INFLUENCE OF MAINTENANCE CRITERIA ON PRIORITIZATION OF ROAD PROJECTS BY ROAD AUTHORITIES IN MACHAKOS COUNTY, KENYA

BY

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DECLARATION

This research report is my original work and has not been submitted for an academic award or certification in any other institution.

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DEDICATION:

The research report is dedicated to my wife Grace, and children; Delite, Delicia and Dorinda for their support, encouragement and indulgence. My sincere appreciation goes to them all.

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ABBREVIATIONS AND ACRONYMS

AASHTO	American Association of State and Highways and Transportation Organization
TRRL	Transport Road Research Laboratory
PIDA	Programme for Infrastructure Development in Africa
CESA	Cumulative Equivalent Standard Axles
F	Frequency
%	Percentage

ABSTRACT

Globally the prioritization of road projects faces significant challenges due to the non-inclusion of key indicators that can assist informed decisions on which roads to be undertaken first. In developed countries, the prioritization is based on the prevailing economic activities and social needs. Developed countries focus on the conventional plans for cities and towns, in making judgments on prioritization of roads. Routine studies are rarely updated through new studies that reflect existing road and traffic condition because the old plans are used as a benchmark. In Kenya, road prioritization fails to balance between the technical feasibility and the Funding for Road Works availability. In most cases, road prioritization occurs due to political influence. In Machakos County, road authorities established as state corporations deal with prioritization of the road projects. The research project discussed the level in which the independent variables which include; road connectivity, traffic volume, road condition survey and Funding for Road Works influence the prioritization of road projects. The dependent variable for the study was the prioritization of road projects. The study aimed at establishing whether the need for road connectivity is considered during prioritization of roads by focusing on intra-county and inter-county roads, access to markets and urban centres, and whether missing road links are given priority. The study sought to identify whether the traffic volume for both motorized and non-motorized traffic is usually considered as a key indicator during prioritization of road projects. Investigations of the road condition survey and Funding for Road Works were discussed as key parameters that affect prioritization of road projects. The research project carried out a descriptive survey design on employees working with the road authorities and representatives of public road transport in Machakos County. The respondents interviewed were from Kenya National Highways Authority, Kenya Rural Roads Authority, Kenya Urban Roads Authority and public transport sacco representatives. A Cronbach alpha coefficient of 0.72 was determined, which indicated that reliability of the research instrument used was good. The study interviewed accountants, engineers, road supervisors, technicians and public road transport sacco members. The target population for the study was 65 and a population census was conducted as opposed to sampling because time and resources allowed it. There were 38 respondents out of the 65, indicating a response rate of 58.46%. The independent and dependent variables showed a good association with all exhibiting a chi-square of less than 0.05 at 95% confidence level. The study found out that availability of funds was a critical component of the maintenance criteria influencing road projects prioritization with 84.2% of the respondents agreeing to a great extent. Second was road connectivity especially access road to major urban centres and markets with approval rate of 78.95% of the respondents. The study established that the road condition survey, especially the road surface condition was a vital component for consideration during prioritization with 71.1% responses on great extent scale. The findings also indicated that the traffic volume, especially motorized was given priority and traffic congestion during road prioritization for maintenance at 60.5% approval rating from the respondents. The research further revealed that priority of maintenance was given to the road surfaces that were in the poor condition. However, the study recommended that road maintenance priority should also be given to the roads with good surface condition to ensure the level of service for the road is maintained and the road asset preserved over its design life.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

The international approach to prioritization of roads often take into consideration safety, traffic operations and in the contemporary society, environmental pollution has become a key element for consideration. In Florida, the urban arterial road network faces the challenges of Funding for Road Works during prioritization, which in turn affects the road programming engineer because it lacks details on timely availability of funds (Lu, 2005). Prioritization in Los Angeles focuses on the introduction of value added services in the utilization of lane services. According to Wilson, Los Angeles will curb the need for traffic demand by adding value to the current usage of the roads, but the concept must be initialized at the prioritization stage (Willson, 2010). Prioritization of road development projects seeks to increase user satisfaction by meeting socio-economic demand of the traffic. In developed countries prioritization focuses on exclusive usage of road facilities, which can range from bus lanes and motorcycle tracks. However, the decisions to ensure the road meets an inclusive demand of the users are vested on the need for prioritization at the road selection stage. The global road construction methodology uses prioritization to meet both throughput and environmental impacts.

In India, the huge traffic costs and implementation of road development projects makes it necessary for initial assessment on the roads to be carried. With the majority of the population living in rural communities, the access to markets and hence economic development is impaired due to unpaved road networks (Asher & Novosad, 2005). Further, the selection criteria for upgrading such roads does not take into consideration key indicators that would otherwise deal with the in-migration booming as a result of seeking economic opportunities in the urban areas. Road Connectivity is considered an immediate tool for assessing the priority of roads to be constructed. Based on the level of seamless Road Connectivity socio-economic growth can be realized without in-migration. Combining the effect of traffic volume to the existing road condition assists in giving a wide benchmark upon which planners and road implementers can make informed judgement prior to allocating Funding for Road Works on development projects. Political influence receives significance attention during prioritization of road projects due to the formation of policies that affect productivity, revenue and tax obligation to the citizens. In lieu of perceived benefits touching

on productivity and augmented revenue, political influence especially concerning policy formulation on road maintenance projects has guided the prioritization criteria. The normative approach being directed towards an eventuality where quick revenue and returns can be realized with the inception of the road maintenance projects. However, politically influenced road policy on prioritization often have the setback of exclusivity and the dominance in subjectivity; hence failing to meet the end user satisfaction (Litman, 2010). The selection criteria becomes subjective in the sense that it does not meet the immediate and most efficient demand for executing a road project, which is ensuring flow of motorized and non-motorized traffic with ease and in a manner the ensures seamless Road Connectivity.

In Africa, a completed and well maintained road network system will lead to a diminution in the rising gap in socio-economic difference of people living in rural and urban areas. Road Prioritization in Africa takes into consideration the effect of the level of service for users. According to Brushett (2005), road networks in Africa are conceptualized to meet certain level of service defined by traffic volume, road condition survey and the need for Road Connectivity. However, the road development projects often fail to meet the goal of Road Connectivity by ensuring access to open markets especially by rural settlers. The failure to meet end user satisfaction from the roads has contributed to lapse in the objectivity of prioritizing roads and consequently led to investing on road ventures that do not yield sufficient returns that can assist in bridging the balance of trade deficit through promoted local trade. Furthermore, the competed road projects depict a non-inclusion of a holistic and conclusive prioritization scheme that would prevent quick deterioration and urgent maintenance needs (Brushett, 2005). The resulting effect is that newly completed road projects in African countries, require immediate maintenance before they can realize the payback period of the investment pumped into construction. The ultimate effect is a growing deficit in the prioritization of roads since most funds are channelled into rehabilitation of the roads that deteriorate quickly. Management and maintenance are tasked with the challenge of ensuring performance indicators are considered during prioritization to ensure value for money and to increase end usability through seamless Road Connectivity and ability to accommodate the ever growing traffic due to the unprecedented population growth (Transportation Research Board, 1982).

In East African countries, the planning, prioritization and implementation of road projects lies with road authorities established as state corporations. In Kenya, Uganda and Tanzania, the roads are planned, managed and maintained by the respective road authorities in each

country. The planning section seeks to alleviate an immediate need and ensure user accessibility. In the East African region planning and prioritization of most roads appears as a mitigation effort in the sense that most rehabilitated and newly conceptualized roads are prioritized when a constraint is evident. The constraint prompting prioritization and rehabilitation of road vary from traffic congestion to natural calamities witnessed yearly due to periodic precipitation. The asymptomatic response is akin to third world countries, as it lacks an insight on the analysis of present conditions and the repercussions in the future; hence making the road development projects appear as an afterthought and mitigation measure. Rarely does road construction in East Africa take into consideration planned and projected traffic provided the existing pavement offer a certain minimum level of service. The upsurge in population has contributed to traffic congestion being witnessed earlier than the forecasted periods, hence the burden to overhaul and increase road networks. The ultimate effect is a scenario where several road networks require rehabilitation and prioritization, but the Funding for Road Works is limited. Further, the influence of politicians in policy formulation gives a setback to the prioritization process as road development projects are executed to further the political supremacy rather than meet immediate and forecasted socio-economic growth (Leyland, 2005). The result is that the prioritization strategy fails to indicate assessment needs and gap analysis prompting for the investment on the road development projects.

In Kenya, prioritization of road projects is the sole responsibility of the road authorities who work under the oversight of the Ministry of Transport and Infrastructure, and Kenya Roads Board as established under the Kenya Roads Act of 2007. The authorities include Kenya National Highways Authority, Kenya Urban Roads Authority and Kenya Rural Roads Authority, which are charged with the mandate of carrying out project needs assessment that forms part of the prioritization process. Nonetheless, the Ministry of Lands Housing and Urban Development has contracted road works aimed at upgrading the living standards of informal settlements and the metropolitan areas. The conventional approach is carrying out a needs assessment, which involves stakeholders from the community, private and public institutions to ensure the road development projects are in conformity with end user expectations. According to the Kenya National Bureau of Statistics (2016), the average Gross Domestic Product of Kenya from 2004 to 2015 was 5.41%. Further, the road network Road Connectivity has been deemed an essential component in poverty eradication as outlined in the National Development and Policy Plan (Matsouka, 2006). Despite the involvement of

stakeholders at the prioritization stage, the essential key indicators often have to be balanced with other prevailing social, economic and political conditions. In a report pioneered to study and develop a master plan for urban transport system in Kenya, Matsouka (2006) points out that an initial prioritization exercise must take into consideration a survey of the road condition, demographic profiles of the people, and traffic volume. The approach aims at realizing meaningful conclusions that will reflect on the immediate and long-term expectation of the users in executing the road development project. Suffice to posit that the balance often leads to neglect on the technical aspects that define the road network capacity to ensure traffic flow hence meet the targeted plan on poverty eradication (Teipelke, 2014).

In Machakos County, only three road authorities are legally mandated in construction and maintenance of public roads. Class A roads are international trunk roads, while Class B roads are national trunk roads. Class C roads are primary roads, which link provincially important centres and classes D, E and F are local roads linking various administrative centres (Chief Engineer Materials -Roads & Aerodomes, 1987). The road authorities include Kenya National Highways Authority, Kenya Urban Roads Authority and Kenya Rural Roads Authority. While operating under the umbrella of the Ministry of Transport and Infrastructure, similar conventional practices are adopted at the county level. However, with the inception of the new constitution passed in 2010 that brought about devolved governments at the county level, the matrix of factors that affect project prioritization have become intricate to implement. Political influence and interference plays the major role in the initialization of road projects; hence the prejudiced approach in selecting roads for Funding for Road Works. Further, the increased governance level and possibility of replication of duties with Funding for Road Works and taxation level remaining constant, an adequate cash flow has hampered the successful prioritization of new roads for construction and old roads that require maintenance and rehabilitation (National Council for Law Reporting, 2010). The need for a feasibility study as part of gap analysis on initial project needs must be reiterated further at the county level. Furthermore, the role of traffic volume, road survey condition and Funding for Road Works at the county level appears vital in the prioritization of road development projects.

1.2 Statement of the problem

The study focused on the influence of maintenance criteria on the prioritization of road projects, which include Road Connectivity, traffic volume, road condition survey and

Funding for Road Works among the road authorities working within the jurisdiction of Machakos County. With approximately more than 93% of the goods and passengers being transported using the road network, the need to make an informed judgement at the prioritization stage appears paramount if the road network are to realize socio-economic growth (Ministry of Roads, 2012) and provide desired level of service to the users. The present system in the county is such that intra-county roads begin and terminate within a county; hence the need for localized Road Connectivity. However, the intra-county roads are viewed as small but integrated components that connect to the larger national road network or to the inter-county roads. The current scenario should therefore be assessed if they take into consideration the link between intra-county and inter county roads, especially at the maintenance stage for any road development project to ensure seamless Road Connectivity. Feasibility studies that ought to indicate the access of roads to major market centres and urban areas are not conducted due to non-exhaustive stakeholder inclusion (Ouko, 2015). The immediate need for road construction does not take into consideration routine studies on the motorized and non-motorized traffic volume in Machakos County. Instead, old baseline surveys are used to project traffic growth, which either may be overestimated or understated making the road networks fail to serve their primary purpose.

A gap existed in determining the extent to which the maintenance criteria of; utilizing road surface condition, safety of road users, vehicle maintenance costs and Funding for Road Works available should influence prioritization of road maintenance projects. The road authorities depend on the fuel levy fund charged per litre of fuel to carry out routine maintenance (Bett, 2010). The inventoried road network in the entire country is 160,866 Km of which only 11,197 Km are paved to bitumen standards, and indication that 146,669Km are either gravel or earth roads (Bett, 2010, p. V). The huge deficit is an indication that the fuel levy fund has not met the deficit in both maintenance and construction of new roads.

Therefore, there was a need to ensure that prioritization of the roads to be maintained was carried out with an informed maintenance criteria (technical and financial feasibility) being part of the needs assessment. Further, the Road Maintenance Levy Fund (RMLF) assisted in cost-effective maintenance of key road networks and missing link roads if proper traffic levels, road condition survey and financial feasibility are considered during prioritization of road projects.

1.3 Purpose of the study

The study aimed at investigating the influence of maintenance criteria on prioritization of road projects in Machakos County, Kenya.

1.4 Research Objectives

The objectives for the study were:

i. To ascertain the influence of road connectivity on prioritization of road projects in Machakos County.
ii. To establish the influence of traffic volume on prioritization of road projects in Machakos County.
iii. To determine the influence of road condition survey on prioritization of road projects in Machakos County.
iv. To determine the influence of Funding for Road Works on prioritization of road projects in Machakos County.

1.5 Research Questions

The study sought to answer the following questions:

i. What is the influence of road connectivity in prioritization of road projects in Machakos County?
ii. What is the influence of traffic volume in prioritization of road projects in Machakos County?
iii. What is the influence of road condition survey in prioritization of road projects in Machakos County?
iv. What is the influence of Funding for Road Works in prioritization of road projects in Machakos County?

1.6 Significance of the study

The study conducted would assist road authorities and policy makers in utilizing the maintenance criteria in making key decisions that would create cost-effective measures in prioritization of road projects. The road authorities will be aware of the need of Road Connectivity, traffic volumes, road condition survey and Funding for Road Works

requirement in order to channel resources on the most appropriate and immediate road networks that directly impact positively to the road users.

It will also assist in cost-cutting measures because planning will be exhausted at the prioritization stage. Due to the minimal Funding for Road Works from the Road Maintenance Levy Fund, the cost-cutting measures realized due to prioritization will contribute to savings that can be channelled to complete other road maintenance backlog. Further, the study will add the field of knowledge on the dynamics that exist with devolved governance especially on functions such as road development for inter-county and intra-county roads, units that never existed before. The study will also assist the government in developing a prioritization criteria guided by both short and long term goals with the ultimate objective of increasing the number of paved road networks.

1.7 Delimitations of the study

The study was conducted in Machakos County and it targeted employees working in road authorities namely Kenya National Highways Roads Authority, Kenya Urban Roads Authority, Kenya Rural Roads Authority and public transport road users. The researcher interviewed accountants, engineers, road supervisors, technicians working in the three road authorities and public road transport sacco officials. Questionnaires were issued as a research instrument for collecting data. The study population was 65 respondents in total.

1.8 Limitations of the study

The main limitation of the study was the organizational bureaucracies involved before getting permission to administer the questionnaire to the respondents. However, this was minimized by creating a positive rapport with the supervisors of the respondents and assuring them that the research was for academic purposes and that the information given would only be used for that purpose. Another limitation for the study was time and finance required to complete the study. The researcher overcame the limitation by engaging one research assistant who assisted in data collection from the road authorities and representatives of public road transport saccos. The study minimized costs by cutting down the travel times and ensuring that the data was collected in one trip.

1.9 Assumptions of the study

This study assumed that the road authorities' organizational cultures did not influence data accuracy. The study assumed that geographical factors were constant because the study was

restricted within Machakos County and therefore could not influence road projects prioritization. Finally, it was assumed that the information obtained from this study would be very useful in highlighting the influence of maintenance criteria in prioritization of road maintenance projects in the county considering that a response rate of 58.46% was achieved.

1.10 Definition of Significant Terms Used in the Study

Maintenance Criteria: Refers to Road Connectivity, Road Condition, traffic Volume and Funding for Road Works.

Road Connectivity: It refers to the movement from one topographical area to another using intra-county and inter-county and the provision of access to markets and urban centres by construction of missing link roads.

Traffic Volume: It is the average annual daily movement of motorized and non-motorized traffic, which takes into consideration congestion and effects of delays caused due to traffic congestion.

Road Condition Survey: It is the preliminary study carried out to determine the quality of road surface condition, safety of road users and vehicle maintenance costs.

Funding for Road Works for Road Projects: It refers to the resources available for maintenance of road projects and it focuses on the availability of funds at road prioritization stage and their timely release to enable an amicable cash flow during road maintenance project stage.

Prioritization of Road Projects: It refers to the selection of road projects based on the Maintenance Criteria of Road Connectivity, road condition, traffic volume and Funding for Road Works.

Road investment program: Is an economic appraisal of maintenance needs for existing road network in a prioritized manner depending on funds available.

Road inventory: Is the list of roads to be maintained and a detailed analysis of their maintenance requirement.

1.11 Organization of the study

The study comprised of five chapters. The first chapter consists of an introduction on the influence of maintenance criteria on prioritization of road maintenance projects, purpose of study, research objectives and questions, significance, delimitations and limitation of the study. Chapter two entails the literature review on prioritization of road maintenance projects and the influence of maintenance criteria as the study's independent variables. The third chapter contains the research design, target population, research instrument, validity and reliability of research instrument, method of data collection, and the operationalization of variables. Chapter four presents data analysis and interpretation made in conjunction with the study objectives. Chapter five offers the discussion, conclusion, recommendations and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews past literature on maintenance criteria as factors influencing maintenance of road infrastructure projects. Literature on global, African and local influence of maintenance criteria on prioritization of road projects is discussed in the chapter. The chapter also offers a review on the relationship between theories and Road Connectivity, traffic volume, road condition survey and Funding for Road Works, which influence the prioritization of road maintenance projects. It also details the conceptual framework upon which the study will be based.

2.2 Prioritization of Road Projects

Globally, the prioritization of road projects follows a systematic and chronological approach meant to inform the best choice of materials for usage and to optimize on Funding for Road Works and sustainability (Lewis, 1999). In Europe, prioritization of road maintenance projects is accomplished through systemic programming of the procedures in software. For uniformity and simplification in road maintenance practise, the maintenance engineer mostly utilizes manuals and codes commonly referred to as road notes and European Norm. The prioritization process depends on the extent of damage for the road that requires repair. Taking into consideration the fact that different surfaces can be used as wearing course for roads, optimization of Road Connectivity, traffic volume, road condition survey and Funding for Road Works are at the epicentre of the prioritization process. The wearing course is the top surface of the road pavement where vehicles ride on and it can be made of lean concrete, asphalt concrete, surface dressing, or complex amalgamation of bituminous mixes to yield modified surfaces like slurry seals among others (Dowall, 2003).

The common wearing courses are asphalt concrete and surface dressing. Both surfaces offer different challenges, which dictate the choice and prioritization for maintenance. The practise in Europe is such that the wearing course is maintained using the inherent materials used during first construction prior to an overhaul maintenance (Lebo & Schelling, 2001). This implies that a road constructed from asphalt concrete will be repaired and maintained using the same material for sealing potholes (patchwork) or complete overhaul. Similarly, roads prepared from surface dressing use the same material for maintenance before upgrading. It is the norm in Europe and the United States to surface dress the road after carrying out asphalt

concrete sealing so that it can increase longevity of the road (Gonzales, 2012). However, the process requires an optimization of the available resources, in terms of Funding for Road Works and the perceived duration for maintenance. For instance, if a road is programmed for maintenance after some years, the choice of surfacing dressing will be considered so that the predicted maintenance life can be achieved with minimal or no repair.

The Transport Road Research Laboratory (TRRL) in Europe produce specifications for materials to be used on the pavement layer, which will vary depending on location of the road; hence, affecting funds and cash flow if not planned properly (Baker, 1975). The normative approach in Europe as outlined by the Road Notes is such that a newly completed road requires maintenance to increase longevity and meet the ultimate goal of sustainable economic growth achieved through transportation from main and minor trunk roads (Aroud, 1980). The assumption is that prioritizing for maintenance on newly completed roads reduces the long run costs associated with continued degeneration of the road pavement layer (Weisbrod, 2000).

In the United States, the American Association of State and Highways Organization (AASHTO) takes a step further in the prioritization of roads to be maintained by considering the entire pavement structure and optimizing it with the traffic volume and resources available (Transportation Research Board, 1982). A completed standard road is composed of several layers, which include the sub grade, sub base, base and wearing course. However, depending on the traffic volume the base layer may be strengthened with an additional structural layer commonly referred to as dense bitumen macadam (Queiroz & Gautam, 1992). Of essence is to note that the pavement layers will vary, but the most roads will follows the standard approach mentioned. Therefore, prioritization of road to be mainlined in the United States gives credence to the structural layer, which is the base. For a completely degenerated road, prioritization will be based on the availability of the local materials, Funding for Road Works and traffic volume. In the event that a detailed feasibility study emerges to be pessimistic, the option of re-routing can be considered as opposed to maintenance (Squire, 2008). However, such an approach is often backed with evidence indicating that local materials are not feasible for use to carry the perceived and projected traffic volume so that the road can be durable for its maintenance life. The cost of importing materials, which would have an effect on the Funding for Road Works and cash flow, may inform the choice of re-routing the road to other avenues with proximity to natural resources (Dahdah, 2008).

The approach adopted in Africa, follows an initiative and replication of studies carried out from the United States and Europe to reflect the prevailing climatic conditions. Nonetheless, efforts to customize the prioritization of road maintenance projects in Africa have proved successful through ministerial department carrying out research on native requirements.

In Africa, road prioritization is often superseded and controlled by the need for Road Connectivity and traffic volume. Since most roads are not completed to bitumen standards, the prioritization must focus on ensuing that the existing road network does not succumb to failure and affect then mobility of both motorized and non-motorized traffic (Awoyinfa, 2012). For instance, roads completed to bitumen standards often offer international and national connection and always receive priority during allocation of Funding for Road Works. The assumption is that Road Connectivity and mobility would be impaired if such roads were not maintained. Unlike in the developed countries, where prioritization of roads for maintenance is carried out on weighted basis with a complex interplay of Road Connectivity, road condition survey, Road Connectivity and Funding for Road Works, in Africa, the emphasis is given to Road Connectivity and traffic volume (Brushett, 2005). Ideally, the road links that carry maximum traffic are assumed to connect international and national centres, and they are accorded priority during maintenance as opposed to feeder roads and will form the inventory for the road investment programme.

The African Development Bank Group funds road infrastructure development in the continent and the prioritization process is more often backed with technical feasibility as opposed to financial feasibility (Ceran & Newman, 1992). This is because the Funding for Road Works from the bank is received from multi-nationals and public private partnership; hence the criteria often revolves around technical feasibility. The technical feasibility includes analysis on the road condition survey, Road Connectivity requirements and the traffic volume. The road condition survey informs which roads to be prioritized based on the existing condition of the road surface, safety of road users and the perceived vehicle maintenance costs (Coogan, 2000). For instance, a road whose surface requires minor repairs, but carries a considerable amount of traffic defined by the calculations from traffic capacity will be given priority. Consequently, a road that has several potholes would compromise on the safety of road users due to the increased susceptibility to accidents; hence, it will receive priority (Ernest&Young, 2014). However, the technical feasibility presented to the African Development bank optimizes cost comparison between repair of such roads and re-routing or complete overhaul of the existing pavement structure. In any case, the ultimate intention and

aim is to ensure safety and Road Connectivity for the traffic volume with ease. Through the Program for Infrastructure Development in Africa (PIDA), the African union Commission initiates strategic prioritization of road for maintenance with the bank acting as the executive agency (Lu, 2005). The program ensures socio-economic growth in Africa through interregional Road Connectivity carried out through re-construction and maintenance of road networks amidst access to other infrastructural amenities like energy, communication and trans-boundary water resources.

In East Africa, the prioritization of road maintenance projects works in line with the existing socio-economic policy framework. As East African Region is comprised of third world countries, the need to meet socio-economic growth that can spur full sustainability and independence often informs the process of prioritization of road maintenance projects (Mubila, Moolman, Zyl, Kokil, & Lufumpa, 2014). As such, the prioritization of road maintenance projects falls under the ministry charged with road infrastructure, which seeks to achieve the socio-economic goals set for the country (Bank, 2014). For instance, in Tanzania socio-economic growth is tied to regional Road Connectivity and the ease with which goods can be moved within the country. In lieu of that, the parliament of the United Republic of Tanzania enacted a law that legalized and controlled the Roads Fund with the creation of the Roads Fund Board in 1998, with the main source of funds emanating from the fuel levy (Kumar, 2002, p. 1). The idea of the fuel levy fund was an improvement of the Roads Tolls No. 2 Act of July 1985, which necessitated collection of monies as part of national taxes to be used for maintenance of roads (Kumar, 2002, p. 3). In July 1st 2000, the Tanzania National Roads Agency abbreviated as "TanRoads" was established following the enactment of the Executive Agencies Act. Its objective was the prioritization of roads for maintenance, procurement and construction of new roads in line with the ministerial budgets (Kumar, 2002).

In Uganda, the Uganda National Authority Act No. 15 of 2006 led to the establishment of the Uganda National Roads Authority that became operational in January 1st 2008 and was charged with the mandate of repair, maintenance, and construction of new roads (Cook, 2005). The Road Sector Development Program initiated by the Ugandan Government in 1996 meant to ensure sustainable socio-economic growth for a period of ten years led to the inception of the road maintenance agency (Howes & Robinson, 2006). The scenario in Tanzania and Uganda is similar because the formation of national road agency was charged with the mandate to repair and maintain the road network. However, the formation of the

road agency was formulated as part of a huge and complex plan meant to spear socio-economic growth in both countries. In essence, the formation of the national road agencies would increase Road Connectivity and ease movement of traffic volume, which would spur socio-economic growth (Estache & Strong, 2000). The road maintenance approach uses road condition survey in both Uganda and Tanzania to benchmark the prioritization criteria so as to ensure the goal of national and regional Road Connectivity with ease flow of traffic is realized and ultimately, socio-economic growth. It suffices to posit that the road maintenance agenda in Uganda and Tanzania was driven by the need to achieve sustainable economic growth through regional Road Connectivity as opposed to only urban concentration of good road network.

In Kenya, the need to achieve Millennium Development Goals and Vision 2030 was pegged on the success of regional road network that ensures Road Connectivity and mobility of human and motorized traffic. Under the Kenya Roads Board Act No. 7 led to the establishment of the Kenya Roads Board, which fell under the Ministry of Transport and Infrastructure and the consequent establishment of the Kenya Roads Board Fund (Kenya Roads Board, 2015). The funds were to be retrieved from the fuel levy charged per litre of fuel consumed by each vehicle in Kenya (Lebo & Schelling, 2001). The specific mandates of the Kenya Roads Board include but not limited to ensuing optimized utilization of monies acquired from fuel levy fund in the successful implementation of road maintenance, rehabilitation and construction programs. Under the Ministry of Transport and Infrastructure road agencies namely, Kenya National Highways Authority, Kenya Rural Roads Authority and Kenya Urban Roads Authority were formed to carry out routine maintenance, upgrading and construction of new roads (MinistryofRoads, 2012). The mandate of rehabilitation and maintenance of roads is carried out by the three road authorities using funds from the fuel levy fund. The maintenance of the road network by the state agencies mainly depends on the need for Road Connectivity, traffic capacity analysis and the existing road condition survey (Park, April 2014). The normative approach in Kenya is to maintain newly constructed roads so as to increase their durability with the aim of achieving Vision 2030, which is an economic stimulus meant to ensure long term development by making Kenya globally competitive and a prosperous nation that can provide amicable living standards for its citizens (Teipelke, 2014).

According to a report released by the Kenya Roads Board (2015) the road condition survey carried out on paved and unpaved roads was ranked based on the status in accordance to

good, fair and poor. The report indicated that there were 11197 Kms of paved and 150253.4 Kms of unpaved roads (Kenya Roads Board, 2015). Out of the 11197 paved roads, 4697.2 Kms were in good condition, 4150.3Kms were in fair condition while 2350.4 Kms were in poor condition. Out of the 150,253.4kms of unpaved roads, only 12582.4 Kms were in good condition, 48665.4 Kms were in fair condition while 89005.6 Kms were in poor conditions (Kenya Roads Board, 2015). The information on the road condition survey sums the total roads in condition at an approximate of 11% in good condition, while those in fair condition at an approximate of 33% and a majority of them being in bad condition at 56%. The results indicate that the authorities charged with the mandate of maintenance of road, prioritizes the roads based on their condition as one of the governing criteria (Kenya Roads Board, 2015). In Kenya, the information on the existing road condition survey forms a crucial part in the prioritization of roads for maintenance as indicated.

In Machakos County, the three road authorities that carry out road maintenance include Kenya National Highways Authority, which maintains a total of 202Kms, Kenya Urban Roads Authority 15.85 Kms and Kenya Rural Roads Authority, which maintains 822.47 Kms of road (Kenya Roads Board, 2015).

2.3 Influence of Road Connectivity on Prioritization of Road Projects

The road network and transport system form an essential component in the socio-economic growth of a country. Prioritization of roads will depend on the demand for Road Connectivity defined by the road network within the County. Taking into consideration the maintenance of inter-county roads will consider links that require an immediate demand for Road Connectivity. In Europe roads are prioritized for maintenance so that they can ensure Road Connectivity between one geographical region to another. Road Connectivity deals with the ability to ensure seamless flow of motorized and non-motorized traffic from one area to another. Road Connectivity occurs because of human mobility and the need to transport commodities and services to different areas (United Nations ACC Task Force on Rural Development, 1985). The objectives for maintaining roads to ensure Road Connectivity is to bring about circumferential and radial movement of the road network aimed at providing an economical and valuable transport system. The need for community cohesion and development is achieved through seamless Road Connectivity of areas divided by geographical features.

A study conducted on the master plan for urban transport in the Nairobi metropolitan area, Kenya noted that the highest priority projects was given to the missing links (Matsouka, 2006). This is because of the ability to ensure radial and circumferential Road Connectivity in urban areas. In terms of Road Connectivity, the Kenyan context and especially in Machakos County the access to market and urban centres was deemed vital in the realization of vision 2030 through road infrastructural maintenance projects.

The aspect of Road Connectivity appears crucial especially for additional purposes like information and communication flow. Hu and Janowicz (2015) have indicated that prioritization of road networks based on communication is vital, especially in cases of disaster response. The ability to transmit information from one avenue to another appears critical during catastrophic events, and the road network is established as a link that can assist in bridging the gap in information flow. Service vehicles and response units utilize road network Road Connectivity to prevent the escalation of disasters, which makes it a crucial for the road maintenance team to factor in radial and circumferential Road Connectivity when choosing the projects to execute. While road network Road Connectivity is essential, studies have indicated that it can spur economic growth brought about changes in land cover usage. Patarasuk (2013) carried out a study on the changes of land cover usage brought about by prioritization of road networks based on Road Connectivity in Lop Buri province and realized that there were significant change in the manner in which land cover usage for plantation, upland crops, forests and water bodies varied because of road connectivity. The aspect of Road Connectivity would either inter-twin the land usage as people adapt to new ways of utilizing land from their normative practices, which would work to improve trade. The resultant effect was an escalation in the socio-economic development. For instance, the need for Road Connectivity can lead to maintenance of existing road network through an upgrade or rehabilitation, which would deplete the existing natural resources; hence, alter the land usage. This is especially true for cases where raw materials are retrieved for maintenance of long stretches of road. Such long expansive road projects would require multiple borrows pits, which would lead to an alteration of land usage from the traditional agricultural usage because of degeneration (Look, 2014). Therefore, Road Connectivity can alter land usage, but the process works to improve the socio-economic development as natives adapt to align their economic goals with the newly improved road infrastructure.

Road connectivity takes into consideration road links that begin and terminate within the same geographical location and those that extend beyond geographical boundaries. The

innate aim is to ensure Road Connectivity and seamless flow from the intra-roads to the inter-connecting roads with ease. Socio-economic development and sustainable achievement of growth through road transport network is achieved through an efficient and functional road network that can guarantee Road Connectivity. The onset of rural and urban in-migration results from differential development in the two areas. With improved Road Connectivity, rural development becomes a realization. The African Development Bank Group seeks to increase Road connectivity of the urban areas with the rural areas with the aim of reducing in-migration by promoting socio-economic growth of the natives and improving access to rural trade centres (Howes & Robinson, 2006). Missing links that ensure Road Connectivity to the rural areas from the urban points will ensure flow of commodity and services; hence, assist in realization of development goals through an improved road infrastructure system.

2.4 Influence of Traffic Volume on Prioritization of Road Projects

Traffic volume is a significant maintenance criteria which maintenance team places emphasis during the inception stage. The European Norms define traffic capacity and loading based on different approaches that measure both vehicular traffic and their impact on the road condition. It is vital to appreciate that the traffic capacity affects the axle loading, which in turn determine the longevity of the road surface condition. In Kenya, Road Note 29 and 31 from the European Norms were adopted in the realization of a road manual that was customized for carrying out traffic analysis on sub-Saharan roads. Different traffic surveys are conducted to determine the traffic capacity and volume of an area. Matsouka (2006) indicated that different surveys were carried out as part of the zoning methodology in the determination of traffic volume in an area. The surveys conducted include but not limited to person-trip survey, cordonline survey, screen line survey, traffic count and public transport usage survey. The surveys are conducted to determine the existing traffic conditions and to form a basis for predicting traffic growth in the future without biases.

Person-trip surveys are used to indicate the information of the travel behaviour and patterns of the residents in an area, and form a basis for predicting future travel traits of the study area citizens. The travel characteristics of the residents and the trip generation are determined as the basis for the survey. Cordonline survey are used to gather information of the trips generated from the study area to other places and it indicates the origin and destination trips for the residents and the survey utilizes vehicle occupancy (National Cooperative Highway Research Program, 2010). The screen line survey provides information that can be used to

calibrate and analyse information acquired from the origin and destination studies, and the survey utilizes the traffic volume based on vehicle types as opposed to occupants. Further, screenline survey also determines turning movement of traffic volume in areas that require or have intersections. The traffic count is obtained from the person-trip survey and it uses the vehicle types to discern the accurate capacity of motorized traffic in the study area (National Cooperative Highway Research Program, 2010).

In Kenya, the traffic count surveys are divided into cars, mini-buses, light goods vehicles, medium goods vehicles and heavy goods vehicles (Chief EngineerMaterials (Roads & Aerodomes), May 1981). In cases where axle loads surveys are to be avoided because of constraint in time and resources, the prioritization based on traffic volume can use the traffic count to generate the Cumulative Equivalent Standard Axles (CESA), which is used to determine the effect of the vehicle type loading on the existing road condition (Chief Engineer Materials, 1987). Such studies are vital as they assist in discerning whether the design pavement type has exceeded the required axle loading, it was designed for and if the maintenance need will have to consider an overhaul. Public transport surveys are used to indicate the existing transport public usage of motorized traffic. The survey focuses on public transport users' characteristics and their preferences. It deals with the public transport transfer situation and problems, especially for people connecting in more than one route.

To discern traffic congestion and delay that results from it, zoning is carried out to distinguish road network routes based on the exiting and predicted traffic volume. The zoning system is used to categorize human traffic based on population and geographical boundaries. The normative approach is to have the zoning systems, which include small, medium and large. The zones will dictate the non-motorized traffic present in an area and the demand for public transport usage within the locality, which will be used to prioritize the roads based on the need to ease flow of both vehicular and human traffic (Transportation Research Board, 1982). Studies have indicated that traffic jams occur because of bottlenecks caused in the variation of traffic volume brought about by speed check measures or intersections (Matsouka, 2006). Minimizing the intersections in an area can contribute to diminution of traffic jams and elimination of speed checks like bumps, but with adequate measures for safety sought as an alternative. The traffic count survey and the junction capacity studies assist to control the maintenance speed to an optimized level that will bring about minimal delays.

Therefore, the prioritization process focuses on the traffic capacity realized through the traffic count, whereby different vehicle types are classified in the present and their growth is predicted in the future. Areas that will have high traffic growth based on vehicle types will receive emphasis. Similarly, origin and destination matrices indicate the trip generation information of the non-motorized traffic in an area and the people travel traits based on present conditions and predicted scenario for the future. Areas that indicate a significant growth in non-motorized traffic will receive priority during maintenance of pedestrian road facilities. Ultimately, an optimization of the motorized and non-motorized traffic growth patterns, for both present and future conditions, forms an essential component in prioritization. In cases where both motorized and non-motorized traffic are significant in the present and predicted to grow exponentially, priority for maintenance and possible expansion of the road network is considered. The determination of human and non-human traffic assist in realizing areas that bring about possible bottlenecks and delays caused as a result of traffic jams in the area. The prioritization process is such that the bottlenecks are increased in capacity during maintenance or shifted to eliminate traffic jams (Hicks, 2007).

2.5 Influence of Road Condition Survey on Prioritization of Road Projects

Determinants for the road condition include road surface, safety of road users and vehicle maintenance costs. Carrying out a survey on road condition involves an inventory record, which is executed over a period. In terms of the road condition survey, the proposed surface for various road networks is checked and recorded for consistency. Ideally, there are three common road surface and they are completed with bitumen (tarmac), gravel, or earth materials. Surfaces completed with bitumen usually have a wearing course of premix, chippings or an amalgam of other materials like slurry seals (Skinner, 2008). Gravel surfaces are delineated based on imported material from other areas, which is used as the wearing course.

In Kenya, the Road Maintenance Manual denotes the quality, consistency and classification of gravel that is standard for use in surfacing roads (Chief Engineer Materials, 1987). Road surfaces completed with earth materials have the natural or native alignment soil materials graded or cleared to make a road. In such cases, no material is imported to the surface of the road. The road surface condition is categorized based on an index that denotes good, fair and poor road conditions. Based on the condition of the road, prioritization will occur to reinstate the pavement to its original condition. The normative approach is to have critical roads that

are in poor conditions maintained first. This is especially true for gravel roads, which tend to wear out quickly and easily. However, a bitumen road that is in good condition would receive high priority for maintenance, while that in poor condition will receive priority for an upgrade or overhaul depending on the economic Road Connectivity it serves to the citizens (Lewis, 1999). A poor gravel road would receive priority for maintenance as opposed to one that is in good condition, because gravel wears out with time and it is uneconomically feasible to maintain a good gravel road.

The safety of road users is as important as the need for Road Connectivity and traffic flow. Roads completed should be able to ensure safety of usage for the existing traffic volume. The aspect of road safety is catered for in the geometric maintenance of the road network and the prioritization process must consider a maintenance review to improve the comfort of driving on the road (Chief Engineer Materials, May 1981). In cases, where the maintenance review indicates that the road is not safe for users either because of inter-visibility or difficulty in manoeuvring using the maintenance speed, such roads receive first priority for maintenance (Baker, 1975). However, the maintenance process leans more on a geometric review of the existing road condition prior to actual construction (Schoon, 2000). Roads in poor condition increase the amount of vehicle maintenance costs and as such, they are given priority.

2.6 Influence of Funding for Road Works on Prioritization of Road Projects

The process of road prioritization is affected by the availability of funds and the cash flow for carrying out activities like road inventory and traffic survey, which are completed at the prioritization or planning stage. In the financial year 2015/2016, the Kenya Roads Board (2015) indicated that only 49350Kms of road network would be maintained against a possible 161451.3Kms and the backlog was Kshs 400 billion, with an annual budget of Kshs 28 billion against required annual maintenance budget of Kshs 50 billion The statistics indicate that not all roads can be prioritized irrespective of the poor condition or state because there is a limited availability of funds. Further, the report from the Kenya Roads Board (2015) indicated that the 49350Kms planned for maintenance in the fiscal year 2015/2016 was a drop in the ocean because of an escalation in the cost of raw materials and labour in the country. The complex interplay of macroeconomic factors coupled with the need to carry out routine maintenance for most roads possess difficulty in the realization of funds through the fuel levy fund. Funds are limited resources, and their disbursement is pegged on repair and

rehabilitation of the most critical links, which implies that not all road networks can be maintained (Ministry of Roads, 2012).

Further, the process of carrying out road inventory requires Funding for Road Works for feasibility studies. Road inventory activities are iterative annual events, which require adequate amount of funds for their success to be accomplished. The channelling of funds must be executed from a technical informed and feasible basis, which can only occur after an exhaustive and inclusive road condition survey. In Kenya, the Public Finance Management Act No. 18 of 2012 requires prudence and accountability from officers dealing with public resources and their allocation would be done on merit basis lest integrity question discredit the performance of the officer (National Council for Law Reporting, 2012). Therefore, detailed feasibility studies on roads to be prioritized and a consistent cash flow throughout the period of carrying out the road inventory program are inevitable eventualities and paramount for public officers. While a consistent cash flow is desirable, the scenario may not always be the case as indicated by delays in disbursement of funds and inflation which reduces the total revenue collection from fuel levy and tolls. Nonetheless, a consistent cash flow will ensure quick and inclusive road inventory and traffic survey are carried out, which will form reasonable grounds for channelling funds to the prioritized roads (Bett, 2010). However, a stringent cash flow will force road maintenance authorities to focus only on the most critical links for immediate address and reinstating them to motorable conditions.

2.7 Regulatory Requirements of Roads Act

The regulatory requirements may not influence the prioritization process directly, but they affect the distribution and selection criteria used. The management, classification, construction and maintenance of roads as per the Kenya Roads Bill (2015) is divided in accordance to national and county roads. Authorities with the sole aim of ensuring regional Road Connectivity maintain national trunk roads as outline in the First Schedule, part A, of the Kenya Roads Bill (2015). Class S, A, H, J, C and D roads fall under national trunk roads with the remaining Class E, F,G, H, J, K, L, M, N and P fall under county roads (Kenya Roads Bill, 2015). Therefore, the prioritization process will be in tandem with the classification and jurisdiction of construction for respective agencies. This implies that national roads will be left to authorities while the county roads will be maintained by county government once the bill is enacted into law.

2.8 Theoretical framework

The study employed the stakeholder's theory advanced by Edward Freeman, in his book titled "A Stakeholder Approach" to focus on the planning and prioritization of different activities that occur in a road construction project (Freeman, Harrison, Wicks, Parmar, & Colle, 2010). The theory states that there are variable stakeholders in a construction project, such as road and they include suppliers, customers, employees, communities, governmental bodies, trade unions, financiers among others (Friedman & Miles, 2006). Therefore, during prioritization and planning the decision-making must take into consideration the resource and market view of the stakeholders for them to make successful choices. The stakeholders in a construction project have increased twofold with the possibility of variable interests being eminent in the process. With the escalation in the stakeholder preferences and choices so as the view for project maintenance changed over time. For instance, stakeholders would view road projects as crucial ventures for socio-economic development and would inherently desire those missing links closest to them to be rehabilitated and maintained on a continuous basis (Phillips, 2011). Due to the constraint of time and money, it is not logical and feasible to select all roads, since this would trivialize the effort of prioritization in itself. Road Authorities in Machakos County need to heed the demands and views of the stakeholders when making considerations on which links they should prioritize. The normative instrumental and descriptive assumption of the theory is that stakeholders' views are the priority during road construction. Their efforts must not be trivialised because each road venture is meant to work for their own good and as such, they are deemed capable of discerning roads that are crucial for their socio-economic and political development.

Different authors contributed to the evolution of the stakeholder theory from a traditional view point to a contemporary and modern perspective. Peterson and Donaldson (1995) argue that the stakeholder theory bore multiple attributes ranging from instrumental, normative, descriptive and supportive (Phillips, 2011). The normative approach was considered to be the focus of the theory because of its ability to relate to business ethics and organizational management. Mitchell, Agle, and Wood (1997) also contributed to the development of the stakeholder theory based on legitimacy, power and urgency of the parties involved (Zakhem, Palmer, & Stoll, 2008). The stakeholders were defined as those with an inherent and inalienable legitimate and powerful voice in making decisions, especially those touching on urgency in an organization. Robert Allen Phillips (2011) further indicated that stakeholders

would be divided into derivative and normative legitimate stakeholders, both of whom an organization had a responsibility to focus and incorporate their views.

2.9 Conceptual Framework

The conceptual framework has four independent variables, which include Road Connectivity, traffic volume, road condition survey and Funding for Road Works while the moderating variables is legislation and policy touching on roads act and classification. The dependent variables is on prioritization of the road projects accomplished through a road investment programme and a road inventory. Resource and market views of stakeholders affect the maintenance criteria on Road Connectivity, traffic volume, road condition survey and Funding for Road Works from a descriptive and normative approach. It is descriptive in the sense that stakeholder would determine and explain which roads are critical for Road Connectivity and they will offer information on traffic surveys carried out (Linger, et al., 2013). It is normative in the sense that stakeholders will give a rating based on personal view on the road condition surface, safety and perceived vehicle maintenance costs. Taking into consideration the stakeholders views will assist the road authorities in coming up with a road investment program and inventory that can aid the process of prioritization. However, the legislation and policy on road acts and classification will be vital in making the correlation between Road Connectivity, traffic volume, road condition survey, Funding for Road Works and the eventuality of having a road investment program and inventory.

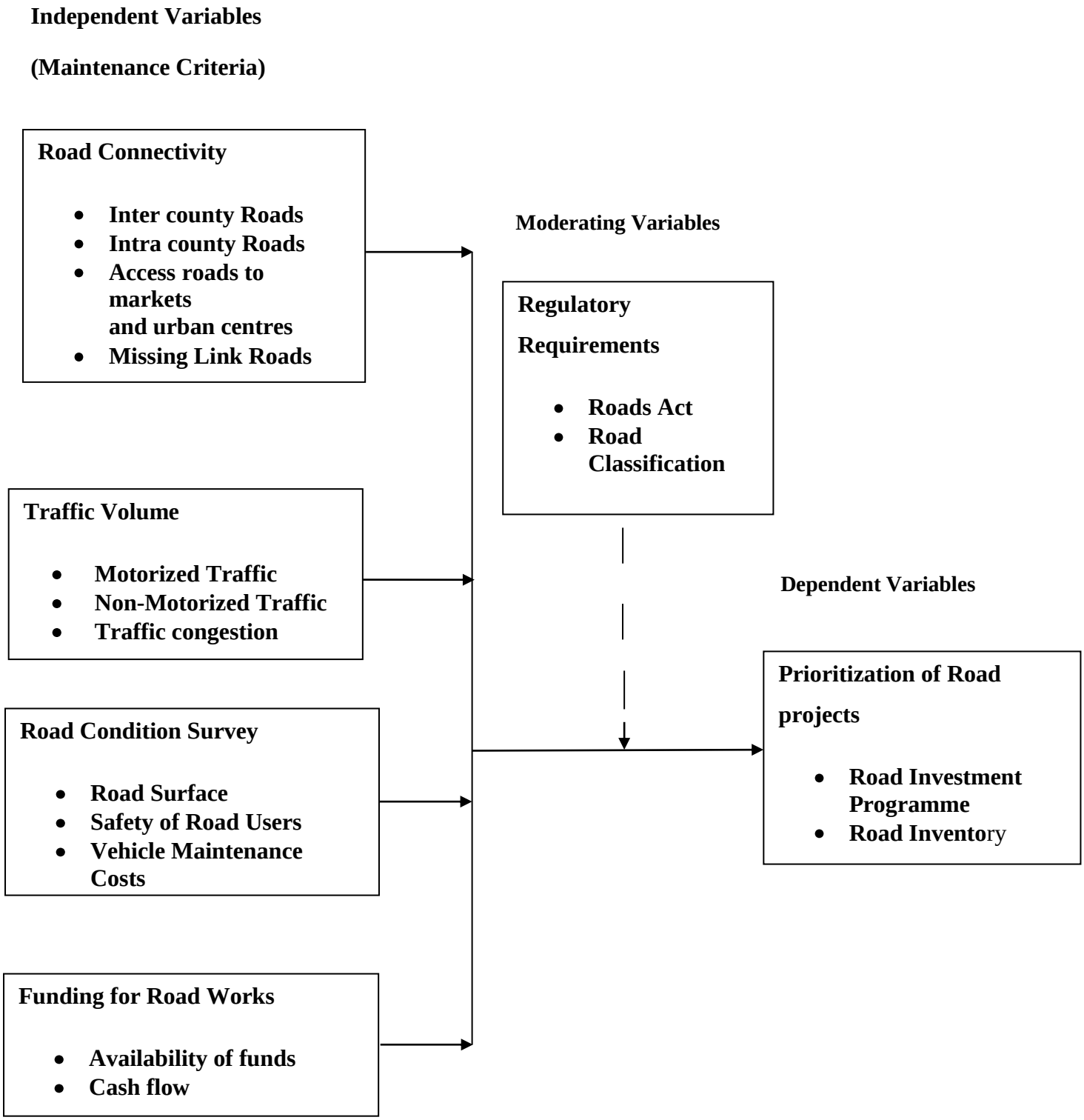

Figure 1: Conceptual Framework

2.10 Summary of Gaps

The chapter reviewed past literature on Road Connectivity, traffic volume, road condition survey and Funding for Road Works with its perceived effects to prioritization of road maintenance projects. Roads Road Connectivity was discussed based on the need for inter-connection and intra-connection, access to major urban centres and markets. Traffic volume was discussed based on the capacity of motorized and non-motorized traffic while road condition survey was discussed from a review of literature involving road surface condition, safety and vehicle maintenance costs. Review of past literature on Funding for Road Works focused on availability of funds and cash flow at the prioritization stage. However, these past studies lacked information on the influence of each maintenance criteria in prioritization of road projects. This study attempted to fill that knowledge gap.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

The chapter discussed the research design, target population, methods of data analysis, validity and reliability of instruments and the operational definition of variables. It indicated the procedure on how data will be acquired, checked for consistency and relevancy to the study.

3.2 Research Design

The study employed descriptive research survey design to collect, record, analyse and report the existing phenomena. A descriptive research survey design is the road map, framework or plan that offers a guide to the researcher. It entails the acquisition of information that seeks to answer the question "what is" and is precise to the study objectives (Flanagan, 2005). A descriptive research design was preferred for the study because it allowed the researcher to find an explanation based on the correlation effect of independent variables on the dependent variables (Ogula, 2005). A descriptive survey design involves collection of data from events then tabulating and describing the information (Thomas, 2011).

A descriptive study is conducted by collecting data and collating it systematically to derive a comprehensive inferences between the independent and dependent variables.

The descriptive study aimed at finding out the influence of road Road Connectivity, traffic volume of motorized and non-motorized, road condition and Funding for Road Works on prioritization of road projects in Machakos County, Kenya.

3.3 Target Population

A target population is an experimental unit used to collect data that can be used to make conclusion based on inferential statistics (Mugenda & Mugenda, 2003). The population consisted of 65 respondents from the public road transport users and the three road authorities operating in Machakos County and they include; Kenya National Highways Authority, Kenya Rural Roads Authority, and Kenya Urban Roads Authority. The population comprised of accountants, engineers, road supervisors, technicians, and public road transport sacco officials in Machakos County.

Table 3.1 Categories of Respondents

Respondent	Population
Accountants	3
Engineers	6
Road Supervisors	28
Technicians	8
Public Road Transport Sacco Representatives	20
TOTAL	65

3.4 Population census

A population census is carried out when the target population is minimal and the resource constraints of time, money and quality of data collected would not compromise the reliability and replication of the study. Mugenda and Mugenda (2003) indicates that a sample population of more than 30% is sufficient to be representative of the entire population. Since questionnaires were dispatched to 65 respondents and the response rate was 58.46%, which was above the stipulated threshold indicated by Mugenda and Mugenda (2003). The accountants were included in the study because of the need to retrieve information on Funding for Road Works while the engineers, technicians, road supervisors and public transport road users were included in the study because they are directly linked to the process of checking Road Connectivity, carrying out traffic volume studies and road condition surveys.

3.5 Research Instrument

The study used close-ended questionnaires and they attracted qualitative and quantitative data. Primary data was acquired using the questionnaires given to the respondents while the secondary data was acquired using information from document review. Questionnaires were preferred for the study because they offered an accurate and detailed feedback of the study objectives as each individual responded on their own convenience (George & Bennett, 2004). The questionnaire had background section and different sections divided in accordance to the study objectives.

3.6 Validity and Reliability of the Research Instrument

Validity and reliability are essential ways by which a research instrument is evaluated before being employed in the field for data collection.

3.6.1 Validity of the Research Instrument

The validity refers to the extent or degree with which the research instrument measures, with accuracy and without bias, the intended information that is relevant to the study objectives in order to bring out the meaningfulness of the inferences from the result acquired (Cooper & Schindler, 2006). Validity refers to the ability of the results obtained from the study to indicate the accuracy of the phenomena under investigation (Swanborn, 2010). A pilot test was conducted on selected but similar respondents in which five questionnaires were issued in the neighbouring Nairobi County to pre-test research instrument and the feedback used to eliminate irrelevant questions and improved it for purposes of bringing about meaningful inferences, which may have been omitted by the research instrument (Rubin & Babbie, 2009). This assisted improve the validity of the research instrument.

3.6.2 Reliability of the Research Instrument

Reliability measures and determines the degree in which the set of independent observations can be consistent over a period and replicated in the future without bias and prejudice (Jackson, 2014). It is the measure or degree for which the set of questionnaires or test would yield same results over repeated trials. Cronbach alpha was used to determine the internal consistency of the data. Cronbach alpha was preferred for the study because data to be acquired would be from an ordinal scale, hence its ability to make a correlation on elements that are not continuous. Cronbach alpha has a range from zero to one and an increased degree of internal consistency is indicated with values close to one. Ideally, scores of more than 0.6 are considered an adequate measure of the internal consistency of the data (Cronbach & Meehl, 1955).

The Cronbach alpha formula is given as:

$$\propto = \frac{N.C}{V + \ N - 1 \ .C}$$

Formula Cronbach Alpha

Where N is the number of components, C is the average of all the covariance, $\propto$ is the Cronbach coefficient, and V is the variance (Cronbach & Meehl, 1955). From the study a reliability coefficient of 0.72 was achieved. According to Cronbach and Meehl (1995), a Cronbach alpha coefficient of ≥ 0.9 is excellent, $0.7 \leq \alpha < 0.9$ is good, $0.6 \leq \alpha < 0.7$ is acceptable, $0.5 \leq \alpha < 0.6$ is poor and $\alpha < 0.5$ is unacceptable. Therefore, the coefficient was good and an indication that the research instrument was reliable.

3.7 Data Collection Procedure

After the research instrument was checked for validity and reliability, the study embarked on field data collection. The questionnaires were distributed to the respondents with the assistance of a research assistant. This method was preferred because it was more reliable as large number of the respondents were easily contacted and given humble time to respond at their convenience unlike other methods like mailing which depended on accessing ICT services. The duly filled questionnaires were collected at agreed time with the respondents and research assistant.

3.8 Data analysis Techniques

The data collected was in both qualitative and quantitative. The data used was from both primary and secondary sources. Questionnaires were distributed with the help of a researcher assistant and the respondents offered to complete them either on spot or delivered later to the research assistant. The research used descriptive statistics of frequencies and percentages for analysis and depict the results in Tables for presentation. The data was presented in form of frequency Tables to explain results obtained. Correlation analysis was done to determine the degree of association between variables using the chi-square at 95% confidence level.

3.9 Operationalization of Variables:

Table 3.1: Operationalization of Variables

Objective	Variable	Indicator	Measure	Measurement Scale	Data Collection Method	Data Analysis
To ascertain the influence of Road Connectivity on prioritization of road projects in Machakos County	**Independent Variable** Road Connectivity	Inter-county Roads Intra-county Roads Access roads Missing link roads	Level of Road Connectivity	Ordinal Ordinal Ordinal Ordinal	Questionnaire	Likert scale, Cronbach alpha, Chi-Square, Frequency, Percentages
To investigate the influence of traffic volume on prioritization of road projects in Machakos County	Traffic Volume	Motorized traffic Non-motorized traffic Traffic Congestion	Level of Service offered	Ordinal Ordinal Ordinal	Questionnaire	Likert scale, Cronbach alpha, Chi-Square, Frequency, Percentages
To establish the influence of road condition survey on prioritization of road projects in Machakos County	Road Condition Survey	Road Surface condition Safety of road users Vehicle maintenance costs	Road Roughness and travel speeds	Ordinal Ordinal Ordinal	Questionnaire	Likert scale, Cronbach alpha, Chi-Square, Frequency, Percentages
To determine the influence of Funding for Road Works on prioritization of road projects in Machakos County.	Funding for Road Works	Availability of funds Cash flow	Adequacy of funds Disbursement of funds	Ordinal Ordinal	Questionnaire	Likert scale, Cronbach alpha, Chi-Square, Frequency, Percentages
Prioritization of road projects	**Dependent Variable** Road projects	Road Investment program Road Inventory	Project cost-effectiveness	Ordinal Ordinal	Questionnaire	Likert scale, Cronbach alpha, Chi-Square, Frequency, Percentages

3.10 Ethical Considerations

Confidentiality and privacy of information was assured to the respondents whereby they were informed that the data acquired was only meant for academic purposes. The data would not be utilized in any manner other than for academic purposes without the consent of the respondents. Further permission from the National Commission for Science and Technology was applied and a permit to carry out the research offered. Another ethical consideration was ensuring anonymity of the respondents was upheld throughout the study. Plagiarism was also avoided at all levels of this research exercise.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1 Introduction

The chapter gives a detailed analysis on data, interpretation and presentation with the aim of addressing the study objectives. The main objective of the research was to determine the influence of maintenance criteria on the prioritization of road projects by authorities within Machakos County. Maintenance criteria was divided into Road Connectivity, traffic volume, road condition survey, and Funding for Road Works. A descriptive survey design was employed in the study and the data analysed using frequencies and percentages.

4.2 Questionnaire Response Rate

The study had a target population of 65 participants. Questionnaires were issued out to 65 and the respondents were 38, indicating a return rate of 58.46% while 27 (41.54%) were non-responsive. The return rate of the questionnaire is indicated in Table 4.1.

Table 4.1 Response Rate

Response	**F**	**%**
Respondents	38	58.46
Non-respondents	27	41.54
Total	**65**	**100**

The typical return rate was because the research assistant was deployed and the respondents were keen on discussing maintenance criteria as a factor influencing prioritization of road projects. A response rate of 30% to 50% was viewed as typical for the study (Rubin & Babbie, 2009).

4.3 Demographic characteristics of the respondents

The section groups the respondents in terms of their gender, category, age, and highest level of education.

4.3.1 Distribution of Respondents by Gender

The gender of the respondents is presented in Table 4.2

Table 4.2 Gender of the Respondents

Gender	F	%
Male	27	71.05
Female	11	28.95
Total	**38**	**100**

According to Table 4.2, most of the respondents were male (71.05%) with few female (28.95%), an indication that gender distribution in road maintenance is almost attaining a third requirement for women employment as per the Kenyan constitution.

4.3.2 Distribution of Respondents by Category

The category of the respondents were divided into Engineer, Accountant, Road Supervisor, Technician and Public Road Transport User as presented in Table 4.3.

Table 4.3 Category of the Respondents

Category	F	%
Engineer	3	7.89
Accountant	4	10.53
Road Supervisor	9	23.68
Technician	7	18.42
Public Road Transport User	15	39.47
Total	**38**	**100**

The Table shows that majority (39.47%) of the respondents were public transport road users, followed by road supervisors (23.68%), technicians at 18.42%, accountants at 10.53% and engineers at 7.89%. The high input of road users is noted because of the need to learn the study objectives from the end users who are the people using road transport system. The low (7.89%) input of the designers who are road engineers was as a result that each Road Authority had only one professional engineer who doubled as the regional manager.

4.3.3 Distribution of Respondents by Age Group

There were four clusters of age groups: 18 – 29 years; 30 – 39 years; 40 – 49 years; 50 and above years. Table 4.4 indicates the age group of the respondents in years.

Table 4.4 Age Group of the Respondents

Age	F	%
18-29	9	23.68
30-39	21	55.26
40-49	5	13.16
50 and above	3	7.89
Total	**38**	**100**

According to Table 4.4 most respondents were aged between 30-39 at 55.26%, followed by respondents between 18-29 years at 23.68%, 40-49 at 13.16% and finally those aged 50 and above (7.89%). From the Table most (55.26%) of the respondents were experienced, which is an indication of high quality and reliable data.

4.3.4 Distribution by Highest Level of Education

The Education background information of respondents was divided into four levels as Secondary, Tertiary, College and University. Table 4.5 indicates the highest education level of the respondents. Table 4.5 indicates the distribution of Education levels of the respondents.

Table 4.5 Education level of the Respondents

Highest Education Level	F	%
Secondary	4	10.53
Tertiary	5	13.16
College	20	52.63
University	9	23.68
Total	**38**	**100**

Most of the respondents (76.31%) had studied past the college level, an indication that they had acquired higher education. 13.16% had acquired tertiary education while few (10.53%) had a minimum of secondary education as their highest study level. The education level was critical for the study because it indicated that the respondents were able to comprehend and answer the questionnaire from an informed viewpoint.

4.4 Road Connectivity

The section gives data analysis, presentation, and interpretation of the influence of Road Connectivity as a maintenance criterion on the prioritization of road projects.

4.4.1 Road Connectivity as a Maintenance Criterion Influencing Prioritization

The need to ensure seamless Road Connectivity is considered as part of the initial factors determining the prioritization of road projects was analysed and presented in accordance with the study objectives. Table 4.6 indicates the influence of Road Connectivity as a maintenance criteria.

Table 4.6 Road Connectivity

Road Connectivity	**F**	**%**
Yes	37	97.37
No	1	2.63
Total	**38**	**100.00**

A significant number, almost all (97.37%) indicated that Road Connectivity is a crucial element for consideration during prioritization of road projects to be maintained by the authorities. This is an indication that the respondents linked the road network to the need of accessibility and inter-connection as being key to prioritization of road projects.

4.4.2 Road Connectivity as a Maintenance Criterion

Table 4.7 indicates the level of agreement by the respondents to the statements contained in the questionnaire.

Table 4.7 level of agreement to statements related to Road Connectivity.

The questionnaire was ranked as follows: 1- Strongly Disagree 2-Disagree 3-Neutral 4-Agree 5- Strongly Agree	**1**	**2**	**3**	**4**	**5**
Statement	**%**	**%**	**%**	**%**	**%**
Inter-county roads connecting Machakos County to the neighbouring Counties are always maintained in good condition	7.89	31.58	36.84	23.68	0.00

Intra-county road connecting Wards and Sub-Counties within Machakos County are in good condition	5.26	47.37	31.58	15.79	0.00
Roads accessing markets and urban centres of Machakos County do not require maintenance interventions	47.37	18.42	18.42	10.53	5.26
Road Connectivity in Machakos County is complete with no missing links between villages or important centres	39.47	18.42	31.58	7.89	2.63

Table 4.7 indicates that majority of the respondents (36.84%) were not aware whether the roads connecting the counties were maintained in good condition. Majority of the respondents (39.47%) noted that the roads connecting the counties were not maintained in a good condition. However, none of the respondents strongly agreed that inter county roads were maintained in good condition though 23.68% agreed. The results indicate that roads connecting Machakos County to the neighbouring counties were not maintained in a good condition. On intra - county roads connecting wards, the majority (52.57%) were of the opinion that intra county roads are not prioritized for maintenance hence are not in good condition while 15.79 % differed. Majority of the respondents 47.37% strongly disagreed on the opinion that roads connecting urban centres did not require maintenance while a minority 5.26% were of strong opinion that the market roads and accesses to urban centres did not require maintenance. The data indicates that people appreciate the need for road connectivity as being key to prioritization of road projects with access to markets and urban centres being given highest priority.

4.4.3 Level of Influence of Road Connectivity

Table 4.8 indicates the level of influence of Road Connectivity as a maintenance criterion during prioritization of the road projects.

Table 4.8 Influence level of Road Connectivity

Influence level of Road Connectivity	F	%
To a very great extent	13	34.21

To a great extent	16	44.74
To a moderate extent	5	13.19
To a low extent	3	7.90
To a very low extent	0	0.00
TOTALS	**37**	**100**

According to Table 4.8 majority (44.74%) of the respondents agreed to a great extent that Road Connectivity was crucial while 34.21% were very strongly convinced, few of the respondents 7.90% were convinced that Road Connectivity is vital during prioritization of road projects. This is an indication that Road Connectivity was viewed as an essential component during the prioritization of road projects.

4.5 Traffic Volume

The section gives data analysis and presentation and interpretation of the influence of traffic volume as a maintenance criterion on the prioritization of road projects.

4.5.1 Traffic Volume as a Maintenance Criterion Influencing Prioritization

Priority of maintenance is given to the roads with the highest level of service, which takes into consideration the amount of traffic and level of weighting of the axles passing on a given road section. The section sought to determine the effect of traffic counts and axle load surveys during prioritization of maintenance projects. Table 4.9 indicates the influence of Traffic Volume as a maintenance criteria.

Table 4.9 Traffic Volume

Traffic Volume	**F**	**%**
Yes	36	94.7
No	2	5.26
Total	**38**	**100**

Most of the respondents (94.7%) indicated that traffic volume needs to be considered during prioritization of roads while few 5.26% were of a different opinion. The Table 4.9 indicates that people were convinced that the amount of vehicles plying a route needs to be considered before choosing roads to maintain.

4.5.2 Traffic Volume as a Maintenance Criterion

Table 4.10 indicates the level of agreement to the questions asked to the respondents on traffic volume.

Table 4.10 Traffic Volume as a Maintenance Criterion

The questionnaire was ranked as follows: 1-Strongly Disagree 2-Disagree 3-Neutral 4-Agree 5-Strongly Agree	**1**	**2**	**3**	**4**	**5**
Statement	**%**	**%**	**%**	**%**	**%**
Roads with higher motorized traffic volume have been given priority during prioritization of road improvement projects	7.89	18.42	26.32	31.58	15.79
Roads with higher number of pedestrians have been provided with walkways	23.68	34.21	26.32	5.26	10.53
Areas with traffic jams like at intersections have been improved and congestion eliminated	15.79	44.74	23.68	10.53	5.26
Traffic congestion determines which roads to be prioritized	5.26	21.05	21.05	39.47	13.16

Table 4.10 indicates that majority of the respondents (47.37%) believed that the roads with high levels of traffic were considered during prioritization of road projects, while few 7.89% strongly disagreed and some of the respondents (26.32%) were not certain. Similarly, 57.89% were of the opinion that roads with non-motorized traffic did not have pedestrian walkways, while others 15.79% thought otherwise. This is an indication that walkways were not considered at the prioritization stage. Most (60.53%) of the respondents concurred that areas

with traffic snarl ups like junctions were not improved while 15.79% though otherwise. A significant number of the respondents (23.68%) remained uncertain. Majority (52.63%) of the respondents concurred that areas with traffic congestion need to be the first to maintain while a minority 26.31% opined otherwise with 21.05% remaining neutral. Table 4.10 is an indication that human traffic was not considered during the prioritization of road projects and emphasis was accorded to motorized traffic.

4.5.3 Level of Influence of Traffic Volume

Table 4.11 indicates the level of influence of traffic volume as a maintenance criterion during prioritization of the road projects.

Table 4.11 Level of Influence of Traffic Volume

Influence level of Traffic Volume	F	%
To a very great extent	11	28.9
To a great extent	11	31.6
To a moderate extent	13	36.8
To a low extent	0	0
To a very low extent	1	2.63
TOTALS	**36**	**100**

According to Table 4.11 majority (60.5%) of the respondents were strongly convinced that traffic volume was crucial while 36.8% remained uncertain, few of the respondents 2.63% were convinced that traffic volume was not vital during prioritization of road projects. This is an indication the number of vehicles and pedestrians in a certain road together with axle damaging effect needs to be considered when making choices on which roads to maintain.

4.6 Road Condition

The section gives data analysis, presentation and interpretation of the road condition as a maintenance criterion on the prioritization of road projects.

4.6.1 Road Condition as a Maintenance Criteria Influencing Prioritization

Road Authorities often carry out an annual road condition survey, which forms a benchmark for decision making during maintenance. The section sought to establish the need for carrying out the road condition survey and its relevance to maintenance. Table 4.12 indicates the influence of road condition as a maintenance criterion.

Table 4.12 Road Condition

Road Condition	F	%
Yes	37	97.37
No	1	2.63
Total	**38**	**100**

A significant number, almost all (97.37%) indicated that a road condition survey is a vital element for consideration during prioritization of road projects to be maintained by the authorities while few 2.63% thought otherwise. The results indicate that there is a need to determine the initial condition of the roads and rank them in order of priority before embarking on maintenance.

4.6.2 Road Condition as a Maintenance Criterion

Table 4.13 indicates the level of agreement to the questions asked to the respondents on need for carrying out a road condition survey.

Table 4.13 Road Condition as a Maintenance Criterion

The questionnaire was ranked as follows: 1-Strongly Disagree 2-Disagree 3-Neutral 4-Agree 5- Strongly Agree	**1**	**2**	**3**	**4**	**5**
Statement	**%**	**%**	**%**	**%**	**%**
There are no big pot-holes in most roads in Machakos County	13.16	26.32	31.58	23.68	5.26
Road surfaces in good condition are continuously maintained in that state in Machakos County	10.53	23.68	47.37	13.16	5.26
While choosing roads to maintain, the safety of road users is taken into consideration in Machakos County	2.63	21.05	36.84	31.58	7.89
Poor road surfaces escalate the vehicle maintenance costs	0.00	7.89	15.79	39.47	36.84

Most of the respondents (39.48%) generally disagreed that there were no potholes in Machakos County, while 28.95% thought otherwise and 31.58% were not certain. Some of the respondents (34.21%) generally disagreed that a road surface in good condition were maintained in the same state, while 18.42% thought otherwise and 47.37% were not certain. The results indicate that priority for maintenance is not given to the road surface in good condition. Majority (39.47%) concurred that the safety of road users was taken into consideration while choosing roads to maintain, while 23.68% opined otherwise and 36.84% were not sure. However, 76.32% of the respondents confirmed that poor road surface condition contributed to high vehicle maintenance costs, while few 7.89% thought otherwise and 15.79% were not aware of the correlation between vehicles and poor road surface. The results indicated that there was a need to ensure the road surface was in good condition so as to prevent escalation of cost. According the research objective, most respondents confirmed that Road Condition influence prioritization of road projects with majority (76.32%) attributing it to need for maintaining roads in poor condition to reduce vehicle maintenance costs.

4.6.3 Level of Influence of Road Condition

Table 4.14 indicates the level of influence of road condition as a maintenance criterion during prioritization of the road projects.

Table 4.14 Level of Influence of Road Condition

Influence level of Road Condition Survey	F	%
To a very great extent	9	23.7
To a great extent	17	47.4
To a moderate extent	11	28.9
To a low extent	0	0
To a very low extent	0	0
TOTALS	**37**	**100**

According to Table 4.14 majority (71.1%) of the respondents were strongly convinced that a road condition survey was essential while 28.9% remained indecisive, none of the respondents thought that a road condition survey was not vital during prioritization of road projects. The results indicate that people acknowledge that a road must be assessed to determine the extent of damage prior to prioritization and therefore Road Condition influence prioritization of road projects.

4.7 Funding for Road Works

The section outlines the influence of Funding for Road Works on the prioritization of road projects.

4.7.1 Funding for Road Works as a Maintenance Criterion Influencing Prioritization

Maintenance of roads requires input in terms of capital expenditure, which is often limited and is not commensurate to the workload. The section sought to determine whether there is a direct effect of the Funding for Road Works level to the prioritization of roads. Table 4.15 indicates the influence of Road Connectivity as a maintenance criterion.

Table 4.15 Funding for Road Works

Funding for Road Works	F	%
Yes	37	97.37
No	1	2.63
Total	**38**	**100**

Majority of the respondents (97.37%) indicated that Funding for Road Works was vital during prioritization of road projects considered for maintenance while few 2.63% were of a different opinion. The findings show that Funding for Road Works in terms of capital expenditure are essential during prioritization of road projects.

4.7.2 Funding for Road Works as a Maintenance Criterion

Table 4.16 indicates the level of agreement to the questions posed to the respondents on Funding for Road Works as a maintenance criterion.

Table 4.16 Funding for Road Works as a Maintenance Criterion

The questionnaire was ranked as follows 1-Strongly Disagree 2-Disagree 3-Neutral 4-Agree 5- Strongly Agree	**1**	**2**	**3**	**4**	**5**
Statement	**%**	**%**	**%**	**%**	**%**
There are adequate funds available to maintain all road networks within Machakos County	39.47	18.42	26.32	13.16	2.63
The cost of road maintenance has increased over time creating a deficit in Funding for Road Works	10.53	10.53	18.42	39.47	21.05
The fuel levy fund is released on timely basis for feasibility studies to be carried out during development of a road inventory and work plans	5.26	23.68	31.58	28.95	10.53
Cash flow can affect the process of decision-making on road projects, especially when delayed	5.26	0.00	2.63	39.47	52.63

Majority (57.89%) of the respondents cited lack of funds for maintenance of road projects in Machakos County and 15.79 generally agreed that there was Funding for Road Works while 26.32% were indecisive. Most (60.53%) generally agreed to road maintenance costs increasing over the years and as a result creating a deficit on the Funding for Road Works requirements and 21.05% thought otherwise while 18.42% were uncertain. A good percentage (39.47%) of the respondents concurred to the release of fuel levy fund in time and

28.94% believed there was a delay while 31.58% could not decide. Majority (92.10%) of the respondents agreed that cash flow would affect timely execution of pre-planning activities for road maintenance activities and a minority 5.26% though otherwise while a few (2.63%) remained uncertain. This showed that Funding for Road Works influenced prioritization of road projects especially the need to avail adequate funds.

4.7.3 Level of Influence of Funding for Road Works

Table 4.17 indicates the level of influence of Funding for Road Works as a maintenance criterion during prioritization of the road projects.

Table 4.17 Level of Influence of Funding for Road Works

Influence level of Funding for Road Works	F	%
To a very great extent	16	42.1
To a great extent	16	42.1
To a moderate extent	5	13.2
To a low extent	0	0
To a very low extent	1	2.63
TOTALS	**37**	**100**

Table 4.17 shows that majority (84.2%) of the respondents were strongly convinced that a Funding for Road Works was essential while 13.2% remained moderate, and a few (2.63%) believed that Funding for Road Works had an insignificant effect to prioritization of road projects. The findings show that funds must be availed in a timely and planned manner to ensure efficiency in the planning of activities for road projects prioritization.

4.8 Prioritization of Road Projects

The section gives findings on the prioritization of road projects based on the road investment program and road inventory.

4.8.1 Prioritization of Road Projects

Table 4.18 indicates the views of the respondents based on the need to utilize a road investment program and road inventory as the benchmarks for prioritization of road projects.

Table 4.18 Prioritization of Road Projects

Prioritization	F	%
Yes	35	94.74
No	2	5.26
Total	**37**	**100**

Majority of the respondents (94.74%) concurred that there was a need to prioritize the road projects for maintenance while few 5.26% were of a different opinion. The results indicated the need for planning road maintenance activities using a needs assessment.

4.8.2 Prioritization of Road Projects

Table 4.19 indicates the level of agreement to the questions posed to the respondents on prioritization of road projects.

Table 4.19 Prioritization of Road Projects as dependent variable

The questionnaire was ranked as follows 1- Strongly Disagree 2-Disagree 3-Neutral 4-Agree 5- Strongly Agree	**1**	**2**	**3**	**4**	**5**
Statement	**%**	**%**	**%**	**%**	**%**
A road investment programme can only be realized with adequate analysis of the traffic volume, funds available, Road Connectivity requirement and road condition survey	0	0	26.2	34.21	39.47
Road inventory aid in planning the work program for roads to be maintained	0	2.63	13.16	44.74	39.47
An effective road investment programme will lead to socio-economic growth in Machakos County	0	0	15.79	26.32	57.89

Majority (57.89%) of the respondents generally agreed that a road investment program can only be actuated with adequate analysis of the traffic volume, funds, Road Connectivity and road condition survey while 26.32% were uncertain. 84.21% concurred that the road inventory assisted in planning a work program and 2.63% though it did not while 13.16% of the respondents remained uncertain. Ultimately, majority (84.21%) of the respondents felt that an effective road investment program would lead to socio-economic growth while 15.79% were not certain. Therefore road prioritization as a dependent variable was found critical.

4.8.3 Level of Prioritization of Road Projects

Table 4.20 indicates the level of influence of Funding for Road Works as a maintenance criterion during prioritization of the road projects.

Table 4.20 Level of Prioritization of Road Projects

Influence level of Prioritization	F	%
To a very great extent	17	47.37
To a great extent	15	42.11
To a moderate extent	2	7.89
To a low extent	0	0.00
To a very low extent	1	2.63
TOTALS	**35**	**100**

89.48% of the respondents agreed that a road investment program and inventory were vital for the prioritization of roads while 7.89% were indecisive and 2.63 thought that they had insignificant effect.

4.9 Inferential statistics on Prioritization of Road Maintenance projects

Inferential statistics were employed in finding out the correlation of variables and to conclude whether differences between observed and expected outcomes were dependable or because of chance. A chi-square analysis was carried at the 95% confidence limit with $\alpha = 0.05$.

Table 4.21 Inferential statistics

Prioritization of Road Projects	Degrees of Freedom	X^2	Chi-Square	P-Value	Significance at
Road Connectivity	4	22.39	9.49	< 0.00001	$p < 0.05$
Traffic volume	4	82.04	9.49	< 0.00001	$p < 0.05$
Road condition	5	123.9	11.07	< 0.00001	$p < 0.05$
Funding for Road Works	4	66.34	9.49	< 0.00001	$p < 0.05$

From the above Table 4.21, all the variables are associated at 95% significance level since the obtained P values were all less than 0.05.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The chapter details the summary of findings, discussion, conclusions, recommendations, and provides suggestions for future research.

5.2 Summary of Findings

The findings of the study were in accordance with each study objective and based on prioritization of road projects by state corporations working in Machakos County.

Based on the first study objective which investigated the influence of Road Connectivity in prioritization of road projects, most of the respondents (78.95%) agreed to a great extent and beyond that that Road Connectivity was an essential component for consideration during the prioritization of road projects. However, most of the respondents (65.8%) noted that the roads connecting the markets and urban centres were not maintained in a good condition and therefore this was found to be the most influencing factor on prioritization of road projects based on Road Connectivity.

The second objective assessed the influence of Traffic Volume in prioritization of road projects. Most respondents (60.5%) concurred that traffic volume needs to be considered during prioritization of road projects for maintenance. The authorities focused more on vehicle traffic as opposed to human traffic. Highest preference was given to areas with traffic snarl ups and congestion (60.53%) for road projects prioritization. The respondents attributed consideration for traffic volume in prioritization based on the need to decongest the towns and ease motorized traffic flow.

The third objective was on the influence of Road Condition in prioritization of road projects. Road condition survey was considered an essential maintenance criteria as articulated by 71.1% of the respondents. The respondents concurred that an initial road condition survey assists in making decisive and informed judgment on which roads to prioritize for maintenance. The highest consideration by the respondents (76.31%) indicated that the roads in poor conditions escalates the vehicle operating costs, and therefore should be given maintenance priority.

Ultimately, the other objective studied was on the influence of Funding for Road Works in prioritization of road projects. 84.2% of the respondents concurred that Funding for Road Works was vital in the prioritization of road projects. The highest majority of the respondents (57.9%) articulated the availability of funds to having a strong influence in timely delivery of road projects. However, few respondents (28.9%) indicated that release of available funds affected the prioritization of road projects and therefore release of funds was not found to influence prioritization of road projects negatively.

5.3 Discussion of Findings

The majority of the respondents confirmed that Road Connectivity as a maintenance criterion influenced the prioritization of road projects. Road Connectivity was linked with the need for human mobility and transfer of commodities from one area to another (United Nations ACC Task Force on Rural Development, 1985). The ability to ensure seamless flow during a crisis and access to public and social amenities was viewed as the result of an effective road network. Intra-county and inter-county Road Connectivity was cited as a means of ensuring quick disaster response, making it an essential component for the maintenance criteria (Hu & Janowicz, 2015).

There was a significant need for the authorities to assess the traffic volume from vehicle count, axle load survey and non-motorized volume counts. The traffic volume of a given road affected the level of service and the ability to ensure timely movement of persons and commodities. Traffic volume formed an essential maintenance criterion as it formed the basis for determining roads to be maintained or upgraded depending on the desired level of service to be achieved (National Cooperative Highway Research Program, 2010). Congestion was viewed as the underlying effect necessitating a need for traffic volume counts at the prioritization stage. However, non-motorized traffic counts were not given priority by the road authorities in Machakos County and this trend should be discouraged.

The road condition survey determined the type and quality of riding surface, which informed the maintenance approach to be used (Skinner, 2008). Roads with poor surfaces were supposed to be considered for rehabilitation while those in excellent condition were not given first priority for maintenance to preserve their asset value. In essence, the roads with good riding surface need to have been given priority during prioritization of roads to maintain (Baker, 1975). The aim was to ensure that the best roads do not deteriorate due to neglect

over time so that they can serve the citizens for a longer duration of time and reduce maintenance backlogs.

Funding for Road Works is part of the maintenance criteria although it does not affect the technical input, but it has a significant impact on the actualization of the proposed maintenance measures. Funding for Road Works availability determined whether the proposed intervention measures will be achieved in a timely and efficient manner so as not to interfere with the welfare of the road users. However, road projects that require maintenance are numerous and the Funding for Road Works level is insignificant, which makes it inevitable for authorities to prioritize on the roads (Kenya Roads Board 2015). Release of fuel levy fund used for maintenance can only address a section of the roads that require maintenance and with an increasing need for maintenance the deficit continues to widen.

5.4 Conclusion of the Study

From the findings in the study, it was apparent that Road Connectivity was a vital component of the maintenance criteria and the road authorities used it while selecting roads though emphasize should be on access roads to markets and urban centres. Road Connectivity ensures that there is a transport network linking different social and commercial point within the county. It ensures that Machakos County can connect and share goods and services with the adjoining counties which include; Kiambu, Nairobi, Kajiado, Kitui and Makueni Counties.

From the fact findings, traffic volume was measured based on the vehicle counts, pedestrian counts, axle load information and other related traffic surveys that measured the origin and destination of the passengers. It was noted that non-motorized (pedestrians) traffic is not considered as a maintenance criterion while selecting roads for prioritization. Instead, motorized counts are given priority with a bias on the congestion in towns being articulated to vehicles as the sole reason. Therefore, motorized traffic counts and congestion in towns were considered as a critical maintenance criterion while prioritizing roads.

Road condition survey was the most vital component considered as a maintenance criterion as per the findings from the study. The road surface condition was used to inform decision makers on which roads they are required to prioritize. It became apparent that the roads in the good conditions were not given priority for maintenance but focus was on those in bad conditions. However, roads in good condition need to be maintained always in that condition

so as to maintain a certain level of service throughout the year if the preservation of the road asset investment is to be sustainable.

Ultimately, the study found out that Funding for Road Works was inadequate and this affected effective prioritization of road projects which affect the success of actualizing the maintenance objectives. However, there was timely release of fuel levy funds which was a prerequisite for effective planning of the road condition survey, assessment of traffic counts, feasibility studies on Road Connectivity and actualization of road maintenance projects.

5.5 Recommendations of the Study

From the study findings, the researcher arrived at the following recommendations to be considered during prioritization of road projects;

- **i.** Inter-county and intra-county Road Connectivity road together with access to commercial and social amenities need to be the underlying benchmarks upon which any maintenance criteria used for prioritization of road projects is based upon by road authorities within the county.
- **ii.** Non-motorized traffic and motorized traffic needs to be assessed simultaneously during prioritization of road projects to be maintained with a view of decreasing congestion in urban towns within the county.
- **iii.** The road authorities need to perform annual road condition survey, updated a real-time road condition on regular basis so as to plan an effective strategy for prioritization of road projects. The real time road condition survey can be developed in the form of a geo-map that indicates the surface condition.
- **iv.** Funds need to be made available and the allocation increased to facilitate pre-planning activities for road prioritization with the view of making informed judgments that can reduce the overall cost of road maintenance.

5.6 Suggestions for Further Research

The following are areas for suggestion on further research:

- **i.** A study focusing on the effect of intra-county Road Connectivity and its direct association to socio-economic growth needs to be carried out. This will create an

informed economic payback period which will assist to determine the benefits of implementing such road maintenance projects.

ii. Development of Road classification and inventory criteria for County Roads so as to clearly determine the extent of inter-county and intra-county roads for proper planning of maintenance works.

iii. An in-depth research to be carried out on traffic growth trends within the County and its associated roads maintenance requirement.

iv. A study on the road condition and its related effect on vehicle operating costs.

v. Developments of a County based road maintenance funds allocation criteria based on Road Connectivity, Road Condition Survey and Traffic Volumes.

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APPENDICES

Appendix I: Letter of Transmittal

Tom Nyamora Omai
P.O Box 7986-00300
Nairobi, Kenya

25/04/2016

Dear Sir/Madam,

RE: INFLUENCE OF MAINTENANCE CRITERIA ON PRIORITIZATION OF ROAD PROJECTS BY ROAD AUTHORITIES IN MACHAKOS COUNTY

I am pursuing a degree in Master of Arts in Project Planning & Management at the University of Nairobi. As part of the requirement for the award of the degree, I am carrying out research study on the above topic.

I request your support and honesty as you spare time and answer the attached questionnaire. Accurate and sincere information will assist in meeting the study objectives. All information and data acquired is confidential and only meant for academic purposes.
Thank you for sparing time to fill in the questionnaire.

Yours faithfully,

Tom Nyamora Omai
University of Nairobi
Reg. No: **L50/76519/2014**

Appendix II: Research Authorization

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/16/81294/10389**

Date: **21st April, 2016**

Tom Nyamora Omai
University of Nairobi
P.O. Box 30197-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Influence of maintenance criteria on prioritization of road projects by road authorities in Machakos County, Kenya,"*** I am pleased to inform you that you have been authorized to undertake research in **Machakos County** for the period ending **19th April, 2017.**

You are advised to report to **the County Commissioner and the County Director of Education, Machakos County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

BONIFACE WANYAMA
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Machakos County.

The County Director of Education
Machakos County.

THIS IS TO CERTIFY THAT:
MR. TOM NYAMORA OMAI
of UNIVERSITY OF NAIROBI, 0-300 NAIROBI,has been permitted to conduct research in *Machakos County*

on the topic: *INFLUENCE OF MAINTENANCE CRITERIA ON PRIORITIZATION OF ROAD PROJECTS BY ROAD AUTHORITIES IN MACHAKOS COUNTY, KENYA*

for the period ending:
19th April,2017

Permit No : NACOSTI/P/16/81294/10389
Date Of Issue : 21st April,2016
Fee Recieved :Ksh 1000

.....
Applicant's Signature

.....
Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 8783

CONDITIONS: see back page

Serial No. ☐

Appendix III: Questionnaire

Questionnaire for Road Authorities Staff and Public Road Transport Representatives in Machakos County

Influence of Maintenance Criteria on Prioritization of Road Projects by Road Authorities in Machakos County

Section 1: Background Information

1. What is your gender?

A) Male ☐ B) Female ☐

2. What is your category?

A) Engineer ☐ B) Accountant ☐ C) Road Supervisor ☐

D) Technician ☐ E) Public Transport Road User ☐

3. What is your age?

A) 18-29 ☐ B) 30-39 ☐ C) 40-49 ☐ D) 50 and above ☐

4. What is your highest education level?

A) Secondary ☐ B) Tertiary ☐ C) College ☐

D) University ☐

Section 2: Road Connectivity

5. Kindly indicate your level of agreement to the statements below.

Key: 1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Statement	1	2	3	4	5
Inter-county roads connecting Machakos County to the neighbouring Counties are always maintained in good condition					
Intra-county road connecting Wards and Sub-Counties within Machakos County are in good condition					
Roads accessing markets and urban centres of Machakos County do not require maintenance interventions					
Road Connectivity in Machakos County is complete with no missing links between villages or important centres					

6. In your opinion is Road Connectivity an important aspect during road prioritization process? ☐

A) Yes ☐ B) No

If yes, to what extent?

To a very great extent [ ] To a great extent [ ] To a moderate extent [ ]

To a low extent [ ] To a very low extent [ ]

Section 3: Traffic volume

7. Kindly indicate your level of agreement to the statements below.

Key: 1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Statement	1	2	3	4	5
Roads with higher motorized traffic volume have been given priority during prioritization of road improvement projects					
Roads with higher number of pedestrians have been provided with walkways					
Areas with traffic jams like at intersections have been improved and congestion eliminated					
Traffic congestion determines which roads to be prioritized					

8. In your opinion is the traffic volume or capacity an important aspect for consideration during road prioritization?

A) Yes ☐ B) No ☐

If yes, to what extent?

To a very great extent [ ] To a great extent [ ] To a moderate extent [ ]

To a low extent [ ] To a very low extent [ ]

Section 4: Road Condition Survey

9. Kindly indicate your level of agreement to the statements below.

Key: 1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Statement	1	2	3	4	5
There are no big pot- holes in most roads in Machakos County					
Road surfaces in good condition are continuously maintained in that state in Machakos County					
While choosing roads to maintain, the safety of road users is taken into consideration in Machakos County					
Poor road surfaces escalate the vehicle maintenance costs and should be prioritized					

10. In your opinion is it vital to carry out a road condition survey during road prioritization?

A) Yes ☐ B) No ☐

If yes, to what extent?

To a very great extent [ ] To a great extent [ ] To a moderate extent [ ]

To a low extent [ ] To a very low extent [ ]

Section 5: Funding for Road Works

11. Kindly indicate your level of agreement to the statements below.

Key: 1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Statement	1	2	3	4	5
There are adequate funds available to maintain all road networks within Machakos County					
The cost of road maintenance has increased over time creating a deficit in Funding for Road Works					
The fuel levy fund is released on timely basis for feasibility studies to be carried out during development of a road inventory and work plans					
Cash flow can affect the process of decision-making on road projects, especially when delayed					

12. In your opinion does Funding for Road Works affect the prioritization process of road projects?

A) Yes ☐ B) No ☐

If yes, to what extent?

To a very great extent [ ] To a great extent [ ] To a moderate extent [ ]

To a low extent [ ] To a very low extent [ ]

Section 6: Prioritization of Road Projects

13. Kindly indicate your level of agreement to the statements below.

Key: 1. Strongly Disagree 2. Disagree 3. Neutral 4. Agree 5. Strongly Agree

Statement	1	2	3	4	5
A road investment programme can only be realized with adequate analysis of the traffic volume, funds available, Road Connectivity requirement and road condition survey					
Road inventory aid in planning the work program for roads to be maintained					
An effective road investment programme will lead to socio-economic growth in Machakos County					

14. In your opinion is Prioritization of Road Projects important?

A) Yes ☐ B) No ☐

If yes, to what extent?

To a very great extent [ ] To a great extent [ ] To a moderate extent [ ]

To a low extent [ ] To a very low extent [ ]