

**FACTORS GOVERNING URBAN ROADS' MAINTENANCE
APPROACHES AND THEIR INFLUENCE ON THE QUALITY OF
MAINTENANCE WORKS. A CASE OF BLANTYRE CITY**

**MASTER OF SCIENCE IN INFRASTRUCTURE DEVELOPMENT AND
MANAGEMENT DISSERTATION**

BERTHA F. MWAKATOBÉ

UNIVERSITY OF MALAWI

THE POLYTECHNIC

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By

BERTHA F. MWAKATOBÉ

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The Polytechnic

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DECLARATION

I, Bertha F. Mwakatobe, declare that this study titled “Factors Governing Urban Roads’ Maintenance Approaches and their Influence on the Quality of Maintenance Works. A Case of Blantyre City” is my original research work. This thesis has not been submitted to any other university for the award of any other qualification. All data and information used in this research work has been duly acknowledged in the text, references, and appendices.

Signature: 
Date: ...28/7/2024.....

WORD COUNT: 34264

CERTIFICATION OF APPROVAL

We, the undersigned, certify that we have read and hereby recommend for acceptance by the University of Malawi in the thesis entitled: **Factors Governing Urban Roads' Maintenance Approaches and their Influence on the Quality of Maintenance Works. A Case of Blantyre City**

Main Supervisor: Dr. Witness Kuotcha
Signature: 
Date: ...2/8/2024.....

Co-Supervisor: Dr. Ignasio Ngoma
Signature: 
Date:2/8/2024.....

Co-Supervisor: Prof. Sambo Zulu
Signature: 
Date: 01/08/2024

Head of Department: Dr. Timothy Chadza
Signature:
Date:

Head of Postgraduate Studies: Assoc. Prof. Rhoda Bakuwa
Signature:
Date:

DEDICATION

I dedicate this thesis to my father, Fred A. Mwakatobe and mother, Tumaini Mwaitege, who always encouraged me to work very hard in school. Their advice has made me to be what I am today. May God keep and bless them.

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ABSTRACT

Road infrastructure is the backbone of sustainable development of any country. Worldwide there is a direct relationship between road development and economic development. A well-maintained road network acts as a catalyst for growth in other sectors. Unfortunately, urban road maintenance has been a very critical problem in many African countries especially Sub-Saharan Africa. Malawi as a landlocked country has much dependency on road infrastructure, however, the poor condition of roads has been an obstacle from advancing it from its current economic status into an industrial economy. This study explored the factors governing urban roads' maintenance and their influence on quality of maintenance works in Blantyre city which is the second largest city in Malawi as well as business and industrial city. It involved the administering of questionnaire and interview checklist to 3 consultant companies, 8 construction companies, Road Authority and Blantyre city council which altogether gave out the total number of 74 respondents. Also, there was observation of maintained roads. However, questionnaire was structured while interview checklists were semi-structured. Data collected were analyzed through STATA 15 for quantitative data and thematic analysis for qualitative data. The key findings revealed that investing in technological factors which were the top three ranked factors under the Relative Importance Index analysis can lead to the improved quality of maintenance works. This study will supplement the knowledge to the existing body of knowledge and unleash the importance of considering the root causes of road deterioration instead of dealing with consequences.

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ABBREVIATIONS AND ACRONYMS

AHP	Analytical Hierarchy Process
BIM	Building Information Modeling
CAG	Controller and Auditor General
GDP	Gross Domestic Product
MR&R	Maintenance, Repair and Rehabilitation
O&M	Operation and Maintenance
PROMETHEE	Preference Ranking Organization Method for Enrichment Evaluation
RII	Relative Importance Index
SSA	Sub-Saharan Africa
WRM	Winter Road Maintenance

CHAPTER 1: BACKGROUND OF RESEARCH

1.1 Introduction

Road infrastructure is the backbone of sustainable development of any country. Worldwide there is a direct relationship between road development and economic development (Messik, 2011). A well-maintained road network acts as a catalyst for growth in other sectors. Urban road maintenance has been a very critical problem in many African countries. About \$30 billion is annually lost worldwide due to insufficient urban road maintenance (Messik, 2011). Poor condition of road infrastructure has been an obstacle to Sub-Saharan Africa (SSA) from advancing from its current economic status into an industrial economy (Gbahabo & Ajuwon, 2017). It is important therefore that SSA works out on how to improve its infrastructure.

According to the UN-Habitat (2021), the presence of well-constructed and maintained infrastructure such as roads, highways, ports, airports, inter-urban railways, and other transport systems determines the economic growth capacity of the country. But this is only possible if there is self-reliance, the leaders' political will, commitment, transparency, and strong frameworks towards implementation of the policies and programs in the transport sector. Investment in the transport sector facilitates not only the improvement of productivity but also brings balanced regional development and reduces the economic gap between places as well as people (UN-Habitat, 2021). However, on average countries all over the world spend only 20%-50% of the amount that should be spent on road network maintenance (Sahoo et al., 2020).

According to Rioja (2007), roads are major mode of transport in most part of the world. These roads influence the economy of any country since they are mostly used compared to any other modes of transport on daily basis. Hence, poor road conditions can lead to a huge loss economically, because they cause delays and traffic congestion which in turn cause the wastage of time that would have been used to generate income for the people and revenue for the government (France-mensah et al., 2019). Moreover, Rioja (2007) has explained the importance of road maintenance which is an increase in the Economic rate of return that is high compared to the construction of new roads. Likewise, delaying or neglecting the maintenance can lead to an increase and accumulation in the cost of maintenance. Therefore, the author is insisting on timely and routinely road maintenance to avoid the side effect of the deterioration of roads (Rioja, 2007). Also, according to Gultom et al. (2017), the "World Bank studies show that every delay of road maintenance by \$1 leads to the vehicle operational cost of \$3 to \$4 in every developing country".

Also, the study by Rioja (2007) has explained about why many developing countries have been failing to adhere to the routine maintenance of roads. This is because most of developing countries have been receiving grants for new constructions and not maintenance. While the maintenance obligation has been given to the particular countries' governments using the collected revenues (Rioja, 2007). Unfortunately, these revenues collected have been facing competing priorities, in which most of the government have been choosing to foregone or delay the investment on infrastructure, roads inclusive for political pressing issues. Furthermore, the infrastructure has been bearing the burden of neglect in order to satisfy other matters that are of political interest (Guevara et al., 2017; Rioja, 2007). Thus, this has led to the occurrence of severe damage of the roads before the end-of-life span expected, that is within 5 years, moreover, most of roads are found in worst conditions, since there are no maintenance that have been taking place (Rioja, 2007).

Road transport has currently gained popularity as it was on rail transport in colonial era (Vilakazi & Paelo, 2017). Hence, the road freight has become a major means of transporting different goods both for imports and exports as it was for railway network. Since these rail networks lacked proper maintenance, then they declined in many areas of Africa (Streatfeild, 2019; Vilakazi & Paelo, 2017). Therefore, currently almost the whole Africa has much dependence on roads for its economic development. Although, roads are the most preferable mode of transport, still they have been facing a lot of challenges in maintenance, which have led to the poor road infrastructure that in turn has affected the trading sector. Furthermore, the poor quality of road infrastructure has led to the increase in road user costs (Streatfeild, 2019). This is because there has been an increase in operation variable costs such as fuel, lubricants, tires and maintenance costs of vehicles. Since the normal cost for the areas with good road conditions is 40% of the operating costs, but for southern Africa, Malawi inclusive, the cost count for 90% of the operating costs, which leads to the discouragement of transportation business (Vilakazi & Paelo, 2017).

Moreover, urban road maintenance has been a very critical problem in many African countries since in the 1970s and 1980s about \$45 billion worth of road stock was lost due to lack of maintenance and about \$30 billion is annually lost worldwide due to insufficient urban road maintenance (Messik, 2011). However, poor infrastructure condition has been acting as an obstacle to SSA from advancing from its current economic status into an industrial economy (Gbahabo & Ajuwon, 2017). Therefore, it is important that SSA works out ways to improve its infrastructure. Moreover, in Africa, urban roads comprise of 30% of road stock which are in good, fair, and poor condition while rural roads comprise of 70% of road stock which are in fair

and poor condition (Chinowsky & Arndt, 2012). Despite their nature, they all contribute to the economic development of African countries, therefore, many countries assign a huge budget to public infrastructure, particularly roads (Arndt et al., 2012).

“Malawi as one of the landlocked countries found in southern region of Africa, depends on roads and rail for handling freight and passengers”. At first the country was relying on the Beira railway line which was later closed due to embankment of Chiromo bridge and bad stretch of 77 Km of Nacala port railway. This is what made the total shift of Malawi towards road dependence which is comprised of 26% of paved roads, which are not well managed in terms of maintenance and remained 74% is unpaved and most of them are seasonal roads (Emuze & Kadangwe, 2014). As many developing countries, Malawi has been facing the challenge of providing quality and timely road maintenance projects both in urban and rural areas. This is because, there have been many factors that have led to the delay and even abandonment of road projects. These factors include the shortage of skilled labors, tender bidding, delayed payments by clients and corruption (Mukasera, 2016). Although there is a Road Authority in three regions assuming their responsibilities, yet the road issues have been unattended that are within their authorities and capacity to control. This has also been caused by the lack of the required technical capacity to supervise the projects that have been undertaken in their areas of jurisdiction (Emuze & Kadangwe, 2014).

As roads are being poorly constructed, that is below the expected standards and quality, this has led to the need for frequent roads maintenance. Hence, the increase in operation and maintenance (O&M) costs which in turn exceed the construction costs before reaching the expected life span (Salih et al., 2016). Mostly, the problem of poor-quality roads has been a result of tendering process, where most of African countries during tender bidding, they opt for lowest evaluated bid. This being a case for tender winning, many contractors opt to offer the lowest price in order to secure the project. Moreover, the clients such as Road Authority or the government do not bother to know the materials that the lowest price tender bidders will use in the construction. Thus, the contractor opts for cheapest materials in order to make profit and hence poor road quality, which will soon require an intensive maintenance (Emuze & Kadangwe, 2014).

According to Malawi National Transport Policy (2015), it is discussed that the government role is to guide the development of an efficient, well integrated and coordinated transport infrastructure and operation which are economically, financially, socially and environmentally sustainable. Also, the National Transport Policy shows that among its medium and long-term goals is to bituminize all trunk roads while at the same time ensuring that all regional roads as

well as key district and urban roads are appropriately rehabilitated and maintained to ensure smooth flow of traffic.

African countries have many attractive and exciting documents, Malawi as any other African countries has a very promising policy on transport sector where the road sector is within as well as other supporting documents. However, these well documented plans are hardly put into practice for their realization, even the annual budgets that have been put aside for the roads' investments have been well documented and exciting and yet things have been rarely appear on the ground. Therefore, this is an indication that, there is a need for studies to be done on urban road maintenance since there are few documentations on road maintenance compared to the newly constructed roads which are mostly funded by international financial institutions and donors while the maintenance is left to the particular countries. Hence, this study will engage much on factors that govern the maintenance programmes in Malawi basing on the case of Blantyre city.

1.2 Problem statement

There has been every year maintenance of roads in Blantyre City using different means of financing. However, some maintained roads take longer than others to deteriorate. Also, many stakeholders differ on the attributes which lead to variations in the quality of urban road maintenance. While other studies have demonstrated that financing is critical to urban road maintenance (Rioja,2007; Hassan, 2018), others also have underscored the importance of technical capacity in road maintenance management (Kulemeka et al., 2015; Mukasera, 2016). Moreover, according to TopschoolsintheUSA (2022) in 2011, 60% of paved roads were in good condition, 33% in fair condition and 7% in poor condition and due to inadequate funds in 2016 the condition of the road deteriorated to 38% good, 40% fair and 22% poor. However, despite all these studies little has been unraveled about the real factors that govern urban roads' maintenance and their influence on the quality of maintenance works especially in Blantyre City.

1.3 Research objective

1.3.1 Main objectives

To explore the factors governing urban roads' maintenance approaches and their influence on the quality of maintenance works in Blantyre city.

1.3.2 Specific objectives

- i. To identify factors that govern urban roads' maintenance approaches.
- ii. To assess the relationship between roads' condition and quality of maintenance work

- iii. To correlate factors governing urban roads' maintenance approaches and road conditions on influencing the quality of maintenance works

1.4 Justification of the study

The study used Blantyre city as a major case and other cases within it which were the maintained roads that were observed to generate the required data. Therefore, the research will involve the use of a questionnaire to understand what have been the factors that govern the urban road maintenance in Blantyre city, observation of the maintained roads' conditions through different sources of funds and the authorities involved in maintenance. Also, the interview was done to validate the data obtained from the observation and any other needed clarification. Also, Blantyre City was selected as the case study because of fund limitations to a researcher.

1.5 Significance of the study

“Malawi as one of the landlocked countries found in southern region of Africa, depends on roads and rail for handling freight and passengers”. At first, the country relied on the Beira railway line which was later closed due to embankment of the Chiromo bridge and a bad stretch of 77 km of Nacala port railway. This is what made the total shift of Malawi towards road dependence which is comprised of 26% of paved roads, which are not well managed in terms of maintenance and remained 74% is unpaved and most of them are seasonal roads (Emuze & Kadangwe, 2014).

Due to the many dependencies on the road by Malawi, the country requires more research on the road sector. However, some studies have been done on the new construction but this research attempts to search for the knowledge that will enable the informed decisions on urban road maintenance in Malawi. Thus, it will provide the researchers, government, politicians and other decision-makers with an understanding of the better approach that will enable the proper decision in road maintenance using the scarce budget.

1.6 Thesis structure

This thesis consists of five parts which are:

i. Chapter 1 describes the background of the study and what triggered a researcher to explore on a particular topic. It indicates the objectives that must be attained and the significance of the study.

ii. Chapter 2 consists of different researchers' opinions related to the topic under study. These opinions are found from the literature reviewed which include journals, conference papers and books.

iii. Chapter 3 describes the methodology used to attain its objectives. It highlights the philosophy of research, the approach, tools and techniques used to obtain data that address the problem.

iv. Chapter 4 provides analysis and interpretation and presentation of data collected from questionnaires, interviews and observation which were administered in a case study area.

v. Chapter 5 discusses the understandings and findings obtained from Chapter 4 which lead to the conclusion and recommendation of the factors affecting urban roads' maintenance and its influence on the quality of maintenance work. However, these conclusions are the researcher's insights in relation to the research objectives.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter involves the review of the available literature on road maintenance worldwide as well as literature that is found and explained in the southern Africa region and Malawi itself. It also reviews the factors affecting road maintenance in different areas. Maintenance schedules are the work plan that involves the assignment of different responsibilities which describe what, how, when and who will do a particular task during maintenance activities.

2.1.1 Road maintenance

Among the requirements for the development of any country is the presence of well-maintained road networks which serve the intended purpose and reduce inconveniences that may be caused by the poorly preserved roads. Having well-preserved roads requires the proper budget allocation and avoidance of unnecessary wastes (Mohammadi et al., 2020). According to Khadka et al (2017), and Elbagalati et al (2018) there are some studies which have been done to come up with recommendations and solutions which will be enhancing the road networks condition and safety considering budget limitations. There has been an increased demand for road maintenance worldwide. Unfortunately, budget limitations have hindered the response towards such demand (Guevara et al., 2017). Therefore, the procrastinated maintenance has in turn accelerated the rise of future maintenance costs and triple the rehabilitation cost (Gultom et al., 2017; Yepes et al., 2016). This has worsened most road networks condition in such a way that they do not need to be maintained but reconstructed.

2.1.2 Road maintenance approaches

The nature of road maintenance works can range from simple things like cleaning, mowing, and marking the pavement to more complicated things like closing cracks, filling potholes, and resurfacing. Maintenance also includes fixing or rebuilding broken or worn-out things, like drainage systems, traffic signs, and guardrails (Diamond concrete sawing, 2023). Thus, regular maintenance of urban roadways is required to guarantee that their functioning for the community. Similarly, proper and smooth road maintenance is possible if there is a record of approaches used in previous maintenance tasks to be used for the existing routine, preventive, reactive or emergency maintenance need (Tee and Ekpiwhre, 2018:761). This is because the records support the projection of the existing maintenance requirements.

Commonly employed road maintenance approaches may vary and be influenced by different factors such as climate, budget, and road condition. Likewise, regular inspections can discover any indicators of damage or degradation on urban roads avoid the presence of poor road

maintenance which is caused by lack of reliable information (Mazele and Amoah, 2018:196). These inspections can be performed by professional personnel who evaluate the state of the road surface, signage, markings, and other important components, this has mostly been done using advanced technology such as 3D models in making proper decisions during maintenance and management (Vilventhan *et al.*, 2021:52). Also, innovative technologies such as novel techniques are employed in road maintenance, such as sensors and data analytics to monitor road conditions, spot problems in real-time, and prioritize maintenance activities more effectively (Vilventhan *et al.*, 2021:52; Rajadurai and Vilventhan, 2022). More so, the information recorded can be used to evaluate any failure that occurs in a road network (Tee and Ekpiwhre, 2018:761). More so, it should be noted that specific maintenance procedures may differ depending on local rules, climate conditions, budget limits, and the general state of the road network. Municipalities and transportation departments frequently create detailed maintenance plans which are appropriate to their specific requirements and resources.

Potholes are a prevalent problem on metropolitan roads owing to excessive traffic and wear and tear. Patching and pothole repair entail repairing damaged sections of the road surface with asphalt or other suitable materials (Karimian and Mbachu, 2019:830). However, the road surface can become worn, cracked, or uneven over time which in turn will require resurfacing which involves adding a new layer of asphalt or concrete to the road surface in order to renew it and increase its smoothness and durability. This maintenance has to be done according to the urgency and importance after evaluation of the road conditions (Nautiyal and Sharma, 2022:413). Therefore, since cracks in the road surface can allow water to sink in and cause further damage, then crack sealing can be appropriate to minimize moisture intrusion and increase the road's lifespan.

For traffic safety, well-defined lane lines, crosswalks, and other pavement markings are important. Repainting and updating these markings regularly serve to improve visibility and guide cars and pedestrians (Karimian & Mbachu, 2019). Correspondingly, since drainage management is critical to preventing water stagnation on urban roads then clearing debris from storm drains, repairing or replacing broken drainage systems, and ensuring adequate slope and grading to allow water flow are all inevitable maintenance tasks (Nora & Reddy, 2018). Therefore, if these tasks are well considered it can ensure the urban roads durability.

Maintenance of street lighting is important as adequate street lighting improves visibility and safety on urban roads. Regular streetlight inspections and maintenance help to maintain well-lit conditions, ensuring visibility while driving at night. All these can be done using the classical

reliability-centred maintenance methodology which does not require any maintenance history with the support of case-based reasoning (CBR) (Tee and Ekpiwhre, 2018:756-757). Likewise, vegetation along urban roadways should be trimmed and managed regularly to prevent overgrowth, which can obscure vision, signage, and cause damage to road infrastructure. Besides, the vegetation reduces the negative impacts of road usage such as air pollution and promotes aesthetics along urban roads (Hussain *et al.*, 2017:157). Therefore, maintenance is there to ensure the safety of the road users, and community as well as the aesthetics of the urban area.

Therefore, urban road maintenance approaches are influenced by different maintenance needs, factors and prioritization of maintenance over other arising government's competing needs on the budget set.

2.1.3 Road maintenance schedules

Maintenance schedules are mainly divided into two types which are routine (continuous) maintenance and periodic (planned) maintenance (Wasike, 2001). Routine maintenance is important for sensitive infrastructure which when differed may lead to the failure of functioning of particular infrastructure especially for bridges which mostly affect a large part of the system while periodic maintenance can be considered for infrastructure that gradually deteriorates such as roads (Salih *et al.*, 2016; Wasike, 2001). It is important to know the proper timing of the maintenance operations in order to have proper decisions for the road maintenance, since it depends on the management system that a particular responsible authority has. This will enable the authority to successfully conduct maintenance using the available resources which are mostly scarce. Denial of timely maintenance has led to an increase in maintenance costs in many countries due to economic instability. In turn, this has led to the worse condition of the roads, since the available funds are more insufficient than it was if the timing was considered (Guha *et al.*, 2021). The worst thing about maintenance is that in most roads projects, the maintenance cost to ensure the pavement longevity has been overlooked and taken for granted. Hence in most countries an emphasis has been put in new construction and neglect the maintenance. This negligence has led to the increase in transportation cost and losses in the economy such as a reduction in Gross Domestic Product (GDP) (Vilakazi & Paelo, 2017). For conducting timely maintenance under scarce funds, prioritization is vital to be considered (Guha *et al.*, 2021).

2.1.4 Maintenance planning

Maintenance planning is the way forward to carry out maintenance activities. Though sometimes things may not go as planned at least one can use time for prior plans to understand options and possibilities. Maintenance planning is important for any maintenance that is about to take place, it acts as a preparation for what is about to be done (Trout, 2023). This ensures the availability or preparation of the needed resources for the maintenance activities. These resources include technicians, construction materials, time that will be spent and financial resources (Salih et al., 2016; Trout, 2023). Also, planning indicates the description of work to be performed and it involves a clear description that even the lowest skilled technician can understand. Generally, planning prepares a given organization or institution for the responsibilities ahead and it deals with what, why and how question. In addition, the planned work helps in the reduction of unnecessary delays during working on a particular assignment (Trout, n.d.).

2.1.5 Maintenance scheduling

According to Trout (2023), maintenance scheduling involves the assigning time and responsible personnel to the tasks that are taking place or about to be undertaken. The scheduling process considers the maximum availability of resources, priorities on maintenance, internal technicians and preventive maintenance (Mohammadi et al., 2020; Trout, 2023). It reduces the delay between jobs and increase productivity, since they involve the maintenance priorities and assignment of tasks basing on the skills. routine road maintenance is vital in making roads passable in all-weather as well as ensure their longevity (Kocher et al., 2007).

Maintenance planning and scheduling are important since they ensure maximum use of available resources for maintenance, avoidance of unnecessary delays in work completion, reduction of failure for the roads to properly function and reduction in material costs since they are purchased in advance (Trout, 2023).

2.2 Global perspectives

Public infrastructure is a basis for economic production and development that is why economists term it as infrastructure capital. Therefore, most of the infrastructure are publicly owned, since they are owned and used by the majority and provided by the government. These infrastructures include road infrastructure (Palei, 2015). Moreover, a road infrastructure acts as a catalyst for the development of other sectors, its consideration is very important to facilitate the development worldwide (Mohammadi et al., 2020). For example, the road infrastructure facilitates the movement of the raw materials from the area where they are found to the

production area, then the finished goods from the area of production to the market areas. With the public infrastructure, there is a reduction of production cost burden to the business people (Palei, 2015).

There are Sustainable Development Goals (SDGs) that cannot be realized if the road infrastructure is not well promoted which is found in sustainable development goal number 9, build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. With poor road infrastructure, there will be low life expectancy, no well-being since there is no safety, poverty will not be ended due to premature deaths and disabilities caused by road accidents as a result of poor road conditions then the increase in number of dependency and reduction in the number of working populations. Also, it will discourage economic growth because the road infrastructure acts as a foundation for economic development (Giles-corti et al., 2020).

Maintenance of infrastructure especially roads is inevitable for the other goals to be realized. As supported by Hendhramoyo et al (2017) who did research in Indonesia, road maintenance priorities are made using the criterion such as road condition, traffic volume, important land uses and available budget. Through Using different approaches Indonesia has been able to allocate the scarce budget in road maintenance and rehabilitation in prioritized roads. These two approaches are Surface Distress Index, that is used in examining roads conditions and Fuzzy logic which is used in decision making on the prioritized road segments in regard to the available budget (Hendhratmoyo et al., 2017). Also, in India due to insufficient funds allocated in road maintenance and increase in the need for maintenance which is caused by the increase in load axles which was not expected since 1950s. This led to the use of Fuzzy based pavement maintenance planning (Suman & Sinha, 2012). In Italy, as in any other countries in the world, the urban roads have been under municipalities. These municipalities face the same problem that is the budget deficit which mismatch the need especially in road maintenance. Thus, these municipalities adopted the approach of equal distribution of budget for five years was adapted, since it assisted to solve the problem of road maintenance also it solved the problem of Vehicle operating cost for vehicles owners and yet it considered other maintenance activities during the five years of budget (Loprencipe et al., 2017). Also, in Noida, the study was done to examine the two models approaches which are Analytical Hierarchy Process (AHP) and Direct Assessment (DA), whereby they were put in test. Then, the AHP was found to be a better approach to be used in decision making especially in prioritizing the roads to be maintained (Prakasan et al., 2015). Similarly, in Croatia, the focus was made on the use of the Analytical Hierarchy Process (AHP) and the Preference Ranking Organization Method for Enrichment

Evaluation (PROMETHEE). These methods were preferred because they are multicriteria for they involve different factors in the analysis of the critical roads that need to be maintained to improve their functionality (Pamuković et al., 2021).

The following are the reviewed cases from different parts of the world which portray the road conditions from both developed and fast-developing countries:

2.2.1 Asia

The road condition in Asia is mainly affected by potholes. Potholes are bowl-shaped depressions found in roads, they mostly occur due to water stagnation, pavement cracks, poor or absence of regular road maintenance and overloading of roads. These potholes lead to unpleasant road surface which in turn lead to the poor road safety to the users as well as vehicles destructions (Namala et al., 2018). Hence, they are hectic and have been causing many losses, such as the lives of the people and their properties, much research has been conducted to find ways to minimize the pothole's effects as well as roads quality. These potholes are not formed overnight, it is a long process that takes time, especially for the roads that are properly constructed. But because of the negligence of timely and proper road maintenance, road surfaces become full of potholes which were at first cracks which were easy to maintain (Yadav, Shinde, Shinde, et al., 2019). Potholes should be given much attention in order to avoid the unnecessary problems they cause if they are lately attended. This is because they are not only the vital elements to be considered when prioritizing the roads to be maintained but also, unattended potholes can lead to road surface deterioration which indirectly affects the economy of the individuals and the country at large (Dr. Sharma & Abhishek, 2015).

Currently, there is several studies that have been conducted on potholes effects, but have failed to be applied because there has been lot of changes that are happening in day to day, such as climate conditions, traffic volumes and densities and road users who are also, among factors that contribute to roads instability due to driving in high speeds (Dr. Sharma & Abhishek, 2015). Which altogether lead to new causes of roads damages (Yadav, Shinde, Sude, et al., 2019). However, potholes have affected the economy including rise in vehicle operating costs to the vehicles' owners and environment pollution due to traffic congestion. Also, it associated with health problems due to the pollution it causes, wastage of time and fuel in congestion and reduction of productivity since people delay to their working and business areas and morale reduction due to the road stresses and hence economic loss to the individuals and nation at large. It is recommended that the repair of potholes should consider the surrounding areas of the hole in order to fix it well and avoid formation of a new pothole nearby the repaired one (Namala et al., 2018).

In a study done by Yadav et al (2019), researchers have insisted the adoption of standardized methodologies in constructing quality and long-lasting roads that can withstand the climatic changes. Also, there should be regular and proper road maintenance to avoid unnecessary road distresses. Also, according to Sharma and Abhishek (2015), it is advisable that, if possible, there should be an avoidance of potholes formation by having proper drainage systems that will be used to drain the surface runoffs on and along the roads. Proper bitumen content in mixing of materials during road construction and traffic control to reduce the load exerted to the pavement. In addition, it is good if there will be an enforcement of speed limit, since the traffic through of vehicles has also been among causes of the pothole formation. Since in high speed the tires cause the road cracks and sometimes moves with particles from the cracks and small potholes are formed and then enlargement of the holes. (Dr. Sharma & Abhishek, 2015).

Also, there has been power delegation in Indonesia. Therefore, for the road infrastructure to be well managed, in Indonesia there was a delegation that was done through classification of roads and the responsible authority to manage, whereby national roads were under the central government, provincial roads were under provinces and district roads were under districts. Each authority has mandate on raising funds for the operation and maintenance of particular roads. Collection of funds is based on the collection models that have been stipulated by the Indonesian Acts. Due to budget deficit for roads maintenance different models have been adopted such as levy, addition of excise duty, tax in vehicles and fuel prices (Gultom et al., 2017).

All researchers have insisted on the importance of making a proper repair for the potholes, since they are very dangerous to road users. They have also made an emphasis on the methodologies, materials used in roads construction and approaches used on detecting the potholes and measure them which are affordable. In addition, they have suggested that there should be avoidance of potholes formation through practicing timely maintenance because potholes take time and process to be formed. However, this is only possible if there is delegation of responsibility from the central government to the local governments or other organs that their attention will only be on roads conditions within their area of jurisdiction.

2.2.2 South Europe

Weather is among the critical factors that contribute in infrastructure destruction (Vajda et al., 2014; Groenemeijer et al., 2015). It is associated with many traffic problems such as road delays and accidents. Whereby in turn they have led to the reduction in manpower and economic losses in different countries. In Serbia as the representative of the South-East European countries which have much dependence on road infrastructure, has been facing the problems that are

caused by the weather condition (Dey et al., 2015). These problems are the one that have been emerging during the winter season and hence need an immediate action in order to rescue the country from the associated losses. Due to this problem, the researchers have been demanding the change in road and transportation institutions culture in order to improve the roads quality especially during the winter season. The improvement should involve the transition from being reactive into being preventive towards those problems associated with winter seasons. Also, the researchers have emphasized on giving much consideration to the Winter Road Maintenance policy (Glavic et al., 2016).

Improvement of this policy aims at ensuring that there are lot of benefits gained than the cost incurred in maintenance. Hence, the use of Economic Evaluation Method has to be adopted in the policy in order to make it productive. Since, economic advantages of maintenance have been taken for granted by the government due to less consideration of the maintenance importance. This biasness in consideration has resulted from poor understanding on cost-benefit of Winter Road Maintenance (WRM) which has been putting the consideration of ratio between benefit and cost in order to come up with proper decisions (Glavic et al., 2016). By so doing, it will lead to the appreciation of the economic evaluation in maintenance. Also, it will enable decision-makers to make reasonable decision in road sector that has high impact to the country, since it is a backbone of the economic development. Therefore, cost-benefit approach was suggested to be used in decision-making on WRM as a part of the improvement of the policy (Glavic et al., 2016; Dey et al., 2015).

2.3 Regional perspective (sub-Saharan Africa)

2.3.1 Policies review

A. Nigeria transport policy

According to Moti & Vambe (2019), there have been poor policy implementation by the successive governments whereby they have been demonstrating the imbalance of the budget and the requirement of the transport sector. However, this imbalance has an impact in the future of transport sector, since the infrastructure have been continuously deteriorating. The author noted that there is a need of policy review and reform to meet the current needs and address the challenges of the 21st century (Moti & Vambe, 2006).

B. Tanzanian transport policy

According to the United Republic of Tanzania (2003), road is the dominant mode of transport in urban areas that guarantee the connectivity of different areas. However, it has indicated that the urban roads face a number of challenges whereby some of them are lack of proper

maintenance and room for future expansion which is due to poor implementation of master plans that are prepared by the town or urban planners to guide and control the development. This has led to inaccessibility of some urban residential areas due to inadequate maintenance of road infrastructure. Moreover, the policy has given the direction on the maintenance of the urban roads whereby it has suggested that there should be the participation of urban residents in contributing in urban road maintenance in their areas through direct involvement or user charges. Also, there should be private sector participation in road funding and management decision making forums (The United Republic of Tanzania, 2003).

C. Kenyan transport policy

Road transport is the major means of transport in Africa, whereby the economic growth of African countries depends on proper care for this infrastructure. But the proper care for roads depends on the road policies of these countries. Since, policy is what gives the direction of what to be done in order to improve the quality of road infrastructure. However, there have been different policies in African countries on roads but they are not specifically for road maintenance. Thus, these policies have been discussing road maintenance as a part of a major discussion, which in reality has undermined the importance of road maintenance. This is because road maintenance discussion is wide, for it is the one that has an economic impact in many countries, although many countries have taken it for granted (Wasike, 2001).

In Kenya, the post-independence road policy reforms tried to address some problems that led to poor road maintenance. It started to put much effort into maintenance and less into new construction of paved roads since the government understood the importance of road maintenance economically. Because most of roads that were inherited from colonialists were in poor condition due to lack of maintenance, which in turn led to economic deterioration in Kenya. So, the government shifted its concerns from new construction into maintenance and rehabilitation to rescue the situation. This took place for sometimes but after the economic crisis, the government shifted its attention from road maintenance to other economic sectors, since then, the road sector has been always the sector foregone for other competing sectors, therefore even the funds that were supposed to be allocated to the road maintenance have been allocated to other sectors. Generally, many countries have not yet realized the importance of roads economically, since it seems like it has indirect impact to the economy. Forgetting that, it facilitates the movement of all resources, goods and services that lead to the economic growth. Moreover, the road acts as a part of the body called economy, whereby it has a vital role as any other parts of that body (Wasike, 2001).

Kenya's road policy focuses on i) provision of adequate funding and strengthening road management ii) improvement of urban transport efficiency iii) increase accessibility and mobility in rural areas by supplementing motorized transport with non-motorized transport. Due to the potential economic value of roads realized by Kenya, which was caused by the rejection of investors in investing in areas with poor infrastructure, the Kenyan government was forced to invest in Maintenance, Repair and Rehabilitation (MR&R) to attract and secure the potential investors in their country. These stimulated different actions of the Kenyan government such as starting to define the MR&R activities that require funds, transparency in road fund management, ensure all the funds meant for maintenance are effectively allocated. Budget allocation of at least 50% of the funds needed for both routine and periodic maintenance. Also, the progressive raising of funds for full routine and periodic maintenance (Wasike, 2001).

It is suggested that there should be research on MR&R innovations particularly in construction materials and new technologies in evaluation and traffic management alternatives during construction, life cycle cost analysis and road asset management systems. Also, there should be the identification of future transportation professionals to prepare the recruiting, training and retention and developing new ways of managing the infrastructure and ensuring timely Maintenance, Rehabilitation and Repair of roads (Wasike, 2001).

2.3.2 Factors affecting road quality in sub-Saharan Africa

Factors affecting road quality are the factors that have contributed to road deterioration in SSA and they are very common in these developing countries which have led to the only 30% of urban road stock to be in a worst condition which need immediate action. However, due to the procrastination in the maintenance of urban roads, these factors have caused the decline of the economy of most developing countries because the roads are the backbone for the development of other sectors. Therefore, the following is the discussion on the factors that have led to the deterioration of urban road stock in SSA hence discouragement of economic growth in the countries found in this region:

A. Drainage

Drainage is the natural or artificial surface water transporter. These are essential road elements since they convey surface water runoff from the road surface and its surroundings, hence, it is vital for the longevity of the road pavement (Zumrawi, 2016; Nora & Reddy, 2018). But this depends on how the drainages have been taken into consideration starting from design, construction and maintenance (Zumrawi, 2016). There are two types of drainage systems which

are surface drainage and subsurface drainage. Designing process of the drainage which consider the catchment areas of the drainage can be useful in proper functioning of the road and reduction of maintenance cost. Unfortunately, even though the drainage system are important element for road longevity, still there has been negligence of their provision along the paved roads, which in turn has led to much operation and maintenance costs for these paved roads (Nora & Reddy, 2018).

In many areas, drainage systems have been taken for granted, and in some areas road construction projects have ignored the drainages. In other places, they have decided to construct the drainages anyhow without considering the amount of surface runoff. That is because there have been construction of drainages which do not serve the intended purpose because they are either smaller or bigger than the needed size (Ngezahayo et al., 2019). Also, in some areas where there are drainages, the inhabitants have undermined the importance of these drains. Since, although they understand the use of drainage systems, still they have chosen to dump their wastes from households, construction activities and even industries into drainage systems (Orhorhoro & Oghoghorie, 2019). This has triggered to the blockage of the drains due to the silt, solid waste and other pollutants accumulation (Zumrawi, 2016; Nora & Reddy, 2018). Moreover, this has led to improper functioning of the drainages and hence floods and water stagnation on roads and at the end potholes formation and pavement deterioration. In addition, there has not been drainage maintenance which has led to drainage deterioration (Zumrawi, 2016; Ngezahayo et al., 2019).

Both the absence of a drainage system and presence of the poorly managed drainage systems have an impact on roads, that is because they weaken the road capacity (Ngezahayo et al., 2019; Orhorhoro & Oghoghorie, 2019) since water stagnate along the roads edges and starts penetrating to the sub-bases as well as soil that hold the road and later on due to expansion and contraction of the soil associated with the presence of water and traffic volume, the roads develop cracks, then potholes and lastly road surface deterioration (Nora & Reddy, 2018; Ngezahayo et al., 2019). This implies that if there is a delay in solving the root cause of the problem then it will be expensive to deal with the effects. Therefore, according to the study done by Nora and Reddy (2018), Most of the roads are damaged because of the negligence of the important element for road functionality which is the drainage system.

Different studies portray the importance of the drainage system in the roads durability, since water is main cause for roads deterioration. Also, they have explained about the inhabitants' dumping wastes in drainage systems but no one has explained about the reasons for them to

choose dumping wastes in drainages and not in other areas while they know the use of drainages and how important they are to them and their livelihood.

B. Climate

According to the study that was made by Strzepek and Strzepek (2015) in the countries that are located along the Zambezi River basin, climate seemed to be the challenge when it comes to road infrastructure maintenance. This is because climate change has affected the construction costs especially in rehabilitation and maintenance. Mozambique being at the end of several transnational river basins, is often subjected to the floods which cause most of its installed infrastructure to be vulnerable to the weather extremes (Arndt et al., 2012). However, this has resulted into the increase in maintenance needs due to the poor capacity of the current road to withstand the climate change such as increases in temperature and change in precipitation patterns (Chinowsky & Arndt, 2012). Whereby, a monthly increase in precipitation by 10% results into decrease of the road life span by 8%, in which the maintenance cost for precipitation caused degradation accounts for 4% of total maintenance costs while for temperature caused degradation accounts for 36% of the total maintenance costs (Chinowsky & Arndt, 2012) citing Miradi (2004). Therefore, regardless of 15% of government expenditure on infrastructure particularly roads, yet there has been a challenge in improving the road sector in Mozambique (Chinowsky & Arndt, 2012).

Also, according to Miradi (2004) an average rainfall of 760 mm per year, with 59 cold days and 17 warm days is the average climatic condition in which the roads without adjusted designs can withstand. Running floods effects on underlying roads require repair costs that are close to the new construction costs (Chinowsky & Arndt, 2012). Moreover, asphalt-surfaced roads with porous cannot have a lifespan older than 13 years if there is no maintenance (Miradi, 2004). However, adherence to the adjusted designs that consider climate change adaptation can reduce the damage by about 50% and save the road inventory by 14% (Chinowsky & Arndt, 2012). According to the discussion, it is worth to incorporate the design standard evolution in responding to climate change instead of relying on the reactive approach which comes after the effects. Therefore, for the new network extensions that have been taking place in many sub-Saharan countries, it is better to apply proactive measures to adapt the climate change in order to reduce future maintenance costs.

C. Finance

Many researchers have underscored the influence of funding on urban road maintenance activities for example, in Nigeria, it was found that budget deficit due to inconsistency funding

and poor information flow has led to the misallocation of funds and a mismatch between financial requirements and deterioration (Hassan, 2018; Yoade et al., 2022). Whilst in Angola, it was found that poor information flow due to political instability and the absence of regular surveys on road inventory and conditions are the reasons for the failure of the government to administer urban road maintenance. But the government has been spending about \$ 4.3 billion annually for road reconstruction due to the destruction caused by war (Hassan, 2018; Benmaamar et al., 2020).

According to the existing studies, it seems that the information updates in many governments has not been given attention, while having information is half way towards solving existing challenges in urban road maintenance. Moreover, in south Africa there has been poor communication among road authorities at different levels which has led to the poor road condition in districts due to lack of fund allocation (Hassan, 2018). However, both central and local governments have to revise their institution arrangements to enhance horizontal and vertical information flow that will enable them to effectively perform their duties particularly in road sector like allocating the fund properly.

D. Technical capacity

Many SSA countries have been lacking technical capacity, For example in Tanzania, the tendering process considers the technical capability of the firm to execute tasks through the reflection of firm's capital, it includes financial resource, human resource, and equipment (Ye & Tekka, 2020). However, the technical capacity needs to be stable to face challenges of inflation and currency exchange rates which are associated with dependence of importation of construction materials (Gbahabo et al., 2017). In many developing countries the contractors have been overstating their capacity in order to secure tenders which in turn has led into poor deliverables (Ogbu & Asuquo, 2018). Therefore, in urban road maintenance technical capacity is a very important factor to be considered during tendering process since it gives an insight of whether the project will be successful at the required quality standards or not.

E. Governance

In sub-Saharan Africa, there has been a high corruption in the procurement process which has led to very high maintenance costs which sometimes exceed the planned budget (Beuran et al., 2015). According to Gbahabo et al (2017) and Ogbu & Asuquo (2018) explain that in SSA there is a very critical problem of cost and time overrun which results from tender competition whereby contractors overstate their capacity, underestimated project costs and exaggerated benefits to win the tender without considering the actual costs for project execution within the

expected quality standards. However, consideration of contractors with the lowest price offers rather than quality standards of the projects has been a disaster in SSA. In addition, Ogbu & Asuquo (2018) noted that in many countries corruption and other unethical practices occur during tendering process. For example, in Europe tendering corruption costs up to 20% of the project prices, in Japan costs up to 33% while procurement bribes cost about 57% in some countries.

Purposeful overestimation has been observed through road authorities and anticorruption commissions together with auditors such as Controller and Auditor General (CAG) in Tanzania (Beuran et al., 2015). In 2011 overestimation was up to 60% which is very high and dangerous (Messik, 2011). Likewise, in Kenya and Zambia this was confirmed by the road authority and anticorruption commission, the office of Auditor General confirmed and documented about the presence of procurement and construction practices that open the doors for corruption and they need to be addressed (Beuran et al., 2015). This entails that governance has a vital role to play in ensuring that the procuring process is done according to the required standard. This can only be possible and successful if there is good governance that allows transparency, accountability, participation and inclusiveness.

F. Road users

Road users are the people who are directly affected by the presence of roads in different areas, but they also contribute to the roads damage. For instance, in Ibadan-Nigeria the city has been facing the problem of poor road conditions due to different reasons including the passage of heavy vehicles on the roads with low capacities. Hence the study that was done in Ibadan has emphasised on the importance of educating the road users to make them ambassadors in protecting the roads. This is because protecting the roads is for their benefit (Yoade et al., 2022).

Also, these people have been contributing much to the road damage. Since they have been dumping wastes in the drainage systems and causing the blockage of the drainage thus leading to water stagnation in drainages as well as on the roads and hence the road deterioration (Zumrawi, 2016). They are also affected by the problem of an increase in vehicle operating costs when the roads are damaged. In addition, the roads are the backbone of their daily activities, since they connect them to different areas such as economic zones, health and education facilities (Namala et al., 2018). Moreover, these road users are affected by any fund collected for the maintenance, since they are tax payers, fuel users as well as vehicle users of which are all taxed indirectly (Hassan, 2018).

All these are the direct effects from and to people when it comes to road sector, therefore they are one of the obstacles that affect road maintenance, hence they have to be considered when discussing road maintenance issues. This is because they are very important element in the discussion, that may carry some sort of solution towards sustainable road infrastructure and its longevity.

2.4 National perspective

In Malawi road transport is the much reliable transport that facilitate the movement of both people and goods within and outside the country (Rabiya & Edward, 2016). The problem of poor maintenance of roads has been caused by the incapacity of contractors who have small capitals and are given tenders to run construction projects, maintenance projects inclusive. This has led to the presence of poor quality which has led to the increase in maintenance costs in one way or another (Kulemeka et al., 2015). However, the presence of poor road transport has led to the deterioration of the economy, since it has been discouraging the business due increase in vehicles operating cost which is caused by poor road infrastructure (Rabiya & Edward, 2016). Also, due to the absence of road worthiness of many vehicles together with the poor roads there has been increase in road traffic collisions in Malawi which has led into many deaths as well as increase in number of people with disabilities (Schlottmann et al., 2018).

Malawi's small or medium scale contractors, it denies them from securing loans from the financial institutions. Therefore, less consideration of these contractors by financial institutions has impacted the road sector in Malawi and led to the poor economy, since roads act as a backbone for economic activities (Kulemeka et al., 2015). Again, in Malawi, the problem of scarcity of technicians has been even worse since the indigenous contractors have been lacking enough experts to run the construction projects. This has also been a problem for the Road Authorities because they lack sufficient and well-knowledgeable experts to oversee the projects and hence lead to the poor-quality standard of roads (Kulemeka et al., 2015; Mukasera, 2016), since the supervisors do not understand the ways to measure the quality of the roads as per requirement. Similarly, due to poor techno know-how in Malawi, maintenance costs have been rising because, there has been a need for regular maintenance, rehabilitation and even reconstruction before the attainment of road life span. As it has been stated by the World Bank that any denial of \$1 for maintenance will lead to \$3 cost in the future to both individuals and the government (Kulemeka et al., 2015).

Since the government has many competing priorities on the collected revenue, this has led it to foregone road maintenance for other demands. Hence, "Poor allocation of scarce budget in road

maintenance projects due to lack of proper approaches that can lead to the optimal allocation of available budget”. It is important to address this problem since it will enable the Malawi local governments especially municipalities and Roads Authority to make proper decisions when it comes to urban roads maintenance using the available scarce budget.

2.5 Emerging issues from selected literature cases

There are several issues that that have been observed from literature and these have been depicted in Table 1.

Table 1: Issues observed from the literature

S/N	Emerging issues	Reference
1.	Negligence of root cause	Zumrawi (2016); Nora & Reddy (2018) ; Ngezahayo et al., (2019)
2.	Lack of awareness among people	Mostafa, (2018); Yoade et al., (2022)
3.	Lack of proper budget plan and allocation	Mostafa, (2018); Yoade et al., (2022)
4.	Unpreparedness of climate change effects	Arndt et al.(2012) ; Chinowsky & Arndt (2012)
5.	Lack of an independent road policy	Wasike (2001); The United Republic of Tanzania (2003); Republic of Malawi National Transport Policy (2015); Moti & Vambe (2019)

2.6 Theoretical and conceptual framework

In any research, theories and concept are important to be reviewed and considered, but this involves the review of the theories and concepts that are relevant to the research problem that has to be addressed. Therefore, the choice for these theories and concepts depends on the researcher’s intellectual background, ideological orientation and the nature of the problem that is under study.

2.6.1 Theoretical framework

A. Maintenance theory

Maintenance theory is the theory that is associated with the policies such as inspection and repair policies. If these policies are well considered then the maintenance will be successful. If the inspection is properly done and the failure is detected then, it is easier for the maintenance to be done accordingly. To ensure the reliability of anything such as machines, plants or roads, then failure detection will enable the maintenance department to make consideration of the critical parts to be maintained by prioritizing them based on the effects of the failure, and the time they take from when they have been detected to the total function failure. This prioritization is done because of the scarce budget especially when the maintenance is expensive and does not match the failure in the system (Pham & Wang, 2006).

Therefore, in this study maintenance theory is the dominant theory but it is backed up by the other two theories which are management and organization theories whereby altogether they bring a desired result.

B. Management theory

This is the theory which applies in this study since it is a product of political, social and economic factors, it is the one that determine the governing process and supervision of the roads projects in a road sector. It enables the authorities to decide on the organization structure. However, if there is a good management system that adheres to the set principles in the road sector, it will be an assurance that the road sector will improve. This theory will enable the authorities to set the working standard and ensure the cooperation and a well description of responsibilities as well as the relationship among responsible institution. This also will bring seriousness and improve integrity into existence when it comes to the serious matters that touch the lives of many, since it sets the information flow systems and operations are well managed. This theory has indicators such as specialization (personnel), standardization (quality) and centralization (decision making especially policy-based decisions done by the top management as for the case of roads management is done by the central government) (Ali, 2014).

C. Organization theory

According to Mr. Møller, organization is all about trustworthiness, integrity and decency. These altogether bring the consideration of different matters that are important for development, aiming higher that is all about attaining the achievement of 100% in whatever is being done, taking small risk instead of allowing the occurrence of major ones. Having a focus without allowing returning back in any circumstances, using the available abilities for the benefit of the institutions, being visionary whereby the institution should rely on what act as milestone that will have to be attained. Also, creating an environment that brings confidence among institutions or organizations (Lægaard & Mille, 2021).

This theory is applicable in this study, since it is inevitable to apply these principles in order to be able to put first things first and not be moved by circumstances when it comes to the issues of road maintenance, because the maintenance is what carries the number of factors that lead to the development of any country particularly economic development. For example, doing regular maintenance as per the schedules is taking the small risks and differing the maintenance of the roads is welcoming way of the major risks to occur. However, maintenance cost is among the risks that will be welcomed with other associated risks such as deaths of people due to road accidents, loss of Growth Domestic Product (GDP) due to delays to working places and increase

of transport costs. Also, differing the maintenance is losing focus and negligence of the vision that is set to be attained. Therefore, many governments have lost their focus and they do not abide by their vision hence they have been led out of the line or the vision that they have in their documents.

2.6.2 Conceptual framework

The conceptual framework is comprised of the variables that are necessary for effective urban roads' maintenance and these variables are the result of the literature that is reviewed as well as the theories. Thus, in this study, six variables are conceptualized and these are institutional factors, resource/assets factors, technological factors, construction supportive services, road maintenance processes (periodic, emergency, routine/normal) and maintenance outcome factors. The framework is shown in Figure 2.1. The following is the description of the factors from the conceptual framework.

A. Technological factors

Technology has become a very important factor in many industries since there is a great move from manual based works into technological based works which is simplified and reliable. The same applies to urban road maintenance, where the technology application is vital, for instance, the importance of the availability of work drawings which are incorporated to avoid interference and conflict of interest among sectors. This can only be resolved by the use of Information Technology (IT) whereby one can understand where other service providers have put their infrastructures through incorporated work drawings (El-Batreek et al., 2013: 1013; Hasan et al., 2018:912; Vilventhan et al., 2021:52; Rajadurai and Vilventhan, 2022). The reliability of contractor's plants and equipment is another technological factor that can lead to the quality maintenance work of urban roads as well as easing the work (Rivas et al., 2011:314; Hussain et al., 2017:158; Tee and Ekpiwhre, 2018). Therefore, the use of technology in urban road maintenance in data storage as well as maintenance itself can save costs and time and avoid the destruction of other sectors' infrastructure such as water, sewage and telecommunication lines since there are incorporated drawings which provide the location of all underground infrastructure.

B. Maintenance supportive factors

These are factors that support the smoothness of maintenance work, they include capacity building which is the enabling of human resources to work under a particular project (Kululanga, 2012), also quality assurance plan and specification which the contractor has to

meet according to the contract prescription (Sultana, Rahman and Chowdhury, 2013:277). Skills improvement and minimal supervision, this requires adequate knowledge for the human resource to carry out their duties (Hussain et al., 2017:167; Hernando, 2019). Consequently, the maintenance supportive factors are the ones which inform the quality of work; hence they are worth to be considered in order to deliver the required standard of work.

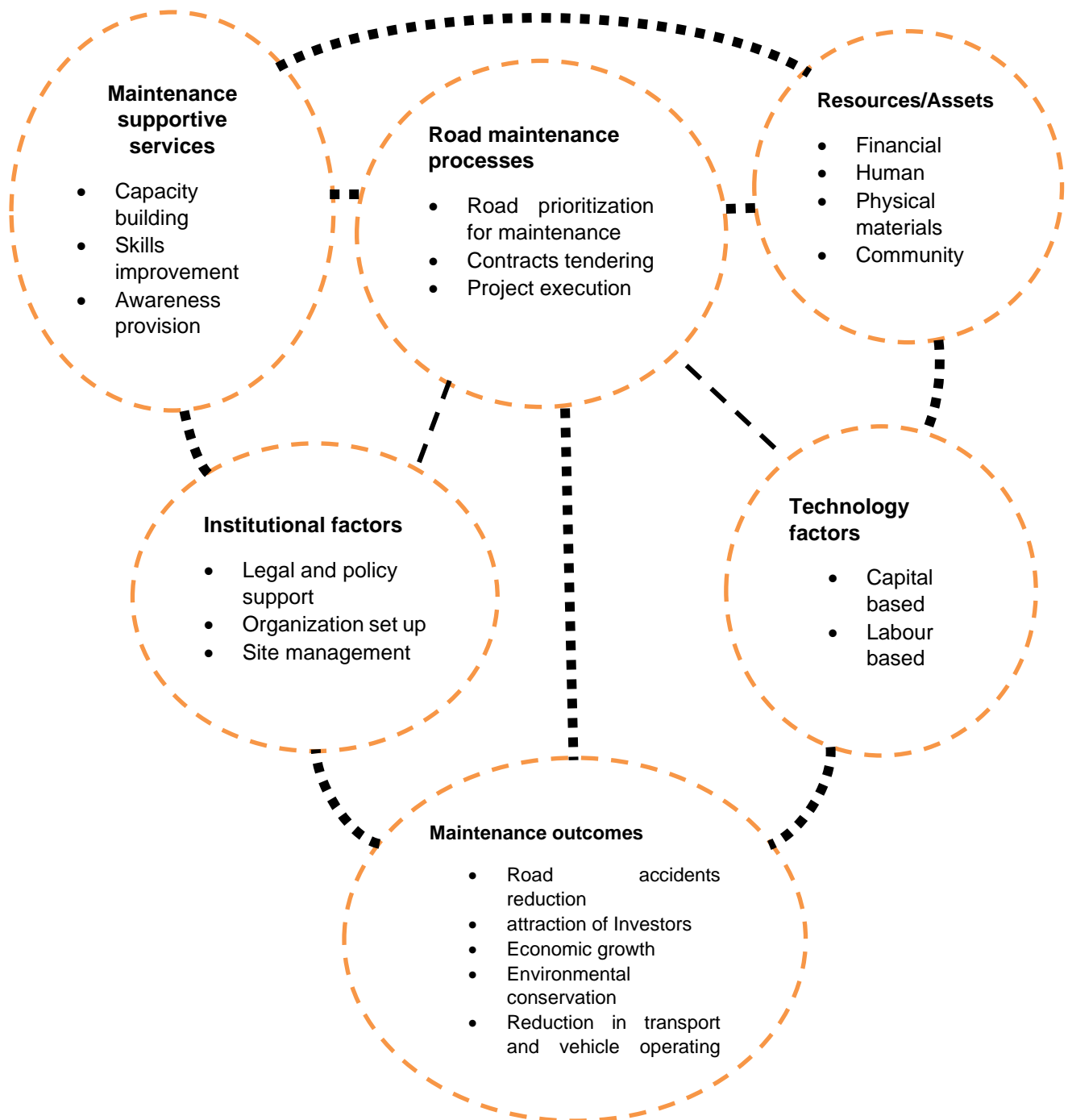


Figure 1: Conceptual framework for the study

C. Institutional factors

These are institutional based factors which are influenced by the institutions such as Consultant issuance of correct site instructions which is very important for the work to be done according to the clients requirements (Abdul Kadir et al., 2005; Hasan et al., 2018); retaining the key staff for the contract duration, this depends on the treatment offered to such particular staff (El-Gohary and Aziz, 2014:13); and client engagement of consultants at the beginning of contract, this can influence the collaborative decision making among the actors (Dolla and Laishram, 2022:367-369). Thus, the institutional factors are the factors which depend on the institutional arrangements in ensuring the smooth working environment as well as execution of work.

D. Resource factors

These are vital factors which facilitate the maintenance work. The factors include the team that requires minimum supervision, this is possible when the team is provided with the appropriate resources to execute the work (Hussain et al., 2017:168); consultants provision of personnel with relevant experiences and skills, these can be imparted to the personnel through training because they need to be cross-functional during the project (Porntepkasemsant and Charoenpornpattana, 2015:3; Hiyassat, Hiyari and Sweis, 2016:9; Hasan et al., 2018). The consultants provision of adequate resources to personnel, and the provision of necessary materials to the personnel can boost the morale of the work (El-Batreek et al., 2013:1013). Moreover, these factors are the ones which are mostly needed for the commencement of work because in their absence work cannot be done. Therefore, when planning for the project, the client has to consider the availability of the resources prior to other factors.

E. Road maintenance process factors

These factors are involved in maintenance, they are there to ensure that the maintenance process take place accordingly within the required quality. They include site meetings to discuss progress and quality of works, these meetings aim ensuring that the works are executed at agreed paces and familiarize the temporary employees with the ongoing project (Jarkas, Kadri and Younes, 2012:9; Hasan et al., 2018:929; Vestola et al., 2021:1448); timeliness in responding to contractor request, this will enable a timely completion of work (Jarkas et al., 2015:333); adherence to quality assurance plans and specifications, this ensures that the maintenance works are of the agreed quality (Sultana et al., 2013:277). Therefore, these are the factors that are vital to be considered during the project execution to avoid unnecessary mistakes and ensure that the project is completed on agreed time and standards.

Table 2 shows possible factors that govern the urban roads' maintenance approaches as explained in other literature. The subthemes groups have been arranged according to five categories which are technological factors, maintenance supportive factors, institutional factors, resource factors and road maintenance process factors.

2.7 Chapter summary

From literature review, it is evident that there are several factors that affect the quality and longevity of the roads especially paved road which mostly found in urban areas. However, these factors call for special attention from the authorities responsible for taking care of the roads within their areas of jurisdiction. Therefore, this justifies the need for the study on the factors governing urban roads' maintenance and their influence on quality of maintenance works in Blantyre city, in order to understand deeply the road maintenance governance in Blantyre city and the factors to be considered for the governance to improve and ensure durability of road infrastructure within the city.

Table 2: Summary of supporting literature on factors governing urban road maintenance approaches

Factors	Supporting literature
<i>Technological factors (TF)</i>	
Adequacy of pavement thickness in urban roads	Krishna and Ch, (2022)
Availability of working drawings	El-Batreek et al. (2013); Hussain et al. (2017); Hasan et al. (2018); Vilventhan et al. (2021); Rajadurai and Vilventhan (2022)
Reliability of contractors' plant and equipment	Rivas et al., (2011); Hussain et al., (2017); Tee and Ekpiwhre, (2018)
<i>Maintenance supportive factors (MSF)</i>	
Adequacy of personnel qualifications and experience	Yik et al. (2002); Porntepkasemsant and Charoenpornpattana (2015); Zaitseva et al. (2017)
Adherence to Quality Assurance plans and specifications	Sultana et al. (2013)
Consultant's engineer site visits frequency	Arslan et al. (2022)
First-time acceptance of contractor's work	Netto et al. (1997)
Key technical personnel matching bid document	Vestola et al. (2021)
Minimal supervision required	Hussain et al. (2017); Hernando (2019)
Provision of key technical personnel at start of contract	Vestola et al. (2021)
Submission of Quality Management Plans	Netto et al. (1997)
Understanding of technical issues on site by key personnel	Arslan et al. (2022)
Capacity building	Kululanga, (2012); Mazele and Amoah (2018)
Skills improvement	Hussain et al. (2017); Hernando (2019)
<i>Institutional factors (IF)</i>	
Ability to retain key staff for duration of contract	El-Gohary and Aziz (2014)
Client engagement of consultant at beginning of contract	Dolla and Laishram (2022)
Client representative site visits frequency	Arslan et al. (2022)
Consultant guidance	Witmer (2018)
Consultant issuance of correct site instructions	Abdul Kadir et al. (2005); Hasan et al. (2018)
Contract document provides enough information	Jarkas et al. (2014)
<i>Resources factors (RF)</i>	
Adequacy of resources provided to team	Hasan et al. (2018)
Consultant provision of adequate resources to personnel	El-Batreek et al. (2013)
Consultant provision of personnel with relevant experience and skills	Porntepkasemsant and Charoenpornpattana (2015); Hasan et al. (2018)
Provision of financial support	Soekiman et al. (2011); Jarkas and Radosavljevic (2013)
Provision of key technical personnel at start of contract	El-Gohary and Aziz (2014)
The team that requires minimum supervision	Hussain et al. (2017); Hernando (2019)
<i>Road maintenance process factors (RMPF)</i>	
Adherence to Quality Assurance Plans	Soham and Rajiv (2013)
Inspection of works by consultant key staff	Porntepkasemsant and Charoenpornpattana (2015)
Site meetings to discuss progress and quality of works	Hasan et al. (2018); Vestola et al. (2021); Dolla and Laishram (2022)
Timeliness in addressing client issues	Hasan et al. (2018)
Timeliness in responding to contractor requests	Jarkas et al. (2015)
Contract tendering	Sultana et al. (2013)
Road prioritization for maintenance	Sayadinia and Beheshtinia (2020)

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter aimed to show the methodologies that were used in information gathering, processing, interpretation and presentation. It specifically brought an explanation on the research design, methods and data collection tools that were used in order to be able to collect the information that were addressing the intended problem through answering the research questions. This explanation was answering the why question, that is why adoption of some methods addressing why question were adopted. However, the chapter acted as the road map towards solving an existing problem, since it was associated with procedures that were scientifically followed in order to come up with a scientific report that opened the eyes towards the solution of such particular problem. Therefore, that is a reason for methodology to differ from one problem to another, because every technique has a logic behind and that logic must be able to abide with the way to a solution (Kothari, 2004).

3.2 Research design and process

This research was a mixed design (concurrent embedded design) where quantitative was a dominant design; therefore, it involved data collection in a semi-structured manner (Creswell, 2014). In this design quantitative and qualitative approaches were used to corroborate findings within a single study

A research process refers to the series of activities that were taking place from the start to the end of the research, whereby in this study, the process started with the problem identification which was obtained through a number of observation and self-questioning followed by literature review that helped in cementing the idea and giving the understanding of research gap, then research objectives and questions formulation. Development of conceptual framework, selection of case study area that considered all the selection criteria, there was a pilot survey of study areas, then, identification of data collection methods and analysis techniques. Lastly data interpretation, presentation and report writing. However, the literature review was done throughout the study except in conclusion and recommendation stage as indicated in Figure 2.

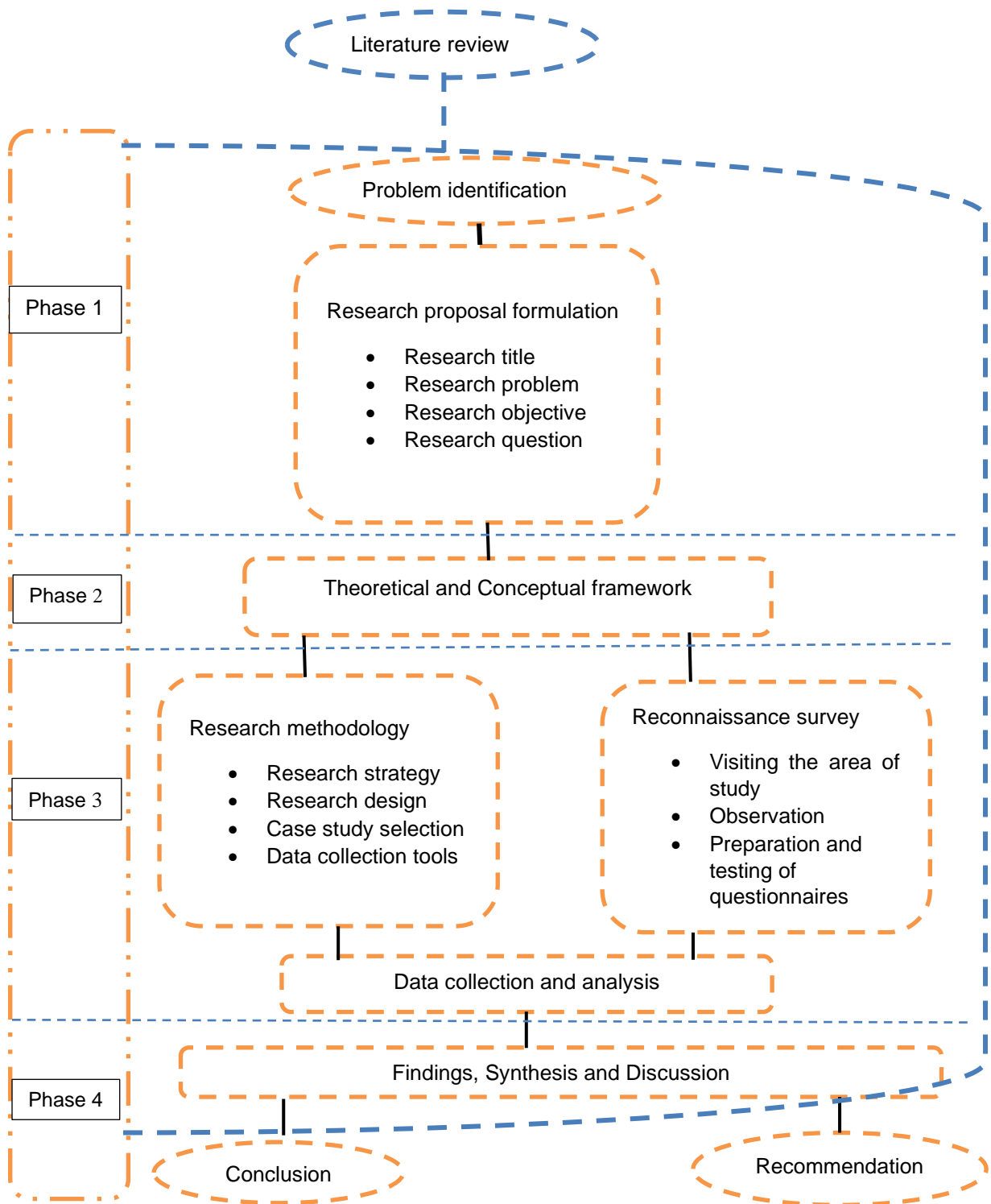


Figure 2: Research process

3.3 Selection of study area

A study area is a place where the needed information is going to be obtained. The information needed was the one that dominated the decision of where the research was going to be undertaken. Mostly, these areas are characterized by the rich information on a particular study.

Thus, in this study, the case study was based on the urban roads, therefore the area of study was a Blantyre City which is one among the cities in Malawi. Hence, the selection was based on the areas with urban characteristics in order to be able to answer the questions posed so that to come up with a reliable solution of the problem that had to be addressed through this study. However, the study dealt with the Blantyre City, Road Authority and some consultants and contractors found in Blantyre City that have been involved in one way or another in roads construction and management in order to capture the required information. Because these were among the major actors in road sector development and management in urban areas and they are directly involved.

The Figure 3 is the map of the areas where the study took place as well as the roads which were observed case during the data collection as provided list by the Blantyre city council.

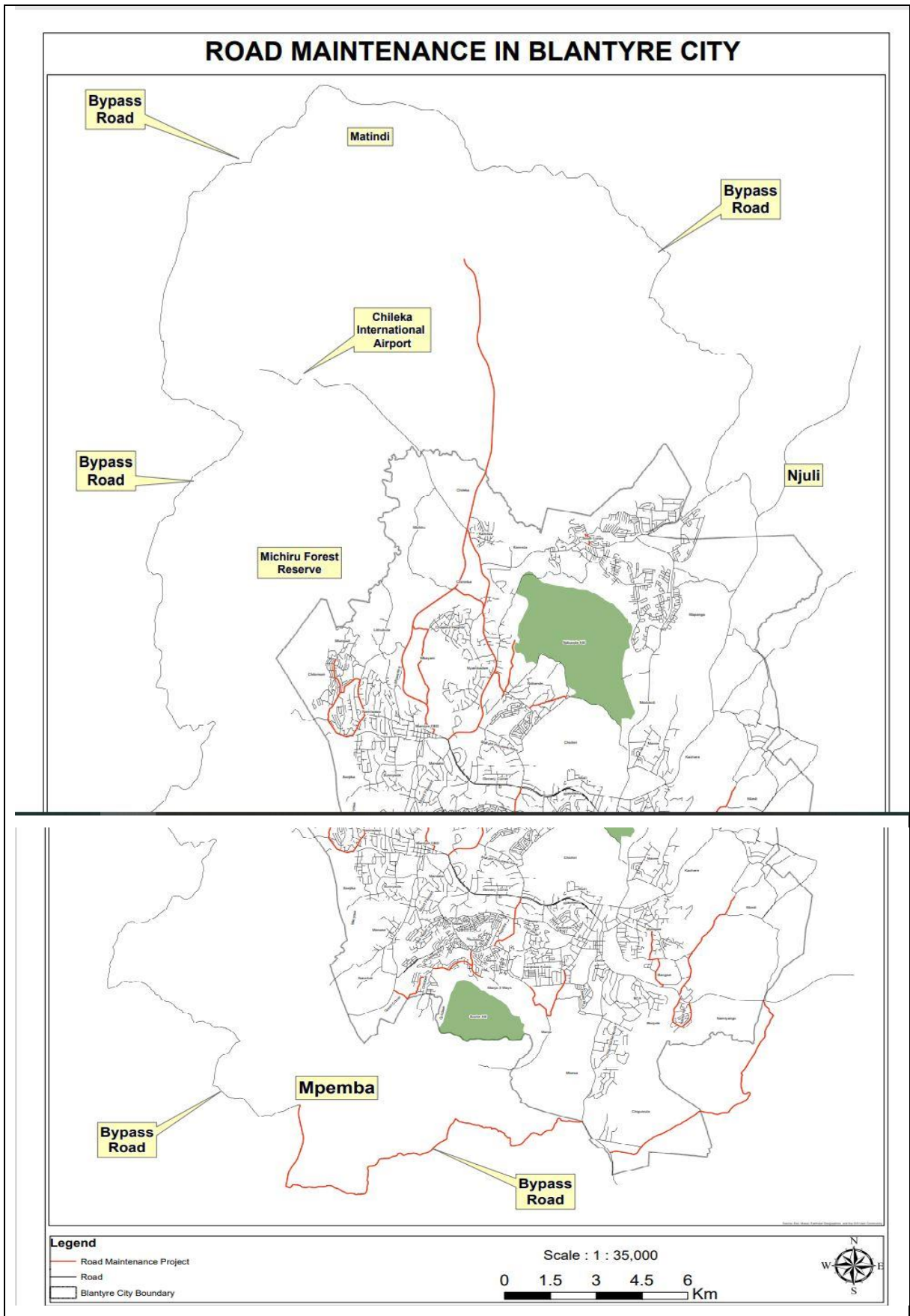


Figure 3: Map showing maintained roads in Blantyre city
 Source: Blantyre city council(GIS Department)

3.4 Smallest unity of analysis and sample selection

In this research, a list received from the Blantyre city council was used to create a population of 98 respondents and 31 recently maintained roads. This list comprised of Road Authority staff, Blantyre city council staff, consultants' staff, and contractors' staff. The full population of 98 was used for data gathering in a questionnaire survey and interview checklists under the census approach for small populations instead of sampling. Singh and Masuku (2014) contend that when a population is small, censuses should be used rather than sampling since they do away with sampling mistakes and sample the entire population, which increases precision. In the case of roads, observation was done in all roads.

3.5 Data collection protocols

Like many research studies, this research comprised both primary and secondary data. Primary data was collected from the field, while secondary data already existed and had been collected by others and published. This included data from journals, magazines, books, theses, and more. Therefore, the nature of this research influenced the data collection methods employed to collect relevant data and avoid unnecessary waste of resources. Since the research involved answering the main questions of how and why, the strategies used were case studies and histories to collect relevant data for the study.

The questionnaire and interviews were divided into four sections. The first section, on the respondents' profile, obtained general demographics about the respondents, including age, gender, organization for which the respondents work, and the professional experience of each respondent. Section two had 5 constructs (technology, maintenance support, institutional, resources, and processes) with 33 Likert-scale statements on factors that have been influencing the urban roads maintenance approaches (see Table 2), where participants were asked to indicate their agreement level with the statements based on their experience in working within the road sector. Closed-ended questions were preferred for section two to reduce the respondent's bias and facilitate the coding of the questionnaire (Akintoye & Main, 2007: 601). Section three set open-ended question on 'which factors need special attention for the governing of urban road maintenance?' Lastly, the questionnaire and interviews included the comment section which allowed the respondents to write their views and experiences on what has been going on in the road maintenance sector. The comment section was designed to allow capturing of information which was not captured in the closed-ended questions. The following tools were used in data collection:

3.5.1 Interviews

Semi-structured interviews were conducted with the various institutional actors in urban road maintenance in Blantyre City which are Blantyre City Council, Road Authority, consultants and contractors.

3.5.2 Questionnaire

The questionnaire comprised most closed and a few open-ended questions. They were developed considering the conceptual framework and research objectives and administered to the Blantyre city council, Road Authority consultants and contractors.

3.5.3 Observation

An observation checklist was used to observe the roads' condition, this was predominantly done on the roads that have been maintained, which enabled a researcher to understand the condition on the ground.

3.5.4 Photography

Roads' photographs were used to validate the observation information. These photographs enabled the researcher to relate the information which were given from the interviews and questionnaires and the reality on the ground.

Table 3: Analytical framework matrix

S/N	Research objectives	Required data	Source of data	Methods	Analysis method
1.	To identify factors that govern urban roads' maintenance approaches	Factors that either influence or discourage urban road maintenance	<ol style="list-style-type: none"> 1. Blantyre city council 2. Contractors 3. Road Authority 4. Consultants 	<ol style="list-style-type: none"> 1. Questionnaires 2. Interview 	Quantitative
2.	To assess the relationship between roads' condition and the quality of maintenance work	The condition of 21 roads by considering the types of deterioration such as potholes, drainage systems, road edges, silt and sand on roads and bridges	<ol style="list-style-type: none"> 1. Urban roads and documents 	<ol style="list-style-type: none"> 1. Observation 2. Photographing 3. Documents' review 	Qualitative

3.	To correlate factors governing urban roads' maintenance approaches on influencing the quality of maintenance works	The quality of maintenance works	<ol style="list-style-type: none"> 1. Blantyre city council 2. Road authority 	<ol style="list-style-type: none"> 1. Questionnaires 2. Interview 3. Observation 	Quantitative
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Figure 4 shows images for showing the conditions of some roads which were inspected.



Figure 4: Images of some of the sampled roads

3.6 Validity and reliability of data collected

In this research the validity of the data was measured using the triangulation method, since the study involved the multi-methods such as documents reviews, interviews, questionnaires and observation which were used to collect information that would answer the research questions. Reliability is measured by the standards and quality of the instruments used in data collection, then if the same instruments are used more than once and brought the same and consistent results then the information will be reliable (Kothari, 2004). In this research the reliability was measured by reviewing the research tools to ensure the focus on the objectives. Also, there was the revisit of the findings by cross checking them with the research tools to ensure correct information that answered the research questions was obtained.

3.7 Data analysis, interpretation and presentation

3.7.1 Data analysis

Both descriptive and inferential statistical analyses was performed using STATA. Also, there was a thematic analysis for the qualitative data.

A. Descriptive statistics

Descriptive statistics is the discipline of quantitatively describing the main characteristics of a collection of information.

Descriptive analysis was used to show the characteristics of respondents used in this study which are their working experiences, age group, gender and the name of the company or institution through frequency distribution table.

In descriptive analysis frequency tables were produced to describe the characteristics of the respondents such as their age group, gender, names of the company they are working and their work experiences by using frequency distribution table. Also, cross tabulation method was used to answer the first specific objective which is to identify factors that govern urban roads' maintenance. In inferential analysis Chi-square test are carried out to study the associations between independent variables and dependent variable hence it answers second specific objective of the study; Ordered logistic regression model was used to study the influence of the independent variables on the dependent variable.

Table 3.2 shows the characteristics of the respondents in Blantyre city who provided their responses on the quality of road maintenance. Out of 98 distributed questionnaire and 98 interview checklist 74 responses were received respectively. The respondents' characteristics included age, work experience, institution/company name, and gender as follows:

Table 4: Characteristics of the respondent`s from Blantyre city

Variable	Freq(n=74)	percent (100%)
Age group		
20-30	12	16.22
31-41	24	32.43
42-52	25	33.78
53-63	13	17.57
Gender		
Male	62	83.78
Female	12	16.22
Work experiences		
Less than 5yrs	36	48.65
6-10 years	26	35.14
More than 10yrs	12	16.22
Institution /Company name		
BBM consultants	3	4.05
Blantyre City Council	4	5.41
CAS construction	2	2.7
Dika	4	5.41
Einstein construction	6	8.11
FARGO LTD	4	5.41
L Gravam	2	2.7
MDF	11	14.86
Mota-Engil	3	4.05
PLEM construction	2	2.7
Pamodzi	9	12.16
Road Authority	12	16.22
Ruo Consultants	12	16.22

The findings from table 4 presented information about the age, gender, and work experience of the respondents, as well as the companies they work for. A total of 74 individuals responded to the survey, with the majority being male (83.78%) and the remaining being female (16.22%). The age group with the largest representation was the 42-52 age group (33.78%), followed by the 31-41 age group (32.43%). The 20-30 age group accounted for 16.22% of respondents, while the 53-63 age group represented 17.57% of the total. This indicates that the majority of the survey respondents were middle-aged professionals, which may have implications for the results of the survey, as they may not represent the opinions of the younger demographic.

In terms of work experience, the majority of participants had less than 5 years of work experience (48.65%), followed by those with 6-10 years of experience (35.14%), and then those

with more than 10 years of experience (16.22%). This indicated that a large proportion of the participants/respondents were relatively inexperienced in their jobs, with less than 5 years of work experience. The next largest group had between 6-10 years of experience, while the smallest group had more than 10 years of experience.

The data also provided information about the companies that the respondents work for. In terms of the institutions/companies represented in the study, the Road Authority and Ruo Consultants had the highest number of respondents (16.22% each), followed by MDF (14.86%) and Pamodzi (12.16%). The remaining institutions/companies had fewer respondents, which are CAS construction, L Gravam, and PLEM construction having the lowest number of respondents at 2.7% each.

Overall, this data provided insight into the demographics and work experience of the individuals who responded to the survey, as well as the companies they work for. This information may be useful for understanding the perspectives and experiences of individuals within the construction and engineering industry in Blantyre city

B. Relative importance index

Data analysis was done through Stata whereby the Relative Importance Index (RII) approach was used to determine the ranking of factors according to their importance in urban road maintenance. Kruskal and Majors (2018) explains that RII is calculated by assigning weights to different factors based on their perceived importance and then multiplying these weights by the factor's frequency of occurrence or level of impact. The resulting values are then normalized to a scale of 0 to 1, with higher values indicating greater relative importance. Also, the RII is a widely known tool for data analysis that is used to rank and evaluate a set of characteristics based on their weighted average values. When predicting the most important variables in a variable list, it is very reliable (Zulu, Zulu and Chabala, 2022:122).

RII can be useful in decision-making processes, as it helps prioritize factors that are most likely to have the greatest impact on an outcome or phenomenon. Similarly, it is important to note that RII is only one tool among many that can be used to analyze data, and its effectiveness depends on the quality and accuracy of the data being used. This was used to answer specific objective number one which is identifying the factors governing urban roads maintenance approaches and their influence on quality of maintenance works in Blantyre city.

Relative Importance Index

$$RII = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{A * N}$$

Where;

n_1 =respondents who says that quality of maintenance works was very good
 n_2 =respondents who says that quality of maintenance works was good
 n_3 =respondents who says that quality of maintenance works was fair
 n_4 =respondents who says that quality of maintenance works was poor
 n_5 =respondents who says that quality of maintenance works was very poor
 $N=74$
 A =High weight (5)

C. *Inferential Statistics*

i) Chi- square test of independence

Inferential statistics used data taken from recently maintained roads to describe and make inferences about the roads. In inferential analysis Chi-square test at 5% level of significance was used to determine the association between two variables with two or more categories. In this study Chi- square test was used to answer second specific objective which was to determine the association between road's conditions, type of maintenance and quality of maintenance works. Since Quality of maintenance works is dependent variable which is categorized into Very poor, Poor, Good, Fair and Very good and independent variables (road's conditions and type of maintenance).

It is computed using the formula;

$$\chi^2 = \sum_i^r \sum_j^c \frac{(f_{ij} - e_{ij})^2}{e_{ij}} \sim \chi^2_{(c-1)(r-1)} \dots \dots \dots (i)$$

Where χ^2 =chi square , f_{ij} = means the observed frequency (the observed counts in the cells),

$(c-1)(r-1)$ shows the degree of freedom

$\sum_i^r \sum_j^c f_{ij}$ = sum of i^{th} row and j^{th} column respectively.

e_{ij} = means the expected frequency But

$$\text{Expected frequencies} = \frac{\text{Row sum} \times \text{Column sum}}{\text{Grand total}} \dots \dots \dots (ii)$$

As depicted in the formula, the Chi -Square statistic is based on the difference between what is actually observed in the data and what would be expected if there was truly no association between the variables.

With r rows and c columns in the contingency table, the test statistic has a Chi-square distribution with

$(r - 1)(c - 1)$ degrees of freedom provided that the expected frequencies was two or more for all categories.

The assumptions of the Chi-square include:

- i. The data in the cells should be frequencies, or counts of cases rather than percentages or some other transformation of the data.
- ii. The levels (or categories) of the variables are mutually exclusive. That is, a particular subject fit into one and only one level of each of the variables.
- iii. Each subject may contribute data to one and only one cell in the χ^2 . If, for example, the same subjects are tested over time such that the comparisons are of the same subjects at Time 1, Time 2, Time 3, etc., then χ^2 may not be used.
- iv. The study groups must be independent. This means that a different test must be used if the two groups are related. For example, a different test must be used if the researcher's data consists of paired samples, such as in studies in which a parent is paired with his or her child.
- v. There are 2 variables, and both are measured as categories, usually at the nominal level. However, data may be ordinal data. Interval or ratio data that have been collapsed into ordinal categories may also be used. While Chi-square has no rule about limiting the number of cells (by limiting the number of categories for each variable), a very large number of cells (over 20) can make it difficult to meet assumption #6 below, and to interpret the meaning of the results.
- vi. The value of the cell expected should be 5 or more in at least 80% of the cells, and no cell should have an expected of less than one. This assumption is most likely to be met if the sample size equals at least the number of cells multiplied by 5. Essentially, this assumption specifies the number of cases (sample size) needed to use the χ^2 for any number of cells in that χ^2 .

Hypothesis

H₀: $r = 0$ (There is no association between dependent and independents variables).

H_a: $r \neq 0$ (There is association between dependent and independents variables).

Cramer's V

Cramer's V is a measure of association between two categorical variables, giving a value between 0 and 1 (inclusive). Cramer's V is the most popular of the chi-square-based measures of nominal association because it gives good norming from 0 to 1. The study employed Cramer's V to examine the strength of the association between quality of

maintenance works and (type of maintenance and road`s condition) as predictor/independent variables.

The interpretation of the strength of the association between variables based on Cramer's V is as follows:

- If $V = 0$, the variables are not associated.
- If $0 < V < 0.25$, the association between the variables is weak.
- If $0.25 \leq V < 0.5$, the association between the variables is moderate.
- If $0.5 \leq V < 0.75$, the association between the variables is strong.
- If $V \geq 0.75$, the variables are perfectly associated.

D. *Ordered logistic regression model*

An ordered logistic regression model is a type of regression analysis used to model the relationship between an ordinal dependent variable and one or more independent variables (Calvin & Long, 1998). In other words, it is a statistical technique that helps to predict the likelihood of an event or outcome occurring, based on a set of predictors. This model estimates the relationship between the independent variables and the odds of moving from one category of the dependent variable to the next, rather than estimating the relationship between the independent variables and the specific values of the dependent variable. It does this by using a cumulative odds ratio to represent the relationship between the dependent variable and the independent variables.

Since the dependent variable in an ordered logistic regression model is an ordinal variable, meaning it has a natural order or ranking example very poor, poor, good, fair and very good. The independent variables, on the other hand, can be either continuous or categorical in nature. Therefore, this model was used to answer the third specific objective of the study which is to assess the influence of factors governing urban roads' maintenance (technological factors, maintenance supportive factors, institutional factors, road maintenance process factors, type of maintenance and roads conditions) on the quality of maintenance works (very poor, poor, fair, good and very good).

The ordered logistic regression model is known as the proportional odds model because the odds ratio of an event is independent of the categories. The odds ratio is assumed to be constant for all categories.

The most commonly used proportional odds model was:

$$\ln\left(\frac{\text{pr}(Y \leq j | x)}{1 - \text{pr}(Y \leq j | x)}\right) = \alpha_j + \beta_i, 1, \dots, \dots, \dots (iii)$$

$$i=1\dots k, j=1, 2\dots P-1$$

Where:

α_0 Or β_0 = Called threshold

β_1 = Parameter, X_i = Sets of factors or predictors

Assumptions of Ordered logistic regression Model

1. Proportional odds assumption: This assumption requires that the relationship between the independent variables and the dependent variable is constant across all levels of the dependent variable. In other words, the effect of the independent variables on the odds of moving from one category of the dependent variable to the next should be the same regardless of the category.
2. Linearity assumption: This assumption requires that the relationship between each independent variable and the log odds of the dependent variable is linear. If this assumption is violated, the model may produce biased or inaccurate results.
3. Independence assumption: This assumption requires that the observations in the sample are independent of each other. If there is dependence among the observations, this can lead to biased or inaccurate estimates of the model parameters.
4. Absence of multicollinearity: This assumption requires that the independent variables are not highly correlated with each other. If there is multicollinearity, the model may produce unstable or unreliable estimates of the regression coefficients.
5. Adequate sample size: This assumption requires that the sample size is large enough to produce stable estimates of the model parameters. A rule of thumb is that there should be at least 10 observations per independent variable in the model.

Hypothesis

HO: There is no relationship between the independent variables and the odds of moving from one category of the dependent variable to the next.

HI: The alternative hypothesis is that there is a relationship between the independent variables and the odds of moving from one category of the dependent variable to the next.

Variables used in Ordered logistic regression model

Variable	Description
Y	Quality of maintenance works
X_1	Maintenance supportive factors
X_2	Institution factors
X_3	Technological factors
X_4	Road's conditions
X_5	Type of maintenance
X_6	Quality maintenance process

E. Qualitative data analysis

The open-ended questions were thematically analysed to see the patterns and themes within the data set (Braun & Clarke, 2006). Using coding approach, five themes that influence urban road maintenance quality were generated. These include the bidding process, laboratory certification, work assessment, maintenance, and longevity of roads.

3.7.2 Data interpretation and interpretation

This is the process in which a researcher clarified the meaning of the data analyzed in order for it to be easily understood by the readers. It was the process that followed after the analysis; therefore, it relied on the analysis process whereby the useful data are the one that are being practical information in real life. It is a very important section, since it is where majority will rely on. It involved the use of tables, pictures, and figures in summarizing and organizing analysis conclusion while word explanation were used in answering the research question (Creswell, 2015).

3.7.3 Ethical issues

In this research the ethical practices were considered throughout the research process, starting from proposal writing where there was avoidance of plagiarism and use of jargons to easy reading. Also, during data collection there was asking for permission to conduct research in different sites that were involved, respect of participants and justice in risk sharing. Finally, data was honestly reported during report writing by avoiding the triggering them to favor a certain group (Creswell, 2015).

3.8 Chapter summary

The chapter presented an overview of how the research was conducted from the beginning to the end when the results were presented. It mainly described on how primary data were collected, analyzed and presented considering the research objectives which were to be attained.

CHAPTER 4: FINDINGS AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents and discusses both descriptive and inferential statistics from the study.

4.2 Identifying factors that govern urban road maintenance approaches

The Relative Importance Index method was used to answer the first specific objectives for this study by identifying the factors governing urban roads maintenance approaches and their influence on quality of maintenance works in Blantyre city shown below:

4.2.1 Frequency distribution table

This method was used to displays the frequency of each factor that has influence on Quality of maintenance works. It provides a summary of the distribution of data in a simple and organized format

Technological factors

Table 5: Technological factors governing urban roads maintenance approaches and their influence on the quality of maintenance works in Blantyre city using frequency distribution table

Technological factors	Quality of maintenance works					Total
	Very Poor	Poor	Fair	Good	Very good	
Factor1	10	2	2	6	1	21
Factor2	5	6	7	3	9	30
Factor3	6	7	5	3	2	23
Total	21	15	14	12	12	74

Where;

Factor1- Adequacy of pavement thickness in urban roads

Factor2- Availability of working drawings

Factor3- Reliability of contractors' plant and equipment

The quality of maintenance works in urban roads is a critical factor in ensuring the safety and comfort of road users. The technological factors that influence the quality of maintenance works in Blantyre city have been analyzed and presented in Table 5. The factors considered were adequacy of pavement thickness in urban roads, availability of working drawings, and

reliability of contractors' plant and equipment. The frequencies of responses on the quality of maintenance works were categorized as very poor, poor, fair, good, and very good.

The majority of respondents rated the quality of maintenance works as fair, good, and very good. This is evident from the frequency distribution table where the total number of respondents who rated the quality of maintenance works as fair, good, and very good was 38, which represents 51.35% of the total respondents. It indicates that the city has made some effort to ensure that the urban roads are well maintained. However, a significant proportion of the respondents rated the quality of maintenance works as poor and very poor, representing 48.65% of the total respondents. These ratings are a cause for concern, as they indicate that some areas in the city require urgent attention to improve the quality of maintenance works.

Maintenance supportive factors

Table 6: Maintenance supportive factors governing urban roads maintenance approaches and their influence on quality of maintenance works in Blantyre city using frequency distribution table

Maintenance supportive factors	Quality of maintenance works					Total
	Very Poor	poor	Fair	Good	Very good	
Factor1	1	0	1	3	2	7
Factor2	0	4	1	2	1	8
Factor3	1	0	0	2	0	3
Factor4	1	0	1	0	2	4
Factor5	1	1	3	1	2	8
Factor6	1	2	1	1	2	7
Factor7	1	0	2	2	0	5
Factor8	0	2	1	1	1	5
Factor9	1	2	1	1	2	7
Factor10	12	1	1	0	0	14
Factor11	2	3	0	1	0	6
Total	21	15	12	14	12	74

where

Factor1=Adequacy of personnel qualifications and experience

Factor2=Adherence to Quality Assurance plans and specifications

Factor3=Consultant's engineer site visits frequency

Factor4=First-time acceptance of contractor's work

Factor5=Key technical personnel matching bid document

Factor6=Minimal supervision required

Factor7=Provision of key technical personnel at start of contract

Factor8=Submission of Quality Management Plans

Factor9=Understanding of technical issues on site by key personnel

Factor10=capacity building

Factor11=skills improvement

Table 6 presents the maintenance supportive factors and their influence on the quality of maintenance works in Blantyre city. In the table the majority which comprised of 51% suggested that the maintenance supportive factors contributed to fair, good and very good maintenance works while the remaining percentage suggested that they led to poor and very poor maintenance works.

Institutional factors

Table 7: Institutional factors governing urban roads maintenance approaches and their influence on quality of maintenance works in Blantyre city.

Institutional factors	Quality of maintenance works					freq
	Very Poor	poor	Fair	Good	Very good	Total
Factor1	5	2	5	0	0	12
Factor2	1	4	3	2	3	13
Factor3	4	2	0	2	0	8
Factor4	5	3	3	4	1	16
Factor5	6	4	3	1	2	16
Factor6	0	0	0	3	6	9
Total	21	15	14	12	12	74

Where

Factor1=Ability to retain key staff for duration of contract

Factor2=Client engagement of consultant at beginning of contract

Factor3=Client representative site visits frequency

Factor4=Consultant guidance

Factor5=Consultant issuance of correct site instructions

Factor6=Contract document provides enough information

Table 7 presents the institutional factors that influence the quality of maintenance works in Blantyre city. These factors include the ability to retain key staff for the duration of the contract, client engagement of consultant at the beginning of the contract, client representative site visit frequency, consultant guidance, consultant issuance of correct site instructions, and whether the contract document provides enough information.

Resources factors

Table 8: Shows Resource factors governing urban roads maintenance approaches and their influence on quality of maintenance works in Blantyre.

Resources factors	Quality of maintenance works					Total
	Very Poor	poor	Fair	Good	Very good	
Factor1	2	5	0	2	3	12
Factor2	0	2	3	3	1	9
Factor3	2	3	3	1	1	10
Factor4	2	0	5	5	4	16
Factor5	5	3	0	3	2	13
Factor6	10	2	1	0	1	14
Total	21	15	12	14	12	74

Where:

Factor1=Adequacy of resources provided to team

Factor2=Consultant provision of adequate resources to personnel

Factor3=Consultant provision of personnel with relevant experience and skills

Factor4=Provision of financial support

Factor5=Provision of key technical personnel at start of contract

Factor6=Requirement of minimal supervision

Road Maintenance Process Factors

Table 9: Shows Road Maintenance process factors governing urban roads maintenance approaches and their influence on quality of maintenance works in Blantyre.

Road maintenance process factors	Quality of maintenance works					Total
	Very Poor	poor	Fair	Good	Very good	
Factor1	4	3	0	6	1	14
Factor2	2	0	1	1	1	5
Factor3	6	6	4	0	2	18
Factor4	2	0	2	0	0	4
Factor5	6	3	2	0	5	16
Factor6	1	2	2	0	2	7
Factor7	0	1	1	7	1	10
Total	21	15	12	14	12	74

Where:

Factor1= Adherence to Quality Assurance Plans

Factor2= Inspection of works by consultant key staff

Factor3= Site meetings to discuss progress and quality of works

Factor4= Timeliness in addressing client issues

Factor5= Timeliness in responding to contractor requests

Factor6= Contract tendering

Factor7=Road prioritization for maintenance

Table 10: Factors governing road maintenance in Blantyre

<i>Factor</i>	<i>RII</i>	<i>Group Rank (GR)</i>	<i>Overall Rank (OR)</i>
Availability of working drawings (TF)	0.229	1	1
Reliability of contractors' plant and equipment (TF)	0.218	2	2
Adequacy of pavement thickness in urban roads (TF)	0.208	3	3
Site meetings to discuss progress and quality of works (RMPF)	0.184	1	4
Capacity building (MSF)	0.181	1	5
The team that requires minimum supervision (RF)	0.168	1	6
Consultant issuance of correct site instructions (IF)	0.159	1	7
Consultant guidance (IF)	0.149	2	8
Timeliness in responding to contractor requests (RMPF)	0.143	2	9
Ability to retain key staff for duration of contract (IF)	0.129	3	10
Adherence to Quality Assurance Plans (RMPF)	0.123	3	11
Provision of key technical personnel at start of contract (RF)	0.122	2	12
Provision of financial support (RF)	0.105	3	13
Adequacy of resources provided to team (RF)	0.1	4	14
Client engagement of consultant at beginning of contract (IF)	0.1	4	15
Consultant provision of personnel with relevant experience and skills (RF)	0.092	5	16
Client representative site visits frequency (IF)	0.086	5	17
Consultant provision of adequate resources to personnel (RF)	0.065	6	18
Skills improvement (MSF)	0.065	3	19
Adherence to Quality Assurance plans and specifications (MSF)	0.065	2	20
Key technical personnel matching bid document (MSF)	0.059	4	21
Road prioritization for maintenance (RMPF)	0.059	4	22
Contract tendering (RMPF)	0.057	5	23
Understanding of technical issues on site by key personnel (MSF)	0.054	6	24
Minimal supervision required (MSF)	0.054	5	25
Adequacy of personnel qualifications and experience (MSF)	0.043	7	26
Inspection of works by consultant key staff (RMPF)	0.043	6	27
Timeliness in addressing client issues (RMPF)	0.043	7	28
Provision of key technical personnel at start of contract (RF)	0.041	8	29
Submission of Quality Management Plans (MSF)	0.038	9	30
Contract document provides enough information (IF)	0.032	6	31
First-time acceptance of contractor's work (MSF)	0.027	10	32
Consultant's engineer site visits frequency (MSF)	0.024	11	33

Technological factors (TF)

The results indicate that the respondents took a technological view as the top three technological factors were ranked highest overall. Availability of working drawings (RII=0.229), reliability of contractors' plant and equipment (RII=0.218), and adequacy of pavement thickness in urban roads (RII=0.208), were considered the factors that influence the quality of maintenance works. Improving these technological factors will enable the improvement of the quality of maintenance works on urban roads in Malawi.

The data from table 10 indicate that availability of working drawings is the most important factor to consider when aiming to improve the quality of road maintenance works (El-Batreek et al., 2013: 1013; Hasan et al., 2018:912; Vilventhan et al., 2021:52; Rajadurai and Vilventhan, 2022). It has to be done in coordination to other utility agencies such as water, sanitation and electricity agencies in order to have a combined file of information in one map or drawing on the utilities as well as road designs to be considered during maintenance, therefore, there should be involvement of Information Technology (IT) for smooth urban road maintenance (Hussain et al., 2017:164-166).

Likewise, the use of 3D and 4D buildings information modelling (BIM) and integrating the road information modelling (RIM) and geographical information systems (GIS) enable the process of creating, updating, sharing, and managing the geometric and semantic information of physical infrastructure including all utilities infrastructure throughout their life cycle. Thus, with the use of GIS, RIM and BIM technology there will be reduction of delays that are caused by the absence of information of the location of the underground utilities' lines along the roads that should not be affected during urban road maintenance works and improve the maintenance works. This is because all the working drawings will be put and found in one package (Vilventhan et al., 2021:52; Rajadurai and Vilventhan, 2022).

The reliability of contractors' plant and equipment, whereby the site workers should be provided with appropriate equipment for their work to be smooth (Rivas et al., 2011:314; Hussain et al., 2017:158; Tee and Ekpiwhre, 2018) and the adequacy of pavement thickness is important for the quality of maintenance works on urban roads. It is argued that when there is surface failure there should be a good bond between the overlaying layers between the existing and the new with the required thickness standard (Krishna and Ch, 2022:1-2).

Maintenance supportive factors (MSF)

Table 10 presents the category maintenance supportive factors governing urban road maintenance and their influence on the quality of maintenance works in Blantyre city. The table shows that institutional factors include adequacy of personnel qualifications and experience, adherence to quality assurance plans and specifications, consultant's engineer site visits frequency, first-time acceptance of contractor's work, key technical personnel matching bid document, minimal supervision required, provision of key technical personnel at start of contract, submission of quality management plans, understanding of technical issues on site by key personnel, capacity building, and skills improvement. Capacity building (RII=0.181) is ranked the fifth factor among the top ten factors which have significant influence on the quality of maintenance works overall.

This is because the lack of both financial and technical capacity can be a challenge towards maintenance activities (Kululanga, 2012; Mazele and Amoah, 2018:202). This factor relates to the provision of training and development opportunities for personnel involved in road maintenance to enhance their skills, knowledge, performances, enthusiasms, and individual abilities to carry out their responsibilities in the construction industry. Correspondingly, other factors such as quality assurance plan and specifications, which can be proved when the contractors meet the performance standards as prescribed in the contract (Sultana, Rahman and Chowdhury, 2013:277). Skills improvement and minimal supervision required are essential in ensuring that maintenance works are carried out according to the prescribed standards and guidelines, and the personnel involved have the necessary skills and knowledge to carry out their duties (Hussain et al., 2017:167). Moreover, the skills improvement and minimal supervision are aligned with the presence of good human resource management within construction industry which include human resource development (HRD), good human resource environment (HRE) and human resource utilization (HRU) (Hernando, 2019). On the other hand, factors such as adequacy of personnel qualifications and experience, provision of key technical personnel at the start of the contract and first-time acceptance of contractors' work have a very little influence on the quality of maintenance work.

Therefore, the findings suggest that investment in capacity building programs for personnel involved in maintenance works as explained in (Kululanga, 2012), and adherence to quality assurance plans and specifications are factors that can significantly improve the quality of maintenance works in Malawi. Road maintenance agencies in the city should focus on these factors to ensure that the maintenance works are carried out to the required standards, and the road network is kept in good condition.

Institutional factors (IF)

Table 10 presents the institutional factors that influence the quality of maintenance works in Malawi. These factors include the ability to retain key staff for the duration of the contract, client engagement of consultant at the beginning of the contract, client representative site visit frequency, consultant guidance, consultant issuance of correct site instructions, and whether the contract document provides enough information. The results show that ‘consultant issuance of correct site instructions’ (RII=0.159) is the most important institutional factor and is ranked seventh in the overall category. Other significant factors are the ‘ability to retain key staff for the duration of the contract’ (RII=0.129), and ‘client engagement of consultants at the beginning of the contract’ (RII=0.100).

This suggests that having clear and accurate instructions for maintenance work is crucial for achieving good results (Abdul Kadir et al., 2005:49-50; Hasan et al., 2018:922). Also, retaining key staff for the contract duration, this depends much on how the staff are being treated and handled during performing their duties in maintenance works (El-Gohary and Aziz, 2014:13); and client engagement of consultants at the beginning of contract which can ensure the proper execution of maintenance work, since that involvement brings out the collaborative decision making among the actors involved in a project and sense of ownership among them (Dolla and Laishram, 2022:367-369). Likewise, the data shows that institutional factors play a crucial role in ensuring the quality of maintenance work in Malawi. Addressing these factors, such as providing clear instructions and retaining key personnel, can lead to better outcomes and more effective maintenance of urban roads.

Resource factors (RF)

The resource factors governing urban road maintenance and their influence on the quality of maintenance works in Malawi listed in Table 10 include adequacy of resources provided to the team, consultant provision of adequate resources to personnel, consultant provision of personnel with relevant experience and skills, provision of financial support, provision of key technical personnel at the start of the contract, and requirement of minimal supervision.

‘The team that requires minimum supervision’ (RII=0.168) is the most important factor under the category of resource factors in ensuring quality maintenance works and it is ranked sixth (6th) among the top ten influential factors in road maintenance works. This factor implies that the maintenance team should be efficient and effective, and require minimal supervision, thus reducing the chances of errors in the maintenance work. However, the minimal supervision can be achieved if and only if the staff will be provided with appropriate resources and equipment to

execute their work as well as the presence of smooth information flow within the organizations involved in maintenance works (Hussain et al., 2017:168). Also, it is good to practice training within the contractors' companies, road authorities, city councils and consultant companies since in the technological era, things change so fast in such a way that these organizations cannot afford to use apprenticeship method to provide useful knowledge to the potential staff within the construction industry, and sometimes the developing countries have no system to provide such a useful knowledge (Hernando, 2019). Provision of key technical personnel at the start of the contract also is a second important factor under its group category to be considered through proper treatment of personnel throughout the projects (El-Gohary and Aziz, 2014:13). This also, suggests that the availability of experienced and skilled personnel at the beginning of the contract is crucial in ensuring the quality of maintenance works in Malawi. Mostly, these key personnel should be cross-functional that they can perform different tasks within the project (Vestola et al., 2021:1448). Other factors are; adequacy of resources provided to the team, because there is no way that the team will be efficient if the resource materials are not available, not provided as required or there is delay in provision (Hasan et al., 2018:929); consultant provision of adequate resources to personnel, especially, the personnel who are involved in site visit should be provided with necessary materials and tools in order to boost their morale and efficiency in fulfilling their duties (El-Batreek et al., 2013:1013); consultant provision of personnel with relevant experience and skills, this provide the projects with competent and conversant personnel (Porntepkasemsant and Charoenpornpattana, 2015:3; Hiyassat, Hiyari and Sweis, 2016:9; Hasan et al., 2018); and provision of financial support which plays a vital role in road maintenance because it acts as an engine that facilitate the execution of the project within the predetermined time, cost and quality (Soekiman et al., 2011; Jarkas and Radosavljevic, 2013:13), hence these factors are important in determining the quality of maintenance work.

Therefore, it is indicated that the requirement of minimal supervision and the provision of key technical personnel at the start of the contract are the most important resource factors in ensuring quality maintenance works in Malawi. Therefore, city authorities and contractors should ensure that experienced and skilled personnel are available at the beginning of the contract, and that maintenance teams are efficient and require minimal supervision. This would ensure that resources are utilized optimally, and that maintenance works are completed to a high standard, improving the overall quality of urban road maintenance in the city.

Also, according to the comments received from the specific questionnaires it showed that laboratory certification can be compromised between the responsible personnel and the

contractors in order to cut down the costs especially when the quality materials are found very far. Correspondingly, for the case of Blantyre city, the quality materials such as good gravels are found 50 Kms from the town, therefore, to cut down the costs of fuel, vehicle maintenance due to tear and wear, hence most contractors opt for compromise which involve corruption.

Road maintenance process factors (RMPPF)

The results in Table 10 on road maintenance process factors and their influence on the quality of urban road maintenance works in Malawi. shows that ‘site meetings to discuss progress and quality of works’, has the highest RII score of 0.184, it is ranked top fourth among the top 10 factors in the overall category. ‘Timeliness in responding to contractor requests’, has the second highest RII score of 0.143 and is ranked top ninth in the overall category. This means that regular meetings among the contractor, the consultant and site workers to discuss the progress and quality of works are crucial in ensuring the delivery of quality maintenance works (Jarkas, Kadri and Younes, 2012:9; Hasan et al., 2018:929; Vestola et al., 2021:1448). Equally, this is because some of team members are being employed in a temporal basis, therefore they require discussions in order to get familiarity with ongoing project (Vestola et al., 2021:1448). Moreover, with site meetings there will be a collaborative decision making between the project managers and the site workers, also, it increase workers morale and build trust within team members since they know that their opinions are being heeded by their leaders (Dolla and Laishram, 2022:367-369). Timeliness in responding to contractor request which is a very crucial factor to be considered during commencement of maintenance activities will enable a timely completion of work (Jarkas et al., 2015:333).

‘Adherence to quality assurance plans’, (RII=0.123), was ranked the third most important factor in the group, it highlights the importance of following the quality assurance plans to ensure that maintenance works are of high quality (Sultana et al., 2013:277). Other factors, like ‘road prioritization for maintenance, RII=0.059, inspection of works by consultant key staff (RII=0.043), timeliness in addressing client issues (RII=0.043) and contract tendering (RII=0.057) have some of the lowest RII scores overall implying that they have the least impact on the quality of maintenance works.

According to the comments from the respondents through questionnaires it was perceived that the bidding process has not been pleasant since the consideration is made based on the price offered instead of the promised quality of the work. Also, there is a bureaucracy in awarding tenders and sometimes it might take a year of which the bid gets expired because the prices of

materials can change within a year as well as exchange rates for the importation of materials fluctuate. Though to many respondents the contract tendering was considered as a sub-factor with least impact in influencing the quality of work due to its group and overall ranking, still few of them had a different opinion which in the real world of practitioners it has a huge impact towards the quality of maintenance work because it gives an understanding of the final product of the project before the commencement of the project work (Sultana et al., 2013:277). Moreover, sometimes the tender awarding authorities remain silent with the bids without giving feedback of either acceptance or rejection which put the bidders in a dilemma about projects. For example, Oyeyipo et al., (2016) and Chileshe et al., (2021) suggest that the adoption of incorrect or improper bidding practices significantly contributes to the inefficiency of the construction industry. Therefore, it is essential for indigenous contractors to approach bid or no-bid decisions with thoroughness and strictness.

In summary, the study identifies site meetings, timeliness in responding to contractor requests, and adherence to quality assurance plans and specifications as the most critical urban road maintenance process factors that significantly influence the quality of maintenance works. These findings suggest that stakeholders should prioritize the most important factors as discussed to ensure the successful delivery of quality maintenance works on urban roads in Malawi.

4.3 The relationship between road condition and the quality of maintenance works

The inferential analysis method was used to answer the second specific objectives for this study by assessing the relationship between roads' condition and quality of maintenance work in Blantyre city as shown below:

Table 11: The relationship between roads conditions and quality of Maintenance works

Road's conditions (I.V)	Quality of maintenance works (Dependent var)					Total	χ^2	P-value	Cramer's V
	Very Poor	Poor	Fair	Good	Very good				
Drainage	1(1.4)	4(2.0)	2(1.1)	0(1.3)	0(1.1)	7(7.0)	52.5327	0.013**	0.4213
Potholes	0(1.8)	7(2.6)	0(1.5)	2(1.7)	0(1.5)	9(9.0)			
Road edges	3(1.80)	0(2.6)	1(1.5)	3(1.7)	2(1.5)	9(9.0)			
Silting	2(1.8)	0(2.6)	0(1.5)	2(1.7)	5(1.5)	9(9.0)			
Traverse Cracks	1(1.6)	2(2.3)	3(1.3)	0(1.5)	2(1.3)	8(8.0)			
Thermal cracking	2(1.8)	3(2.6)	0(1.5)	4(1.7)	0(1.5)	9(9.0)			
Distress Patches	2(1.6)	1(2.3)	2(1.3)	1(1.5)	2(1.3)	8(8.0)			
Rutting	2(1.4)	1(2.0)	2(1.1)	2(1.3)	0(1.1)	7(7.0)			
Fatigue	2(1.6)	3(2.0)	2(1.3)	0(1.5)	1(1.3)	8(8.0)			
Total	15(15.0)	21(21.0)	12(12.0)	14(14.0)	12(12.0)	74(74.0)			

Relationship between roads conditions and quality of maintenance works

(..) in brackets are the expected values

**Significant at 5% level This Table 11 presents the results of an analysis of the relationship between the quality of maintenance works and the condition of roads. The quality of maintenance works is the dependent variable, while road conditions are the independent variable. The table shows the frequency counts of the quality of maintenance works for each level of road conditions. The expected values are also provided in brackets.

The Chi-square test of independence was conducted to test the null hypothesis that the quality of maintenance works is independent of the condition of roads. The test yielded a Chi-square value of 52.5327 with a p-value of 0.013, which is statistically significant at the 5% level since

p-value 0.013 is less than 0.05 at 5% level of significance. The Cramer's V value is 0.4213, indicating a moderate relationship between the two variables.

Overall, the findings suggest that the quality of maintenance works is related to the road condition of

Table 12: The relationship between type of maintenance and quality of Maintenance works

		Quality of maintenance works (Dependent var)							
Type of maintenance (I.V)		Very Poor	poor	Fair	Good	Very good	Total	χ^2	P-value
Drainage and shoulder improvement	and	0(2.6)	6(3.7)	6(2.1)	0(2.5)	1(2.1)	13(13.0)	27.0824	0.008**
Upgrading asphalt surface	of	5(4.1)	2(5.7)	1(3.2)	6(3.8)	6(3.2)	20(20.0)		
Dualization		8(4.9)	8(6.8)	2(3.9)	4(4.5)	2(3.9)	24(24.0)		
Shoulder improvement		2(3.4)	5(4.8)	3(2.8)	4(3.2)	3(2.8)	17(17.0)		
Total		15(15.0)	21(21.0)	12(12.0)	14(14.0)	12(12.0)	74(74.0)		

drainage. Roads with very poor and poor drainage are more likely to have led to poor quality maintenance works than those with fair, good, and very good drainage. This agrees with the arguments from Zumrawi (2016) and Nora & Reddy, (2018) which suggest that the longevity of the paved roads depend on the availability of functional drainages. However, there is no significant association between the quality of maintenance works and other road conditions such as potholes, road edges, silting, traverse cracks, thermal cracking, distress patches, rutting, and fatigue. These results provide valuable information for policymakers and road authorities to prioritize maintenance works for specific road conditions to improve the overall quality of roads

Relationship between quality of maintenance works and type of maintenance.

(..) in brackets are the expected values

**Significant at 5% level

Table 12 shows the relationship between the type of maintenance and the quality of maintenance works on the roads. The dependent variable is the quality of maintenance works, while the independent variable is the type of maintenance. The results of the study were analyzed using the Chi-square test and Cramer's V coefficient.

The findings reveal a significant relationship between the quality of maintenance works and the type of maintenance performed on the roads. The p-value for the Chi-square test is less than 0.05, indicating that the results are statistically significant. The Cramer's V coefficient is 0.3493, which suggests a moderate effect size.

Looking at the individual categories, it can be observed that drainage and shoulder improvement are closely related to the quality of maintenance works. The expected values for this category range from 2.1 to 3.7, while the observed values range from 0 to 6. This difference indicates that the quality of maintenance work for drainage and shoulder improvement is poor and needs improvement. Figure5 below shows a part of Bangwe to St.Patrics with poor shoulders and no drainage system.



Figure 5: Bangwe to St.Patrics road with poor shoulders and without drainage system

Source: Author's capture

On the other hand, upgrading of asphalt surface, Dualization, and shoulder improvement have moderate relationship with the quality of maintenance works. For these categories, the expected and observed values are relatively similar, indicating that the quality of maintenance works for these types of maintenance is fair to good.

In summary, the findings of the study suggest that there is a significant relationship between the type of maintenance and the quality of maintenance works on roads. Drainage and shoulder improvement have the close relationship with poor quality of maintenance works, while upgrading of asphalt surface, dualization, and shoulder improvement have moderate relationship with the quality of maintenance works. These results indicate that there is a need to improve the quality of maintenance works in roads, particularly for drainage and shoulder improvement.

4.4 Correlation of factors governing urban roads' maintenance approaches and roads condition on influencing the quality of maintenance works

The ordered logistic model was used to answer the third specific objectives for this study by looking at the correlation of factors governing urban roads' maintenance approaches and road condition on influencing the quality of maintenance works in Blantyre city as shown in table 13:

Table 13: Ordered logistic model used to correlate the factors governing urban roads' maintenance approaches and roads condition on the quality of maintenance works.

Quality of Maintenance works				
			Number of obs	= 74
			LR chi2(39)	= 96.58
			Prob > chi2	= 0.0000
			Pseudo R2	= 0.4115
Variables	Odds Ratio	Std. Err.	z	P> z
Maintenance Supportive Factors				
Adequacy of personnel qualifications and experience -Reference				
Adherence to Quality Assurance plans and specifications	0.8079	0.1619	-1.26	0.020
Consultant's engineer site visits frequency	0.3054	0.5597	-0.65	0.518
First-time acceptance of contractor's work	0.9567	2.6895	-0.02	0.987
Key technical personnel matching bid document	5.7248	5.5132	1.65	0.008
Minimal supervision required	0.2683	1.9639	1.05	0.292
Provision of key technical personnel at start of contract	0.10791	0.1891	-1.27	0.204
Submission of Quality Management Plans	3.4346	7.8462	0.54	0.589
Understanding of technical issues on site by key personnel	0.2342	0.4243	-0.8	0.423
Capacity building	0.1632	1.1637	0.71	0.048
Skills improvement	0.679	0.1307	-1.4	0.016
Institution factors				
Ability to retain key staff for duration of contract -reference				
Client engagement of consultant at beginning of contract	1.2389	1.4916	0.18	0.859
Client representative site visits frequency	0.2439	0.3334	-1.03	0.303
Consultant guidance	0.8087	2.3859	0.86	0.039
Consultant issuance of correct site instructions	0.1381	0.1656	-1.65	0.019
Contract document provides enough information	3.2106	4.3631	2.39	0.172
Technological Factors				
Adequacy of pavement thickness in urban roads -reference				
Availability of working drawings	0.6537	0.6856	-0.4	0.0092
Reliability of contractors' plant and equipment	0.1033	0.1183	-1.98	0.147
Road conditions				
Drainage-Reference				
Potholes	0.1783	0.2746	-1.12	0.263
Road edges	0.828	0.9448	1.87	0.006
Silting	2.7925	5.1559	0.56	0.578
Traves cracks	7.4496	11.5544	1.29	0.195
Thermal cracking	1.3239	2.2688	0.16	0.87
Distressed Patches	6.6468	10.7627	1.17	0.242
Rutting	0.121	0.1787	-1.43	0.153
Fatigue	0.2491	0.463	-0.75	0.455

Resource Factors				
Adequacy of resources provided to team -Reference				
Consultant provision of adequate resources to personnel	1.4722	2.7606	2.02	0.144
Consultant provision of personnel with relevant experience and skills	0.1095	9.2532	1.51	0.0132
Provision of financial support	0.251	5.9738	3.59	0.011
Provision of key technical personnel at start of contract	0.689	7.9425	1.25	0.021
Requirement of minimal supervision	0.7885	0.9456	-0.2	0.182
Road Maintenance process factors				
Adherence to Quality Assurance Plans -Reference				
Inspection of works by consultant key staff	0.2635	1.854	3.87	0.751
Site meetings to discuss progress and quality of works	0.2323	0.2343	-1.45	0.148
Timeliness in addressing client issues	0.6335	1.7027	2.05	0.421
Timeliness in responding to contractor requests	0.2352	2.5397	1.07	0.0283
contract tendering	0.2745	0.3726	-0.95	0.341
road prioritization for maintenance	0.2282	0.3299	-1.02	0.0307
Type of maintenance				
Drainage and shoulder improvement-Reference				
Upgrading of asphalt surface	5.4714	8.3863	1.11	0.268
Dualization	0.5106	0.7103	-0.48	0.629
Shoulder improvement	0.572	2.7723	2.76	0.006

The output provided in table 13 represents an ordered logistic regression model that aims to correlate factors governing urban roads' maintenance and roads condition on influencing the quality of maintenance works. The dependent variable is the quality of maintenance works, which is an ordinal variable consisting of five categories, including very poor, poor, fair, good, and very good. The independent variables are grouped into various factors, including maintenance supportive factors, institutional factors, technological factors, road conditions, resource factors, road maintenance process factors, and type of maintenance.

The pseudo R-squared value of 0.4115 indicates that the model can explain approximately 41.15% of the variability in the quality of maintenance works. Also, the likelihood ratio chi-square of 96.58 with a p-value of 0.0000 show that the whole/overall model is statistically significant at 5% level of significance, since p-value 0.0000 < 0.05 the model is significant. Therefore, there is need of interpreting odds ratios.

Odds Ratios interpretation

When interpreting the odds ratios, a value greater than 1 indicates that the likelihood of the outcome variable's higher category increases with a unit increase in the independent variable (more likely), while a value less than 1 indicates the opposite (less likely) and if the Odds ratio is equal to 1, it

means that there is no association between the exposure and the outcome. An odds ratio (OR) is a measure of association between two variables, such as exposure and outcome, in a case-control or cohort study. Also as ordered logit model assumes that the probability of moving from the lowest category versus all higher categories of the response variable are the same as those described in the next lowest categories and all higher categories. Therefore, interpretation will be as follows;

Interpretations for Maintenance supportive factors which are statistically significant.

The results from Table 13 shows that; this was the proportional odds ratio of evaluating the effect of Maintenance supportive factors that govern urban roads' maintenance approaches on the quality of maintenance works in Blantyre city given the other variables in the model are held constant.

For category Adherence to Quality Assurance plans and specifications (p-value 0.020<0.05);

Respondents who considered Adherence to Quality Assurance plans and specifications to be an important factor for maintenance works were 0.8079 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized the adequacy of personnel qualifications and experience. In other words, those who consider adherence to quality assurance plans and specifications to be an important factor for maintenance work are less likely to believe that it can result in poor quality maintenance works compared to those who prioritize personnel qualifications and experience. This imply that individuals who prioritize adherence to quality assurance plans and specifications may have more confidence in the quality of maintenance work that is carried out, as they believe that following the plans and specifications will ensure that the work is done correctly (Soham & Rajiv, 2013). On the other hand, those who prioritize personnel qualifications and experience may believe that the expertise of the maintenance personnel is more important for ensuring quality work (Yik et al., 2002;Porntepkasemsant & Charoenpornpattana, 2015; Zaitseva et al., 2017).

For category Capacity building p-value (0.048<0.05); respondents who considered capacity building to be an important factor for maintenance works were 0.1632 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized the adequacy of personnel qualifications and experience. This finding may indicate that investing in capacity building, such as training and development programs, for maintenance personnel can lead to improved quality of maintenance works. Those who prioritize capacity building are more likely to believe that it can result in better quality of maintenance works as in (Kululanga, 2012; Mazele & Amoah, 2018).

For category skills improvement; p-value (0.016<0.05); respondents who considered skills improvement to be an important factor for maintenance works were 0.679 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized the adequacy

of personnel qualifications and experience. This indicates that respondents who prioritize skills improvement are less likely to perceive it as a risk to the quality of maintenance work. They may believe that enhancing their skills and knowledge can actually contribute to better maintenance outcomes (Hussain et al., 2017; Hernando, 2019), while those who prioritize personnel qualifications and experience may not see the same value in skills improvement.

Interpretations for Institutional factors that are statistically significant

For category Consultant guidance (p-value $0.039 < 0.05$); respondents who considered consultant guidance to be an important factor for maintenance works were 0.8087 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized the Ability to retain key staff for duration of contract. In other words, they believe that consultant guidance can improve the quality of maintenance works (Witmer, 2018). On the other hand, those who prioritize the ability to retain key staff for the duration of the contract are more likely to believe that consultant guidance can lead to poor quality of maintenance works. This implies that they believe that relying on consultant who rarely visit the site for guidance can result to the lack of ownership and accountability among the maintenance staff, leading to poor quality of work.

For category Consultant issuance of correct site instructions (p-value $0.019 < 0.05$); respondents who considered Consultant issuance of correct site instructions to be an important factor for maintenance works were 0.1381 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized the Ability to retain key staff for duration of the contract. In other words, they believe that correct site instructions issued by consultants can improve the quality of maintenance works (Abdul Kadir et al., 2005; Hasan et al., 2018). On the other hand, those who prioritize the ability to retain key staff for the duration of the contract (El-Gohary & Aziz, 2014) are more likely to believe that consultant issuance of correct site instructions can lead to poor quality of maintenance works. This may imply that relying on who rarely visit the site for site instructions can result in a lack of ownership and accountability among the maintenance staff, leading to poor quality of work.

Interpretations for Technological factors that are statistically significant.

For category Availability of working drawings (p-value $0.0092 < 0.05$); respondents who considered Availability of working drawings to be an important factor for maintenance works were 0.6537 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized Adequacy of pavement thickness in urban roads .This implies that the respondents who prioritized "Adequacy of pavement thickness in urban roads" believed that having adequate pavement thickness is more important for the quality of maintenance works compared to the Availability of

working drawings. However, according to Styles & Bichard (2012) working drawings are also as important as the thickness of pavement since that pavement thickness depends on what the drawings instruct, because the drawings are acting as compass in any construction projects urban roads' maintenance inclusive (El-Batreek et al., 2013; Hussain et al., 2017; Hasan et al., 2018; Vilventhan et al., 2021; Rajadurai & Vilventhan, 2022).

Interpretations for Road conditions that are statistically significant.

For category Road edges (p-value $0.006 < 0.05$); respondents who considered road edges to be an important factor for maintenance works were 0.828 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized drainage. This implies that those who prioritize road edges may have greater confidence in the effectiveness of maintenance work done on road edges compared to those who prioritize drainage.

Interpretations for Resource factors that are statistically significant

For the category Consultant provision of personnel with relevant experience and skills (p-value $0.0132 < 0.05$); respondents who considered Consultant provision of personnel with relevant experience and skills to be an important factor for maintenance works were 0.1095 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized Adequacy of resources provided to the team. This implies that providing personnel with relevant experience and skills through consultants can be perceived as a way to enhance the quality of maintenance works (Porntepkasemsant & Charoenpornpattana, 2015; Hasan et al., 2018).

For category Provision of financial support (p-value $0.011 < 0.05$); respondents who considered Provision of financial support be an important factor for maintenance work were 0.253 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized Adequacy of resources provided to team. This implies adequate financial support as in (Soekiman et al., 2011; Jarkas & Radosavljevic, 2013) is perceived as a crucial factor for maintaining high quality maintenance works.

For category Provision of key technical personnel at start of contract (p-value $0.021 < 0.05$); respondents who considered Provision of key technical personnel at start of contract be an important factor for maintenance work were 0.689 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized Adequacy of resources provided to team. This implies that having key technical personnel available at start of contract can be perceived as a way to improve quality of maintenance works (Vestola et al., 2021).

Interpretations for Road maintenance process factors that are statistically significant.

For category timeliness in responding to contractor requests (p-value 0.0283<0.05); respondents who considered timeliness in responding to contractor requests to be an important factor for maintenance work were 0.2352 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized Adherence to Quality Assurance Plans. In other words, those who prioritize timeliness in responding to contractor requests may believe that quick and effective communication with contractors is a key factor in ensuring high-quality maintenance work (Jarkas et al., 2015). On the other hand, those who prioritize adherence to quality assurance plans are more likely to believe that timeliness in responding to contractor requests can lead to poor quality of maintenance works. This may imply that they believe that responding to contractor requests quickly may compromise adherence to quality assurance plans.

For category road prioritization for maintenance (p-value 0.0307<0.05); respondents who considered road prioritization for maintenance to be an important factor for maintenance work were 0.2282 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized Adherence to Quality Assurance Plans. In other words, those who prioritize road prioritization for maintenance may believe that it is important to focus resources on the most critical roads in order to achieve the highest level of maintenance quality. They may believe that strict adherence to quality assurance plans is not as important as making sure that resources are allocated to the most critical areas. This is in agreement with the studies done by (Prakasan et al., 2015; Pamuković et al., 2021) which make an emphasize on the prioritization of the roads to be maintained under the scarce budget. On the other hand, those who prioritize adherence to quality assurance plans may believe that following standardized procedures is the most important factor in ensuring high-quality maintenance works, regardless of which roads are being maintained.

Interpretations for Types of maintenance that are statistically significant.

For category shoulder improvement (p-value 0.006<0.05); respondents who considered shoulder improvement to be an important factor for maintenance work were 0.572 times less likely to believe that it can lead to poor quality of maintenance works compared to those who prioritized Drainage and shoulder improvement. In other words, the respondents who prioritize shoulder improvement are more likely to believe that it does not lead to poor quality of maintenance works than those who prioritize Drainage and shoulder improvement. This implies that there is a relationship between the respondent's priorities for maintenance work and their beliefs about the impact of shoulder improvement on the quality of maintenance works. Figure 6 below shows a part of the road from Kandodo corner shop to Zalewa where the shoulder and drainage system was improved which led to

its longevity compared to other roads which did not consider these two things, because through observation, it was observed that many roads which were in worse condition had poor shoulders and had no drainage systems which encourages easy deterioration of the particular road.



Figure 6: Improved shoulders and drainage system between Kandodo corner shop to Zalewa

Source: Author's capture

4.5 General Observations

These are the observations that were obtained through administering the open-ended questions to the consultants, contractors, road authority and city council to get their opinions on the factors governing urban road maintenance and their influence on the quality of maintenance works. Also, other comments are the result of the observation that was done on the selected roads which were maintained between 2016 and 2020. The opinions were collected and analyzed qualitatively. The following are the comments which were recorded.

Table 14: Recorded comments from thematic analysis

<i>Factor</i>	<i>Main factor</i>	<i>Comment</i>
Bidding	Road maintenance process	Bidding process is not pleasant since the consideration is made based on the price offered instead of the promised quality of the work. There is a bureaucracy in awarding tenders and sometimes it might take a year of which the bid gets expired because the prices of materials can change within a year as well as exchange rates for the importation of materials fluctuate. The tender awarding authorities remain silent with the bids without giving feedback of either acceptance or rejection which put the bidders in a dilemma about particular projects.
Laboratory certification	Resources	Laboratory certification can be compromised between the responsible personnel and the contractors in order to cut down the costs especially when the quality materials are found very far. However, for the case of Blantyre city, the quality materials such as good gravels are found 50 Kms from the town, therefore, to cut down the costs of fuel, vehicle maintenance due to wear and tear, hence most contractors opt for compromise which involve corruption between the contractor and laboratory technician.
Work assessment	Resources	Absence of the stand-alone board that has qualified technicians to assess the work done by the contractors before handing over to the client. For example, in Tanzania there is inspectors which include a number of technicians which goes to different parts of Tanzania to assess the projects which have been completed ready to start operating and if there is any defect they are rejected and left to be redone. Moreover, the team that is involved is not the same in every year to avoid the occurrence of the corruption during the assessment.
Maintenance	Road maintenance process	In Blantyre city, the maintenance that has been taking place are reactive maintenance of which the authority makes some repairs such as patching when the potholes are in worse condition and sometimes when the road has developed several potholes. Also, most of the time the routine maintenance has been ignored, therefore, mostly the maintenance that takes place in the city is reconstruction. Regardless of the presence of routine maintenance policy, the procrastination of maintenance has been a common issue in Blantyre city.
Longevity of roads	Road maintenance process	Roads that were upgraded in the same year or within a difference of one year were in different conditions due to the difference between expected or projected and the real existing traffic volumes and axle loading, for instance, Chigumula to Mpemba Bypass Road since its upgrade had no traffic at all, Luwanda to Namilango school road had very low traffic as well as axle loading compared to the projection while the Safarao road had high traffic compared to the projected one. also, lack of maintenance of the roads that accommodate high traffic volume as well as the absence of supportive infrastructure that ensures the durability of the road such as drainage systems. However, the roads that have drainage systems, are not regularly attended, hence they are full of mud and waste thus they are not supportive anymore.



Figure 7: Showing the Safarao road condition which was upgraded in 2017
 Source: Author's capture



Figure 8: Showing Luwanda to Namilango school road condition which was upgraded in 2018
 Source: Author's capture

4.6 Comparison analysis of the findings in the region

Most of the findings in Blantyre city are the same with other parts of SADC region such as Tanzania, Zambia and Zimbabwe for instance the bidding process based on price and bureaucracy attached to it is the same for all. However, the prolonged and bureaucratic bidding process in the region has provided the loophole for the corruption to take place during the process, hence unfair bidding process, this applies to all countries in the region which lead to poor road condition (Messik, 2011; Beuran et al., 2015).

Assessment of infrastructure projects, in Tanzania there has been a new technicians' team in each year which is involved in inspection of the completed projects including the road projects while in Malawi there is no such a team that is assigned for that task.

In the region most of countries undergo reactive rather than proactive maintenance due to competing demands which many African countries face such as health, food, and water. Therefore, there has

been deter of the roads maintenance in order for the government to attend to other people needs, thus the budget which has been allocated to the maintenance activities has been diverted to other activities, this proves that the Sahoo et al (2020) findings were right which was showing that only 20% to 50% of the road maintenance allocated budget has been spent in maintenance purposes.

The whole region has got transport policy, none of the countries has a separate road transport policy, therefore, the matters concerning the roads have been briefly discussed regardless of its importance in the region. Therefore, there should be an advocacy for the separate policy for road that will be intensively discussing the road issues and how to resolve them for the sector to facilitate the development of the region and Africa in general (The United Republic of Tanzania, 2003;*Republic of Malawi National Transport Policy*, 2015).

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This final chapter of the study highlights the summary and conclusions of the research project in line with the objectives and recommendations of the research results.

5.2 Summary

This study analyzed the factors governing urban road maintenance approaches and their influence on the quality of maintenance works by using primary source of data which involve the use of questionnaire, interview checklist and observation method to answer the objectives of the study. The dependent variable was Quality of maintenance works which is ordinal in nature with categories very poor, poor, fair, good, and very good and the independent variables were resource factors, technological factors, road maintenance process factors, institutional factors, road conditions, type of maintenance and maintenance supportive factors.

The study used STATA 15 to analyze both descriptive and inferential statistics. For descriptive statistics, a frequency distribution table was used to give the general characteristics of respondents considered in this study such as their gender, ages, working experiences, and the companies or institutions they are working for. Also, the Relative Importance Index method was used to answer the first specific objective of the study.

In the case of inferential statistics chi-square test of independence was used to answer the second specific objective of the study. The results show that there are statistically significant associations between dependent variables and independent variables at a 5% level of significance. After finding the significant associations between variables then an ordered logistic regression was used to answer the third specific objective of the study. Results show that there is a statistical influence between dependent variables and independent variables.

5.3 Conclusion

To first specific objective:

Technological factors; findings reveal that the quality of maintenance works on urban roads in Blantyre city is a critical factor that needs urgent attention. The city council has made some efforts to maintain the roads, as evidenced by the majority of respondents rating the quality of maintenance works as fair, good, and very good. However, the proportion of respondents rating the quality of maintenance works as poor and very poor is significant and requires attention. The availability of

working drawings was identified as the most important factor influencing the quality of maintenance works, followed by the adequacy of pavement thickness in urban roads and the reliability of contractors' plant and equipment. Improving these technological factors will enable improvement of the quality of maintenance works on urban roads in Blantyre city.

Maintenance supportive factors; the findings suggest that investment in capacity building programs for personnel involved in maintenance works and adherence to quality assurance plans and specifications are critical factors that can significantly improve the quality of maintenance works in Blantyre city. Road maintenance agencies in the city should focus on these factors to ensure that the maintenance works are carried out to the required standards, and the road network is kept in good condition.

Institutional factors; The analysis of institutional factors that govern urban road maintenance approaches in Blantyre city highlights a significant need for improvement in the quality of maintenance works. The majority of respondents were dissatisfied with the quality of work, and factors such as unclear site instructions, insufficient consultant guidance, and inability to retain key staff were identified as contributing factors. Addressing these issues through effective strategies such as improved communication and collaboration between stakeholders and enhancing the quality of site instructions can help to improve the quality of maintenance works on urban roads in the city.

Resource factors; the findings indicate that the provision of key technical personnel at the start of the contract and the requirement of minimal supervision are the most important resource factors in ensuring quality maintenance works in Blantyre city. Therefore, city authorities and contractors should ensure that experienced and skilled personnel are available at the beginning of the contract and that maintenance teams are efficient and require minimal supervision. This would ensure that resources are utilized optimally and that maintenance works are completed to a high standard, hence, improving the overall quality of urban road maintenance in the city.

Road maintenance process factors; the study identifies site meetings, timeliness in responding to contractor requests, and adherence to quality assurance plans as the most critical road maintenance process factors that significantly influence the quality of maintenance works. These findings suggest that stakeholders should prioritize these factors to ensure the successful delivery of quality maintenance works on urban roads in Blantyre city.

Generally, the quality of maintenance works is a crucial aspect of road maintenance, and several factors influence it. This study analyzed 74 responses and found that some maintenance supportive

factors, institutional factors, technological factors, resource factors, road maintenance process factors, and the type of maintenance all have a significant impact on the quality of maintenance works.

The study has indicated that among maintenance supportive factors, adherence to quality assurance plans and specifications had a negative impact on the quality of maintenance works, while key technical personnel matching bid documents had a positive effect. Capacity building was also found to have a positive influence on the quality of maintenance works.

Regarding institutional factors, consultant guidance and the contract document providing enough information had a positive impact, while client engagement of the consultant at the beginning of the contract and consultant issuance of correct site instructions had a negative influence. Technological factors also played a role, with the availability of working drawings having a positive effect and the reliability of contractors' plant and equipment having a negative impact on the quality of maintenance works. Regarding road conditions, road edges had a positive impact, while potholes and thermal cracking had a negative effect on the quality of maintenance works.

In terms of resource factors, consultant provision of personnel with relevant experience and skills and provision of financial support had a positive effect, while the requirement of minimal supervision had a negative impact on the quality of maintenance works. Lastly, road maintenance process factors were found to have a mixed impact on the quality of maintenance works, with inspection of works by consultant key staff, timeliness in addressing client issues, and road prioritization for maintenance having a positive effect, while site meetings to discuss progress and quality of works had a negative impact.

Overall, this study provides valuable insights into the various factors that influence the quality of maintenance works, which can help road maintenance agencies and stakeholders prioritize their efforts to improve road maintenance practices.

For the second specific objective, the findings reveal that there was a statistically significant association between type of maintenance and quality of maintenance works with ($p=0.008$) at a 5 percent level of significance, but drainage and shoulder improvement have the highest association with poor quality of maintenance works, while upgrading of asphalt surface, dualization, and shoulder improvement have moderate associations with the quality of maintenance works. These results indicate that there is a need to improve the quality of maintenance works in roads, particularly for drainage and shoulder improvement.

Also, there was statistically significant association between roads conditions and quality of maintenance works with ($p=0.013$) at 5 percent level of significance. But Roads with very poor and poor drainage are more likely to have poor quality maintenance works than those with fair, good, and very good drainage. However, there is no significant association between the quality of maintenance works and other road conditions such as potholes, road edges, silting, traverse cracks, thermal cracking, distress patches, rutting, and fatigue. These results provide valuable information for policymakers and road authorities to prioritize maintenance works for specific road conditions to improve the overall quality of roads.

Generally, the study found that the type of maintenance and road conditions are significant factors influencing the quality of maintenance works in roads. Specifically, drainage and shoulder improvement were found to have the highest association with poor quality maintenance works. The results highlight the need for improving the quality of maintenance works, particularly for these areas, to enhance the overall quality of roads.

To third specific objective of the study

One of the critical maintenance supportive factors that affect the quality of work is the provision of key technical personnel matching bid documents. This finding implies that the availability of the right personnel with the right skills and experience to undertake maintenance work significantly impacts the quality of work. Additionally, the capacity building of personnel through skills improvement programs positively impacts the quality of maintenance work. The findings suggest that the ability to improve and upgrade the skills of personnel through training and development programs can enhance the quality of maintenance work.

Institutional factors also play a significant role in determining the quality of maintenance work. For instance, the client's engagement of consultants at the beginning of the contract and the consultant's guidance are essential factors in ensuring quality work. The analysis shows that consultant guidance has a significant positive impact on the quality of work. This implies that the availability of experienced and knowledgeable consultants can enhance the quality of maintenance work.

Technological factors are also critical in determining the quality of maintenance work. For instance, the availability of working drawings significantly affects the quality of work. This implies that provision of accurate and comprehensive working drawings can help enhance the quality of maintenance work. Additionally, the reliability of contractors' plants and equipment affects the quality of work. This finding suggests that the availability of reliable and well-maintained equipment is crucial in ensuring quality maintenance work.

Resource factors, such as the provision of adequate resources to the team, the provision of financial support, and the provision of key technical personnel at the start of the contract, have a positive impact on the quality of maintenance work. These findings suggest that the availability of sufficient resources, including personnel and financial support, can enhance the quality of maintenance work.

Road maintenance process factors, such as site meetings to discuss progress and quality of works and timeliness in responding to contractor requests, significantly affect the quality of maintenance work. The analysis shows that timely responses to contractor requests can enhance the quality of maintenance work.

Finally, the type of maintenance is also an important factor in determining the quality of work. Shoulder improvement has a positive impact on the quality of work while upgrading of asphalt surface has no significant impact on the quality of work.

Generally, the ordered logit model identifies several factors that significantly affect the quality of maintenance work on roads. The analysis suggests that the availability of the right personnel with the right skills and experience, the provision of accurate and comprehensive working drawings, the availability of reliable and well-maintained equipment, and the availability of sufficient resources, including personnel and financial support, are crucial in ensuring quality maintenance work. Additionally, timely responses to contractor requests and site meetings to discuss progress and quality of works are essential in enhancing the quality of maintenance work.

5.4 Recommendations

Based on the findings of the study, several recommendations can be made to improve the quality of maintenance works in urban roads in Blantyre city. These recommendations can be implemented by road maintenance agencies, contractors, and consultants involved in road maintenance activities. Here are recommendations that can be considered:

Firstly; Design supervision strategies: The study found that designing supervision strategies is crucial to ensuring the quality of maintenance works. Road maintenance agencies and contractors should develop supervision strategies that ensure that maintenance works are properly supervised and inspected. For example, road maintenance agencies can require contractors to submit daily progress reports and conduct regular site visits to ensure that maintenance works are on track and of the required standard.

Secondly; Understand the priorities of maintenance teams when allocating resources: The study found that understanding the priorities of maintenance teams is essential to ensuring the quality of

maintenance works. Road maintenance agencies and contractors should work closely with maintenance teams to understand their priorities and allocate resources accordingly. For example, if maintenance teams prioritize the maintenance of drainage systems, road maintenance agencies can allocate more resources to ensure that drainage systems are properly maintained.

Thirdly; Prioritize Road edges and the improvement of drainage and shoulders in maintenance works: The study found that prioritizing road edges and the improvement of drainage and shoulders in maintenance works is crucial to ensuring the quality of maintenance works. Road maintenance agencies and contractors should prioritize the maintenance of road edges the improvement of drainage and shoulders in maintenance works to prevent further deterioration of the road surface. For example, road maintenance agencies can allocate more resources to the maintenance of road edges to ensure that they are properly graded and compacted and implementing measures such as regular cleaning of drainage systems, ensuring proper slope gradient for effective water flow, and improving the quality of shoulder material. By improving edges, drainage and shoulder conditions, society can reduce the risk of road damage and accidents, leading to safer and more efficient road networks.

Fourthly; Ensure the availability of working drawings and emphasize on adherence to quality assurance plans and specifications: The study found that the availability of working drawings and emphasize on adherence to quality assurance plans and specifications are essential to ensuring the quality of maintenance works. Road maintenance agencies and contractors should ensure that working drawings are available and up-to-date. For example, maintenance teams should have access to working drawings that show the location of underground utilities and drainage systems. Also, should prioritize the development and implementation of quality assurance plans and specifications that meet international standards. For example,

road maintenance agencies can require contractors to submit quality assurance plans and specifications as part of the bidding process.

Fifthly; Provide consultant guidance and instructions: The study found that consultant guidance and instructions are crucial to ensuring the quality of maintenance works. Road maintenance agencies and contractors should ensure that consultants provide clear and concise guidance and instructions to contractors and maintenance workers. For example, consultants can provide detailed site instructions and clarify technical issues to ensure that maintenance works are done to the required standard.

Sixthly; Invest in capacity building: The study found that capacity building is crucial to improving the quality of maintenance works. Road maintenance agencies and contractors should invest in training programs that focus on enhancing the skills of maintenance workers, supervisors, and

consultants. For example, training on the use of modern equipment and technology, safety measures, and quality control procedures can be provided to enhance the effectiveness and efficiency of maintenance works.

Seventhly; emphasizing timeliness is also an important consideration. Addressing client issues and contractor requests in a timely manner can help to improve the quality of maintenance works. Setting timelines for responding to client issues and contractor requests and monitoring adherence to this timeliness can help to ensure that maintenance works are carried out efficiently and effectively. For instance, if a client reports a pothole or a damaged section of a road, it is important for the road maintenance agency to respond promptly to the issue. The agency can set a timeline of 24 hours to inspect the site, identify the cause of the problem, and develop a plan to fix it. The agency can then prioritize the repair work and allocate the necessary resources to complete the work within a reasonable time frame, say, 48 hours. This approach ensures that the maintenance works are carried out in a timely and efficient manner, which helps to prevent further damage and improve the safety of road users.

Eighthly; road maintenance agencies should adopt a proactive approach to maintenance works. Instead of waiting for road conditions to deteriorate before carrying out maintenance works, society can adopt a more proactive approach. This can involve implementing regular maintenance schedules to ensure that road conditions are regularly monitored and maintained. Adopting a proactive approach can help to identify and address issues before they escalate into more significant problems, thereby reducing the cost and effort required for maintenance works. Additionally, it can help to ensure that roads remain safe and efficient, leading to improved road quality and overall road user satisfaction.

Generally, the study identified several factors that significantly influence the quality of maintenance works on urban roads. The recommendations provided above can help road maintenance agencies, contractors, and consultants to improve the quality of maintenance works and ensure that they meet international standards. Investing in capacity building, emphasizing adherence to quality assurance plans and specifications, providing consultant guidance and instructions, ensuring the availability of working drawings, prioritizing road edges, understanding the priorities of maintenance teams when allocating resources, and designing supervision strategies can all lead to improved quality of maintenance works.

Also improving the quality of maintenance works in roads is essential to ensure safer and more efficient road networks. Society can significantly enhance the overall quality of roads by prioritizing the improvement of drainage and shoulders and adopting a proactive approach to maintenance works.

These recommendations can help to reduce the risk of road damage and accidents, thereby improving road user satisfaction and enhancing the overall well-being of society.

5.5 Areas for further study

Here are some recommendations for further studies on the topic of factors governing urban roads' maintenance approaches and their influence on the quality of maintenance works, based on the case of Blantyre City:

- i. **Comparative analysis:** A comparative study of Blantyre City's Road maintenance practices with other urban areas in the region or country can help identify best practices, areas of improvement, and the factors influencing the differences in maintenance practices.
- ii. **Stakeholder analysis:** Conducting a stakeholder analysis of the road maintenance sector in Blantyre City can provide insights into the roles and responsibilities of different stakeholders, their interactions, and the factors that influence their decisions and actions.
- iii. **Cost-benefit analysis:** A cost-benefit analysis of road maintenance practices in Blantyre City can help identify the economic, social, and environmental costs and benefits associated with different maintenance practices and inform decisions on resource allocation.
- iv. **Long-term impact:** A longitudinal study of the impact of maintenance practices on road quality over time can provide insights into the effectiveness and sustainability of different approaches and inform decision-making on maintenance strategies.

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APPENDICES

Appendix i: Cover letter



MUBAS
Chichiri
Blantyre 3
P/Bag 303

25th November 2022

To Whom It May Concern

Dear Sir/Madam

REFERENCE LETTER FOR MS BERTHA MWAKATOBE

The bearer of this letter, **Ms Bertha Mwakatobe**, is a postgraduate student in the Department of Mechanical Engineering at Malawi University of Business and Applied Sciences (MUBAS). She is pursuing a Master of Infrastructure Development and Management (IDM) degree programme and currently required to undertake research study in partial fulfilment of the requirements for the master's degree. She is undertaking a research on the topic '**Factors governing urban road maintenance approaches and their influence on the quality of maintenance works: A Case of Blantyre City Council.**'

The main objective of the research is to explore factors governing urban road maintenance and their influence on the quality of maintenance in the City of Blantyre. This research study will involve collecting data from stakeholders through structured and unstructured interviews and observations.

My writing is to kindly request your to support our student by appointing relevant officers she could be engaged with in the interviews. On our part, we promise to use the data responsibly for the intended academic research purpose.

I thank you in advance for the support.

Yours faithfully

Kenneth J Gondwe, PhD
Acting Coordinator IDM Programme
Senior Lecturer- Mechanical Department
Cell: 0994730531/ 0888515050

Appendix ii: Questionnaire

RESEARCHER’S INTRODUCTION

Name: Bertha F. Mwakatobe

Research Title: Factors Governing Urban Road Maintenance approaches and their Influence on the Maintenance Works. A case of Blantyre City.

Research objectives

Main objectives

To explore the factors governing urban roads maintenance approaches and their influence on quality of maintenance works in Blantyre city.

Specific objectives are to:

1. To identify factors that govern urban roads’ maintenance approaches.
2. To characterize condition of the roads that have been maintained.
3. To assess the influence of factors governing urban roads’ maintenance approaches on the quality of maintenance works

SECTION A – PARTICIPANT PARTICULARS

Please provide the information as requested below

Age:

Gender (Please tick one) 1. Male () 2. Female ()

Work Experience in years:

	Contractor’s staff	Consultant’s Staff	Roads Authority Staff	City council’s staff
Less than 5 years.....
6 - 10 years
10 years or more.....

SECTION B - QUESTIONS

To what extent do these factors govern/manage urban road maintenance?

Maintenance supportive services

Please answer questions by circling the frequency with which these maintenance supportive services are being considered. Considering the Likert scale after every question below:

- I. Is there capacity building for workers involved in road maintenance?
 1. Never
 2. Rare
 3. Occasional

- 4. Frequent
 - 5. Always
- II. Is there skills improvement among the involved staff in order to adapt to technological changes that are happening here and then?
- 1. Never
 - 2. Rare
 - 3. Occasional
 - 4. Frequent
 - 5. Always
- III. Is there an awareness provision to the community about the maintenance projects taking place in their area?
- 1. Never
 - 2. Rare
 - 3. Occasional
 - 4. Frequent
 - 5. Always

Road maintenance processes

Please answer questions by circling the level of consideration of the road maintenance processes.

The Likert scale of consideration used is as follows:

1 – Never, 2- Rare, 3 – Occasional, 4 – Frequent, 5 - Always

IV. How does road prioritization for maintenance made?

Description	Scale of Consideration				
Is it by road condition	1	2	3	4	5
Is it by the budget allocation	1	2	3	4	5
Is it according to city council plans	1	2	3	4	5
Is it by the cost incurred for the road to be maintained?	1	2	3	4	5

V. What is being considered during contract tendering?

Variable	Description	Scale of consideration				
Contract tendering related	Contractors pricing too low (PPDA decision to not to use Engineer's estimate)	1	2	3	4	5
	Contractors' pricing not realistic	1	2	3	4	5
	Contractors compromising on the quality in order to make profits	1	2	3	4	5
	Lack of database for poor-performing contractors	1	2	3	4	5
	Failure by contractors to give correct information on firms' capacity	1	2	3	4	5
	Internal self-interest by procuring entities	1	2	3	4	5
	External self-interest by procuring entities	1	2	3	4	5
	Delays by procuring entities (City council/Road Authority)	1	2	3	4	5
	Delays by the approving authorities such as PPDA, Government contracting unit, Anti-Corruption Bureau (ACB), Office of President and Cabinet (OPC) etc.	1	2	3	4	5
		Contractors are not conversant with specifications during tendering	1	2	3	4

VI. What affects the urban road maintenance project execution?

Variable	Description	Scale of consideration				
		1	2	3	4	5
Project execution	Low morale/lack of motivation by site personnel	1	2	3	4	5
	Lack of ethics	1	2	3	4	5
	Lack of sensitization on ills of corruption	1	2	3	4	5
	Lack of incentives	1	2	3	4	5
	Attitude towards own profession	1	2	3	4	5

Technology factors

Please answer questions by circling the level of agreement on the effect of technology on urban road maintenance approaches. The Likert scale of agreement used is as follows:

1. Totally disagree
2. Disagree a little
3. Neutral opinion,
4. Agree a little,
5. Totally Agree

VII. How do Labor and capital-based technology affect urban road maintenance approaches?

Variable	Description	Scale of agreement				
		1	2	3	4	5
labor and capital-based technology	Lack of qualified technical personnel among contractors	1	2	3	4	5
	Lack of qualified technical personnel in consultancies	1	2	3	4	5
	Lack of qualified technical personnel in the Road Authority or City council	1	2	3	4	5
	Failure by contractors to employ engineers	1	2	3	4	5
	Failure by consultants to employ engineers	1	2	3	4	5
	Non-availability of consultant staff on site	1	2	3	4	5

	Absence of importation of expertise from developed countries to work with indigenous experts for the purpose of impartation of advanced technology.	1	2	3	4	5
	Lack of advanced equipment for projects execution	1	2	3	4	5
	Lack of investment in research and development	1	2	3	4	5

Please answer questions VIII, IX, X, XI, and XII by circling the level of truth of how below mentioned factors have impact on urban road maintenance approaches. The Likert scale of truth used is as follows:

1. Mostly untrue, 2. Somewhat untrue, 3. Can't say true or false, 4. Somewhat true, 5. Mostly true

Resources/Assets factor

VIII. What are the effects of physical material resources in governing urban road maintenance approaches?

Variable	Description	Scale of truth				
Physical Material Resource	Suitable material not available	1	2	3	4	5
	Suitable material available at very long distances	1	2	3	4	5
	Available material not meeting specifications	1	2	3	4	5
	Lack of knowledge in stabilizing proportions and procedures	1	2	3	4	5
	Available material being sold at inflated prices	1	2	3	4	5

IX. What are the financial impacts on urban road maintenance approaches?

Variable	Description	Scale of truth				
Financial related	Untimely response from the Road Fund administration	1	2	3	4	5

	Bureaucracy in securing funds for urban road maintenance	1	2	3	4	5
	Lack of promising sources of funds to finance the urban road maintenance	1	2	3	4	5
	Lack of ability to predict inflation in order to plan the budget accordingly.	1	2	3	4	5
	Delay of finance lead to budget failure due to inflation that takes place between the budget plan and the fund securing time.	1	2	3	4	5

Institutional factors

X. How does site management affect the governing/ administration of urban road maintenance?

Variable	Description	Scale of Truth				
Site management	Most laboratories use old equipment in the testing of materials	1	2	3	4	5
	Lack of proper monitoring by supervising staff	1	2	3	4	5
	Lack of expertise in the interpretation of results	1	2	3	4	5
	Lack of own laboratory by the client for checking results	1	2	3	4	5
	Theft of construction materials on site	1	2	3	4	5
	Absence of monitoring guidelines for consultant's site personnel	1	2	3	4	5
	Lack of contractors with independent Labs	1	2	3	4	5

XI. How does the organization set up impact the urban road maintenance?

Variable	Description	Scale of Truth				
Organization set up	Lack of defined responsibilities between City Council and Road Authority	1	2	3	4	5
	Lack of defined working boundaries City Council and Road Authority	1	2	3	4	5
	Lack of delegation of power	1	2	3	4	5
	Lack of communication among stakeholders	1	2	3	4	5

XII. How do the Legal and policy support impact urban road maintenance?

Variable	Description	Scale of Truth				
Legal and policy support	Lack of laws that address road maintenance issues	1	2	3	4	5
	Absence of strict measures against the corrupt staff	1	2	3	4	5
	Lack of strong corruption evidence to sue the corrupt contractors	1	2	3	4	5
	Lack of roads individual policy leads to the poor urban road maintenance.	1	2	3	4	5
	lack of seriousness of lawyers in observing the contracts signing on assuring the accountability for any unethical conducts during the project implementation.	1	2	3	4	5

XIII. Comments

Please provide any general comments and suggestions on how the above factors govern/administrate urban road maintenance.

Appendix iii: Interview checklist for the client

RESEARCHER'S INTRODUCTION

Name: Bertha F. Mwakatobe
Research Title: Factors Governing Urban Road Maintenance approaches and their Influence on the Maintenance Works. A case of Blantyre City.
Research objectives
Main objectives
 To explore the factors governing urban roads maintenance approaches and their influence on quality of maintenance works in Blantyre city.
Specific objectives are to:

1. To identify factors that govern urban roads' maintenance approaches.
2. To characterize condition of the roads that have been maintained.
3. To assess the influence of factors governing urban roads' maintenance approaches on the quality of maintenance works

SECTION A – PARTICIPANT PARTICULARS

Please provide the information as requested below

Age:

Gender (Please tick one) 1. Male () 2. Female ()

Work Experience in years:

Roads Authority Staff City council's staff

Less than 5 years.....
 6 - 10 years
 10 years or more.....

INTERVIEW QUESTIONS

Factors that govern urban roads' maintenance approaches and their influence on the quality of maintenance works.

1. Kindly rate your answers according to the given Likert scale by ticking (√)

A. Does the consultant provide adequate resources to his team?
 1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
 5. Totally Agree()

B. Does the consultant provide personnel with relevant qualifications and adequate experience?
 1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
 5. Totally Agree()

C. Does the consultant address issues from the client within a reasonable time?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

D. Does the consultant key staff inspect the works regularly?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

E. Does the consultant respond to the contractor's request promptly?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

F. Does the contractor submit Quality Management Plans?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

G. Does the contractor require minimal supervision?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

H. Does the contractor adhere to Quality Assurance plans and specifications?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

I. Is the contractor's work accepted the first time?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

J. Is the thickness of pavement in urban roads adequate?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

K. Is the increase in the intensity of traffic affect urban road maintenance?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

2. Explanation questions

Factors that govern urban roads' maintenance

A. Which factors need special attention for the governing of urban road maintenance to be easier among road maintenance stakeholders?

B. How do you define work boundaries/responsibilities between the City council and Road Authority in dealing with urban road maintenance management?

C. What type of urban road maintenance projects does the road fund administration fund?

Characterization of the condition of maintained roads

D. Which institutions are responsible for routine maintenance in urban roads such as sweeping of the road, cutting the grasses and minor reshaping of ditches?

E. What is the interval considered for periodic maintenance to take place in Blantyre city?

F. What is the interval considered for rehabilitation/reconstruction to take place in Blantyre city?

Appendix iv: Interview checklist for consultant’s staff

<p>RESEARCHER’S INTRODUCTION Name: Bertha F. Mwakatobe Research Title: Factors Governing Urban Road Maintenance approaches and their Influence on the Maintenance Works. A case of Blantyre City. Research objectives Main objectives To explore the factors governing urban roads maintenance approaches and their influence on quality of maintenance works in Blantyre city. Specific objectives are to: 1. To identify factors that govern urban roads’ maintenance approaches. 2. To characterize condition of the roads that have been maintained. 3. To assess the influence of factors governing urban roads’ maintenance approaches on the quality of maintenance works</p>
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SECTION A – PARTICIPANT PARTICULARS

Please provide the information as requested below

Age:

Gender (Please tick one) 1. Male () 2. Female ()

Work Experience in years:

Consultant’s staff

Less than 5 years.....

6 - 10 years

10 years or more.....

INTERVIEW QUESTIONS

Factors that govern urban roads’ maintenance

Kindly rate your answers according to the given Likert scale by ticking (√)

L. Do the contractors provide key technical personnel at the start of the contract?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

M. Are the key technical personnel the ones provided for in the bid document?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

N. Are the key personnel able to understand technical issues on site?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

O. Is the contractor's work accepted the first time?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

P. Do contractors adhere to Quality Assurance Plans?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

Q. Are contractors able to retain key staff for the duration of the contract?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

R. Do contractors require minimal supervision?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

S. Are the contractors plant and equipment reliable?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()
5. Totally Agree()

T. Do contractors submit a method statement before the commencement of works

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

U. Which factors need special attention for the governing of urban road maintenance to be easier among road maintenance stakeholders?

Appendix v: Interview checklist for contractor’s staff

<p>RESEARCHER’S INTRODUCTION Name: Bertha F. Mwakatobe Research Title: Factors Governing Urban Road Maintenance and their Influence on the Maintenance Works. A case of Blantyre City. Research objectives Main objectives To explore the factors governing urban roads maintenance and their influence on quality of maintenance works in Blantyre city. Specific objectives are to: 1. To identify factors that govern urban roads’ maintenance. 2. To characterize condition of the roads that have been maintained. 3. To assess the influence of factors governing urban roads’ maintenance on the quality of maintenance works</p>
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SECTION A – PARTICIPANT PARTICULARS

Please provide the information as requested below

Age:

Gender (Please tick one) 1. Male () 2. Female ()

Work Experience in years:

Contractor’s staff

Less than 5 years.....

6 - 10 years

10 years or more.....

INTERVIEW QUESTIONS

Factors that govern urban roads’ maintenance

Kindly rate your answers according to the given Likert scale by ticking (√)

V. Does the contract document provide enough information to be used in project execution?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

W. Does the client engage a consultant at the beginning of the contract?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

X. Does the consultant's Engineer visit the site often?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

Y. Does the consultant respond to issues in good time?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

Z. Does the consultant give guidance when asked?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

AA. Do you have site meetings to discuss progress and quality of works?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

BB. Does the consultant provide working drawings / Works Orders in good time?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

CC. Does the consultant provide personnel with relevant experience and skills?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

DD. Does the consultant provide adequate resources to his personnel?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

EE. Does the consultant issue correct site instructions?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

FF. Do the consultants' inspectors stay on site 100%?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

GG. Does the client's representative visit the site regularly?

1. Totally disagree () 2. Disagree a little () 3. Neutral opinion () 4. Agree a little ()

5. Totally Agree()

HH. Which factors need special attention for the governing of urban road maintenance to be easier among road maintenance stakeholders?

Appendix vi: Observation checklist

Question 2. Grade using

1=Very Good, 2=Good, 3=Fair, 4=Poor, 5=Very poor

Name of the road	Current Condition of the road								
	Drainage	Potholes	Road edges	Siltin g	Traverse cracks	Thermal crackin g	Distressed patches	Rutting	Fatigue crackin g

**Appendix VII: List of consultants, consultants and roads
2016 TO 2021**

S/N	CONTRACTOR NAME	CONTACT	LOCATION OF THE COMPANY	ROAD NAME	YEAR OF MAINTENANCE	CONTRACT DESCRIPTION
1.	Fargo Limited	0888832775		Chilomoni ring road	2016	Upgrading to Asphalt Surfacing of Chilomoni Ring Road (3.57km)
				Mugabe Highway to Mpingwe road	2016	Upgrading to Asphalt Surfacing off Mugabe Highway to Mpingwe Road (4km)
2.	WC Construction	0884514476		Land Rover (Chirimba-level crossing (Magalasi)	2016	Upgrading of Land Rover (Chirimba - Level Crossing (Magalasi) Road (1.2km)
				Chinseu to Magalasi	2016	Upgrading to Asphalt Surfacing of Chinseu to Magalasi Road (0.936km)
3.	Einstein Construction	0888839733		Living waters to Zion road	2016	Upgrading to Asphalt Surfacing of Living Waters to Zion Road (2.1km)
				Living waters to Zion road	2016	Upgrading to Asphalt Surfacing of Living Waters to Zion Road (0.43km)
4.	Hema Construction	0999951283		Angelo Goveya to Manje road	2016	Upgrading to Asphalt surfacing of Angelo Goveya to Manje Road (4.160km)

				Angelo Goveya to Manje road	2016	Upgrading of Angelo Goveya to Manje Road (Extra 1.18km)
				Namiyango Ring Road	2017	Upgrading to Asphalt Surfacing of Namiyango Ring Road (2.2km)
5.	Ufulu Electrical			CI to Green Corner	2016	Supply, Installation and Commissioning of Street Lighting System (CI to Green Corner) In Blantyre City - Lot 3
				Mount Soche to MBTS and CI Church	2017	Supply, Installation and Commissioning of Street Lighting System along Victoria Avenue (From Mount Soche to MBTS and CI Church) In Blantyre City - Lot 4
6.	Tahit Networks	0998474260		Safarao Road	2017	Upgrading to Asphalt Surfacing of Safarao Road (1.3km)
				Bangwe to St Patricks Road	2017	Upgrading to Asphalt Surfacing of Bangwe to St Patricks Road (3km)
				Mbayani Market to Tam Tam	2017	Upgrading to Asphalt Surface of Mbayani Market to Tam Tam (2.7 km)
				Chigumula to Mpemba Bypass Road	2017	Upgrading to Asphalt Surface of Chigumula to Mpemba Bypass road in Blantyre City (13km)

7.	EPAC			Ndirande Ring Road	2016	Supply, Installation and Commissioning of Street Lighting System of Ndirande Ring Road (5Km)
				Blantyre Girls to Ndirande Flats via Chinseu joining Makata Road	2017	Supply, Installation and Commissioning of Street Lighting System along Victoria Avenue (From Blantyre Girls to Ndirande Flats via Chinseu joining Makata Road) In Blantyre City - Lot 3 (3Km)
8.	High Performance Capabilities Africa (HPC)			Masauko Chipembere Highway	2016	Supply, Installation and Commissioning of Street Lighting System along Masauko Chipembere Highway (8Km)
9.	CAS Civil Contractors	0888871508		Masauko Chipembere Highway	2016	Construction and Installation of Concrete Poles with Base along Masauko Chipembere Highway (8km)
				Chilobwe- Stella Maris Road	2021	Construction of Chilobwe- Stella Maris Road in Blantyre City-Lot 6
10.	MDF	0999316546		Zalewa Road from Kandodo Corner Shop to Kameza	2017	Shoulders and Drainage Improvement Works along Zalewa Road from Kandodo Corner Shop to Kameza (8.2 Km)

				Moi Road	2017	Shoulder reconditioning and surface resealing of Moi Road
				Naperi Bridge	2017	Upgrading of Naperi Bridge to double Lane Bridge from single lane
				Kasungu Crescent Footpaths	2017	Kasungu Crescent Footpaths
11.	PLEM CONSTRUCTION	0999742582		Mtenje Parish to Club Banana Road And Luwanda to Namilango School Road	2018	UPGRADING TO ASPHALT SURFACE OF TWO ROADS IN BLANTYRE CITY - LOT 2 (Mtenje Parish to Club Banana Road (7.1 Km) and Luwanda to Namilango School Road (0.6 Km))
12.	MOTA-ENGIL	0999842398		Clock Tower to Kameza Roundabout Road	2018	Dualisation of Clock Tower to Kameza Roundabout Road in Blantyre City (8.0Km)
				Chinseu to Majiga	2018	Upgrading to Asphalt Surface of Chinseu to Majiga (2.1km)
13.	Dika Construction Company	0888121544			2018	Upgrading to Asphalt Surface of Sectional (Residential) Roads (1.9Km) and Construction of Drainage Systems along Various Roads (5.88Km)
				MITSIDI ROAD NEAR LUMBIRA PRIMARY SCHOOL	2019	EMERGENCY CIVIL WORKS ALONG MITSIDI ROAD

						NEAR LUMBIRA PRIMARY SCHOOL
				BETHEL ON KAPENI ROAD	2019	EMERGENCY CIVIL WORKS FOR CONSTRUCTION OF A BOX CULVERT AT BETHEL ON KAPENI ROAD
				SOMANJE ON CHILOBWE	2020	EMERGENCY CIVIL WORKS FOR CONSTRUCTION OF A BOX CULVERT AT SOMANJE ON CHILOBWE
CONSULTANTS						
1.	Royal Associates	999325382			2017-2020	
2.	L Gravam	996618183			2019 - 2021	
3.	Pamodzi Consulting Limited	999830092			2021 - 2022	