ST. MARY'S UNIVERSITY SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF PROJECT MANAGEMET

PERFORMANCE ASSESSMENT OF ETHIOPIAN TOLL ROADS ENTERPRISE (ETRE) SYSTEM

Prepared By: Yoseph Tadesse

No.: SGS/0380/2014A

June, 16 2023
Addis Ababa, Ethiopia

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PERFORMANCE ASSESSMENT OF ETHIOPIAN TOLL ROADS ENTERPRISE (ETRE) SYSTEM

A Thesis Submitted to the School of Graduate Studies of St. Mary's University for the Partial Fulfillment of the Requirements for the Degree of Master of Project Management

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June, 2023

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The thesis entitled "Performance Assessment of Ethiopian Toll Roads Enterprise (ETRE)" is conducted by Yoseph Tadesse. It is submitted as partial fulfillment for the requirement for the Master of Project Management to the School of Graduate Studies of St. Mary's University. We therefore, testify that the thesis satisfies the standard so the University and henceforth approved by the Members of the Board of Examiners.

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Declaration

I declare that the thesis entitled “Performance Assessment of Ethiopian Toll Roads Enterprise (ETRE) System” is my original work and it is not previously presented in partial or full form for any degree award at any university and/or academic institution. I affirm that all these secondary sources used in the thesis are duly acknowledged.

Name:Yoseph Tadesse

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Date _____

Certification of Approval

I attest that the works contained in the thesis entitled “Performance Assessment of Ethiopian Toll Roads Enterprise (ETRE) System”: A Study in Addis Ababa-Adama Toll Road Segment” are the original works of Yoseph Tadesse and conducted under my supervision.

Advisor: Muluadam Alemu (PhD)

Signature & Date  16/06/23

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Abstract

During recent years the infrastructure sector has grown tremendously, including toll roads. Toll road sections spread across the regions in Ethiopia. ETRE is now managed by various toll road operators with different management styles. In providing their services to the public, Government requires the operators to meet a certain Toll Road Service Standard. unfortunately, the performance indicators do not have service quality track mechanism. The purpose of this research was to obtain performance indicators and assess performance between toll road segment. The basic performance indicators were obtained from literature review of previous research. Next to that a survey was conducted by collecting data through questionnaires to toll road users, operators, regulators, etc. The result provides stakeholders response and feeling in KPIs service outcomes. 25 KPIs and 14 RSPIs were obtained. Based on the performance assessment and result obtained final conclusion and recommendation test was rectified, the performance indicators obtained from this research can be applied to develop toll road performance indicators in ETRE

Keywords/terms:

- *Tool Roads*
- *KPIs*
- *RSPIs*

ACRONYMS AND ABBREVIATIONS

ETRE	……	Ethiopian Toll Roads Enterprise
AAR	……..	Addis Ababa Road
ADR	……..	Adama Road
MOR	……..	Mojo Road
ERA	……	Ethiopian Roads Authority
KPI	……	Key Performance Indicator
ITS	……	Intelligent Transportation Systems
MTC	……	Manual Toll Collection
ETC	……	Electronic Toll Collection
BOT	……	Build ,Own &Transfer (Build, Operate &Transfer)
OCR	……	Optical Character Recognition
PUC	……	Passenger Car Units
FDRE	……	Federal Democratic Republic of Ethiopia
OMT	……	Maintenance and Tolling Segment
PIs	……	Performance Indicators
SMART	……	Measurable, Achievable, Relevant, and Time Bound
ADT	……..	Traffic Volume Measured as Average Daily
RUS	……..	Road User Satisfaction Survey
TTSS	……..	Toll Technology and Surveillance System
TOA	……..	Toll Office Amenities
QSP	……..	Qualitative Service Parameters
MOTP	……..	Mojo Toll Plaza
LAC	……..	Latin America and the Caribbean Country
EU	……..	European Union

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Chapter One
Introduction

1.1. Background of the Study

Transport infrastructure investment is projected to increase at an average annual rate of about 5% worldwide over the period 2014 to 2025. Sub-Saharan Africa leads the pack with the fastest average annual growth rate of over 11%. Meanwhile, Asia-Pacific remains by far the largest transport infrastructure market, with investments increasing from $557bn per year to nearly $900bn per year in 2025. On the downside, transport infrastructure investment levels in Western Europe are expected to take a long time to recover due to continual fiscal austerity returning only to 2008 levels in 2022 (Price water house Coopers (PwC) Report. Assess the global transport infrastructure market: Outlook to 2025). Further, Sub Saharan Africa is the fastest growing regional infrastructure market, with a projected average increase in transport spending of over 11% per year from 2015 to 2025. Most of this growth is expected in roads and ports (Price water house Coopers (PwC) report. Assess the global transport infrastructure market: Outlook to 2025).

Development and maintenance of physical infrastructure are key to rapid economic growth and poverty reduction. Production costs, employment creation, access to markets and investment depend on the quality of the infrastructure, especially transport. Road transport is the most widely used means of transportation in Africa. The authors in (Harral C. and Faiz A. 1988) argued that failure to maintain roads is tantamount to an act of disinvestment. The author in (The Analysis of Road Infrastructure Development Financing Bank Studies 2006) writing on the topic "The Analysis of Road Infrastructure Development Financing in Lithuania" declared that "Well run and effective transport is not only the service creating high value but also the necessary preconditions of the successful development of other fields of the economy and of the quality of human wellbeing". Road infrastructure is one of the fundamental factors predetermining the performance of transport activities.

The availability of an efficient transport system is essential to foster economic development. Tolls on highways and bridges could increase funds for construction and maintenance of transportation infrastructure, and reduce congestion and air pollution by giving residents incentives to use the highway system more efficiently. Tolls generally take two forms. Flat rate tolls remain constant throughout the day (though they may vary by type of vehicle). Time varying (congestion) tolls impose higher rates when traffic is heavy, and lower rates during off peak times. Time varying tolls may change on a well-

defined schedule for example, a constant high rate during 6:00-9:00 a.m. on weekdays and 4:00-7:00 p.m. on weekdays and a constant lower rate at all other times (ERA, 2003).

The authors in (Harral C. and Faiz A. Road Deterioration in Developing Countries, Causes and Remedies. 1988) estimated the annual maintenance expenditure required to prevent road deterioration to increase from 0.2% to 1.6% of GDP in East Asia and the pacific to 3.5% in South Asia. Developing nations should not only build roads infrastructure projects but also operate successfully. However, it is often observed that once the road is ready for operation, toll collection starts and service performance parameters are forgotten. In this research, therefore, focus is given to assess overall performance of toll roads in Ethiopia considering Addis Adama Express toll road segment.

1.2. Statement of the Problem

Traditionally, highways in Ethiopia 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. Since then a number of projects have been implemented, particularly with the collaboration of China government. Consequently, it has become increasingly accepted that highways should be built, financed, and operated by different stakeholders 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 (ERA, 2007). However, the Ethiopian Toll Roads Enterprise (ETRE) continues to carry out regulatory operational functions including, traffic count and toll collection from road users. In addition to operational activity, 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, user's/ clients feedback, etc., but this kind of information is always missing and also missing performance indicator which is suitable to developed country.

The Federal Democratic Republic of Ethiopia government has given mandate to ETRE to revise and increase in toll charges if necessary (Toll Roads Proclamation No. 84 31201 4), but there are no tracking parameters that could measure the quality of service for travelers Inin ETRE there is hardly any mechanism devised for measuring toll road performance unlike other countries. In the absence of such programmers virtually the Ethiopia Toll Roads Enterprises not in a position to identify and incentives/penalizes 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 toll ways 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.

1.3. Objective of the study

The general objectives of this study are intending to analyze the operational standards and assess the level of performance of the Toll Road System in Addis-Adama Express Road Segment (Addis Ababa Toll Road station, Adama Toll Road Station and Mojo Toll Road Station,) with the following specific objectives

- To assess the performance of Ethiopian toll roads enterprise using key performance indicators
- To investigate how much the significant of KPIs in performance assessment of Ethiopian Toll Roads Enterprise
- To check deviation in performance factors and suggest measures for improvement .

1.4. Research Questions

- How to assess performance of operational toll road system and what are the key indicators of performance?
- How is the public level of understanding and response to ETRE system performance?
- What are the factors that affecting performance of Ethiopian Toll Roads Enterprise?

1.5. Significance of the Paper

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 Ethiopian Toll Road Enterprise (ETRE) and Ethiopian Road Authority (ERA) involved in road maintenance and management. As the government, mostly the ETRE/ERA, 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.

1.6. Scope of the Study

The study covers performance assessment of Ethiopian Toll Roads Segment which covers 54Km and twenty-nine toll booth 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 researcher's perspective. The focus is on two key components of toll way operational system- (i) Toll Plaza Operations and (ii) Public opinion about road user amenities.

The Addis Adama toll roads system will be assessed on corresponding performance parameters, such as operational 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:

1. 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.
2. Public is very important component in toll roads projects. So, a road user study in terms of passenger's 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

1.7. Research Hypotheses

Null hypothesis H_0: Mean Scores in service indicator ($\mu1$ to $\mu3$) are the same across the three cases of toll road segment.

Alternate Hypothesis H_a: Mean Scores in service indicator are not same across the three cases of toll road segment

1. Hypothesis for Indicator 1: Smoothness of toll way

   H0: $\mu1 = \mu2 = \mu3$

   H_0: Mean Scores of smoothness in AAR, ADR & MOR are the same across the three road segment

   Ha: $\mu1 \neq \mu2 \neq \mu3$

   Ha: Mean Scores of smoothness in AAR, ADR & MOR are the different across the three road segment

2. Hypothesis for Indicator 2: Roadway Marking

   H0: $\mu1 = \mu2 = \mu3$

I.

H_0: Mean Scores of Roadway Marking in AAR, ADR & MOR are the same across the three road Segment

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores of Roadway Marking in AAR, ADR & MOR are the different across the three road segment

3. Hypothesis for Indicator 3: Shoulder condition

H0: μ1= μ2= μ3

H_0: Mean Scores of Shoulder condition in AAR, ADR & MOR are the same across the three road segment

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores of Shoulder condition in AAR, ADR & MOR are the different across the three road segment

4. Hypothesis for Indicator 4: Pedestrian crossing facilities

H0: μ1= μ2= μ3

H0: Mean Scores of Pedestrian crossing facilities in AAR, ADR & MOR are the same across the three road segment

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores of Pedestrian crossing facilities in AAR, ADR & MOR are the different across the three road segment

5. Hypothesis for Indicator 5: Signs and signals

H0: Mean Scores of Signs and signals **in AAR, ADR & MOR are the same across the three road segment**

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores of Signs and signals **in AAR, ADR & MOR are the different across the three road segment**

6. Hypothesis for Indicator 6: Lighting at the Junctions

H0: Mean Scores of Lighting at the Junctions **in AAR, ADR & MOR are the same across the three road segment**

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores of Lighting at the Junctions **in AAR, ADR & MOR are the different across the three road segment**

7. Hypothesis for Indicator 7: Highway Police patrolling

H0: Mean Scores in Highway Police patrolling **in AAR, ADR & MOR are the same across the three**

road segment

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores in Shoulder condition in AAR, ADR & MOR are the different across the three road segment

8. Hypothesis for Indicator 8: Ambulance for accidents victims

H0: Mean Scores of Ambulance for accidents victims **in AAR, ADR & MOR are the same across the three road segment**

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores of Ambulance for accidents victims **in AAR, ADR & MOR are the different across the three road segment**

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

H0: Mean Scores of Crane facility for vehicle breakdown **in AAR, ADR & MOR are the same across the three road segment**

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores of Crane facility for vehicle breakdown **in AAR, ADR & MOR are the different across the three road segment**

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

H0: Mean Scores of Telephone booth for emergency calls **in AAR, ADR & MOR are the same across the three road**

segment

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores of Telephone booth for emergency calls **in AAR, ADR & MOR are the different across the three road**

segment

11. Hypothesis for Indicator 11: Cafeteria

H0: Mean Scores of Cafeteria **in AAR, ADR & MOR are the same across the three road segment**

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores of Cafeteria **in AAR, ADR & MOR are the different across the three road segment**

12. Hypothesis for Indicator 12: Medical aid

H0: Mean Scores of Medical aid **in AAR, ADR & MOR are the same across the three road segment**

Ha: μ1≠ μ2 ≠μ3

I.

Ha: Mean Scores of Shoulder condition in AAR, ADR & MOR are the different across the three road segment

13. Hypothesis for Indicator 13: Parking lots

H0: Mean Scores of Parking lots **in AAR, ADR & MOR are the same across the three road segment**

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores of Parking lots **in AAR, ADR & MOR are the different across the three road segment**

14. Hypothesis for Indicator 14: Allowable Rest Time for Drivers

H0: Mean Scores of Allowable Rest Time in AAR, ADR & MOR are the same across the three road segment

Ha: μ1≠ μ2 ≠μ3

Ha: Mean Scores in Allowable Rest Time in AAR, ADR & MOR are the different across the three road segment

1.8. Limitations of the Study

The study is only limited to Addis- Adama toll road found in Ethiopia. So, all the result of this study is mainly applicable to Addis-Adama toll road but doing further studies it can also be used for other toll roads in Ethiopia. Also, the main objective of the study is its effectiveness which limits the study to only this area neglecting other areas of the toll system. Moreover, the results obtained with regard to the performance factors are mostly as per user expectations, and at the same time they may not hold well in another place elsewhere in the country. This is because of the fact that the characteristics of toll ways and the people acceptance levels may be different in other places.

1.9. Organization of the Paper

This paper is hence organized /composed of five chapters. Chapter one is introduction to the study. It contains background of the study, problem statement, objective of the study, significance of the study, scope of the study, and organization of the paper. Chapter two, deals with the review of related literatures. Chapter three presents the methodology of the study. Chapter four covered data analysis and interpretation; whiles Chapter five contains summary of the study findings, conclusions, and recommendations

Chapter 2
Review of Related Literature

2.1. INTRODUCTION

The literature review began with a search for any resources that had the potential for further review. International experience soon privatizing road infrastructures had been studied i n different developed, developing or transition countries in Asia and Latin America, and Sub-Saharan African Countries have been reviewed

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 told. 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 toll way 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 toll ways 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.

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 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 Short falls, 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.

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 well than the plaza based system of toll collection as the commuters are not forced to wait.

The Addis Ababa-Adama expressway in Ethiopia will be first expressway in Ethiopia and East Africa when complete and also the first toll road in the nation. It will connect the capital city Addis Ababa to Adama in Nazareth. Construction started in April 2010 and is scheduled to be complete in April 2014. The project is estimated to cost US$612 million and when complete the expressway will be able to accommodate 15,000 vehicles per day. The project is financed through a US$350 million loan from Export-Import (Exim) Bank, with the remaining US$262 million coming from the Ethiopian Government constructed by Chinese Communications Construction Company (CCCC) on behalf of the Ethiopian Roads Authority (ERA), the new road uses advanced technologies such as a traffic management center and intelligent transportation systems (ITS) for effective operation, together with overpasses, underpasses and interchanges. ITS technologies include traffic cameras and variable message signs (VMS) for effective traffic management and incident management. Tolling is expected to be implemented on the Addis Ababa-Adama expressway, a first for Ethiopia. Toll gates will be installed at Addis Ababa and Adama, as well as at the six other interchanges. The toll road will reduce the travel time to around 40 minutes from the average two hours between Addis Ababa and Adama.

2.2. **Review of Theoretical Literature**

2.2.1. **Toll Plaza Operational Service**

Performance of toll plaza integrates different view that supports the management and performance of road maintenance projects. Even though there is different theoretical perspective about road maintenance and it project management, this study used theories as base to assess key performance indicator can be used to assess toll road plaza operational practice. According to Padayhag and Sigua (2003), the key indicators of performance of a toll plaza include the service times of the different modes of payment, the toll-lane capacities and the motorist's waiting times or queue delays. This view is supported by Klodzinski and Al- Deek (2003), who also lists through put, queue length, inter-vehicular time and speed of the toll lanes as other important toll-lane performance indicators. A description of these indicators and how they are measured is presented below.

I.

2.2.2. Toll Collection System

Toll collection is the most important process in any Expressway because the maintenance & the operation processes are done with collected revenue. Many countries are using more precise ways to collect tolls from road users. The manual toll collection system will be closed or opened or both systems together based on the geometry, design and operational requirement. The toll fee for the journey varies with respect to the type of vehicle and the number of kilometers travelled. Other hand, the Toll collection system will be varied with their technology and operation methodology (Das, 2012) .

2.2.3. Toll Collection Methods

I. Manual Toll Collection (MTC)

Collection of toll charges shall be done using manual method. All or few operations of following process which are Identification of vehicle, Classification of vehicle, Toll Fee collection (Transaction), Issuing of User Fee Receipt, Barrier or Toll gate operation & keeping of necessary records will be done by the operator who is assigned to the toll booth. The few process of above can be done with automated mechanical system. Users can be paid their toll charges by cash, credit cards, debit cards, smart cards as a manual payment mode.

II. Electronic Toll Collection (ETC)

All of the activities of this toll lane shall be done using automated system. As such to do the complete the transaction, it is required to complete following processes. The Vehicle Recognition, Vehicle classification, Transaction Processing (Maintaining customer accounts through Database), Violation Enforcement (Police patrols, Physical Barriers, Automatic number plate recognition-video, other Enforcement Systems) will be done automatically via electronic devices which are fixed on toll lane to complete the successive transaction. These types of toll lanes are operated under various technologies and are the most popular toll method in the world. ETC users can be paid their toll charge by using prepaid or post-paid payment options as their willingness.

III. Mixed Toll Collection

Mixed toll collection system is a combination of above two toll techniques. Under the Mixed system it was offered ETC and at the same time cash payments. Throughput of mixed type of toll lanes is higher than the fully manually operated toll lanes. Some other countries such as Holland, India, Philippines are

I.

using mixed toll systems and at the same time both manual & ETC users can be served.

2.2.4. Elements of Toll Collection System

Basically any of the toll collection system is consisted with following elements.

- Vehicle Identification
- Vehicle Classification

Under the manual method all or few process of above will be done with manual means and under the ETC system all the process will be done automatic means.

i. Vehicle Identification

Before deciding the toll charge corresponding to the vehicle, it is essential to identify the details of vehicle such as Vehicle number, vehicle type, registration, no of axles etc. Under the manual method this task has been done by operators. But using electronic devices, it can be done quickly & accurately. Optical Character Recognition (OCR) techniques used to identify the information from a motor vehicle. Under the ETC, Automatic Vehicle identification (AVI) technology is used and while passing vehicle through toll lane, a receiver communicates with the tag installed on the rear-windshield of the vehicle and reads the vehicle information. Varies non-invasive technologies, soft wares and high definition cameras are used for Automatic Number Plate Recognition in Expressways based on the cost, accuracy, efficiency & durability

ii. Vehicle Classification

For determination of toll charge, it is required to identify the vehicle class. The vehicle classification is done by Teller/operator in manual system and automatically done by electronic devices in ETC methods. Vehicles are categorized into various classes where different amounts of tolls are charged based on the class. Vehicle Classification systems are included various devices that measure the physical characteristics of vehicles. Normally vehicle classification can be done based on axle/tire arrangement of vehicles, Size/heights/length of vehicles and their gross weights. Then the toll charges shall be assigned based on lane occupancy as passenger car units (PCU), purpose of uses (public, private, commercial etc.) axle damaged to the road pavements by each category of vehicles. Technically developed laser curtains, sensors, antennas, cameras, weigh bridges are used for automatic vehicle classification purpose by various toll authorities (Das, 2012).

2.2.5. **Traffic Terminology**

I.

i. Waiting Time/Delay Time

Waiting time or delay is the difference between a specific vehicle's arrival and departure time. A vehicular arrival is recorded as the time the vehicle was filmed in queue, the departure time is recorded immediately after the vehicle is serviced and begins moving (accelerating) away from the plaza. The average delay for each payment lane is the average of the individual vehicular delays for each lane of each peak hour. Total lane delay is the summation of all the individual vehicular delays for one lane during one peak hour for one direction. Waiting time includes any queuing delay, the vehicle service time and headway.

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 users, 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 motorist can drive in virtually free flow conditions at 80 to 100 km/ph. 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)

ii. Processing Time in Toll Booth

Service time is the length of the payment process at a toll booth. As such the time requires to complete the transaction per vehicle which enter in to the toll booth until exit the customer from the toll booth.

The service time does not include the waiting time in the queue.

iii. Queue length

Queue length is the number of vehicles in queue calculated at one minute intervals for the entire 60 minutes of each peak hour. It is the difference between the volume of traffic departing from the toll booth for each minute and the volume of traffic arriving to the toll lane for the same minute, plus any remaining vehicles from the previous minute interval (Das, 2012).

2.2.6. **Road User Services**

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 enterprise is expected to provide to the travelling public

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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.When considering service performance, there are essentially two perspectives of measurement – through the lens of the organization measuring operational processes, or through the lens of the customer, measuring performance through customer satisfaction feedback (Hill et al, 2007). An organization measuring process performance may be given a false sense that they are highly performing by hitting targets such as picking up a phone within three rings or re-letting vacant properties within a seven-day target. However, in practice the customer service advisor who promptly answered the call may have presented themselves as rude to customers and the property may have been re-let in an unclean condition with a poor standard of repairs. Despite there being a clear role and rationale for process-focused performance management, it cannot fully encompass all perspectives of service provision. Such standards, both great and poor, would however be picked up through customer-focused performance measurement techniques, such as customer satisfaction. Hill advocates that "customer satisfaction is the ultimate arbiter of the success of public organizations (Hill et al, 2007) as it is the recipients of service who are best placed to assess its quality rather than the often well-meaning professionals delivering the service.

2.2.7. **Quality of Service**

The Federal Democratic Republic of Ethiopia government has given mandate to ETRE to revise and increase in toll charges if necessary (Toll Roads Proclamation No. 84 31201 4), 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 FDRE 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).

The primary objective of a road operator should be customer satisfaction. It is important to provide good

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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 Addis Adama Express Roads project was conducted and, highlighting the drivers of user satisfaction like safety, quality service, travel time savings, etc.

These quality service parameters provide 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. This 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.

2.2. Review of Empirical Literature

Findings of a study of Amelia Makmur (2019) several performance indicators that should be considered in determining future toll road service performance indicators, especially for Indonesia. Users were choosing toll road because of smooth traffic, pavement conditions and smooth road surface, the existence of clear signs as well as a clean environment. These reasons should be considered when determining future performance indicators as they would meet the expectations of toll road users. In addition, performance indicators that were significant were safety, besides security and comfort. These performance indicators would meet toll user expectations based on the result of the survey. Safety is the most important aspect for Indonesians, so all performance indicators that support the creation of toll road safety should be of main concern. Lack of information and socialization regarding the existence of the toll road Service, which regulates the minimum service that must be provided by the operator, is a factor that is of great concern. Feedback related to toll road service fulfillment is very much needed in measuring toll road performance. The grouping of performance indicators based on the survey of Indonesian toll road users, resulted in 10 proposed performance indicators with safety aspect, 9 proposed performance indicators with security aspect, and 20 proposed performance indicators with comfort aspect. Total performance indicators obtained were 39 performance indicators. Verification process of 31 proposed performance indicators based on results of the surveys was carried out to ensure that the

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proposed performance indicators were in accordance with the conditions in Indonesia, next to that were in compliance with prevailing laws and regulations of Indonesia, and were in accordance with the wishes of Indonesian toll road users. The result obtained through this verification process was 22 performance indicators that can be re-proposed into the long list of performance indicators that will be used for subsequent surveys.

2.2.1. Limitations of Previous Research

Presently, while considering the Toll roads system performance assessment, there are many research gaps related to the key performance measurement indicator. To date, there are no effective Toll Roads Performance assessments, without booth area firefighting system (KPI) (existing measures) proposed for the assessment of the toll road performance of projects like express lanes and toll lanes. Therefore, the main objective of this research is performance assessment of toll roads in the city and regional state traffic using firefighting system as key measuring indicator.

2.3. Research Framework

The framework of this research flow was composed of 6 research stages, each of which had its own path that was sequential to one another. in order to conduct performance indicators that would be proposed for the development of toll road in Indonesia, the data collection method was by literature review and field survey. In addition, previous Indonesian research studies were also reviewed, specially related to the development of toll road and based on the toll road performance indicators in Indonesia which referred to the Minister of Public Work Regulation No. 16/PRT/ M/2014 on Toll Road Minimum Service Standard. Whereas the survey was carried out by online questionnaires that had to be filled in by respondents, in addition interviews with respondents were also conducted. It was important to first determine respondent criteria so that the collected data could be used for analyzing. The data obtained from this survey were analyzed using a descriptive statistical method by which the performance indicators could be determined. The first survey was conducted to identify respondents' expectations in using toll road sections. Respondents in question were groups of consumers or toll road users. The second survey involved respondents from groups, government/regulators,

An analysis of the quality of service was conducted and looked at its correlation to customer satisfaction. This study found that there was a correlation between customer desires and service quality, including travel time, toll rates, and completeness of toll road physical facilities. The difference of this study compared to previous research is that it used the SERVQUAL model and focused on customer

satisfaction. This study explored opinions and expectations of toll road users compared to services received. Based on the review of previous studies conducted in Indonesia, it seems that no research has been conducted to develop toll road MSS performance indicators using literature and data of other countries' experiences, consumer opinions, expert opinions, and opinions of operators in developing performance indicators. Previous research used Toll Road service references derived from regulators, both current and previous ones. Like the research conducted in Indonesia, most research outside Indonesia also aimed to evaluate the applicable toll road service performance indicators. One example is a study entitled The Attica Tollway Operations Authority KPI Performance System.

The researchers conducted a study of performance indicators to measure the level of service of toll roads in Greece. The developed KPI would be used to simplify more than performance indicators had done before in measuring toll road performance. The method used was a quantitative method, based on the data obtained from the information system. The developed performance indicator was an overall performance indicator for toll road management, not just related to toll road service. This study stated that the weaknesses found were performance indicators that were not clearly measurable and had to be understood, so that differences in perceptions of operators would make it difficult to assess performance. In this study of performance indicators, only data that were already in the information system were used. The weakness is that public expectations of toll road services change and develop in line with level of education, income level and community lifestyle.

Another study entitled Measurable Performance Indicators for Roads: Canadian and International Practice (Tyrogianni, ., Halkias, ., Politou, a. & Kotzampassi, (2012), said that performance indicators were formed to improve the quality of services to the public and to increase the effectiveness and productivity of management institutions or institutions. Indicators aimed at improving service to the public were service for non-toll roads. Even so, the proposed performance indicators are relevant to be applied in the toll road service performance indicators.

Most prior studies have measured performance in public sector companies and private sector companies in developed countries (Ferdousi et al., 2019; Rad, 2005; Flynn et al., 1995; Saraph et al., 1989), the research in developing countries is scarce (Ferdousi et al., 2019; Abdullah et al, 2008, Saleheldin, 2003; Joseph et al., 1999). Therefore, it is considered important to examine how performances are measured in developing countries owing to their distinctive environments, in particular their differences in terms of the quality of infrastructure and market size (Gosen et al., 2005). Accordingly, given the scarce research, this study focuses on examining the performance measurement in a developing country,

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India. India was chosen as the research setting because of its competitive environment.

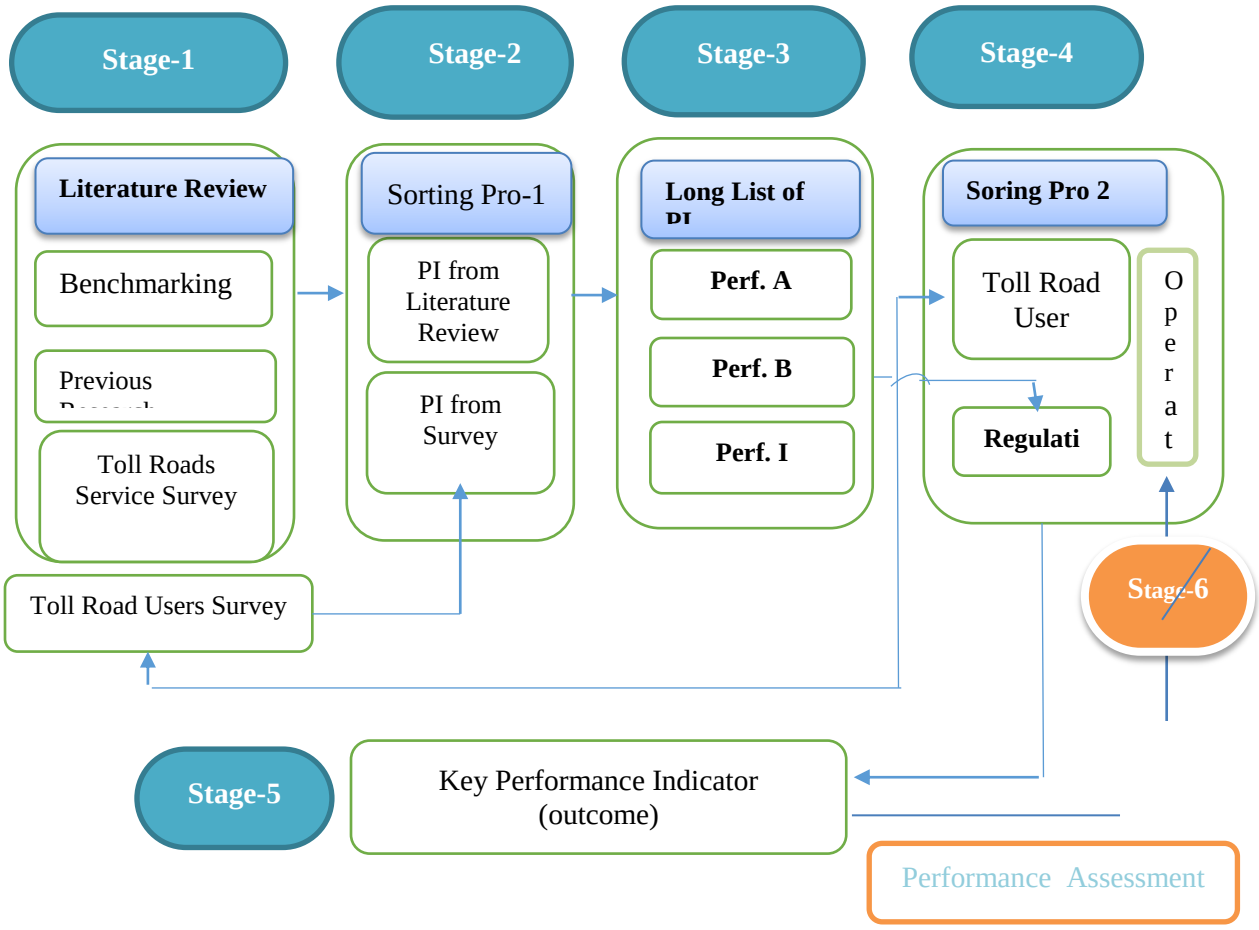

Fig. 1: Research framework for the study

Source: *Makmur et al., Int. J. of Integrated Engineering Vol. 11 No. 8 (2019)*

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Chapter Three
Research Methodology and Methods of the Study

3.1. Research Approach

Research approach is plan and procedure for research that span the decisions from broad assumptions to detailed methods of data collection and analysis. The function of research approach is to provide the collection of relevant evidence with minimal expenditure of effort, time, and money (Creswell, 2009). Hence, the I have used a **Mixed-method research approach** in terms of its purpose as it describes and analyzing a phenomenon through identifying and obtaining information on the characteristics of a particular issue through the collection and analysis of qualitative data (Kohtari, 2004)

3.2. Research Design

A **Mixed-method research approach** is used in terms of purpose as it describes and analyzing a phenomenon through identifying and obtaining information on the characteristics of a particular issue through the collection and analysis of qualitative data (Kohtari, 2004)

3.3. Data Sources and Data Types

In order to address the aims of this study, the researcher use Primary data according to Kothari (2004) is the data collected for the first time. Andre (2004) explains that primary data is data that is used for a scientific purpose for which it was collected. Structured questioned and review of **statistical data** were used to come up with primary data.

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3.4. Sampling Methods and Sample Size Determination

The sample for the study is represented by the toll way users like, passengers, drivers, driver owners and staff in vehicles. A **simple random sampling and purposive sampling** 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-uses.

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 road users travelling across the regional state of the country, using these roads by different travel modes, depending upon the length and purpose of the journey, are the population for the study. Roughly 18,750 people travel in various transport modes everyday on all the toll routes (as per the break-up given in table 3.1), the sampling size is calculated for 95 % confidence level, as follows:

- Sample size: The sample size of this research is calculated by using Trro Yamane formula (Yamane, 1973) n = N/1+ N e2 where N = population = 18,750, e = 0.05 (at 95% confidence level)

$$300 = \frac{N}{1+Ne^2}$$

Where ‘e‘is level of significance (revised for sample size 300)
‘N’ is the population = 18,750
$\mathbf{e^2}$=√0.0029742857
e=0.054537

Table 3.1: **Size in Study Area-Toll Road Segment Wise**

No	Toll Station	Sample Size	Estimate of Passengers Per Day
1	Addis Toll Roads	150	9400
2	Mojo Toll Roads	75	4,690.00
3	Adama Toll Roads	75	4,660.00
Total		**300**	**18750**

3.4.1. Sample Location:

All three toll road segments of Addis Adama Expressway, Addis Ababa road (AAR), Adama roads (ADR).and Mojo road (MOR) In short, the study locations are:

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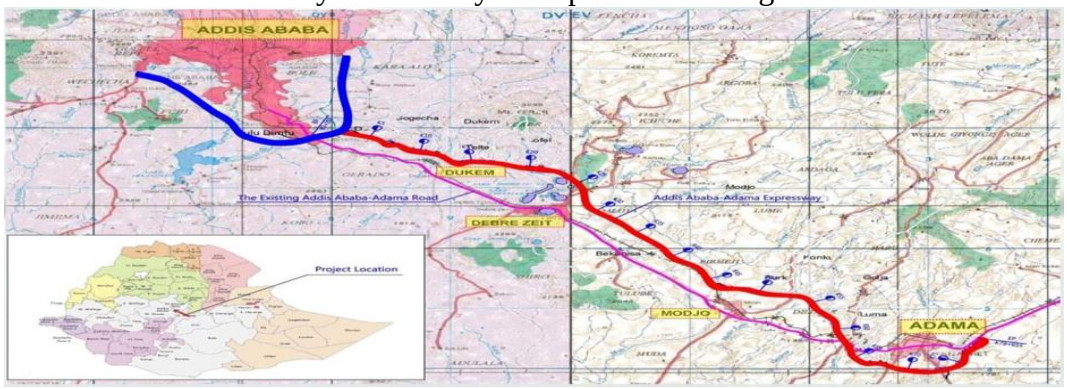
The study location layout is presented in Figure 3.1



3.5. Data Collection Tool

Primary data were collected using a combination of closed and open-ended questionnaire. The closed questionnaire including observation check-list was so designed that time required for filling the questionnaire should not exceed 20-30 minutes. The open-ended questionnaire is designed in sections which include some peripheral questions on the toll way operational systems to evaluate toll ways. General system performance indicators and the most important one is Road User Service indicators.

Table shows below the sets of questions covering various aspects are as follows:

Table 3.2 Sets of questions with various aspects

Question(s)	Covering
Q-1 to Q-6	General System Performance
Q-7	Complaints People Have on Toll Roads
Q-8	Road User Service Performance Indicators

However, question No.8 is the main section, which is considered as study variables representing the roadway service indicators that are measured by opinion of users/clients as perceived quality of toll ways, safety, security services and road user amenities. The road user survey questionnaire is attached in the Appendix II, page no.55

- Toll Plaza Operational Data

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 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, and fire controlling system, Weigh

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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.55.

- The Road User Satisfaction Survey (RUS)

The road user survey is aimed to capture perceptions and expectations of travelers on specific service parameters as mentioned below (Table No. 3.3). 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 user's perception in 14 road service indicators (Table 3.3), 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 traveler on the toll roads.

Table 3.3: Road User Service Indicators

Road Service Parameters	Service Indicators
Quality of Road	Smoothness
	Roadway markings
	Shoulder condition
Safety of Road	Pedestrian crossing facilities
	Signs and signals
	Lighting at the Junctions
Security and emergency services on the road	Highway Police patrolling
	Ambulance for accidents victims
	Crane facility for vehicle breakdown
	Telephone booth for emergency calls
Road user amenities	Cafeteria
	Medical aid
	Parking lots
	Allowable Rest houses for drivers

3.6. Methods of Data Analysis and Interpretation

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

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survey involved asking a sample of road users such as drivers, staff in vehicle, passengers, etc. The users were contacted and the structured questionnaires were given to the road users at various points along the roads such as road side Addis Adama Express roads, lay buy, checkpoints, etc. During face to face interview, the respondents were asked to give their personal attributes such as mode of travel, category of user. On the other section of questionnaire, data on respondent's opinion on various services were measured using a five-point numeric scale, popularly known as Likert Scale‖ or service quality scale in this particular study.

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 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, one-way ANOVA, factor analysis etc. The software primarily used for Analyses are MS-Excel and SPSS (Version15.1 for Windows.) Although, observation study was mostly textual and less statistical; the questionnaire survey responses were analyzed through quantitative methods like ANOVA and Factor Analyses.

- Road User Service 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 traveler's 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

Fourteen service indicators that are grouped into the above factors are as follows, in Table 4.12

Table 4.12: Roadway Service indicators

Road Service Parameters	Service Indicators
Quality of Road	Smoothness-1
	Roadway markings-2
	Shoulder condition-3
Safety of Roads	Pedestrian crossing facilities-4
	Signs and signals-5
	Lighting at the Junctions-6
Security and emergency services on the road	Highway Police patrolling-7
	Ambulance for accidents victims-8
	Crane facility for vehicle breakdown-9
	Telephone booth for emergency calls-10
Road user amenities	Cafeteria-11
	Medical aid-12
	Parking lots-13
	Allowable Rest Time for drivers-14

Validity and Reliability of Data

The data is reliable as the Cronebach Alpha is calculated and found to be more than0.70 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 Road Services Indicator (RSI)

A five-point Likert Scale was used to record the satisfaction level of users 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 weight 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.

- Interpretation of Road User Services Analysis

A set of 14 indicators have been used in computing the Indices which are grouped into Four sub-groups Quality of Roadway, Safety, Security and Road way amenities. The Three 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 AAR scores high performance where as ADR and MOR roads attaining around average level of performance. It is stipulated that they need to provide infrastructure and facilities for enhancing quality service. Based on the data through primary survey, the performance indices were calculated for all 14 parameters. The highway, Addis Ababa Road (AAR) secured the highest overall performance index value of 3.36, followed by Adama Main Station Road (ADR) 2.83 and Mojo Road (MOR) 2.84: Comparative Segmental Average Scores of three Roadways.

3.7. Ethical Considerations of the Study

There are certain considerations made in this study. Primarily, study subjects were included upon their consent. Once this is done, the information they provided through the data collection instruments are kept confidential. Furthermore, their identity is also being kept confidential. Confidentiality of the information was guaranteed by informing respondents not to write their names or anything that makes them is identified by others.

Chapter Four
Data Analysis, Results and Interpretation

4.1. Introduction

This chapter is providing toll plazas assessment on four broad parameters which include 26 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 I, page no.52 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 help to observe the behavior of the system, for example, as how it works for vehicles data 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. 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 (TTSS) with 6 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 53 points (8+6+4+35). The Operational parameters, covering Quantitative (objective) and Qualitative (subjective) ones are listed below:

4.2. Background Summary of Addis Ababa-Adama Toll Road Segment

Segment 1: Tulu-Dimtu-Km-2– Addis Ababa Toll Plaza

This Road Segment is usually considered as inter-urban section though it is administered by the Ethiopian Toll Roads Enterprise. It starts at Dukem round about around Eastern Industry Zone and passes through Tulu Dimtu Toll Plaza Exit. It has approximately about 18Km.

Segment 2: Adam Main Km-64—AdamaToll Plaza

This Road Segment is usually considered as Outer-urban section though it is administered by the Ethiopian Toll Roads Enterprise. It starts at Wolechinti- Mazoria and passes through Adam Main Toll Plaza Entrance. It has approximately about 16Km.

Segment 3: Mojo-Km-52– MojoToll Plaza

This Road Segment is usually considered as inter-urban section though it is administered by the Ethiopian Toll Roads Enterprise. It starts at Debri-Zeit Round about around Ethiopian Air Force in the South and passes through Mojo Toll Plaza Exit. It has approximately about 20Km.

4.3. Key Performance Indicators Related to the Toll Plazas Assessment

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

I. ➢ 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
- Auto Railing/Boom Barrier

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

- Security Personnel
- CCTV in Toll cabin
- Electronic Toll Collection System
- Over Load Control System
- Automatic Vehicle Classifier
- Fire Controlling System in Toll Station

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

4.4. Analysis of Toll Plaza Survey Data

Process Involved for determining toll plaza operation service scores across three station plazas are illustrated in the tables 4.1 to 4.3

Table 4.1: Quantitative Parameters			
Toll Plaza Information and Management System (TPIMS)	**Addis Ababa**	**Adama**	**Mojo**

1	Display of Project Details Near the Toll Plaza Area	YES / No	1	1	1
2	Toll Rates Display	YES / No	1	0	1
3	Separate Lane for Over Sized Vehicle	YES / No	1	1	1
4	Speed Restriction Sign at Plaza	YES / No	1	1	1
5	Lane Guidance for Vehicles	YES / No	1	1	1
6	Traffic Wardens	YES / No	1	0	1
7	Bike Lane	YES / No	0	0	0
8	Auto Railing/Boom Barrier	YES / No	1	1	1
Toll Technology and Surveillance Systems (TTSS)					
1	Security Personnel	YES / No	1	0	1
2	CCTV in Toll Cabin	YES / No	1	2	1
3	Electronic Toll Collection System	YES / No	0	0	0
4	Over Load Control System	YES / No	1	0	0
5	Automatic Vehicle Classifier	YES / No	0	0	0
6	Fire Controlling System in Toll Station	YES / No	0	0	0
Toll Office Amenities (TOA)					
1	Toll Pass Office	YES / No	1	1	1
2	Parking Lots in Emergency	YES / No	1	1	1
3	Commuter Complaint Register	YES / No	0	0	0
4	Toll Tag Recharge	YES / No	0	0	0
Objective Total			**12**	**9**	**11**

Table 4.2: Qualitative Parameters

	Qualitative Service Parameters (QSP)		**Addis Ababa**	**Adama**	**Mojo**
1	Public Toilets	YES / No	0	0	0
	IF YES THEN, LEVEL	1 2 3 4 5			
2	Plaza Lighting	YES / No	4	3	4
	IF YES THEN, LEVEL	1 2 3 4 5			
3	Lighting Through Approach Areas	YES / No	3	1	2
	IF YES THEN, LEVEL	1 2 3 4 5			
4	Pavement Condition at The Approach Area	YES	4	2	3

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		No							
	IF YES THEN, LEVEL	1	2	3	4	5			
5	Vehicle Queue Length	YES					3	3	3
		No							
	IF YES THEN, LEVEL	1	2	3	4	5			
6	Appealing Environment Around Premise	YES					4	3	3
		No							
	IF YES THEN, LEVEL	1	2	3	4	5			
7	Overall Cleanliness	YES					3	3	3
		No							
	IF YES THEN, LEVEL	1	2	3	4	5			
SUBJECTIVE TOTAL							**21**	**15**	**18**
Grand Total (Subjective +Objective)							**33**	**24**	**29**

Table 4.3 Ranking of Toll Plazas

Ranking of Toll Plazas (RTP)	**Addis Ababa**	**Adama**	**Mojo**
Objective Total (Out of 17)	12	11	9
Subjective Total (out of 35)	21	18	15
Total (Out of 53)	33	29	24
Ranking	**1**	**2**	**3**

Source: Compiled by the researcher

I. Interpretation of Analysis Made on Addis Ababa Toll Plaza

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 but bike lanes such as project details, toll rates display, and speed restriction sign at Plaza, lane guidance for vehicles, traffic wardens. With respect to the TTSS factor, it has three facilities out of six which includes security personnel, over load control system and CCTV camera in the Toll Plaza, Toll pass office and amenities at the plaza such as parking lots are exist 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. Technological elements such as electronic toll collection system and Fire Controlling System in Toll Station are missing.

From the process explained in the tables (4.1 to 4.3), it can be observed that the toll plaza at Addis Ababa road side at Tulu- Dimtu station has been provided with comparatively good tolling service infrastructure leading to good operational efficiency. Further on QSP front it is observed that the element public toilet low points in 5-point scale, so special attention is required. The pavement, lighting at the approach area is provided at the high level, as is desired at a Tulu-Dimtu Toll Plaza. The other feature in evaluation process for the toll plaza is the house keeping. Addis Ababa Road side at Tulu

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Dimtu Toll Plaza, the overall cleanliness is rated as above average, thereby need not get greater focus with respect to this parameter. The appealing environment around the Toll Plaza is rated at high level. Finally, the Addis Ababa Road side at Tulu-Dimtu Toll Plaza scores a total of 33 points out of 53; by this, it can clearly be inferred that less attention is required with respect to various aspects, so as to increase the overall efficiency and effectiveness of the Toll Plaza.

II. Interpretation of Analysis Made on Adama Toll Plaza

Except Bike Lane, and traffic wardens, Adama Main Toll Plaza compliance with the five parameters(TPIMS) out of eight 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, Auto Railing. The presence of physical parameters such as Toll pass Office is observed. Amenities at Plaza like Commuter Complaint Register and Toll Tag recharge service parameter are absent. Technology elements such as Electronic Toll Collection system, (over load control system) weigh in Motion Bridge, Fire Controlling System and automatic vehicle classifier is absent. Whereas the roadway parameters that are available include highway patrolling, first aid and emergency phone. With respect to the QSP it is observed that the Public Toilets have been rated as 0 (null) thereby indicating no attention is given to customer service and satisfaction. This emphasizes the need to improve service. The Pavement at the approach area is provided with an average score and therefore, can be increased to ensure better accessibility. The other feature is housekeeping, in which the Adama Toll Plaza have good 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 0(null) and two (2) each. Adama Main Toll Plaza scores a total of 29 rating in which the prime areas of focus are public toilets as well as sub parameters of lightening facility to improve the score points of this Plaza.

III. Interpretation of Analysis Made on Mojo Toll Plaza

In TPIMS factor, it has all features as per expected standard Project Details‖ display near the Plaza Area as well as Toll Rates display. Except bike lane, there are 7 entrance lanes including a separate lane for oversized vehicles, lane guidance for vehicles, traffic wardens, violation enforcement system etc. Presence of physical features such as Toll pass office is observed. Amenities such as complaint register and Toll Tag Recharge are not observed. Technological elements are found missing such as toll

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collection system, automatic vehicle classifier, Fire Controlling System 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 low. It is further observed that the vehicle queues feature scores is average, which infers that more emphasis should be laid on management of the public toilets and lighting through approach area so as to increase lightening facility 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 Mojo Toll Plaza gets average 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. The Mojo Toll Plaza total of 24 points in which special attention is needed at providing the public toilet, and lighting facility can be area of focus to increase the score of this Toll Plaza.

4.5. 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 II at page no.56.

Frequency distribution technique of analysis is used from Q.No.1 to 7 the method of ranking is applied to derive the ranks of various complaints. For Q.8, being the most important part of the study, inferential statistics involving ANOVA, Factor analysis, etc. are carried out.

4.6. Result and Interpretation

4.6.1. Personal Details

Table 4.4: Presents Analysis of Purpose of Travel.

Type of Vehicle	Toll Road Segment
Business	62%
Recreation	6%
Social	27%
Other	5%
Total	**100%**

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Source: Primary data Analysis (2023)

From overall analysis of the three road segment it is revealed that a 62 per cent of total users are business class travelers, 6 per cent are recreation 27 per cent social. 5 per cent are for other than the three e.g. military vehicle and higher official cars.

Table 4.6: Percentage Distribution of Respondent Profile

Toll Road Segment	Respondents (Toll paying?)	Size of sample	% Of sample
AAR	Yes	144	96
	No	6	4
ADR	Yes	67	89
	No	8	11
MOR	Yes	69	92
	No	6	8
Overall	Yes	280	93
	No	20	7

Source: Primary data Analysis (2023)

D: Drivers P: Passenger O: Other

From the results in Table 4.5, Addis Ababa Road, around 12.7 percent of the customers in vehicles are Drivers. About 83.3percent customers are passengers and 4 percent are other. For Adama Roads, less than one fourth (16%) of those surveyed are drivers and around more three fourth (80%) respondents belong to passengers and 4 percent are other. For Mojo Road, about 24% of surveyed are drivers and 73.3% are passenger and 2.7 are others.

Table 4.7: Percentage Distribution of Toll Payers across the Roads

Toll Road Segment	Respondents (Toll paying?)	Size of sample	% Of sample
AAR	Yes	144	96%
	No	6	4%
ADR	Yes	67	89%
	No	8	11%
MOR	Yes	69	92%
	No	6	8%

Source: Primary Data Analysis (2023)

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The overall results show that highest number of respondents on Addis Ababa Road, Adam Road and Mojo Roads pays toll (96%), 89% and 92% respectively and rest of them fall under the toll-exempted category. The over-all analysis of the three station roads revealed that 93% of total customers pay toll at the toll booth as shown in Table 4.7. However, the remaining 7% of total vehicles fall under various categories those are exempt from paying toll such as VIP, ambulances, special mission military vehicles etc.*)*

Table 4.8: Percentage distribution of users of Toll passes

Toll Road Segment	Respondents (Using Toll Pass)	Size of sample	% Of sample
AAR	Yes	5	3%
	No	145	97%
ADR	Yes	4	5%
	No	71	95%
MOR	Yes	2	4%
	No	73	97%
Overall	Yes	11	4%
	No	289	96%

Source: Primary Data Analysis (2023

It was found that the percentage of users having Toll pass is 3% each on AAR, and MOR and ADR roads where as 5%. Toll-pass is provided to those clients who commute daily and want buy package service with some incentives. However, the numbers in this Category are very small number (4 % overall) as is presented in Table 4.8

4.6.2. System Evaluation Using Indicators

Table 4.9: Opinion on Toll Prices

Toll Road Segment	Toll Price	Size of Sample	% of Sample
AAR	LP	80	53.3%
	MP	60	40.0%
	HP	7	4.7%
	VHP	3	2.0%
	CS	0	0.0%
	Total	**150**	**100%**
ADR	LP	51	68.0%
	MP	15	20.0%

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	HP	4	5.3%
	VHP	3	4.0%
	CS	2	2.7%
	Total	**75**	**100%**
MOR	LP	48	64.0%
	MP	18	24.0%
	HP	5	6.7%
	VHP	0	0.0%
	CS	4	5.3%
	Total	**75**	**100%**
Overall Toll Segment	LP	179	59.7%
	MP	93	31.0%
	HP	16	5.3%
	VHP	6	2.0%
	CS	6	2.0%
	Total	**300**	**100%**

Source: Primary Data Analysis (2023)

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

From the results in Table 4.9, on AAR road, 53.3% of travelers said toll rates are low where as 40% said they are moderate but 6.7% of customer were not happy about toll prices as they are high.

From the results in Table 4.9, on ADR road, 63% are of the opinion that toll rates are low while 20% said toll-rates are moderate, 9.3% are of the opinion that toll rates are high / very high and very small group (2.7%) were not able to comment.

From the results in Table 4.9, on MOR road, 64% of respondents were happy about toll prices as they are low and about 24% said they are moderate and very small group (6.7%) were not happy about toll prices as they are high and five percent (5.3%) of group were not able to comment.

Overall, about 59.7 % feel that the toll prices across all these roads are low and 31% moderate and nearly 7.3% said that toll rates are high / very high and very small group (2%) were not able to comment. This part of Analyses is presented in Table 4.11

Table 4.10: Aware ness about Toll Payment

Toll Road	Category	Size	%
AAR	Yes	125	83%

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	No	25	17%
ADR	Yes	55	73%
	No	20	27%
MOD	Yes	50	67%
	No	25	33%
Overall	**Yes**	**230**	**77%**
	No	**70**	**23%**

Source: Primary Data analysis (2023)

From the results in Table 4.10, about 83% of users on AAR road said they have understanding about the service provided by ETRE, whereas around 17% of users informed having no knowledge about toll roads. On ADR about 73% know about the toll roads service provided, about but not little user around (27%) said they have not come across any such information. On Mojo road, around (67%) numbers of users are aware / attended awareness on toll but little less than quarter (23%) users had no knowledge of the program.

Table 4.11: Opinion on Complaint Redress System

Toll Road Segment	Category	Frequency	%
AAR	Highly satisfaction	64	43%
	Somewhat satisfaction	61	41%
	Somewhat dissatisfaction	15	10%
	Highly dissatisfaction	10	7%
ADR	High satisfaction	29	39%
	Somewhat satisfaction	23	31%
	Somewhat dissatisfaction	11	15%
	Highly dissatisfaction	12	16%
MOR	High satisfaction	14	19%
	Somewhat satisfaction	23	31%
	Somewhat dissatisfaction	23	31%
	Highly dissatisfaction	15	20%
Overall	High satisfaction	107	36%
	Somewhat satisfaction	107	36%
	Somewhat dissatisfaction	49	16%
	Highly dissatisfaction	37	12%

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Total	300	100%

Source: Primary Data analysis (2023)

From the results in Table 4.11, Satisfaction regarding complaint redress system is analyzed and presented as follows. Around (85%) of users on Addis Ababa road are highly or somewhat satisfied, whereas about 17% are dissatisfied / highly dissatisfied. Nearly 70% of respondents on Adam Road are happy with the redress system but 30% are not happy about the redress system. While 50% show satisfaction, 50% are not satisfied about redress system on Mojo Toll Road. Table 4.10 provides analyses for the above factor.

Table 4.13: Descriptive Statistics for Road Service Scores

Road Service Indicators		Addis Ababa Road	Adama Road	Mojo Road
Quality of Road	1	3.33	3.13	2.95
	2	3.29	3.03	3.36
	3	3.64	3.4	3.57
Avg		**3.42**	**3.19**	**3.29**
Safety of Road	**4**	3.38	3.41	3.28
	5	3.36	2.89	3.09
	6	3.61	3.04	3.13
Avg		**3.37**	**3.11**	**3.17**
Security and emergency services	7	3.26	2.88	2.67
	8	3.41	2.44	1.76
	9	3.05	1.4	1.84
	10	3.37	2.77	2.61
Avg		**3.28**	**2.20**	**2.07**
Road user amenities	11	2.72	2.71	2.03
	12	2.79	1.64	1.51
	13	3.21	3.27	3.33
	14	3.01	2.85	2.93
Avg		**3.00**	**2.59**	**2.59**
Average of All Constructs		**3.36**	**2.83**	**2.84**

Source: Compilation of Primary Data based on Questionnaire Survey

Note: Column 1 represent 14 roadway service indicators Mentioned in Table No 4.13

I. Toll Roadway Service and Performance indicator wise Analysis

a. Quality of Road

From the results in Table 4.12, 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

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quality of road is assessed through three indicators: Smoothness, Roadway markings and Shoulder condition. Addis Ababa Road is in the top slot on this parameter with average score of 3.42, followed by Adama Main Road (3.19), and Mojo Road (3.29).

b. Safety of Road

From the results in Table 4.12, the 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 AAR as best with top score of 3.37, followed by MOR and ADR (3.17).

c. Security and Emergency Services

From the results in Table 4.12, four indicators are considered for defining this particular construct, viz, highway Police patrol, Ambulance services, Crane facility and Telephone booth. The AAR toll Road is rated as best in terms of average indicator score of 3.28, followed by ADR (2.20), and MOR (2.07)

d. Road User Amenities

From the results in Table 4.13, our indicators are considered for defining this particular construct, viz, Cafeteria, Medical aid, Parking lots and Allowable Rest Time for drivers. The AAR toll Road is rated as best in terms of average indicator score of 3.00, followed by ADR (2.59), and MOR (2.59).

II. Validity of Results

It is observed that quality of service defined by these indicators varies across the segments. For analyzing 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 14 parameters, are found statistically significant at error rates ranging 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 users travelling on the study area ETRE toll roads, and want to see if the aggregate mean scores, for all these three populations (Total passengers on three Toll roads) from where samples are drawn, are unequal.

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Null hypothesis: Mean Scores of various indicators across cases (Three Toll Road Segment) are same.

Dependent Variable	Sum of Squares	df	Mean Square	F	Sig.	Result

Alternate Hypothesis: Mean Scores of various indicators across cases (Three Toll Road Segment) are not same.

Hypotheses Structure

Null Hypothesis, H0: μ1= μ2= μ3

Alternate Hypothesis, Ha: μ1≠ μ2 ≠μ3

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 14 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 but consider the hypothetical sample results for three toll roads and mean scores of each service variable are presented with a couple of significance test results

Table 4.14 ANOVA Results

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1	Between Groups	5.56	2	2.78	7.468	**0**	H0 =Rejected
	Within Groups	110.56	297	0.372			
	Total	116.12	299				
2	Between Groups	4.287	2	2.143	5.392	**0.005**	H0 =Rejected
	Within Groups	118.06	297	0.398			
	Total	122.347	299				
3	Between Groups	1.21	2	0.605	2.001	**0.137**	Ho =Accepted
	Within Groups	89.787	297	0.302			
	Total	90.997	299				
4	Between Groups	17.46	2	8.73	25.123	**0**	H0 =Rejected
	Within Groups	103.207	297	0.347			
	Total	120.667	299				
5	Between Groups	6.833	2	3.417	7.03	**0.001**	H0 =Rejected
	Within Groups	144.353	297	0.486			
	Total	151.187	299				
6	Between Groups	13.98	2	6.99	19.399	**0**	H0 =Rejected
	Within Groups	107.02	297	0.36			
	Total	121	299				
7	Between Groups	19.47	2	9.735	25.044	**0**	H0 =Rejected
	Within Groups	115.447	297	0.389			
	Total	134.917	299				
8	Between Groups	93.78	2	46.89	127.9	**0**	H0 =Rejected
	Within Groups	108.887	297	0.367			
	Total	202.667	299				
9	Between Groups	159.913	2	79.957	210.61	**0**	H0 =Rejected
	Within Groups	112.753	297	0.38			
	Total	272.667	299				
10	Between Groups	35.64	2	17.82	50.877	**0**	H0 =Rejected
	Within Groups	104.027	297	0.35			
	Total	139.667	299				
11	Between Groups	26.703	2	13.352	26.483	**0**	H0 =Rejected
	Within Groups	149.733	297	0.504			
	Total	176.437	299				
12	Between Groups	81.23	2	40.615	91.011	**0**	H0 =Rejected
	Within Groups	132.54	297	0.446			
	Total	213.77	299				
13	Between Groups	0.73	2	0.365	0.9	**0.408**	Ho =Accepted
	Within Groups	120.507	297	0.406			
	Total	121.237	299				
14	Between Groups	1.203	2	0.602	1.639	**0.196**	Ho =Accepted
	Within Groups	109.047	297	0.367			
	Total	**110.25**	**299**				

From ANOVA results of indicator 1 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 7.468 and the corresponding probability is

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printed as .000 as SPSS rounds-off the probability to 3 decimal places. We have found that the p-score is so low that the result is statistically significant at 5% 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. Similar process is followed for indicator 3 for which the result is statistically not significant. The comprehensive statistics for all indicators is presented. Similar process is followed for indicator 3, 13 and 14 for which the result is statistically not significant. In this case it is concluded that the means of three roads vehicular population do not differ across toll Roads and the result is attributed to randomness in sampling process. 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 4.15). 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 AAR Road with of MOR. The second set of rows compares the score in AAR Road with of the other two roads and so on

Table 4.14: **POST HOC TEST**

(For the Variable statistically significant at 5% level of significance)

The important aspect of Table: 4-14 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.

Table 4.15: Multiple Comparisons

	Mean	Std.	Sig.	95% Confidence Interval

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Dependent Variable			Difference	Error		Lower Bound	Lower Bound
Smoothness	Addis Ababa Road	Mojo Road	.387*	0.093	**0**	0.17	0.61
Roadway markings	Addis Ababa Road	Adama Road	.260*	0.093	0.015	0.04	0.48
Pedestrian crossing facilities	Addis Ababa Road	Adama Road	.460*	0.087	0	0.25	0.67
		Mojo Road	.633*	0.087	0	0.43	0.84
Signs and signals	Addis Ababa Road	Adama Road	.467*	0.103	0	0.22	0.71
		Mojo Road	.267*	0.103	0.028	0.02	0.51
Lighting at the Junctions	Addis Ababa Road	Adama Road	.573*	0.091	0	0.36	0.79
		Mojo Road	.480*	0.091	0	0.27	0.69
Highway Police patrolling	Addis Ababa Road	Adama Road	.380*	0.088	0	0.17	0.59
		Mojo Road	.593*	0.088	0	0.39	0.8
Ambulance for accidents victims	Addis Ababa Road	Adama Road	1.407*	0.1	0	1.17	1.64
		Mojo Road	1.180*	0.1	0	0.95	1.41
Crane facility for vehicle breakdown	Addis Ababa Road	Adama Road	1.647*	0.087	0	1.44	1.85
		Mojo Road	1.207*	0.087	0	1	1.41
	Mojo Road	Adama Road	.440*	0.101	0	0.2	0.68
Telephone booth for emergency calls	Addis Ababa Road	Adama Road	.600*	0.084	0	0.4	0.8
		Mojo Road	.760*	0.084	0	0.56	0.96
Cafeteria	Addis Ababa Road	Mojo Road	.693*	0.1	0	0.46	0.93
Medical aid	Addis Ababa Road	Adama Road	1.153*	0.092	0	0.94	1.37
		Mojo Road	1.287*	0.092	0	1.07	1.5

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 of the road ways are computed and interpreted as follows: the mean difference between the ratings on smoothness indicator of Addis Ababa Road and Mojo road is 0.387. The standard error between the mean ratings of Addis Ababa Road and Mojo road on average is .093, smaller the standard errors the closer are the two values. The upper and lower

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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 in the above Table. The same explanation holds good for rest of the statistics across the indicators.

Similar Statistical Analysis process as followed above, for remaining 14 road user indicators has been carried out along with other relevant analyses reliability and the factor analysis in the subsequent article Road user study statistical analyses.

Table 4.16: **Reliability Statistics**

Cronbach's Alpha	N of Items
0.71	**14**

Cronbach's Alpha Reliability coefficients were generated using computer program to estimate the reliability of the questionnaire. The Cronbach's alpha reliability coefficient of 0.7 and above is acceptable (Sekaran 2003).

Inter-Item Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	**1**													-
2	0.019													
3	0.122	0.036	**1**											
4	0.177	0.028	0.065	1										
5	0.151	0.082	0.179	0.107	1									
6	0.28	0.042	0.092	0.116	0.175	1								
7	0.204	0.099	0.087	**0.607**	0.167	0.127	1							
8	0.11	0.106	0.155	**0.307**	0.175	0.277	0.287	1						
9	0.09	0.074	0.083	**0.347**	0.229	**0.318**	**0.323**	**0.471**	1					
10	0.102	0.063	-0.068	0.203	0.216	0.18	**0.318**	**0.365**	**0.444**	1				
11	0.106	-0.158	-0.062	0.138	0.123	0.012	0.126	0.15	0.149	0.278	1			
12	0.198	0.01	0.157	**0.391**	0.196	0.237	**0.362**	**0.475**	**0.542**	**0.358**	0.201	1		
13	-0.042	0.075	-0.028	-0.12	0.003	0.084	0.014	-0.091	0.079	0.011	-0.115	-0.03	1	
14	-0.107	-0.061	0.119	-0.014	0.005	-0.061	0.005	0.169	0.115	0.173	0.058	0.06	0.016	1

Table 4.17: Correlation Matrix

Table 4.18: Item Statistics

Item Statistics

	Mean	Std. Deviation	N
Smoothness	3.19	.678	300
Roadway markings	3.24	.666	300
Shoulder condition	3.56	.622	300
Pedestrian crossing facilities	3.02	.672	300
Signs and signals	3.18	.753	300
Lighting at the Junctions	3.35	.695	300
Highway Police patrolling	3.11	.676	300
Ambulance for accidents victims	2.76	.959	300
Crane facility for vehicle	2.33	.955	300
Telephone booth for emergency calls	3.03	.683	300
Cafeteria	2.54	.768	300
Medical aid	2.18	.890	300
Parking lots	3.26	.637	300
Allowable rest time for drivers	2.95	.607	300

Table 4.19: Scale Statistics

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
41.70	22.605	4.755	14

A principal component:

A concept related to most methods of factoring is the idea of a principal component. A principal component is a liner combination of observed variables that is independent (orthogonal) of others components. The first principal component accounts for the largest amount of variance in the input data. The second component accounts for the largest amount of the remaining variance in the data and so on.

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Table 4.20 **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	3.346	23.898	**23.898**	**3.346**	23.898	23.898	2.682	19.159	19.159
2	1.348	9.627	**33.525**	**1.348**	9.627	33.525	1.670	11.927	31.086
3	1.284	9.169	**42.694**	**1.284**	9.169	42.694	1.423	10.165	41.251
4	1.148	8.203	**50.897**	**1.148**	8.203	50.897	1.272	9.087	50.338
5	1.124	8.030	**58.926**	**1.124**	8.030	58.926	1.202	8.588	58.926
6	.938	6.700	65.626						
7	.912	6.513	72.140						
8	.791	5.647	77.787						
9	.710	5.070	82.857						
10	.622	4.442	87.298						
11	.535	3.822	91.121						
12	.486	3.475	94.596						
13	.408	2.914	97.510						
14	.349	2.490	100.000						

Extraction Method: Principal Component Analysis.

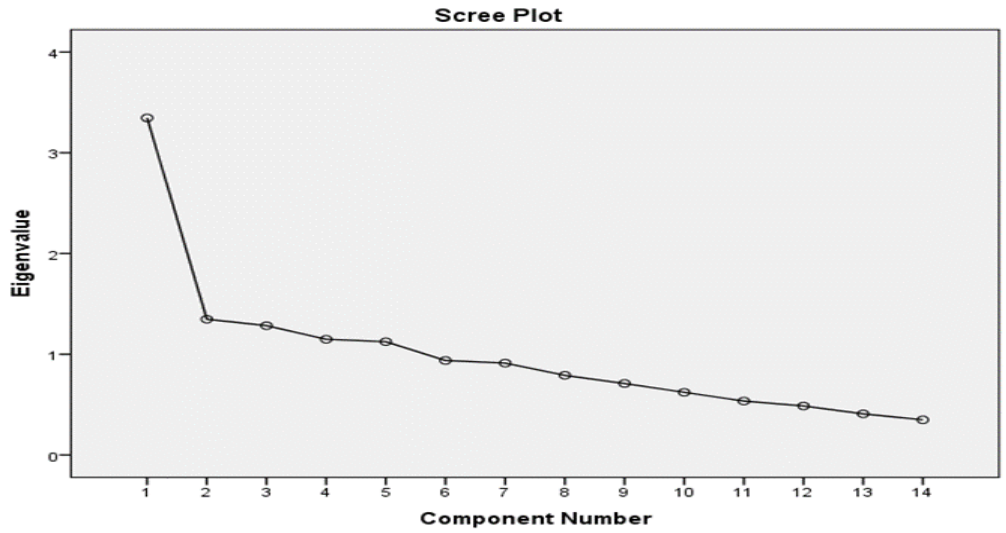

Figure 4.5: Scree Plot

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

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Table 4.21: Component Matrix [a]

Component Matrix [a]						
Indicators	Component					Communalities
	1	2	3	4	5	
Medical aid	**0.729**	-0.052	0.068	0.061	-0.016	**0.543**
Crane facility for vehicle breakdown	**0.726**	-0.032	0.309	-0.1	-0.105	**0.645**
Ambulance for accidents victims	**0.695**	-0.074	0.186	0.049	0.146	**0.547**
Highway Police patrolling	**0.644**	0.054	-0.349	-0.331	0.262	**0.719**
Telephone booth for emergency calls	**0.626**	-0.293	0.196	-0.193	-0.209	**0.597**
Pedestrian crossing facilities	0.573	-0.017	-0.5	-0.25	0.328	0.749
Lighting at the Junctions	0.444	0.417	0.117	0.165	-0.401	0.573
Signs and signals	0.406	0.207	0.093	0.29	-0.103	0.311
Cafeteria	0.327	-0.538	-0.215	0.17	-0.348	0.592
Roadway markings	0.11	0.468	0.193	-0.411	0.247	0.499
Rest house for drivers or Travelers	0.138	-0.434	0.505	0.186	0.365	0.63
Parking lots	-0.038	0.305	0.465	-0.361	-0.249	0.503
Smoothness	0.349	0.373	-0.382	0.306	-0.276	0.577
Shoulder condition	0.209	0.322	0.127	0.596	0.496	0.765

Extraction Method: Principal Component Analysis.

a. 5 components extracted.

Note: - Without rotation, first factor is the most general factor onto which most items load and explains the largest amount of variance.

The correlation value above 0.5 deemed important for interpreting the five principal component results in this study. The first component is strongly correlated with almost all variables in all constructs Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.14 Road user service variables selected in the study are finally grouped into five underlying factors which are called Principal components shown in the component plot which represent the largest factors loadings on the 5 principal components

Factor I were identified as prime factors which explain around 58.9 of variance on the over extent of adoption on user amenities, and security and emergency service on road by Ethiopia toll roads Enterprise. Theses includes Medical Aid Service (23.33), Crane facility for vehicle breakdown, (9.629), Ambulance for accidents victims (9.169), Highway Police patrolling (8.203) and Telephone booth for emergency calls (8.030). It could be seen from the table that the Security and Emergence service on the road highest factor loading.

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Chapter Five
Summary, Conclusions and Recommendations

5.1. Summery

The study focused on analyzing the performance of Toll Roads sector in Addis Adama Express Road segment, which consists of 29 toll booth plazas. The operational system primarily comprises of tolling infrastructure and roadway services such as parking, 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 regional state and city.

5.2. Performance of Roads Across Various Indicators:

5.2.1. Conclusion on Tolling Operations Service

It is observed that the Tulu Dimtu toll plaza on Addis Ababa 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. It is seen that they have a good toll plaza management system which is even better than the Adama and Mojo Roads

The toll plaza built on all station lags in police aid and Electronic tool system 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.

5.2.2. Main Factors Affecting Tolling Operations Performance

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. There are no electronic tolling collections systems are adopted by any toll operators in the Ethiopian Toll Roads Enterprise (ETRE).

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5.2.3. Conclusion for Toll Road Users Service

In the study of Road User Service parameters, the aggregate performance of various factors is 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. Across all main service factors, that averaged 3.36, 2.83, and 2.84, respectively. Addis Ababa Roads Expressway is perceived relatively as best performing road though it scored 3.36 against the minimum targeted score of 3 points. Mojo and Adama Roads poorly performing against an expected score of 3 points.

5.2.4. Recommendations for Improving of Services

Plan better emergency services on the road by increase the number of ambulance and crane in each road station so that increase first aid response time and better crane service availability during vehicles breakdown on the roads. Response to public grievances should be prompt and courteous. The road user's complaints given in writing must always be followed up through written feedback. Road users feel that the facility should be provided free by the Ethiopian Toll Enterprise as they are already paying Toll fee. 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.

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Appendix I

Name of the Toll Plaza location: **Tulu-Dimtu**

Type of road: **Addis Ababa Road**

Questionnaire For of Tolling Operations Efficiency Ranking								
Name of the Toll Plaza location: Addis Ababa Direction Road (**Tulu-Dimtu Station**)								
TOLL PLAZA INFORMATION AND MANAGEMENT SYSTEM (TPIMS)								**Yes=1, No=0**
1	Display of Project Details Near The Toll Plaza Area						Yes/No	
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	Auto Railing						Yes/No	
TOLL TECHNOLOGY AND SURVEILLANCE SYSTEMS (TTSS)								
1	Security Personnel						Yes/No	
2	CCTV in Toll Booth						Yes/No	
3	Electronic Toll Collection System (ETC)						Yes/No	
4	Over load control System (WIM Bridge)						Yes/No	
5	Automatic Vehicle Classifier						Yes/No	
6	Fire Controlling System in Toll Station						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								If Yes, the Level of Quality of Facility
1	Public Toilets Lay Buy						Yes/No	
	If Yes, the Level of Quality of Facility	5	4	3	2	1		
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	5	4	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	
	If Yes, the Level of cleaners	5	4	3	2	1		

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Appendix I

Name of the Toll Plaza location: **Adama**

Type of road: **Adama Road**

Questionnaire For of Tolling Operations Efficiency Ranking								
TOLL PLAZA INFORMATION AND MANAGEMENT SYSTEM (TPIMS)								**Yes=1, No=0**
1	Display of Project Details Near The Toll Plaza Area						Yes/No	
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	Auto Railing						Yes/No	
TOLL TECHNOLOGY AND SURVEILLANCE SYSTEMS (TTSS)								
1	Security Personnel						Yes/No	
2	CCTV in Toll Booth						Yes/No	
3	Electronic Toll Collection System (ETC)						Yes/No	
4	Over load control System (WIM Bridge)						Yes/No	
5	Automatic Vehicle Classifier						Yes/No	
6	Fire Controlling System in Toll Station						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								If Yes, the Level of Quality of Facility
1	Public Toilets Lay Buy						Yes/No	
	If Yes, the Level of Quality of Facility	5	4	3	2	1		
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	5	4	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	
	If Yes, the Level of cleaners	5	4	3	2	1		

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Appendix I

Name of the Toll Plaza location: **Mojo**

Type of road: **Mojo Road**

Questionnaire For of Tolling Operations Efficiency Ranking								
TOLL PLAZA INFORMATION AND MANAGEMENT SYSTEM (TPIMS)								**Yes=1, No=0**
1	Display of Project Details Near The Toll Plaza Area						Yes/No	
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	Auto Railing						Yes/No	
TOLL TECHNOLOGY AND SURVEILLANCE SYSTEMS (TTSS)								
1	Security Personnel						Yes/No	
2	CCTV in Toll Booth						Yes/No	
3	Electronic Toll Collection System (ETC)						Yes/No	
4	Over load control System (WIM Bridge)						Yes/No	
5	Automatic Vehicle Classifier						Yes/No	
6	Fire Controlling System in Toll Station						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								If Yes, the Level of Quality of Facility
1	Public Toilets Lay Buy						Yes/No	
	If Yes, the Level of Quality of Facility	5	4	3	2	1		
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	5	4	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	
	If Yes, the Level of cleaners	5	4	3	2	1		

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Appendix II

Questionnaire Toll Road User Satisfaction Survey This survey is meant for **Masters of Art Project Management Program 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.

A. Personal Details

1. Type of Vehicle Observed on the Road

a. Business
b. Recreation
c. Social
d. Other

2. Category of respondent

a. Driver ☐ Passenger ☐ c. Other ☐

3. Have you ever paid toll): Yes ☐ No ☐ Toll Exempted? ☐

4. Do you possess Toll pass Yes ☐ No ☐

Mention the type of pass Monthly ☐ Quarterly ☐ Other ☐

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. Have you attended any Toll road awareness programme (for understanding the benefits of toll road)?

Yes ☐ No ☐

7. How satisfied are you with the complaint redress system of road maintenance agencies?

a. Highly satisfied ☐
b. Somewhat satisfied ☐
c. Somewhat satisfied ☐
d. Somewhat dissatisfied ☐
e. Highly dissatisfied ☐

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

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

	Parameters	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	Cafeteria					
2	Medical aid					
3	Parking (Lay Bay)					
4	Allowable Rest houses for drivers					

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Appendix III

Photos of Various Toll Plazas in the Study Area

Photo of Toll Plaza (Addis Ababa Road Tulu-Dimtu Station)

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Photo of Toll Plaza (Adama Road –Adama-Km-64 Station)

Photo of Toll Plaza (Mojo-Road Km-52)

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