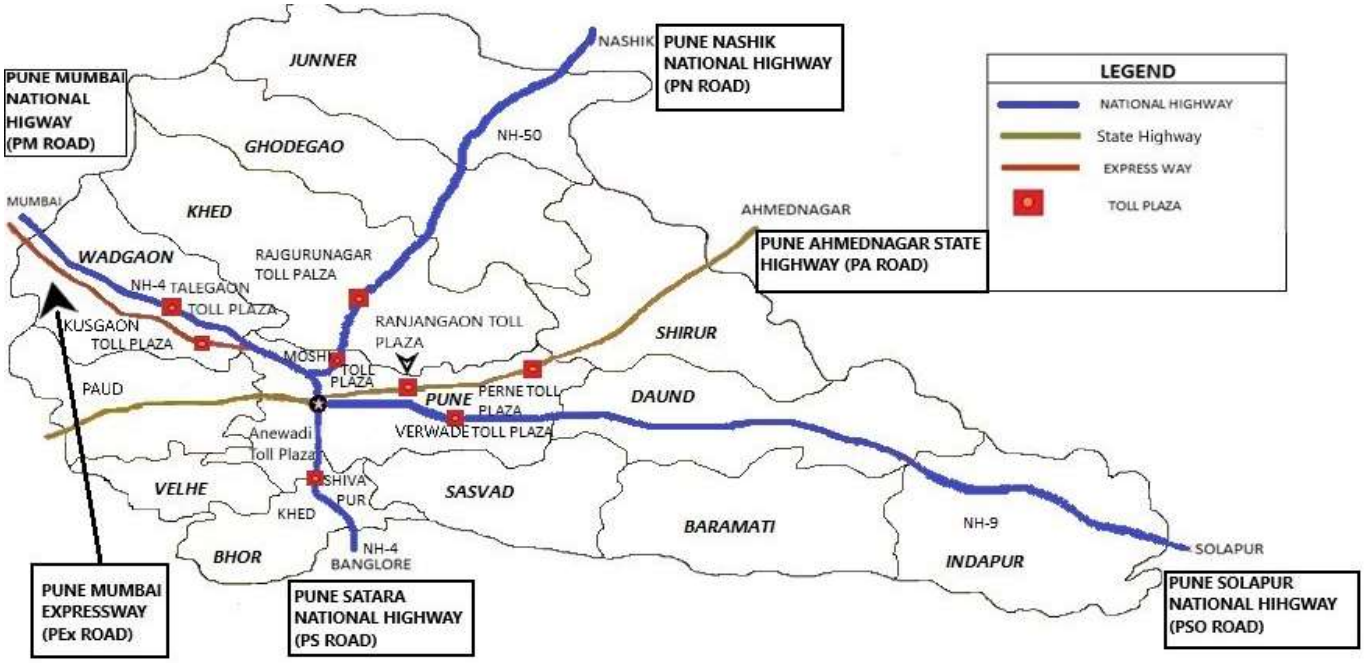
Appendix IV

Operation Maintenance Cost of Toll Roads under Study

Toll Road	Unit Length (km. no. of lanes in tollway)	Cost /Km (in Rs. lakhs)	Total Road Maintenance Cost (A) (Rs.in lakhs)	No. of Lanes at Toll Plaza	Total Plaza Maintenance Cost, @30 Lakhs/toll length (B) (Rs.in lakhs)	A+B (Rs.in lakhs)	Incremental Cost (Rs.in lakhs)
PA	60	3.25	195	6	180	375	375 (2014)
	4						394 (2015)
							418 (2016)
PN	30	3.25	97.5	6	180	278	278 (2014)
	4						292 (2015)
							310 (2016)
PM	131	3.25	425	8	240	665	665 (2014)
	4						698 (2015)
							740 (2016)
PS	42	3.25	136.5	12	360	497	497 (2014)
	4						522 (2015)
							553 (2016)
Pso	103	3.25	335	12	360	695	695 (2014)
	4						730 (2015)
							774 (2016)
PExp	94	5	470	14	570	1040	1040 (2014)
	6						1092 (2015)
							1158 (2016)

Appendix V

Study Area Lay Out



Appendix VI

Photos of Various Toll Stretches and Toll Plazas in the Study Area

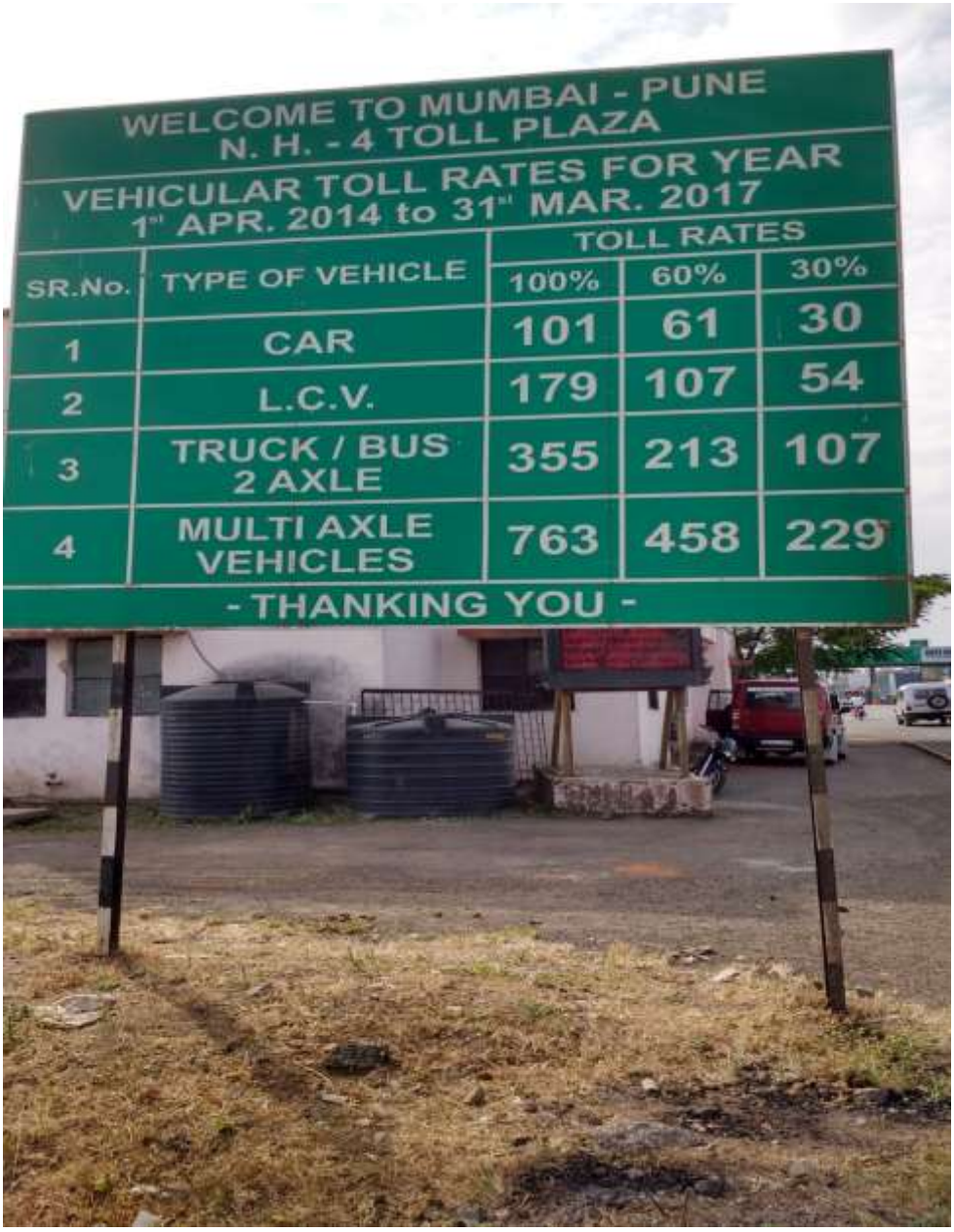
Photo of Toll Plaza Lanes (Pune- Ahmednagar Tollway)

Photo of Toll Plaza Lanes (Pune- Nashik Tollway)

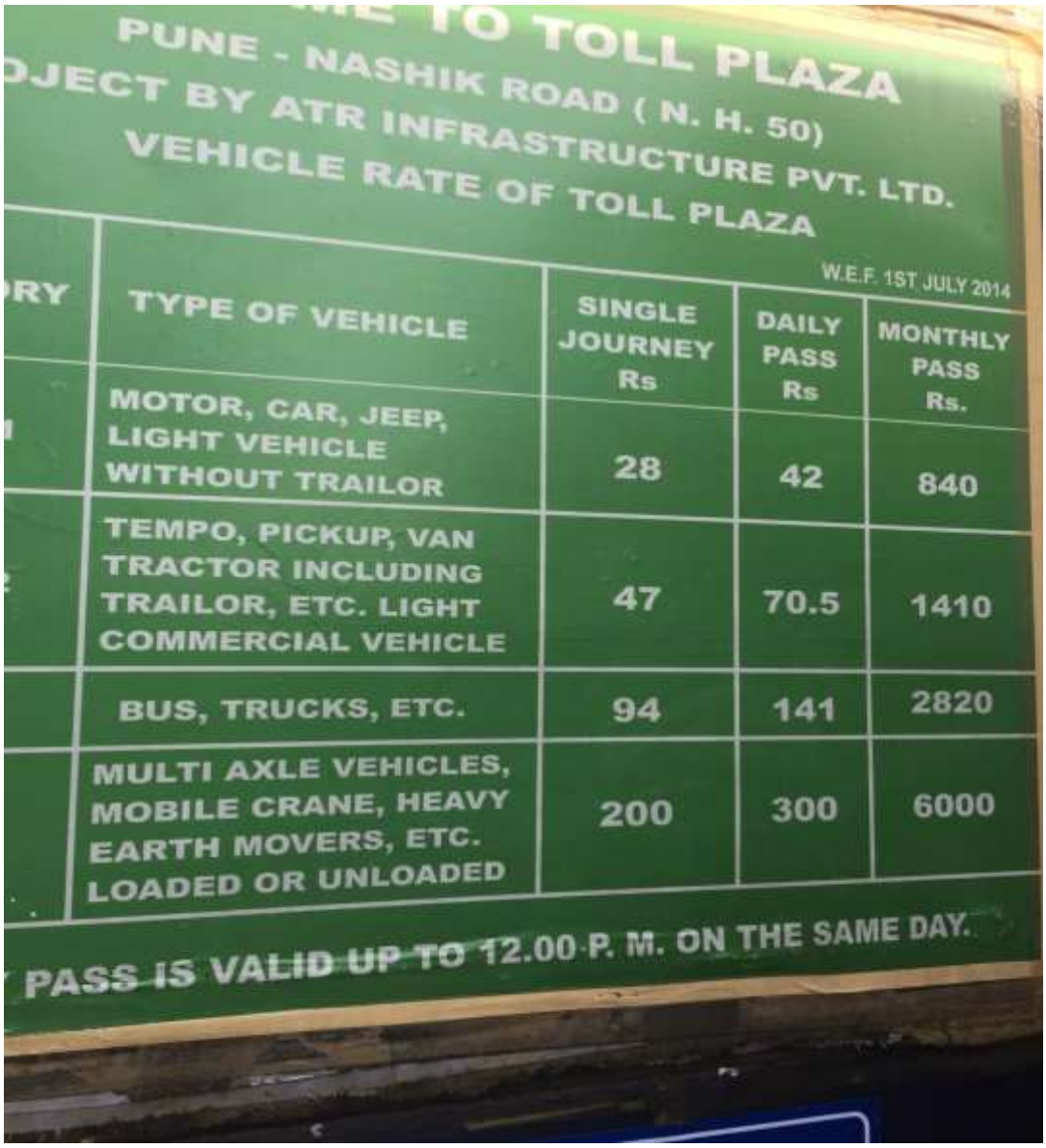
Photo of Toll Plaza Lanes (Pune- Mumbai Expressway)

Photo of Toll Plaza Lanes (Pune- Satara)

Photo of Toll Plaza Lanes (Pune- Solapur)



Display Toll Rates at Toll Station (Pune- Mumbai)



Display Toll Rates at Toll Station (Pune- Nashik Tollway)