A STUDY ON THE USE OF ROAD PRICING TO GENERATE MAINTENANCE REVENUE AND REDUCE TRAFFIC CONGESTION ON THIKA HIGHWAY

BY

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A MANAGEMENT RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION, UNIVERSITY OF NAIROBI

OCTOBER 2012

DECLARATION

I declare that this research project is my original work and has not been presented for the award of a degree in any other University.

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This research project has been submitted for examination with my approval as the University Supervisor.

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ACKNOWLEDGEMENT

First and foremost, I would like to thank the Almighty God for His divine intervention in this academic endeavor, and who, through His grace, made all things possible.

I would like to acknowledge and extend my heartfelt gratitude to my classmates who have been a constant source of encouragement and support.

I would like to express my deepest gratitude to my supervisor, Dr. Josphat Lishenga, for his excellent guidance and unwavering support.

Above all, I give my utmost appreciation to my family; for their endless love and good-natured forbearance through the duration of my study, and for their pride in this accomplishment.

DEDICATION

I dedicate this project work to my mother, who instilled a love of reading and respect for education, and to my family, who have always believed in my ability to accomplish that which I set out to do.

ABSTRACT

The objective of the study was to determine an indicative road pricing charge that can be used to generate revenue for the maintenance of the Thika Highway. An exploratory research design was adopted since the concept of road pricing is fairly new in Kenya.

Secondary sources of data were mainly used in this study. They included motor vehicles registration database, government ministry reports, surveys and interviews with professionals in the field. Data was analyzed using Statistical Packages for Social Sciences (SPSS) version 11. Regression and correlation analysis was used to determine the nature and the strength of the relationship between the independent and dependent variables.

Based on the regression and correlation analysis of each of the variables involved in the study, the findings indicated that the introduction of road pricing has the potential to generate revenue for the maintenance of Thika Highway. This is well illustrated by the existence of a strong correlation between the level of road pricing fees charged and the revenue generated. It was established that maintenance costs, operating costs and congestion charges would positively influence the revenue realized from road pricing. This would imply that as more costs of this form are incurred, higher fees in the form of road prices should be charged and this would lead to increased revenue. However, controllable costs like operating costs, including equipment and administration costs should be properly monitored to minimize the overall effective costs passed on to the motorists. The study showed that the introduction of measures that discourage congestion on roads should be used to minimize the fees charged on motorists plying the highway. The overall regression results showed that passenger car units had a negative influence on the price charged on motorists using Thika Highway. This would imply that as more passenger car units are introduced on the highway, the price charged on motorists decreases. The study also showed that the inclusion of a congestion fee in the road pricing charge can be used to control the volume of motor vehicles on the road, thereby offering a solution to traffic congestion.

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LIST OF ABBREVIATIONS

AC	-	Average Cost
AFDB	-	African Development Bank
ALS	-	Area Licensing Scheme
CCTV	-	Closed Circuit Television
CO	-	Carbon Monoxide
CO2	-	Carbon Dioxide
CVA	-	Controlled Vehicular Access
ERP	-	Electronic Road Pricing
GBP	-	Great Britain Sterling Pound
IBM	-	International Business Machines
KM	-	Kilometer
KPH	-	Kilometer Per Hour
LOS	-	Level Of Service
LRMC	-	Long Run Marginal Cost
NCBD	-	Nairobi Central Business District
NPV	-	Net Present Value
PED	-	Price Elasticity of Demand
PCU	-	Passenger Car Unit
RMLF	-	Road Maintenance Levy Fund
SEK	-	Swedish Kronor
SGD	-	Singapore Dollar
SPSS	-	Statistical Program for Social Sciences
SRMC	-	Short Run Marginal Cost
UK	-	United Kingdom
US	-	United States
VOC	-	Volatile Organic Compound
ZTL	-	Zone of Traffic Limitation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Roads are the dominant mode of transport in Africa, carrying close to 90 percent of the region's passenger and freight transport, and providing the only access to rural communities where over 70 percent of Africans live. Despite their importance, most of the roads are poorly managed and badly maintained. By 1990, nearly a third of the 150 billion dollars invested in roads had been eroded through lack of maintenance. This was attributed to lack of funds. To restore the roads that are economically justified and prevent further deterioration will require annual expenditures of at least USD 1.5 billion over the next ten years, or more than double the requirements of regular maintenance (Andreas and Bull, 1993).

There is an urgent need for reforms aimed at establishing an adequate and stable flow of funds for infrastructure development and maintenance. Most Governments in Africa are seriously short of fiscal revenues. Budget allocations for road maintenance rarely exceed 30 percent of requirements, and in most cases it is not feasible for governments to increase these allocations under present fiscal conditions. Improved revenue mobilization is thus essential to manage the shortfall. Several African countries are addressing this issue by introducing an explicit road tariff consisting of vehicle license fees and a fuel levy (Newbery et. al, 1988).

Road pricing is an example of an innovative revenue generation proposal for roads. The term "pricing," as applied to road usage, entails fees that vary by level of vehicle demand and usage on the facility. This will also assist the Ministry of Roads and Kenya Roads Board (KRB) in the collection of Revenue (Appropriation in Aid to bridge the resource gap in the funding of the roads maintenance and repair. By varying the charges, free flow can be maintained while generating revenue that can support either construction of the additional tolled capacity or transit and highway services. Aside from the generation of revenues, road pricing has the potential to reduce the levels of traffic congestion and its negative externalities, namely wasted time, fuel, and harmful emissions (Decorla-Souza, 2011).

Road pricing is popular way to fund highway and infrastructure projects in many countries in both developed and developing countries. The charges levied under road pricing are on a fee-for-service basis, with revenues dedicated to roadway project costs. This is considered more equitable and economically efficient than other roadway funding options which cause non-users to help pay for the projects. Road pricing is often proposed in conjunction with road privatization (that is, highways built by private companies and funded through road pricing). Road pricing charges are often structured to maximize revenues and the success of such schemes is measured in terms of project cost recovery. Where road pricing is implemented, the administering authorities may discourage development of alternative routes or modes. (Metschies, 2001).

Given the fact that congestion levels on roads are steadily increasing, there is a need to ensure that the resources are utilized in an optimum manner. People using scarce public resources, including road space, should pay for what they use, and should understand the reasons behind the charge. Once the public understands that good involve a cost element, they begin to use resources judiciously. This ultimately leads to a more functional, organized and responsive road network where user's pay the full costs of the service they receive (Schweitzer & Taylor, 2010).

The Kenyan road network consists of 63,300 kilometers (km) of classified roads and 114,500 km of unclassified roads. About 14% of the classified road network (that is 9,100 km) is paved, the rest being of gravel or earth surface. Road transport is the predominant mode of transport in Kenya, accounting for about 85% of the total domestic transportation.

Overall expenditure for the Ministry of Roads in the financial year 2011/2012 was 82.2 billion Kenya shillings, up from 61.2 billion Kenya shillings the previous year (Kenya National Bureau of Standards, 2012). This is a huge budget requirement given that there are other increasing constraints to the national budget from other sectors of the economy.

The number of people owning cars is on the increase. This indicator calls for the opening of new roads and expansion of the existing ones, and hence the need for innovative and alternative methods to raise revenue that will then act as a resource base to provide an efficient and effective road network.

A paved road in good condition, carrying about 500 vehicles per day, requires resealing or light overlays, costing about 23,600 dollars per kilometer, every seven years to keep it in good condition. This has a net percent value (NPV), discounted at 12 percent over twenty-five years, of 17,688 dollars per kilometer. Without maintenance, the road will deteriorate from good to poor condition. This will increase vehicle operating costs by about 5,000 dollars per kilometer, which has an NPV, when discounted over twenty-five years, of 39,200 dollars per kilometer. The benefit/cost ratio of a fully-funded road maintenance program is thus 21,512 dollars (Thriscutt et al., 1999).

The Kenya Roads Board (2006) estimates the annual maintenance costs of Kenya roads to be 23.8 billion Kenya shillings. In addition, an estimated sum of 421 billion shillings is required to clear the maintenance backlog. This includes provision for 1% that is earmarked for allocation to the Kenya Wildlife Service (KWS) and the 2% allocated as administrative charges for the Kenya Roads Board.

The current allocation by the Government to finance roads is inadequate. Also, the allocation of resources to the roads department is arbitrary and does not leave room for innovative ways to fund the infrastructure development and maintenance. Road infrastructure funding is distributed across different ministry's departments, resulting in inadequacy of the resource. Table 1 shows the roads maintenance receipts, which has been a consistent financing source of the roads kit.

Table 1: Road maintenance receipts from Kenya Roads Board

Year	Road maintenance levy fund (Ksh)
1999/00	500,000
2000/01	208,179,146
2001/02	32,000,000
2002/03	60,000,000
2003/04	158,471,737
2004/05	160,000,000
Total	**459,150,883**

Source: City Engineer Department, 2005

The current practice used by the Government of Kenya to finance roads is inadequate. The Government of Kenya established the Road Maintenance Levy Fund (RMLF) in the year 1993 in an effort to create a steady and reliable source of funds for road maintenance. The RMLF generates a substantial amount of money, which is adequate to cover the periodic and routine maintenance needs of the network but not the maintenance backlog. The RMLF is managed by the Kenya Roads Board and is allocated based on the following breakdown: 57% for main roads (class A, B, C), 31% for district roads (class D & E), and 8% for urban roads. About 65% of the funds are allocated to paved roads, and 35% to the unpaved network. Table 2 below shows the maintenance funding sources.

Table 2: Road Maintenance Fuel Levy Collections for the period 2002-2006

(Figures millions of dollars)

Description	**2002-03**	**2003-04**	**2004-05**	**005-06**	**2006-07**
Fuel Levy	111.52	130.34	136.41	148.54	237.46
Transit Tolls	-	-	-	-	4.70
Surplus b/f	3.05	4.31	13.60	13.93	14.53
Total	**114.57**	**134.65**	**150.01**	**162.47**	**256.69**

Source: Kenya Roads Board, 2008

Alternative sources of finances should be harnessed, particularly from the private sector or through cost sharing mechanisms. In many cases, motorist and frequent road users have been a source of funds through excise taxes on motor vehicles, annual license fees, fuel taxes, road and bridge tolls and parking charges (Wasike, 2001).

A solution that is considered key to strengthening the financing and management of roads is commercialization. This means that roads must be brought into the marketplace, priced and put on a fee for service basis (World Bank, 1991).

Revenue generated from road pricing can be used as the primary source of funds for repayment of long-term debt issued by donors to finance an infrastructure project. The funds can also be reinvested in capacity expansion or used to pay for operations and maintenance of the facility (Timothy, 2006).

The Nairobi-Thika Highway is one of three major corridors linking downtown Nairobi to the suburbs and satellite towns. Traffic demand on the road is almost twice the existing capacity. The condition of the road had deteriorated and required rehabilitation. The poor level of service resulted in long traffic delays, unpredictable travel times, excessive harmful emissions and numerous accidents. To accommodate the existing and future traffic, the highway needed substantial improvements to increase its capacity. This resulted in the Nairobi-Thika Highway Improvement Project that entailed construction of additional lanes and the replacement of intersections with interchanges at several locations (Ministry of Roads, 2011).

The Nairobi-Thika highway was initially a dual-carriageway road of about 45 km. The road is part of the classified international trunk road A2 which originates in downtown Nairobi and extends to Moyale at the Ethiopian border. The road is an important link on the Great North Trans-African Highway (Cape Town to Cairo), and is one of the highest priorities in the NEPAD short-term action plan. The section of highway under consideration was constructed to bitumen standard in the early 1970's. This road operates beyond capacity, carrying more than 60,000 vehicles per day (African Development Fund Appraisal Report, 2007).

Modern highways and infrastructure projects are normally costly and require major financing for smooth operations. Despite these costs, financiers are always willing to step-in for long term gain. The African Development Bank (AfDB) financed the first two phases of the Nairobi Thika Highway from Nairobi city centre to Kenyatta University at a cost of 14 billion Kenya Shillings. The government of Kenya also gave KSh3 billion. The third phase from Kenyatta University to Thika town was financed by the Chinese government. Approximately 32Billion will have been used by the time it is completed. The operation and maintenance costs for this project are also going to be high given the size of the project (The Centre for Sustainable Urban Development, 2012).

Most financiers of large scale and complex infrastructure projects in Kenya enter into Engineering, Procurement and Construction (EPC) contracts with the relevant parties in a bid to safeguard their investments. The EPC contract ensures that the contractor provides a suitable performance security since he is obliged to deliver a complete facility to the developer for a fixed price by a specific date. This in turn helps secure the ability of the developer to meet the financiers' repayment terms and conditions thus effectively reducing the risk of default in repayment (Tharani et al., 2012).

The negative externalities created by overstretched road infrastructure facilities also present an ideal case for a Pigouvian corrective tax or charge, and provides the standard argument for road pricing. A charge equal to the marginal congestion cost would make drivers face the true cost of their journey, thus maximizing social surplus and internalizing the congestion externality (Vickrey, 1969).

1.2 Statement of the Problem

The budgetary requirements of various sectors of the Kenyan economy have been increasing over time, a trend which is expected to continue in future. This calls for innovative solutions to sustain the current development programs and projects.

The idea behind road pricing comes from the standard economic theory of efficiency and externalities. This study attempts to apply to the commodity 'road space' the economic principles on which we rely for the allocation of most of our goods and services. The objectives of this study are to show roads have the capacity to generate revenue that can finance their construction costs and also provide funds for their maintenance.

If roads were provided privately and competitively then the inefficiency in the use of roads and the related congestion problem currently being experienced would not exist. Road owners would price to maximize profits and in so doing would take into account the issue of net investment so that prices would accurately convey information about where and when to build new roads (Button 1993)

This study is concerned with the use of road pricing to generate revenue from the newly constructed Thika Highway. There are no studies that have been done in Kenya to explore the use of road pricing in generating revenue from infrastructure projects, most notably the Thika Highway.

1.3 Objective of the Study

The objective of this study is to explore the possibilities of using road pricing as an alternative means of generating revenue for maintenance of Thika Highway. The specific objective of this study is to establish an indicative road price for the Thika Highway.

1.4 Significance of the Study

This study will benefit the Government of Kenya by highlighting the possibility of generating revenue through road pricing, and specifically the fees levied on motorists using the Thika Highway. This revenue would be used to repay loans that were extended to assist with the construction of the highway. The revenue may also be used to improve and enhance efficient road transport on the Thika Highway, resulting in a sustainable urban transit system. The study will also attract and promote private sector involvement in management and operations of the roads and other public facilities, thereby availing much needed financial and skill resources.

The Government of Kenya will also benefit from this study since it will act as a blue print for future road and infrastructure projects where their funding would be generated by road pricing based on the existence of demand for the same. Other roads that could be financed under this method include the Nairobi Kisumu Highway and the recently commissioned Lamu Port and Lamu Southern Sudan-Ethiopia Transport Corridor (LAPSSET) that is expected to cost between 22 billion dollars and 23 billion dollars.

By ensuring that roads are able to generate revenue to fund their maintenance and future expansion projects, the Government of Kenya will benefit from an improved infrastructure network. Significant infrastructure improvement would then result in the growth of the identified driving sectors of the economy. Better roads will also contribute to poverty reduction by lowering the costs of goods and services, improving access to social facilities and administration centers and improving safety and security.

This study will increase the social welfare of the citizens. This is because road pricing may ultimately lead to a change in commuting patterns of motorists, thus encouraging the development of an efficient, sustainable and reliable transport network. Such transport networks include train/rail systems, bus networks and car pooling systems. This will result in reliable and predictable travel schedules which will ultimately lead to reduced commuter fares.

This study will also benefit users of the Thika Highway by reducing congestion on the road. This is because the introduction of road pricing will act as signals to motorists about the real costs associated with particular trips and journeys, thus ensuring that only necessary trips are made. This will subsequently act as a tool for reducing traffic congestion.

Last and not least, the society as a whole will also benefit from more efficient land use decisions. This is because most of the future road construction projects will be pegged on the amount of revenue that can be raised from the project. The society will also benefit from reduced emissions and pollution to the atmosphere. This is because road pricing suppresses demand for motorized travel and thus normally results in less cars being on the road. Thus, the levels of carbon monoxide (CO) and volatile organic compound (VOC) emissions will be reduced. This will lead to a reduction of the negative effects of global warming that are being felt all over the world. Further to this, the reduced fuel usage will result in less demand for fuel, which is a big reason for the country's unfavorable balance of payments.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature that forms the basis of this study. It will highlight the theoretical framework where theories and models relating to the study are discussed. This will be followed by a review of empirical literature of past studies by various scholars. Since road pricing is fairly new in Kenya, the empirical literature reviewed will predominantly have a global focus. A review of other literature on road pricing will then follow. Lastly a summary of literature will conclude the chapter by pointing out the gap in literature in Kenya that the present study seeks to bridge.

2.2 Key Theories Guiding this Study

An Overview

The traditional approach to financing road construction and infrastructure projects in Kenya has been to seek donor support through the form of grants and loans. This approach is problematic since it exposes the Government to unfavorable terms and conditions that also form part of such agreements.

Rising incidences of traffic congestion have also necessitated the construction of new roads and related infrastructure projects in a bid to reduce the negative externalities that arise from this condition. Traffic congestion is a consequence of the unique nature of vehicular supply and demand: capacity is time consuming and costly to build and is fixed for long time periods; demand fluctuates over time, and transport services cannot be stored to smooth imbalances between capacity and demand. Road pricing is a concept from market economics regarding the use of pricing mechanisms to charge the users of roads for the negative externalities generated by the peak demand in excess of available supply. Its economic rationale is that, at a price of zero, demand exceeds supply, causing a shortage, and that the shortage should be corrected by charging the equilibrium price rather than shifting it down by increasing the supply. Whenever the price of using some scarce, valued good does not increase as demand increases, that good will be in short supply. Shortages will be acute if supply cannot be readily enhanced. Throughout the economy, when demand for some commodity or service exceeds supply, the price tends to rise until demand and supply is in balance. (Small and José, 1998).

In its simplest form, road pricing requires motorists using roads to pay for the use of the road that was constructed using scarce resources, including public funds. Road pricing also forces motorists' to pay for the congestion they cause other motorists. In the short run, the optimal congestion charge generates a sizeable amount of revenue and reduces congestion to its most efficient level. Road pricing theory holds that congestion charges not only optimize the use of the current road system and generate substantial revenue in the short run, but in the long run, and if other assumptions hold, they also generate enough revenues to provide for demand in the future (Mohring and Harwitz, 1962).

2.2.1 The Theory of Demand, Supply and the Price Mechanism

Supply and demand is an economic model of price determination in a market. It concludes that in a competitive market, the unit price for a particular good will vary until it settles at a point where the quantity demanded by consumers (at current price) will equal the quantity supplied by producers (at current price), resulting in an economic equilibrium of price and quantity. The interaction between market demand and supply determines the equilibrium or market price (where demand equals supply). Shifts in the demand curve and/or the supply curve lead to changes in the equilibrium price. The market price and the price mechanism send signals to both producers and consumers (Arthur and Steven, 2003).

2.2.2 The Demand Curve Theory

The economics rationale for implementing road pricing is based on the assumption that roads mispriced goods; that is, highway capacity at a specific place and time is mostly inadequate to satisfy the demand it generates. The quantity supplied is less than the quantity demanded at what is essentially a price of zero (United States Congress Joint Economic Committee, 2003).

If a good or service is provided free of charge, people tend to demand more of it – and use it more wastefully – than they would if they had to pay a price that reflected its cost. Hence, road pricing is premised on a basic economic concept: charge a price in order to allocate a scarce resource to its most valuable use, as evidenced by users' willingness to pay for the resource (Holtz-Eakin and Douglas, 2003).

2.2.3 The Utility Theory

The demand model utilized is based on the random utility theory, where the travel behavior is represented assuming that each users: a) considers a positive finite number of mutually exclusive travel alternatives constituting his choice set; b) associates with each travel alternative of his choice set a utility regarded as a random variable; and c) selects a maximum utility travel alternative. It is assumed that the travel choice process can be broken down into a sequence of mobility choices (in this case: to travel or not to travel to the Thika Highway, by which transport mode, and following which route). This can be represented by a choice tree, and each travel alternative can be thought as a path on the choice tree, specifying the choice made at each level, and its utility is the sum of the utilities associated with each arc of this path. In particular, each travel alternative (except for the not-to-travel on the Thika Highway alternative) is associated with one path on a modal network connecting the origin node of the trip to the destination node. On this basis, user's behavior is described in terms of the probability that each of his travel alternatives has maximum utility (Ben-Akiva and Lerman, 1985).

2.2.4 The Price Elasticity of Demand Theory

The price elasticity of demand (abbreviated Ped) is defined as the percentage change in the quantity demanded divided by the percentage change in price. Thus, it represents a measure of the responsiveness of the quantity demanded of a good to a change in its price, all other factors held constant (Stiglitz and Driffill, 2000).

2.3 Review of Literature Related to the Study

Road pricing is widely viewed by economists as the most efficient means because it employs the price mechanism, with all its advantages of clarity, universality, and efficiency. Pigou (1920) and Knight (1924) were the first to advocate it. But it was the late William Vickrey (1969), who steadfastly promoted road pricing for some forty years, and was arguably the most influential in making the case on both theoretical and practical grounds. In one of his early advocacy pieces, Vickrey (1969) identified the potential for road pricing to generate revenue and also influence travelers' choice of route and travel mode.

2.3.1 Twentieth century leaders

Smith (1977) proposed that all transportation and infrastructure projects (including roads and bridges) be managed in such a way that they are able generate revenue that will defray their own expense, without bringing any burden upon the general revenue of the society. The first argument made by Smith is one of equity by stating that a carriage which passes over a highway or a bridge should pay toll in proportion to its weight and thus ultimately pay for the maintenance of those facilities exactly in proportion to the wear and tear which they cause.

Buchanan (1952) emphasized the potential role of road pricing in generating revenue and improving usage of road facilities. He explained that concentration on the allocation of benefits and equitable distribution of total highway costs had obscured the more important problem of adjusting user charges in order to promote an optimum utilization of existing road networks.

2.3.2 Mid-twentieth century models and practical proposals

To support the successful implementation of road pricing, Vickrey (1969) conveyed the idea that the charge set for road pricing should be set at short-run marginal cost (SRMC) rather than either long-run marginal cost (LRMC) or average cost (AC). He also proposed that random demand fluctuations should be met with responsive pricing whereby prices are adjusted to match SRMC as closely as practical.

In Norway, road pricing has been used to part-finance new roads since 1934, and now represents 35% of the annual road building budget. In 2007 there were 44 road pricing projects. Over 100 successful road pricing projects have been implemented to date. The operating-cost-to-revenue ratio varies, in some projects being only 5–10% whilst in others it can be up to 35–40%. (Amdal et al., 2007).

The trial and subsequent implementation of the Road Pricing in Stockholm was implemented with cameras on gantries at all entry and exit points to monitor the users of the scheme. According to Transek (2006), the revenues on an annualized basis were 763 million Swedish Kronor (SEK), which is equivalent to 103.77 dollars. Its estimated annual running costs were SEK 220 million (29.92 million dollars). The start-up cost, including capital cost and operating cost for the first year, was estimated to be about SEK 2 billion (272 million dollars). Thus in financial terms it would take 3.5 years for net income to cover the investment cost, or 4 years in socioeconomic cost–benefit terms. This is a very short repayment period compared to investments in road infrastructure or public transport, which have a repayment time of 15–25 years at best. After that, net income is estimated to be SEK 540 million (73.44 million dollars) per annum, not taking into account any growth in traffic. Thus, the net income for 10 years' operation would be SEK 3.5 billion (476 million dollars), or close to SEK 9 billion (1.224 million dollars) over 20 years.

The road pricing scheme that was introduced in London generated revenues of 213 million pounds. Associated operation and administration costs amounted to 90 million pounds, leaving net revenues of 123 million pounds (Transport for London, 2007).

In the United States, San Diego City has had an operational road pricing scheme in place since 1998. Vehicles pay a per-trip fee each time they use the priced lanes. Charges and fees under this scheme vary dynamically with the level of traffic demand on the lanes. Fees vary in 25-cent increments as often as every six minutes to help maintain free-flow traffic conditions. The project generates a revenue of 2 million dollars annually, with about one-half of this revenue being used to support transit service in the region (United States Department of Transport, 2006).

According to the German road pricing system operator, Toll Collect (2009), the scheme generated more than 4.4 billion Euros during the year 2009. Its operating costs were between 11-12% of the income.

The Singapore Electronic Road Pricing scheme went live in 1995, using advanced technology and camera-based enforcement. In 2004, the annual revenue generated under this scheme was 80 million Singapore Dollars (SGD), which is equivalent to 58.4 million dollars. The running costs of the scheme were SGD 16 million, equivalent to 11.68 US dollars (Gopinath, and Chin, 2004).

2.4 General Literature Review

There has been a vast accumulation of the literature that deals with the theoretical and empirical aspects, policy experiences, and environmental issues of road pricing. A fundamental question is how to choose the optimal charge level of congestion prices in a simple yet practical manner. Subsequently, the travel demand function for road pricing is considered to be very important. Unfortunately, the demand curve is usually unknown and difficult to estimate in practice even with advanced transport modeling techniques. To resolve this dilemma, Li et al. (2007) proposed a practical iterative procedure in deriving the optimal congestion price in the absence of demand function, and applied the procedure to estimate the congestion price by directly using the commonly available traffic count data for the area under review. This enlightening implementation idea can date back to Vickrey (1969) and Downs (1992) who argued that road pricing could go ahead on a trial-and-error basis without the accurate computation of the demand function.

The optimal charge (also known as Pigouvian Tax) to be levied on a particular road at a particular moment in time can be well explained by matching the personal marginal cost of road use to the social marginal cost of the same road. For each road and each time period, the is the marginal external cost (marginal social cost less marginal private cost) at the point where the marginal social cost is equal to the marginal social benefits.

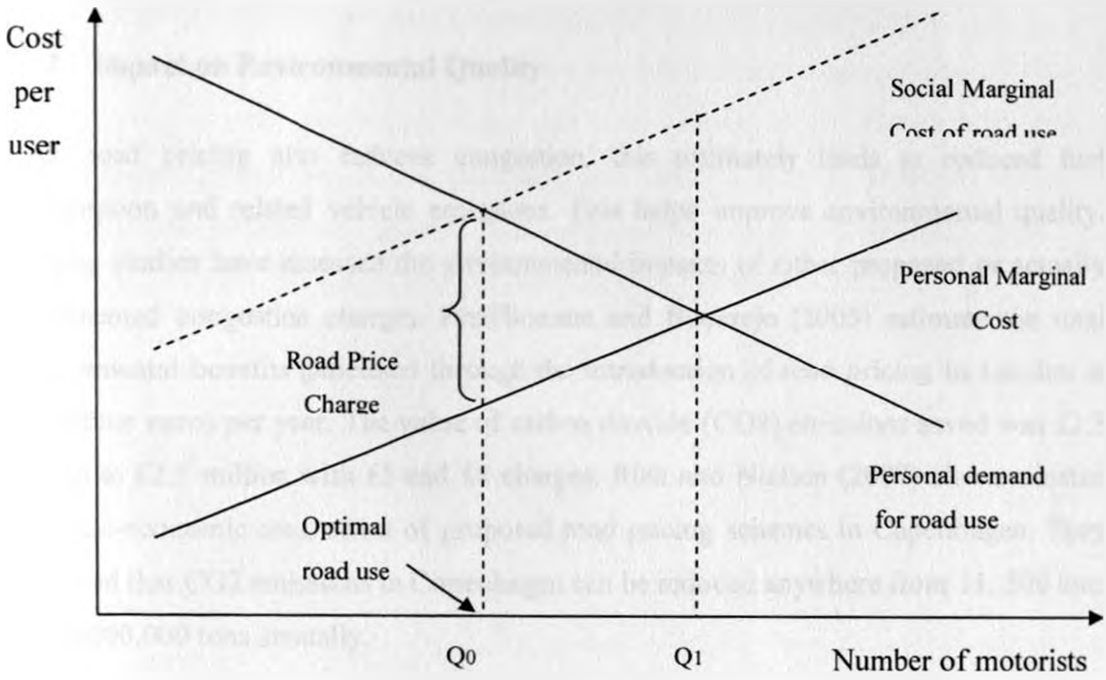

Figure 1: Road pricing Illustrated
Source: Nye (2008).

In the absence of road pricing, road use is Q_1, at which the private benefits are lower than the social costs, hence an inefficient outcome. Levying an optimal congestion price would move road use to Q_0 (Nye, 2008).

2.5 Impact of Road pricing

In addition to generating revenue, road pricing has several impacts, such as reducing fuel consumption, and improving environmental quality and social welfare.

2.5.1 Impact on Transportation Services

One of the objectives of road pricing is to generate revenue. However, road pricing also reduces traffic congestion. This can be done by facilitating a shift to other modes of transportation. This requires the establishment of an effective transport system. For example, the road pricing system introduced in London led to the reduction in traffic by 12%; of which 50-60% shifted to public transport (Transport for London, 2004).

2.5.2 Impact on Environmental Quality

Since road pricing also reduces congestion, this ultimately leads to reduced fuel consumption and related vehicle emissions. This helps improve environmental quality. Existing studies have assessed the environmental impacts of either proposed or actually implemented congestion charges. Prud'homme and Bocarejo (2005) estimate the total environmental benefits generated through the introduction of road pricing in London at 4.9 million euros per year. The value of carbon dioxide (CO_2) emissions saved was £2.3 million to £2.5 million with £5 and £8 charges. Rich and Nielson (2007) also evaluated the socio-economic assessment of proposed road pricing schemes in Copenhagen. They estimated that CO_2 emissions in Copenhagen can be reduced anywhere from 11, 500 tons to 154,000,000 tons annually.

2.5.3 Impact on Economy and Social Welfare

A number of studies have analyzed the economic and social welfare impact of road pricing. Whether or not a road pricing improves welfare depends on several factors, including the definition of welfare itself. Studies conducted as early as the 1960s have showed that road pricing can increase social welfare. This is because road pricing ensures a more efficient use of existing infrastructure while generating revenues, which then can be invested in the road and public transport systems (Walters, 1961).

Webster and Evans (2005) argue that low-income groups can benefit from road pricing if the revenue generated is invested in public transportation. This is because low-income groups use public transportation more often than higher income groups, and thus will profit more from the revenues generated through road pricing.

2.6 Attitudes towards road pricing on public roads

When it comes to markets, people are continually choosing between lower-priced but more crowded conditions, and more expensive, less congested alternatives. They do this in their daily choices to patronize, or not, a crowded fast food chain, or a bargain sale at a local department store which they expect will attract large crowds. The problem with a road network in this regard, is that there is no functioning market in which the consumer can make his preferences known; there are no congested but cheaper highways, competing alongside more expensive but emptier ones (Block and Yuker, 2002).

Thus, road pricing on roads is a simple concept that extends the common practice that is virtually ubiquitous in every other sector of a market economy whereby prices are used to reflect scarcity, and to allocate resources to those that can best use them. In most places road space, even in such supposedly market orientated societies as the United States (U.S.), is in actuality allocated in a manner more akin to the general practices employed in pre-1989 communist Russia, namely by waiting in queues and lines (Button, 1993).

2.7 Difficulties in Implementing Road pricing

Widespread implementation of road pricing has been opposed because of practical difficulties. There are several practical considerations as explained below.

2.7.1 Technology and administration costs

The costs of road pricing were a major concern in the 1950s and 1960s. Foster (1974) expressed unease about the need for frequent and costly collection booths. Such concerns have faded since the advent of affordable and reliable electronic collection systems, which permit congestion charges to be varied by location, time of day and various vehicle characteristics. But for roads with low traffic volumes, the costs of pricing are inhibitive, and some economists still perceive them to be a problem generally.

2.7.2 Difficulties in computing a comprehensible optimal charge

The best way to finance road construction and ration their capacity where they cannot be expanded is to charge a market price for the right to use them. Charges should be set just high enough to hold traffic down to levels that can move freely. The principle is equivalent to that of admission to a theater: it is self-defeating to let in so many people that everybody's view is spoilt, so sensible theater managers set prices that fill them to just below the point of discomfort (The Economist, 1997).

It is obvious that setting a proper price is important to the success of road pricing. If the fees are too low, they will not generate sufficient revenue to recover their initial capital outlay or fund their maintenance and related operations. If the prices are too high, the roads will be underused, and motorists and voters can be expected to be critical of that as well (Toh, 1977).

Given that there is no perfect way to predict the appropriate prices to charge, a derived estimate for the peak fee can be computed using standard approaches to calculating demand elasticities and short run marginal costs, and then subsequently adjusting the fees in response to observed traffic patterns. Thus, it is important to determine an appropriate traffic flow for a facility and then to set the price according to estimates of motorists' sensitivity to price increases in analogous situations. However, given the administrative and political constraints that road pricing proposals face, it may be difficult to obtain public and political approval of a proposal without publishing the fees in advance (Meyer et al., 1965).

2.7.3 Political opposition

The main challenge to the implementation of road pricing is opposition from politicians and other groups who consider themselves worse off once it is established. Users generally accept road pricing on a road that was not previously available if other roads are free. However, where all previously free roads are also charged, there is often opposition because the charge is perceived as double taxation and thus a burden on less affluent people. One of the key lessons learned from implemented road pricing projects is that the rationale behind road pricing has to be communicated well to the public in order to ensure the necessary acceptance. When the system of road pricing is transparent, and its advantages made clear to all road users, then public support may be high. This greatly assists in overcoming political opposition (Borins, 1988).

2.7.4 Legal framework

To implement road pricing in urban areas, municipalities must be in the legal position to directly charge for road use. National and local legislation does not always provide the legal grounds for such measures. In addition, legal procedures must exist for the identification, tracing and fining of offenders.

2.7.5 Strong planning institutions

Road pricing is a rather complex issue that needs a competent and well-organized transport planning authority. Such an agency needs professional skills to address a wide range of issues such as political issues, public awareness, transparency, transport planning, technical implementation, operational management, financial management and various other aspects. In many developing cities, the creation of such an agency may be a major bottleneck to the introduction of road pricing.

2.8 Chapter Summary

According to Pickford (2007), a comparison between the operating costs and the related revenues should be done before any road pricing program is implemented. Operating cost drivers are important features of such a decision. These include volume (economies of scale and diversity of payment channels); the proportion of services provided internally and measures (such as education and publicity) to achieve higher levels of compliance.

The success of road pricing largely depends on the accounting treatment (amortization) of scheme implementation costs; and the cost of enforcement. Revenue drivers of road pricing are the charging policy (high charges versus low charges); the decision on whether to collect road pricing fees to pay for infrastructure operations or to elicit change in road user behavior; the level of demand and willingness to pay for services received (elasticity of demand); and the inclusion of enforcement revenues (Pickford, 2007)

The evidence from countries that have implemented road pricing shows that such a scheme plays a vital role in generating revenue, encouraging improved quality of life in the urban environment, advancing economic productivity for goods movement and business, increasing the use of public transit, and reducing congestion and emissions.

The literature review reveals that most studies on road pricing have been conducted in Europe and other developed countries, with none having been done in Kenya. However, the reasons that led to the implementation of road pricing schemes in Europe and other developed countries, namely the need to generate revenue from expensive infrastructure and transportation projects, are similar to those being experienced in Kenya.

This study therefore seeks to bridge this gap in literature by using primary and secondary data to in exploring the use of road pricing to generate revenue for maintenance of the Thika Highway. The researcher's intention is to fill this gap in knowledge and thus provide valuable insights and ideas that would lead to generation of revenue from road projects that are mostly constructed using use public funds and resources.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research design, population, sampling design, the data collection method, research procedures and data analysis methods that were used in this study. This section also indicates the research tools that were employed to collect data and carry out the data analysis.

3.2 Research Design

Research design is a plan used to generate answers to a research problem. It refers to the way the study is designed and the method used to carry out the research. This study adopted an exploratory research design.

This research design was chosen because there are very few earlier studies on this topic in the country to which references can be made. Thus, it would aid the researcher gain new insights, discover new ideas and increase knowledge on the road pricing to generate revenue on the Thika Highway. Exploratory research design was also flexible and could address the research question in this study, namely, to establish an indicative road pricing charge that could be levied on Thika Highway.

3.3 Population of the Study

A population is the subject (such as a person, organization, customer database or amount of quantitative data) on which measurement is being taken (Cooper and Schindler, 2006). Since this is study adopted an exploratory research design, population for this study consisted of all the Government departments, planning authorities and the relevant stakeholders who would be involved in the implementation of a road pricing scheme on Thika Highway.

3.4 Sample Selection

A sample in a research study is a group on which information is obtained (Fraenkel and Wallen, 2006). Since the population in this study is not large, the researcher included the entire population.

3.5 Data Collection

The research study relied on primary and secondary sources of data. The data that is to be collected was used to determine the road pricing charge that would raise revenue that could be used to maintain Thika Highway.

The researcher relied on semi- structured or unstructured interviews to gather the primary data. These interviews were conducted on the relevant professionals and officials in the field and were aimed at getting their views on the issue. This included the Kenya Urban Roads Authority, the Ministry of Transport, The Kenya National Highways Authority and the Kenya Airport Parking Services (KAPS) company, among others. KAPS has been a solution provider of car parking, access control and revenue management systems since 1999. The company has become one of the regional leaders in this sector.

The semi- structured or unstructured interview formats were chosen because they allow greater flexibility and freedom in determining the interview process. To get in-depth views of the respondents, open-ended questions were used in such a manner that the respondents were free to provide as much information as possible. The respondents were assured that their participation was voluntary and that all responses would be anonymous and confidential.

The researcher also relied on secondary data to collect information. Data collected was from credible, respected, verifiable and generally available sources. These would include reports, publications and related surveys.

3.6 Data Analysis

Data analysis for this study would include the transcription of interviews. The data was edited in order to sieve any unnecessary information that may be supplied by the respondents. In editing, the researcher continuously tested the data for accuracy, validity and consistency. The data was then coded. This referred to the interpretive technique that both organized the data and provided a means to introduce the interpretations into certain quantitative data which was then analyzed. Regression analysis was conducted to establish the relationship between the variables in question. Statistical Package for Social Sciences (SPSS) software was also used for data analysis in this study. The package helped in organizing and summarizing data by use of descriptive statistics like tables. Data presentation was done through pie charts, graphs, percentages and frequency tables to ensure that gathered information was clearly understood.

3.6.1 Variables and Variable Measurement

The main aim of exploratory research is to uncover the boundaries of the environment in which the problems, opportunities or situations of interest are likely to reside and to uncover the salient variables that may be found there and which are relevant to the research project (Webb, 1992).

From the literature reviewed, it was discovered that the optimal road price levied on motorists in order to generate revenue is positively affected by the maintenance costs, operating costs, congestion charges and externality costs that are associated with the road. The research adopted the following model where the optimal road pricing charge was computed as shown below:

$$P = \frac{K + MC + OC + CC + EC}{PCU}$$

Where P = Road pricing charge

K = Loan repayment (where applicable)

MC = Maintenance cost of the road

OC = Operational cost of the scheme

CC = Congestion charge

EC = Externality Charge

PCU = Passenger Car Units

The road price charge (P) represented the indicative charge that should be levied on motorists using the Thika Highway. It represented the difference between the marginal social cost and private social cost of travel.

The loan repayment (K) is a constant that represented the amount of money that development partners and lenders expect on the loan that was used to build the infrastructure facility. In this study, the researcher considered the kshs 33 billion that was used to construct the road as a sunk cost, thus $K = 0$.

The maintenance cost (MC) represented the cost incurred to keep the road in a usable state. This maintenance cost included structural maintenance (of footways, cycle tracks and other rights of way), removal of some or all of the structural layers of a road or pavement and their replacement with new material, any consequent works in connection with drainage, road markings and kerbs, replacement of the existing wearing course to restore the running surface, filling of potholes and repair of barriers. There was also safety maintenance that includes the maintenance and replacement of existing road marking and studs, traffic signals, signs, crossings, illuminated bollards and road markings. These data was collected from the relevant authorities that regularly deal with road maintenance.

The annual operational cost (OC) represented the running and administrative costs of the road pricing scheme. This included research and modeling costs, information campaign costs, equipment costs (cameras, toll booths), call centre enquiries, enforcement costs, office administration and staff costs.

The congestion charge (CC) represented the price every additional driver must pay for the costs imposed to the infrastructure, and for the marginal increase in the average costs of the whole group of drivers on the road. The rationale of this charge implied that the road charge increased with congestion levels since the cost suffered by users was increasing with the quantity of vehicles. The objective of this charge was to make users more aware of the costs that they impose upon one another when consuming during the peak demand, and that they should pay for the additional congestion they create, thus encouraging the redistribution of the demand in space or in time, or shifting it to the consumption of a substitute public good; for example, switching from private transport to public transport. By varying this charge, it was possible to control the level of congestion on the road.

The externality charge (EC) represented the cost of negative components produced by the use of the road. Externality costs included air and noise pollution, environmental degradation and accidents. For the purpose of this study, the model above assumed that road use did not impose costs related to pollution, noise or accidents to society (that is, EC = 0). This would enable the study focus on the main objective, which was to establish an indicative road price.

Passenger Car unit (PCU) is a vehicle unit used for expressing highway capacity. It comprised of different types of cars being combined and expressed as a singular unit. Generally, one passenger car was considered as a single unit, while motorcycles were considered as half car units. Due to their size, buses and trucks were considered to be equivalent to 3 car units. For the purpose of this study, the researcher will include private cars, motor cycles, trucks, minibuses and passenger vans as the components of PCU. For example, one PCU in this study could comprise of 0.25 minibus, 0.15 passenger van, 0.15 passenger car, 0.35 truck and 0.1 motor cycle. This data was gathered by establishing the actual volume of each of the five types of vehicles on Thika Highway.

The dependent variable in this study was road price while the independent variables were road maintenance costs, scheme operational costs, congestion charge and the passenger car unit.

3.7 Data Validity and Reliability

Reliability is defined as the extent to which a test, observation or any measurement procedure produces the same results during repeated trials. It also referred to the extent to which data collection techniques or analysis procedures would yield consistent findings (Saunders et al., 2009). Data validity is the extent to which the instrument measures what it purports to measure. Content validity pertains to the degree which the instrument fully assesses or measures the construct of interest (Allen and Yen, 1979). Data validity is also concerned with whether findings are really what they appear to be (Saunders et.al, 2009). It also refers to how well the result of a research can give the right answer to the research questions (Remenyi and Quinones, 2000).

Data collected was from credible, respected, verifiable and generally available sources. Data was tested for accuracy to detect any possible errors, bias and manipulations. It was subjected to validity tests to ensure its validity for the intended study by ensuring that it is timely and relevant. A pilot study was conducted to evaluate the validity and reliability of the research instrument. The purpose of pretesting is to access the clarity of the items on the instrument so that those items found to be inadequate in measuring the variables could be discarded or modified to improve the quality of the research instrument.

During the pre test stage, the researcher discussed the questions with one of the respondents to determine their suitability, clarity and relevance for the purpose of the study. Modifications where necessary were made before it is the actual data collection commences. Reliability of the data is assured because the study relies on primary data and secondary data that can be easily verified.

CHAPTER FOUR

4.0 DATA ANALYSIS AND FINDINGS

4.1 Results Findings

Calculation of road pricing charge

Given

1. Average Maintenance Cost of 64,500 Kms is Kshs 23.8 billion p.a. (Kenya Roads Board, 2010)

$$\text{Maintenance Cost for Thika Superhighway} = \frac{23,800,000,000}{64500} X50.4 = 20,941,395$$

2. Kenya National Highways Authority– KeNHA:

Administration and operational costs are given as kshs 320 million (Kenya Roads Board, 2010). Responsibility for class A – 3541, B – 2639, C – 7851, Total = 14031 km

$$\text{Operational Cost for Thika Superhighway} = \frac{320,000,000}{14031} X50.4 = 1,149,455$$

3. Congestion Charge

German federal highways toll 17 cents/km (Federal Ministry of Transport, 2012)

Stockholm Congestion charging per vehicle $1.5-$3.0 USD (Bent, 2010)

$$\text{Congestion Cost for Thika Superhighway} = 2.25 \text{ X } 80 \text{ X } 0.1 \text{ X } 30000 = 540,000$$

4. Passenger Car Unit based on number of vehicles in 2009

	2009*	Unit PCU	Total PCU
Motor Cars	499,679	1	499679
Utilities, Panels Vans, Pick-ups, etc	219,901	2.9	637712.9
Lorries, Trucks and Heavy Vans	91,431	2.9	265149.9
Buses and Mini-buses	84,844	2.5	212110
Motor and Auto cycles	252,960	0.4	101184
Trailers	27,039	2.9	78413.1
Other motor vehicles**	45,229	1	45229
Total	**1,221,083**		**1,839,478**

Source: (Author, 2012)

PCU for Thika Superhighway for 30,000 cars = $\frac{1,839,478}{1,221,083} X30,000 = 45,193$

$$P = \frac{K + MC + OC + CC + EC}{PCU}$$

$$P = \frac{20,941,395 + 1,149,455 + 540,000}{45,193} = 459$$

$$\text{Price per kilometer} = \frac{459}{50.4} = 9.9$$

4.2 Regression Analysis Results

4.2.1: Analysis of Variance

The table below gives the analysis of variance results for the regression model.

Table 3: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	498.098	3	166.033	330.577	.001[b]
	Residual	52.234	104	.502		
	Total	550.332	107			

a. Dependent Variable: Price/Km
b. Predictors: (Constant), Passenger Car Unit, Operating Cost, Congestion Charge

Source (Author, 2012)

Based on the findings of this study the p-value for the model was determined to be 0.001. Since the p-value for the model was found to be less than 0.05, the model was significant at 5% level of significance. This implied that the results of the analysis were reliable to draw conclusions from.

4.2.2: Model Summary

Table 4.2 below gives the model summary for the regression model studied.

Table 4: Model Summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.951[a]	.905	.902	.70870

a. Predictors: (Constant), Passenger Car Unit, Operating Cost, Congestion Charge
Source (Author, 2012)

Based on the findings, the coefficient of determination (R Square) value was found to be 0.905. This implied that 90.5% of variations in price/kilometer were explained by the four factors namely: Maintenance cost, Operating costs, Congestion Charge and Passenger Car Unit. 9.5% of variations in price/kilometer were influenced by other factors.

4.2.3: Linear Regression Coefficients

Table 4.3 below gives the linear regression coefficients for the model studied.

Table 5: Multiple Regression Coefficients[a]

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	9.627	.225		42.808	.001
	Operating Cost	1.426	.152	.284	9.409	.001
	Congestion Charge	.136	.026	.174	5.191	.001
	Passenger Car Unit	-.061	.002	-.969	-28.951	.001

a. Dependent Variable: Price/Km

The regression model was found as shown hereunder.

$$Y = 9.627 + 1.426OC + 0.136CC - 0.061PCU$$

4.2.3.1 Constant Coefficient: Maintenance Cost

Based on the results the constant coefficient was found to be 9.627. This implied that holding Operating Costs, Congestion Charge and Passenger Car units constant the motorists would have to pay Ksh.9.627 per kilometer as the road pricing charge of Thika Highway.

The corresponding p-value for the maintenance costs was found to be 0.001. Since 0.001 was less 0.05 hence maintenance costs were significant in explaining variations in price charged per kilometer at 5% level of significance.

4.2.3.1 Operating Cost

This study results indicated that the operating costs coefficient was 1.426. This implied that for every addition million shilling spent on operating costs of Thika Superhighway, motorist would be required to pay an extra Ksh.1.426 per kilometer for the road pricing charge.

The corresponding p-value for the operating costs was found to be 0.001. Since 0.001 was less 0.05 hence operating costs were significant in explaining variations in price charged per kilometer at 5% level of significance.

4.2.3.2: Congestion Charge

The study findings indicated the congestion charge coefficient to be 0.136. This implied that for every additional million shillings levied as congestion charge, the price charged per kilometer would increase by Ksh.0.136.

The corresponding p-value for the congestion charge costs coefficient was found to be 0.001. Since 0.001 was less 0.05 hence congestion charge costs were significant in explaining variations in price charged per kilometer at 5% level of significance.

4.2.3.3 Passenger Car Unit

Findings from this study for the Passenger Car Unit coefficient were -0.061. This implied that for every additional thousand passenger car units introduced on Thika Highway, the price charged per kilometer would decrease by Ksh.0.061.

The corresponding p-value for the Passenger Car Unit coefficient was found to be 0.001. Since 0.001 was less 0.05 hence Passenger Car Units were significant in influencing variations in price charged per kilometer at 5% level of significance.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the summary of the findings of the study, and also gives conclusions and recommendations based on the objective of the study which sought to explore the possibilities of using road pricing as an alternative means of generating revenue for maintenance of Thika Highway. The specific objective of this study was to establish an indicative road price for the Thika Highway.

5.2 Summary of Findings

The general objective of this study was to explore the possibility of using road pricing as an alternative means of generating revenue for maintenance of Thika Highway.

Based on the findings, the coefficient of determination (R Square) value was found to be 0.905 as shown in table 4.2 above. This implied that 90.5% of variations in price/kilometer were explained by the four factors namely: Maintenance cost, Operating costs, Congestion Charge and Passenger Car Unit. 9.5% of variations in price/kilometer were influenced by other factors. By extension this also implied that 90.5% of variations in revenue were explained by the four factors.

Based on the findings of this study the p-value for the multiple regression model was determined to be 0.001 using the ANOVA as shown in table 4.1 above. Since the p-value for the model was found to be less than 0.05, the model was significant at 5% level of significance. This implied that the results of the analysis were reliable to draw conclusions from.

5.2.1 Maintenance Costs

Based on the results the constant coefficient was found to be 9.627 as shown in table 4.3 above. This implied that holding Operating Costs, Congestion Charge and Passenger Car units constant the motorists would have to pay Ksh.9.627 per kilometer as the road pricing charge of Thika Superhighway.

The corresponding p-value for the maintenance costs was found to be 0.001. Since 0.001 was less 0.05 hence maintenance costs were significant in explaining variations in price charged per kilometer at 5% level of significance.

5.2.2 Operating Costs

This study results indicated that the operating costs coefficient was 1.426 as shown in table 4.3 above. This implied that for every additional million shillings spent on operating costs of Thika Highway; motorist would be required to pay an extra Ksh.1.426 per kilometer for the road pricing charge.

The corresponding p-value for the operating costs was found to be 0.001. Since 0.001 was less 0.05 hence operating costs were significant in explaining variations in price charged per kilometer at 5% level of significance.

5.2.3: Congestion Charge

The study findings indicated the congestion charge coefficient to be 0.136 as shown in table 4.3 above. This implied that for every additional million shillings levied as congestion charge, the price charged per kilometer would increase by Ksh.0.136.

The corresponding p-value for the congestion charge costs coefficient was found to be 0.001. Since 0.001 was less 0.05 hence congestion charge costs were significant in explaining variations in price charged per kilometer at 5% level of significance.

5.2.4: Passenger Car Unit

Findings from this study for the Passenger Car Unit coefficient were -0.061 as shown in table 4.3 above. This implied that for every additional thousand passenger car units introduced on Thika Highway, the price charged per kilometer would decrease by Ksh.0.061.

The corresponding p-value for the Passenger Car Unit coefficient was found to be 0.001. Since 0.001 was less 0.05 hence Passenger Car Units were significant in influencing variations in price charged per kilometer at 5% level of significance.

5.3 Conclusions

The study concludes that in the use of road pricing as an alternative means of generating revenue, the maintenance costs of Thika Highway, its operating costs and congestion charges would positively influence its pricing. This would imply that as more costs of this form are incurred, the higher the prices charged and consequently the higher the revenue. Furthermore, the study concludes that passenger car units had a negative influence on the price charged on motorists along Thika Highway. This would imply that as more passenger car units are introduced on the Thika Highway, the less the price charged on motorists. Finally, the model developed would facilitate development of an indicative road price to be charged on Thika Highway.

5.4 Recommendations

From the findings and conclusions, it was clear that it would be possible to establish an indicative road price for the Thika highway using maintenance costs, operating costs, congestion charges and passenger car units. This study therefore recommends that controllable costs like operating costs including research and modeling costs, information campaign costs, equipment costs (cameras, toll booths), call centre enquiries, enforcement costs, office administration and staff costs be properly monitored through thorough procurement policies and standards to minimize the overall effective costs. Furthermore, this study recommends that minimal congestion on roads should be encouraged to minimize the overall price charged on the motorists plying the Thika highway.

5.4.1 Suggestions for further Studies

The study was able to establish an indicative road price for the Thika Highway using maintenance costs, operating costs, congestion charges and passenger car units. However, the model developed could only influence road price charged up to 90.5% and other factors would influence 9.5%. This study therefore recommends that an investigation of the other factors that represent the 9.5% of influence on the price that would be charged on motorists on Thika Highway. This study could also be extended to the other upcoming road projects. These include the Nairobi Urban Transport Improvement Project (NUTRIP) that is aimed at decongesting traffic on the Northern Corridor Road and also the Lamu Port and Southern Sudan-Ethiopia Transport Corridor (LAPSSET) that is expected to cost between 22 billion dollars and 23 billion dollars.

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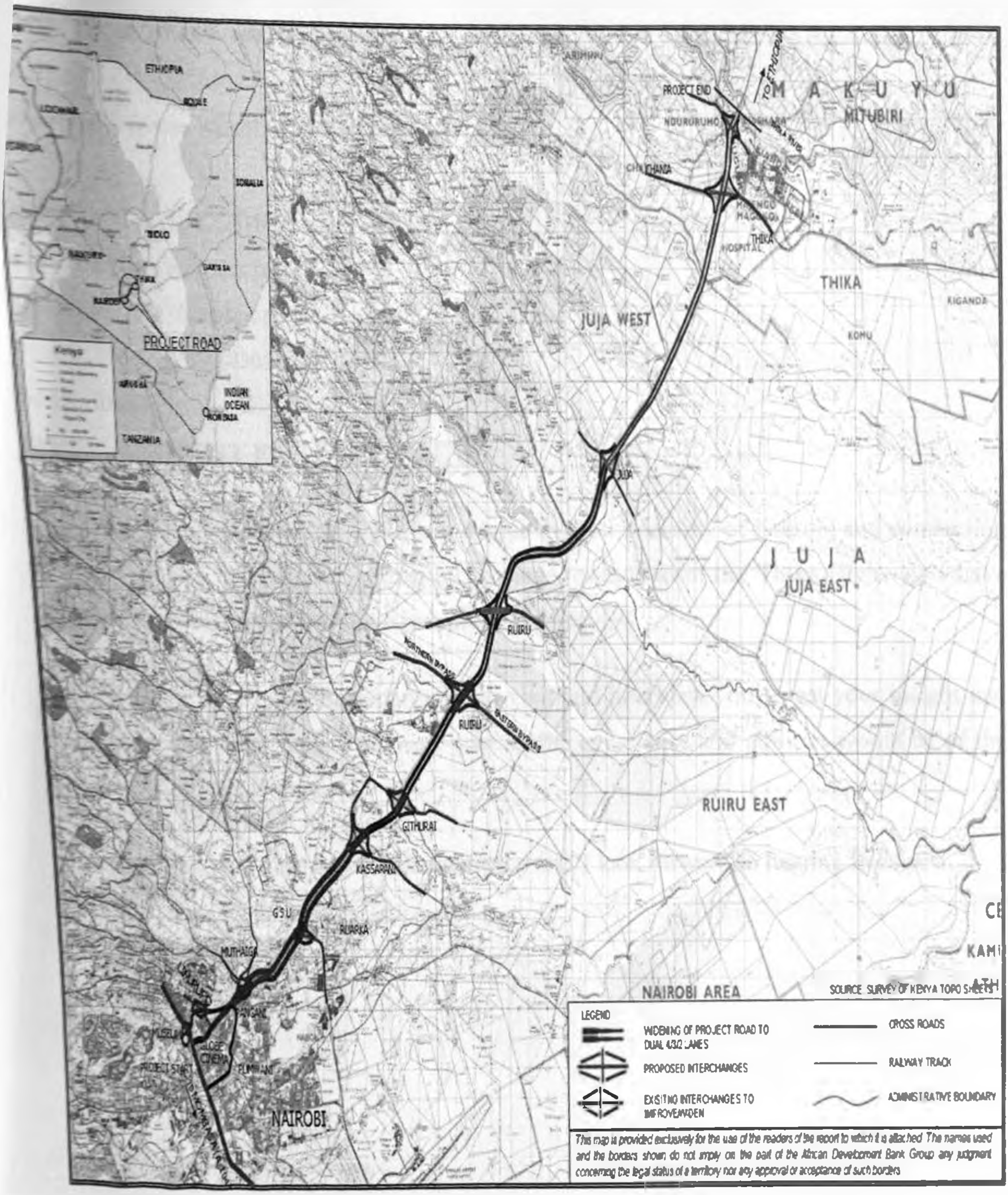
APPENDICES

APPENDIX I

AP OF THE NAIROBI-THIKA HIGHWAY IMPROVEMENT PROJECT



Source: African Development Fund Appraisal Report

APPENDIX II

LETTER REQUESTING INTERVIEW WITH MINISTRY OF TRANSPORT

Wambugu John Mark Nyaga

P. O. Box 79749- 00200,

Nairobi.

Mobile Phone Number 0729588677

23RD AUGUST, 2012

The Permanent Secretary,

Ministry of Transport,

P. O. Box 52692-00200,

Nairobi.

REF: REOUEST FOR INTERVIEW

I am a student undertaking a Masters degree at the University of Nairobi and conducting a study on the use of road pricing to generate revenue from the Thika Highway. I have attached an abstract of the same herein for your review.

I am writing to request an opportunity to visit and interview you to get your insight and suggestions on this issue. I am sure your skills, experience and abilities would be of the greatest value to my study.

I am available at a time of your convenience and I look forward to hearing from you.

Thank you in advance.

Sincerely,

Wambugu John Mark Nyaga.

APPENDIX III

LETTER REQUESTING INTERVIEW WITH THE KENYA URBAN ROADS AUTHORITY

Wambugu John Mark Nyaga
P. O. Box 79749- 00200,
Nairobi.
Mobile Phone Number 0729588677

23RD AUGUST, 2012

Director General,
Kenya Urban Roads Authority
P.O. Box 41727-00100,
Nairobi.

REF: REQUEST FOR INTERVIEW

I am a student undertaking a Masters degree at the University of Nairobi and conducting a study on the use of road pricing to generate revenue from the Thika Highway. I have attached an abstract of the same herein for your review.

I am writing to request an opportunity to visit and interview you to get your insight and suggestions on this issue. I am sure your skills, experience and abilities would be of the greatest value to my study.

I am available at a time of your convenience and I look forward to hearing from you.

Thank you in advance.

Sincerely,

Wambugu John Mark Nyaga.

APPENDIX IV

LETTER REQUESTING INTERVIEW WITH THE KENYA NATIONAL HIGHWAYS AUTHORITY

Wambugu John Mark Nyaga

P. O. Box 79749- 00200,

Nairobi.

Mobile Phone Number 0729588677

23RD AUGUST, 2012.

The Director General,

Kenya National Highways Authority,

P .O. Box: 49712-00100,

Nairobi.

REF: REOUEST FOR INTERVIEW

I am a student undertaking a Masters degree at the University of Nairobi and conducting a study on the use of road pricing to generate revenue from the Thika Highway. I have attached an abstract of the same herein for your review.

I am writing to request an opportunity to visit and interview you to get your insight and suggestions on this issue. I am sure your skills, experience and abilities would be of the greatest value to my study.

I am available at a time of your convenience and I look forward to hearing from you.

Thank you in advance.

Sincerely,

Wambugu John Mark Nyaga.

APPENDIX V

LETTER REQUESTING INTERVIEW WITH THE KENYA AIRPORT PARKING SERVICES LIMITED

Wambugu John Mark Nyaga

P. O. Box 79749- 00200,

Nairobi.

Mobile Phone Number 0729588677

23RD AUGUST, 2012.

Kenya Airport Parking Services Ltd,

P .O. Box: 75740-00200 City Square,

Nairobi.

REF: REQUEST FOR INTERVIEW

I am a student undertaking a Masters degree at the University of Nairobi and conducting a study on the use of road pricing to generate revenue from the Thika Highway. I have attached an abstract of the same herein for your review.

I am writing to request an opportunity to visit and interview you to get your insight and suggestions on this issue. I am sure your skills, experience and abilities would be of the greatest value to my study.

I am available at a time of your convenience and I look forward to hearing from you.

Thank you in advance.

Sincerely,

Wambugu John Mark Nyaga.

APPENDIX VI

DATA COLLECTED

Years of concession 20 to 30 (Sangira, 2012)

Price charge

Sh1.20 passenger vehicles

Sh1.79 commuter taxi

Sh3.59 multi axle vehicles

number of vehicles 30,000

Length of Thika superhighway 50.4km (Xinhua, 2012)

Number of footbridges 17 (Rubadiri, 2012)

Average Maintenance Cost of 64,500 Kms at Kshs 23.8 billion p.a. (Kenya Roads Board, 2010)

Kenya National Highways Authority– KeNHA administration and operational costs 320 million (Kenya Roads Board, 2010) Responsibility for class A – 3541, B – 2639, C – 7851.

Fuel levy by KRA (Kenya Roads Board, 2012) = sh 9/litter

German federal highways toll 17 cents/km (Federal Ministry of Transport, 2012)

Stockholm Congestion charging $1.5-$3.0 USD (Bent, 2010)

London Congestion Charging $13 USD (Bent, 2010)

The Toll Plaza, Weigh Bridge and associated administration blocks will be located in LOT3. [KM 25+540 to KM 26+225 (Wilfred, 2012)

Project Cost 30 billion

Number of Vehicles 80,000 (Ongiri, 2012)

South Africa monthly toll charge 6,178 (Ongiri, 2012)

Number of vehicles 60000 (African Development Fund Appraisal Report, 2007)

REGISTERED VEHICLES, 2006-2009				Number
	2006	2007	2008	2009*
Motor Cars	372,530	410,812	450,137	499,679
Utilities, Panels Vans, Pick-ups, etc	195,153	202,671	209,628	219,901
Lorries, Trucks and Heavy Vans	69,716	75,347	81,285	91,431
Buses and Mini-buses	50,242	55,997	61,886	84,844
Motor and Auto cycles	63,321	78,981	130,307	252,960
Trailers	40,010	41,803	43,485	27,039
Other motor vehicles**	28,472	30,961	32,710	45,229
Total	819,444	896,572	1,009,438	1,221,083

REGISTERED VEHICLES, 2001-2005

	2001	2002	2003	2004	2005
Motor Cars	255,379	269,925	286,281	307,772	329,068
Utilities, Panels Vans, Pick-ups, etc	162,603	166,811	172,571	179,613	184,125
Lorries, Trucks and Heavy Vans	58,501	59,835	61,538	63,999	66,472
Buses and Mini-buses	42,629	46,606	50,428	55,705	60,109
Motor and Auto cycles	46,004	47,451	49,257	53,508	57,465
Trailers	13,897	14,261	14,994	16,106	17,296
Other motor vehicles**	32,255	32,724	33,439	34,439	35,145
Total	611,268	637,613	668,508	711,142	749,680

Source (Kenya National Bureau of Statistics, 2011)

NEW VEHICLE REGISTRATION IN KENYA

Body Type/Month	2009 Cumulative 2009	2010 Cumulative 2010	2011 Cumulative 2011	2012 Jan	2012 Feb	2012 Mar
Saloons	16,930	16,154	11,026	985	468	821
Station Wagon	27,599	37,549	31,199	3,046	1,356	2,534
Vans, Pick ups	7,120	6,975	7,442	594	459	622
M/Buses	4,483	3,600	451	10	6	12
Buses	1,057	1,266	1,662	91	90	126
Lorries	6,037	4,924	5,247	660	497	365
Trailers	2,883	2,379	2,556	286	235	319
Motors Cycles	91,151	117,266	140,215	7,655	9,205	7,600
3 Wheelers	863	1,521	2,140	217	133	194
Wheeled Tractors	1,115	1,167	1,179	89	129	148
Others	2,575	3,648	2,724	97	115	325
TOTAL	**161,813**	**196,449**	**205,841**	**13,730**	**12,693**	**13,066**

Source (Kenya National Bureau of Statistics, 2012)

A paved road in good condition, carrying about 500 vehicles per day (Thriscutt et al., 1999)

- 23,600 dollars per kilometer every seven years to keep it in good condition.
- This has a net percent value (NPV), discounted at 12 percent over twenty-five years, of 17,688 dollars per kilometer
- increase vehicle operating costs by about 5,000 dollars per kilometer
- The benefit/cost ratio of a fully-funded road maintenance program is thus 21,512 dollars

In the UK, the Department for Transport recommend these values: (Ahuja, 2007)

- Motorbike 0.4
- Car 1.0
- LGV 1.0
- RGV 1.9
- Articulated goods vehicle 2.9
- PSV (bus) 2.5

LGV - *Large Goods Vehicle*

RGV-Rail Guided Vehicle

PSV -Public Service Vehicle

APPENDIX VII

NAIROBI THIKA HIGHWAY IMPROVEMENT PROJECT

Abridged TOR for Private Sector Participation

Operation and Maintenance of Nairobi Thika Highway

Introduction

The Ministry of Roads and Public Works, Kenya, would like to explore the possibility of contracting to a private entity the maintenance, management and operation of Nairobi - Thika Highway, and is seeking consultancy service on the detailed operating modalities and transaction advisory services for private sector participation. The intention is to recover the operation and maintenance expenses through revenues generated from road user charges.

Scope of Consultancy Services

Stage I

Operation and Maintenance strategy

1. The consultant shall estimate the Operation and Maintenance costs for the smooth and uninterrupted flow of traffic during implementation period. The operation costs include operation of toll plaza, patrolling systems, emergency and medical and aid services etc.

2. The consultant shall estimate the maintenance costs for both routine and periodic maintenance of the road. The routine maintenance shall include maintenance of pavement, shoulders, landscaping, road furniture, drains, junctions, overpasses/underpasses/flyovers, bridges, etc in accordance with the agreed standards as per the O & M manual.

3. The periodic maintenance shall include the renewal of pavement surface for carriageway of highway, service roads, toll plaza, bus and truck lay bye, and the related profile corrective layers, stone rip rap at specific locations etc.

Review of existing financial allocation for operation and maintenance of roads

1. Review of financial needs for operation and maintenance of roads for the last five years vis-à-vis allocated fund from the government's consolidated budget to support road maintenance.

2. Review existing road user taxes and charges and estimate how much money is collected during the last five years in the form of road levy

. Review of additional requirement for the proposed Nairobi - Thika road project and alidation of the estimated strategy and needs.

Estimation of User Charges

1. Estimation of road user charges for different categories vehicle and clearly establishes the rationale behind it. Also establish the mechanism for estimation of user charges for frequent users.

2. Establish the mechanism for indexing of user charges along the program horizon of 15 years.

Exploring the possibility of imposing road user charges

1. Conducting "willingness to pay survey" for different category of road users also indicate the level of acceptance by the society in general.

2. Estimate the share of frequent users among the total users according to vehicle category.

Establishment, operation and maintenance of toll plaza

1. Indicate the locations of toll plazas/ booths/ counters for minimum leakages and estimate the capital investment to establish the same.

2. Indication of locations after conducting necessary surveys for other utility services including road safety measures

3. To build up toll plazas/booths and other structures keeping in balance with culture and producing a proper ambience through landscaping.

4. Estimate the operation and maintenance costs of the toll plaza.

Financial Analysis

1. Estimate the cost and revenue streams.

2. Indicate the scope and extent of other sources of revenues.

3. Analyze the attractiveness of the proposition to the private sector in terms of financial internal rate of return.

4. Conducting sensitivity analysis for the proposed investment.

5. If it turns out as non-viable proposition, the consultants have to indicate possible scope and extent of sops including tax benefits and/ or grants to make it viable.

6. If the proposition attracts excess profit, consultants have to indicate the extent of concession fees

to be imposed on the private party.

7. Estimate the requirement of minimum concession period.

8. Estimate the fund flow to the road maintenance fund during the defect liability period.

9. If it is possible to impose concession fees, estimate the stream of fund flow to the road maintenance fund during the concession period.

Concession Agreement

1. Based on the approved financial analysis the consultant should prepare draft concession agreement.

2. The concession agreement will also take care of legal aspects of private sector participation with proper amalgamation with the national legal procedures.

Policy document, institutional framework and Capacity Building

1. Consultants have to prepare draft tolling policy in general and subsequently to make it specific to the project road and to indicate its replicability elsewhere in the country with required level of modification.

2. Consultants have to recommend the institutional framework and to identify the needs for capacity building in connection with monitoring the program as well as to maintain the road maintenance fund.

Stage II

Selection of Private Party

1. Consultants have to provide necessary support in the process of bidding and evaluation to select the private party.

2. During pre-bid meeting consultants needs to make presentation to the intended private parties and to clarify the queries in association with Ministry of Roads and Public Works.

3. Consultants have to prepare the evaluation criteria and recommend to the ministry about the final selection of private party.

4. Based on identified need of capacity building, consultant will finalize the scope of training and prepare training calendar.

5. Conducting training program.

Source: The Ministry of Roads and Public Works, Kenya, 2007