



JIMMA UNIVERSITY
JIMMA INSTITUTE OF TECHNOLOGY
SCHOOL OF GRADUATE STUDIES
FACULTY OF CIVIL AND ENVIRONMENTAL ENGINEERING
CONSTRUCTION ENGINEERING AND MANAGEMENT CHAIR

ASSESSMENT OF ASPHALT ROAD MAINTENANCE MANAGEMENT
PRACTICE: IN THE CASE OF JIMMA TOWN

A Thesis submitted to the School of Graduate Studies, Jimma University, Jimma
Institute of Technology, Faculty of Civil and Environmental Engineering in Partial
Fulfillment of the Requirements for the Degree Master of Science in Construction
Engineering and Management

By

Asrat Eshetu Teshome

August, 2024

Jimma, Ethiopia

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Advisor: Eng. MAMUYE BUSIER (Assistant Professor)		
NAME	SIGNATURE	DATE

Co - Advisor: Engr. FISTUM ALEMAYEHU		
NAME	SIGNATURE	DATE

August, 2024

Jimma, Ethiopia

DECLARATION

I declare that this research entitled “Assessment of Asphalt Road Maintenance Management Practice: In The Case Of Jimma Town” is my original work and has not been submitted as a requirement for the award of any degree in Jimma University or elsewhere.

Asrat Eshetu Teshome

NAME

SIGNATURE

DATE

As research Advisor, I hereby certify that I have read and evaluated this research prepared under my guidance by Asrat Eshetu Teshome entitled “ASSESSMENT OF ASPHALT ROAD MAINTENANCE MANAGEMENT PRACTICE: IN THE CASE OF JIMMA TOWN” and recommend and would be accepted as a fulfilling requirement for the Degree Master of Science in Construction Engineering and Management.

Advisor: Eng. MAMUYE BUSIER (Assistant Professor)

NAME

SIGNATURE

DATE

Co - Advisor: Engr. FISTUM ALEMAYEHU

NAME

SIGNATURE

DATE

ABSTRACT

Road transport is an important sector of economic activity, especially in developing countries, where it plays an essential role in providing access to health, education, agricultural inputs and extension services. Due to increased and continued traffic crossing, pavements are more easily damaged and distressed. Inadequate maintenance, overloading, bad road design, lack of a road asset management system, delayed maintenance, and scarcity of materials are the primary issues with asphalt road maintenance management.

The aim of the study was to examine the asphalt road's maintenance management practices, identify factors that affect asphalt road maintenance management and categorize the approaches to maintaining the asphalt road in Jimma Town. The scope of the research was to assess asphalt road maintenance management practices. The study covered Ten kilometers.

According to the assessment, most commonly road failure were caused by so many factors from them bad drainage condition and poor road-use culture were ranked firstly with RII value of 0.788 followed by poor maintenance culture with RII value 0.764 the most common causes of asphalt road failures in the case study area.

On asphalt road construction the entrance of water to the other layers of the road leads the surface strength to affected by shrinkage and swelling. And also if the overlapping through centerline of the pavement because of the void that surface become fail so when we saw the result it indicated that asphalt roads faces so many defects because of different factors from those defects on the study area Potholes and Shovels, Longitudinal cracking and Raveling (very porous asphalt) are the most common defects present ranked from first to third respectively with RII values 0.752, 0.748 and 0.712.

The factors that affect road maintenance in the case study area were Maintenance Age, Availability of Drainage System and Road Surface Condition ranked from first to third with RII value of 0.796, 0.768 and 0.720 respectively. This indicates that, typically, pavement deteriorates at an ever-increasing rate: at first, very few distresses are present, and pavement stays in relatively good Condition, but as it ages, more distresses develop, with each distress making it easier for subsequent distresses to develop. Also, the quality of the road surface is critical to ensure the safety of drivers and other road users.

From the assessed methods, the most commonly performed applicable types in the study area are by removing and replacing at least a portion or all part of the road layer in order to restore areas of deterioration that is full-depth crack repair ranked firstly, followed with pothole patching, crack filling, and crack repair.

Keywords: Asphalt road, Road Maintenance, Road Maintenance Management

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TABLE OF CONTENTS

DECLARATION	I
ABSTRACT	II
ACKNOWLEDGMENT	III
TABLE OF CONTENTS	IV
LIST OF TABLES	VII
LIST OF FIGURES	VIII
ABBREVIATION	IX
CHAPTER ONE	1
1. INTRODUCTION	1
1.1. Background	1
1.2 Statement of the Problem.....	2
1.3 Research Questions	3
1.4 Objectives of the Study	3
1.4.1 General Objective	3
1.4.2 Specific Objectives.	3
1.5 Scope of the Study	3
1.6 Significance of the Study	4
CHAPTER TWO	5
2. LITERATURE REVIEW	5
2.1 What is road pavement failure?	5
2.1.1 Causes of Road Deterioration and Failures	5
2.1.2 Types of Asphalt Road Defects and Failures.....	8
2.2 Concepts of Road Maintenance	10
2.3. Importance of Road maintenance	11
2.3 Effects of Poor Road Maintenance	13
2.4 Types of Road Maintenance	14
2.4.1 Routine Maintenance	14

2.4.2 Periodic Maintenance.....	14
2.4.3 Urgent Maintenance.....	15
2.4.4 Preventive Maintenance.....	15
2.4.5 Corrective Maintenance	15
2.4.6 Emergency Maintenance.....	15
2.5 Road maintenance management	17
2.6 Factors that affect asphalt road maintenance management.....	19
2.7 The methods to maintain the asphalt road	20
2.7.1 Pothole Repair.....	20
2.7.2 Crack Sealing.....	20
2.7.3 Seal Coating.....	21
2.7.4 Asphalt Milling and Asphalt Grinding	21
2.7.5 Asphalt Patching.....	21
2.7.6 Skin Patching	22
2.7.7 Crack Sealing.....	22
2.7.8 Street Planer Patching.....	22
2.7.9 Chip Sealing.....	22
2.7.10 Full-Depth Recycling.....	24
2.7.11 Partial Depth Reconstruction	24
2.7.12 Full Reconstruction.....	24
CHAPTER THREE	25
3. RESEARCH METHODOLOGY	25
3.1 Research Area	25
3.2 Research Design.....	25
3.3 Study Variables	26
3.3.1 Dependent Variable	26
3.3.2 Independent Variables	26
3.4 Population and Sampling Method.....	26
3.5 Sources of Data and Collection Procedure	26

3.6 Data Presentation and Analysis	26
CHAPTER FOUR.....	28
4. RESULTS AND DISCUSSION	28
4.1 Basic Information about the Respondents	28
4.2 Respondent's Position, Education Level and Level of Experience	28
4.3 Asphalt Road Maintenance Practice	29
4.3.1 Asphalt road construction and quality of materials	29
4.3.2 Effects of qualified and skilled Labour on Asphalt road maintenance	29
4.3.3 Negative Impacts of poor ARM Management on daily activities of Users.....	30
4.3.4 Effects of Roadway facilities on Road maintenance management.....	31
4.4 The most common causes of Road failure.....	31
4.5 failures or Defect present on asphalt Road	32
4.7 The main factors that affect asphalt road maintenance.....	33
4.8 Methods of Road Maintenance	34
4.9 Recommended Road Maintenance Management Strategies.....	36
CHAPTER FIVE	37
5. CONCLUSIONS AND RECOMMENDATION	37
5.1 Conclusions.....	37
5.2 Recommendation	39
REFERENCE.....	40
APPENDIX A.....	44
APPENDIX B	48

LIST OF TABLES

Table 2-1 Causes of Road Deterioration and Failures	7
Table 2-2 Types of Road Maintenance	17
Table 2-3 Asphalt Maintenance Techniques (Arshad et al., 2022).....	21
Table 4-1 Respondents' Information	28

LIST OF FIGURES

Figure 2-1 Types of Road Maintenance.....	16
Figure 2-2 Typical flow chart of road maintenance management and planning (Sahoo, 2022)...	18
Figure 3-1 Study Area.....	25
Figure 4-1 Position of the Respondents in the Projects	28
Figure 4-2 Asphalt Road Construction and Cultures of Asphalt Road Maintenance in Study Area	29
Figure 4-3 Effects of qualified and skilled Labour on Asphalt road maintenance	30
Figure 4-4 Negative impacts of poor ARM management on the daily activities of users.....	30
Figure 4-5 Effects of Road facilities on Road maintenance management.....	31
Figure 4-6 The most common causes of Road failure	32
Figure 4-7 Failures or Defect present on asphalt Road.....	33
Figure 4-8 shows the main factors that affect asphalt road maintenance	34
Figure 4-10 Recommended Road maintenance management strategies.....	36

ABBREVIATION

AASHTO)	American Association of State Highway and Transportation Officials
ARM	Asphalt Road Maintenance
ASCE	American Society of Civil Engineers
CII	Construction Industry Institute
CIRIA	Construction Industry Research and Information Association
FDR	Full depth recycling
JIT	Jimma Institute of Technology
OM	Operation and maintenance
PMS	Pavement Management System
RII	Relative Importance Index

CHAPTER ONE

1. INTRODUCTION

1.1. Background

Road transport is an important sector of economic activity, especially in developing countries, where it plays an essential role in marketing agricultural products and providing access to health, education, agricultural inputs and extension services. The impact of road transportation in developed regions is also significant (World Bank, 2021). If the pavement has been well-maintained and there are no significant base failures, it may be possible to do an asphalt overlay or hot-in-place recycles. (Rajgor, et al., 2019).

Pavement maintenance is a strategy adopted to maintain, recover, or improve the functionality of the pavement surface. It is applied to road pavements with acceptable structural strength and surface deterioration. When it comes to the maintenance of road assets, determining the contradiction between the financial burden of maintenance and the level of service of highways is a major preeminence (Kilic et al., 2021). Regular maintenance can slow the rate at which a pavement deteriorates from traffic loads and climatic conditions (Thomas et al., 2019).

The Government of Ethiopia has given significant attention to the road sector, considering its immense impact on the socio-economic development of the country as road transport reaches the majority of the people (Yilma et al., 2019). Road coverage is the main part of the country's development and facilitates smooth interaction throughout the country. In measuring the country's development rate, international organizations put a grade on the coverage quality of roads. Roads are the major asset of any country, and to conserve maintenance is essential. The delay in maintenance works can lead the road to the stage of expensive rehabilitation and reconstruction (Mulmi, 2016).

A road pavement must fulfill two basic functions, which are structural and functional requirements. In terms of structural performance, the pavement must be of sufficient thickness and be composed of materials of sufficient quality to be able to withstand the various loads that are applied to it by heavy vehicles. In terms of functional performance, the pavement must have a good riding quality to ensure comfortable travel for the road user, and the surface must have adequate drainage, skid resistance, reflectivity and line markings to ensure safe travel (Arshad et al., 2022).

A pavement starts to deteriorate at an increasing rate once a road is opened to traffic. Initially, few distresses are present, and the pavement stays in relatively good Condition. Over time, as more traffic passes through it and as it ages due to the environment, more distress develops, making it easier for subsequent damage to occur. The timing of maintenance and rehabilitation actions can greatly influence their effectiveness and cost as well as overall pavement life. Once a pavement needs treatment, the sooner maintenance or rehabilitation activity is undertaken, the more cost-effective it will be (Yilma et al., 2019). Pavement maintenance is the routine work performed to keep a pavement, which is exposed to normal conditions of traffic and nature as near to its original Condition as possible. Because destructive environmental and traffic forces are constantly at work, all pavements require maintenance. Cracks, holes, depressions, and other types of distress are the visible evidence of pavement wear. In urban areas, utility cuts and repairs are major contributors to the need for pavement maintenance (Sultana et al., 2013).

1.2 Statement of the Problem

Road coverage is the main part of the country's development and facilitates smooth interaction throughout the country (Kesto et al., 2022). The quality of infrastructure impacts the quality of life of the people living in cities. The problem of traffic flow impacts the transportation infrastructures substantially. Recently, cities have been expanding rapidly, and the need to use motor vehicles is growing. As the number of vehicles increases in the existing traffic infrastructure, new problems emerge (Thomas et al., 2019). In the last few decades, the increasing traffic load has sped up the deterioration and ageing of pavements. Worn-out pavements lead to environmental, financial, and social issues, such as high expenses for vehicle repair, traffic delays, time delays, accidents, and fuel emissions (Kilic et al., 2021).

Accordingly, meeting the increasing requirement for road system service is critical to the country's economic development. The Government gives the highest priority to arterial road improvement. Roads are deteriorated largely, and they require both paving and improving vertical alignment to cope with floods. Proper evaluation of pavement is required prior to deciding the maintenance and rehabilitation strategies for the road (Yilma et al., 2019). The quality of infrastructure impacts the quality of life of the people living in cities. The problems of traffic flow impact the transportation infrastructures substantially.

Recently, cities have been expanding rapidly, and the need to use motor vehicles is growing. As the number of vehicles increases in the existing traffic infrastructure, new problems emerge (Kilic et al., 2021).

Early detection and repair of minor defects are among the most important activities of road maintenance crews. In their first stages, cracks and other surface breaks are almost unnoticeable, but they may develop into serious defects if not soon repaired. Open joints and cracks allow water to enter the subgrade and lead to pumping and faulting with resultant structural failure (Arshad et al., 2022).

Due to increased and continued traffic crossing, pavements are more easily damaged and distressed. The main problems associated with asphalt road maintenance management are inadequate maintenance, overloading, poor road design, an absence of a road asset management system, untimely maintenance, and a lack of construction materials.

1.3 Research Questions

1. What is the current practice of Asphalt road maintenance?
2. What are the factors that affect asphalt road maintenance management?
3. What are the approaches to maintaining asphalt roads?

1.4 Objectives of the Study

1.4.1 General Objective

The general objective of this research was to assess asphalt road maintenance management practices in the case of Jimma Town.

1.4.2 Specific Objectives.

- a. To examine the current practice of road maintenance management practices in Jimma Town.
- b. To identify factors that affect asphalt road maintenance management in Jimma Town
- c. To categorize the approaches to maintaining the asphalt road in Jimma Town.

1.5 Scope of the Study

The scope of the research was assessed maintenance management practices and factors affecting asphalt road maintenance and identifies approaches to maintain the asphalt road in Jimma Town.

1.6 Significance of the Study

Poorly maintained roads constrain mobility, significantly raise vehicle operating costs, increase accident rates and their associated human and property costs, and aggravate isolation, poverty, poor health, and illiteracy in urban communities. Pavement maintenance is a strategy adopted to maintain, recover, or improve the functionality of the pavement surface. It is applied to road pavements with acceptable structural strength and surface deterioration. So, this study is significant to assess more about the issue and is important to recommend the concerned bodies.

CHAPTER TWO

2. LITERATURE REVIEW

2.1 What is road pavement failure?

Road pavement failure refers to the deterioration and degradation of a road's surface and underlying layers, resulting in compromised structural integrity and functionality. It encompasses various distresses and defects that make the road unsafe or unsuitable for smooth transportation.

2.1.1 Causes of Road Deterioration and Failures

The main causes of road deterioration resulting in failures of road pavement, according to (Otheke, 2019), are as follows-

- The actions of traffic and heavy goods vehicles have the greatest detrimental effects. The predominant cause of road deterioration is due to vertical deformation in the wheels of trucks. Every vehicle that passes over a pavement induces transient strains in the pavement layers and the subgrade.
- The action of weather, rain and heat.
- Usable ground conditions and poor drainage.
- Poor construction activities and methods.
- Post-construction activities like digging trenches along the road, dumping building materials and other obstructions in the road, and uncontrolled street trading.
- Poor workmanship.
- Inadequate maintenance.

(Burningham, et al., 2015) Here are some of the main reasons a road may become seriously damaged in the first place.

Heavy Traffic

Roads are intended to make driving easier. However, heavier vehicles can also put much pressure on the surface itself. This consistent stress can cause weaknesses to emerge in the road surface, which, as a result, causes cracking. This puts the cracked surface at risk of breaking off entirely and forming a pothole.

Water

Water is one of the biggest causes of damage to road surfaces and is the reason why tarmac seals and pavement preservation are needed to avoid significant damage to the road surface.

If the surface is cracked, which can happen over time or as the result of particularly heavy pressures on the road, water seeps in and weakens the base course layer, which causes depressions.

What is often an issue is that if that base layer is damaged, the road will continually have problems with traffic load and be more vulnerable to cracks and potholes until the road is completely repaved.

Sunlight

Asphalt as a surface consists of a binder that sticks the rock, aggregate, and sand that make up the surface together. Over a long time, ultraviolet rays can dissolve this binder, causing the road to more closely resemble a loose arrangement of gravel than a road. Once the road starts

Oxidation

Have you ever wondered why road surfaces are black when they are new and gradually become lighter grey as they age? The reason for this is exposure to oxygen, which gradually breaks down the asphalt layer and causes the surface to be less flexible.

Eventually, the tarmac layer is closer to concrete than its original state and is more susceptible to being cracked under heavy loads.

The Earth Itself

Despite how it may feel, the earth is consistently moving on tectonic plates, and this, along with earthquakes and other natural phenomena, can cause the surface under a road to shift and settle over time, which in itself can cause cracks, sinkholes and other major damage.

According to (Olabisi, 2022), the main causes of road deterioration resulting in failures of road pavement are as follows:

- Traffic congestion
- The action of weather, rain and heat.
- Usable ground conditions and poor drainage.
- Poor construction activities and methods.
- Post-construction activities like digging trenches along the road
- Poor workmanship.
- Inadequate maintenance.

According to (Monirul, 2022), factors affecting operation and maintenance cost budget in highway projects are:-

Table 2-1 Causes of Road Deterioration and Failures

➤ Poor Road Design ➤ Lack of Road Asset Management System ➤ Lack of Sufficient Construction Materials ➤ Poor Construction Quality ➤ Materials Selection ➤ Lack of Qualified Staff ➤ Lack of Institutional Capacity ➤ Lack of Strong Private Sector Participation ➤ Lack of Strong Governance ➤ Risk of Corruption ➤ Lack of Quality Contractor ➤ Lack of Advanced Technology ➤	➤ Lack of Strong Governance ➤ Risk of Corruption ➤ Lack of Quality Contractor ➤ Lack of Advanced Technology ➤ Workmanship ➤ Lack of Communication and collaboration skills ➤ Under estimating the impacts of operation and maintenance cost ➤ Lack of understanding of the maintenance process, design and construction ➤ Initial and operational fund unavailability ➤ high maintenance cost due to lower maintenance quality ➤ Modern highway construction and technology ➤ Weather and Climate Conditions ➤ Lack of Qualified Staff ➤ Lack of Institutional Capacity ➤ Lack of Strong Private Sector Participation
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2.1.2 Types of Asphalt Road Defects and Failures

As stated (Priyanka, 2019), Pavement maintenance can be described by two different categories:

- Preventive maintenance: Activities that prevent or reduce further damage to the pavement.
- Structural maintenance: Activities that repair or improve the structural integrity of the pavement.
- Preventive maintenance activities include:
 - ✓ Pavement sealers or seal coats
 - ✓ Crack filling and sealing
 - ✓ Surface treatments.
- Structural maintenance activities include:
 - ✓ Pothole filling
 - ✓ Patching
 - ✓ Overlays
 - ✓ Reconstruction.

According to (CCPIC, 2021), Asphalt Road Defects and Failures are broadly categorized as follows.

A. Alligator Crack

Alligator cracking is a load-associated structural failure. The failure can be due to weakness in the surface, base or subgrade; a surface or base that is too thin; poor drainage; or the combination of all three. It often starts in the wheel path as longitudinal cracking and ends up as alligator cracking after severe distress.

This is a very common type of asphalt pavement failure. It refers to a surface damaged in a way that the cracks form a pattern that looks like **reptile scales**. This is the most serious issue that can harm your asphalt surface. It is caused by:

- Weak surface, base, or sub-base
- Thin surface or base
- Poor drainage

B. Edge Cracks

Edge Cracks travel along the inside edge of a pavement surface within one or two feet. The most common cause for this type of Crack is poor drainage conditions and lack of support at the pavement edge.

Edge cracking is a pavement distress which frequently occurs on narrow pavements. This distress can be started by shrinkage of the asphalt at the edge of the pavement. Edge load tend to be the cause of these types of cracking or failures. Edge cracks causes are:

- Lack of lateral support
- Settlement of underlying material
- Shrinkage of soil drying out

C. Pot Hole

Potholes are the result of moisture infiltration and usually the result of untreated alligator cracking. As alligator cracking becomes severe, the interconnected cracks create small chunks of pavement, which can be dislodged as vehicles drive over them. The remaining hole after the pavement chunk is dislodged is called a pothole. Potholes can be formed through the regular water seeping inside the asphalt surface. When water expands all the way from the sub-base, then it will form a large hole that will spread over time. Major reasons why potholes occur:

- Weak pavement, surface, base, or sub-grade
- Thin surface
- Poor drainage

D. Asphalt Depression

Depressions are localized pavement surface areas with slightly lower elevations than the surrounding pavement. Depressions are very noticeable after rain when they fill with water. Depressions are the small, distressed areas. Their height will be slightly lower than the surrounding areas. Depressions should be repaired by removing the affected pavement, digging out, and then replacing the area of the poor subgrade. It can be caused by:

- Consolidation of sub-grade
- Poor construction
- Poor drainage

E. Rutting

Ruts in asphalt pavements are channelized depressions in the wheel-tracks. Rutting results from consolidation or lateral movement of any of the pavement layers or the subgrade under traffic. It is caused by insufficient pavement thickness, lack of compaction of the asphalt, stone base or soil, weak asphalt mixes, or moisture infiltration.

Ruts in asphalt pavements are channelized depressions in the wheel tracks. It results from consolidation or lateral movement of any of the pavement layers or the subgrade under traffic.

Rutting can be caused by:

- Displacement in asphalt surface layer
- Not compacted properly

If the rutting is minor, then it can be filled and overlaid, but if the distress is severe, then the rutted area should be removed and replaced with a suitable material.

F. Asphalt Shoving

Shoving is the formation of ripples across a pavement. This characteristic shape is why this type of distress is sometimes called wash-boarding. Shoving occurs at locations having severe horizontal stresses, such as intersections. It is typically caused by excess asphalt, too much fine aggregate, rounded aggregate, too soft asphalt, or a weak granular base.

2.2 Concepts of Road Maintenance

With the growth in global population and infrastructure, the requirement for a proper mode of transportation has become an integral part of it. Moreover, to fulfil this need, urban road construction, maintenance, and management technology have evolved over the years (Sahoo, 2022). Maintenance is the combination of all technical, administrative, and managerial actions during the life cycle of an item intended to retain it in or restore it to a state in which it can perform the required function under normal stated operating conditions. Maintenance provides maximization of the use of road components and the reliability of these assets to achieve operational and business objectives. (Ayalew, et al., 2022). Maintenance is a combination of actions intended to retain an item in, or restore it to, a state in which it can perform the function that is required for the item to provide a given service.

This concept leads to a first classification of maintenance actions into two main groups or types: actions oriented towards retaining certain operating conditions of an item and actions dedicated to restoring the item to said conditions (Mulmi, 2016). A proper pavement maintenance program includes crack filling, pothole repair, seal coating, and many other surface applications, depending on the Condition of the pavement. It should also include sweeping and periodic line striping (Merga et al., 2021). Pavement maintenance is intended to upgrade or preserve the Condition of a highway segment above some minimum requirement (Aluonzi et al., 2016).

The goal of maintenance is to preserve the asset, not to upgrade it. Unlike major road works, maintenance must be done regularly. Road maintenance comprises “activities to keep pavement, shoulders, slopes, drainage facilities and all other structures and property within the road margins as near as possible to their as-constructed or renewed condition” It includes minor repairs and improvements to eliminate the cause of defects and to avoid excessive repetition of maintenance efforts (Burningham et al., 2015).

2.3. Importance of Road maintenance

Road maintenance is essential in order to preserve the road in its originally constructed Condition, protect its resources and user safety, and provide efficient, convenient travel along the route. Ajani (2001) noted that during the design life of the road, efforts must be made to arrest the various deterioration that take place on it. The purpose of this course of action is to ensure the road provides an acceptable level of services to the user for a substantial period of its service life (Otheke, 2019).

Roads are among the most important public assets in many countries. Road improvements bring immediate and sometimes dramatic benefits to road users through improved access to hospitals, schools, and markets, improved comfort, speed, and safety, and lower vehicle operating costs. For these benefits to be sustained, road improvements must be followed by a well-planned program of maintenance. With regular maintenance, roads can easily avoid falling into disrepair, preventing the realization of the longer-term impacts of road improvements on development, such as increased agricultural production and growth in school enrollment (Burningham et al., 2015) and postponing road maintenance results in high direct and indirect costs.

If road defects are repaired promptly, the cost is usually modest. If defects are neglected, an entire road section may fail, requiring full reconstruction at three times or more the cost, on average, of maintenance costs (Mulmi, 2016).

As stated by (Merga et al., 2021), asphalt Road maintenance is essential in order to: -

- Preserve the road in its originally constructed Condition
- Protect adjacent resources and user safety, and
- Provide efficient, convenient travel along the route. Unfortunately, maintenance is often neglected or improperly performed, resulting in rapid deterioration of the road and eventual failure from both climatic and vehicle use impacts. It follows that it is impossible to build and use a road that requires no maintenance.

A lack of road maintenance services in an area ultimately results in a failing transport system, soaring costs and a significant financial cost to the local economy and population. Specifically, insufficient road maintenance leads to reduced service delivery and decreased safety on the roads. Reduced service delivery: Any growing community relies on service delivery, which means that goods and products are delivered to businesses in the local area whilst other goods are transported away from the area and across the country or overseas (Johnson, 2010). According to (Yilma et al., 2019), a lack of road maintenance services puts this economic process in jeopardy, reducing profits for local businesses, increasing unemployment and eventually leading to businesses closing and moving away from the area.

As stated (Olabisi, 2022), the importance of road maintenance enhances national development in the following ways;

- Employment creation
- Agricultural production
- Industrial development
- Manpower development
- Research and development

1. **Employment creation:** All road maintenance agencies create employment opportunities for various categories of citizens and help with poverty eradication.

2. **Agricultural production:** Past and present efforts in rural road maintenance are focused on improving agricultural production and creating links between rural areas for the free movement of agricultural products.
3. **Industrial development:** The level of industrialization in any economy depends largely on the conditions of its road network. This is why governments continued to pay great attention to road development and maintenance as a catalyst for industrial growth.
4. **Manpower development:** The acquisition of technical skills in road maintenance by engineers and technologists through the various road maintenance agencies will assist the nation in its drive towards technological advancement.
5. **Research and development:** Challenges created by the road maintenance needs have opened up tremendous opportunities for research institutions, universities and polytechnics in the area of cheaper road maintenance materials and methods.

2.3 Effects of Poor Road Maintenance

In the last few decades, the increasing traffic load has sped up the deterioration and ageing of pavements. Worn-out pavements lead to environmental, financial, and social issues, such as high expenses for vehicle repair, traffic delays, time delays, accidents, and fuel emissions (Kilic et al., 2021). With proper maintenance, the high value of any road network can be rapidly eroded, and road users and society can experience significant adverse impacts if a road is in good Condition. Inadequate road maintenance affects not only the present generation but places an undue burden on future generations (Highways, 2015). With poor road conditions, it is very difficult for the manufacturers to access their products,

Poor road maintenance has created much serious damage to the road network available, which hinders the effective and smooth running of daily operations and activities (Olabisi, 2022).

Improper maintenance of roads can also represent an increased safety hazard to the use, leading to more accidents, with their associated human and property costs. According to (Otheke, 2019), poor road maintenance can take many forms, including severe potholes that cause a driver to lose control or a malfunctioning traffic light that causes vehicles to collide in an intersection. It also emphasizes that if poor maintenance does not cause the accident, it can make the injuries and damage in an accident much worse, such as when the safety barrier in a freeway medium does not function properly.

Poor management of road maintenance will result in serious consequences on the economic well-being of a nation (Kesto et al., 2022).

Poor road conditions can and do cause serious injury accidents. A slick road surface can cause a driver to lose control, while poor visibility due to a blind turn can make it difficult for drivers to see other nearby vehicles (Eric, 2022).

As stated (Arshad et al., 2022), The Effects of Poor Road Maintenance-

- Reduce the riding comfort.
- Shortening the service/design life of the roads and increasing vehicle operating costs are the top-ranked frequently occurring effects of poor road maintenance on road function.

2.4 Types of Road Maintenance

There are three types of road maintenance, and they are as follows (Ayalew et al., 2022):

2.4.1 Routine Maintenance

Routine maintenance is based on routine (daily) inspection of the Condition of pavement, cut and filled slopes, drainage, bridges, and other structures and facilities to monitor any defects and damage. The results of the routine inspection will be promptly reported to the operation office for follow-up maintenance works to be undertaken either continually throughout the year or at certain intervals every year (Thomas et al., 2019). Maintenance requires execution once or more times per year on a section of road, and that is typically small in scale or simple but widely dispersed and requires skilled or unskilled manpower. The need for some routine maintenance can be estimated and planned on a regular basis (e.g., vegetation control).

2.4.2 Periodic Maintenance

Maintenance is occasionally required on a section of road after a number of years, and that is normally large in scale and usually requires the temporary deployment of special equipment and skilled resources for implementation. Periodic maintenance is costly, requires specific identification and planning for implementation, and often requires design work as well (Ayalew et al., 2022). Periodic maintenance is based on detail

ed inspection performed at certain time intervals, such as seasonally or yearly, depending on the type and kind of facilities. It includes checking and testing the conditions of various structures and facilities. Defects and damage will be reported for repairs or remedies (Kilic et al., 2021).

2.4.3 Urgent Maintenance

Certain unforeseen situations that necessitate remedial maintenance to be taken as soon as possible (e.g., flood damage, slips).

According to (Johnson, 2010), there are three types of pavement maintenance operations:

2.4.4 Preventive Maintenance

Preventive maintenance is defined as maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure or the degradation of the functioning of the equipment. Preventive maintenance can be predetermined or Condition-based: x Predetermined maintenance.

Preventive Maintenance: Performed to improve or extend the functional life of a pavement. It is a strategy of surface treatments and operations intended to retard progressive failures and reduce the need for routine maintenance and service activities.

Preventive maintenance is defined by AASHTO as "a planned strategy of cost-effective treatments to an existing roadway system that preserves the system, retards future deterioration, and maintains, or improves the functional Condition. Note that applying a preventive maintenance treatment (i.e. chip seal) as a stop-gap measure to hold together a badly distressed pavement until reconstruction funds are available is not considered preventive maintenance, and such treatments will not be considered in terms of life cycle cost effectiveness nor performance benefits – this does not infer that all stop-gap treatments are not cost-effective. (Thomas, et al., 2019)

2.4.5 Corrective Maintenance

Corrective Maintenance: Performed after a deficiency occurs in the pavement, such as loss of friction, moderate to severe rutting, or extensive cracking. It may also be referred to as "reactive" maintenance.

2.4.6 Emergency Maintenance

Emergency Maintenance: Performed during an emergency, such as a blowout or severe pothole that needs repair immediately. This also describes temporary treatments designed to hold the surface together until more permanent repairs can be performed.

Emergency maintenance basically consists of works to restore road and road-related facilities to their normal operating conditions after road accidents or natural causes damage them.

It is impossible to foresee the frequency, but such maintenance requires immediate action (Thomas et al., 2019).

All types of maintenance are needed in a comprehensive pavement maintenance program. However, emphasizing preventive maintenance may prevent a pavement from requiring corrective maintenance. Preventive maintenance is completing the right repair on the right road at the right time.

Preventive maintenance is carried out in accordance with established intervals of time or number of units of use (i.e., scheduled maintenance) but without previous item condition investigation; condition-based maintenance—preventive maintenance based on performance and parameter monitoring and the subsequent actions. Performance and parameter monitoring may be scheduled, on request or continuously.

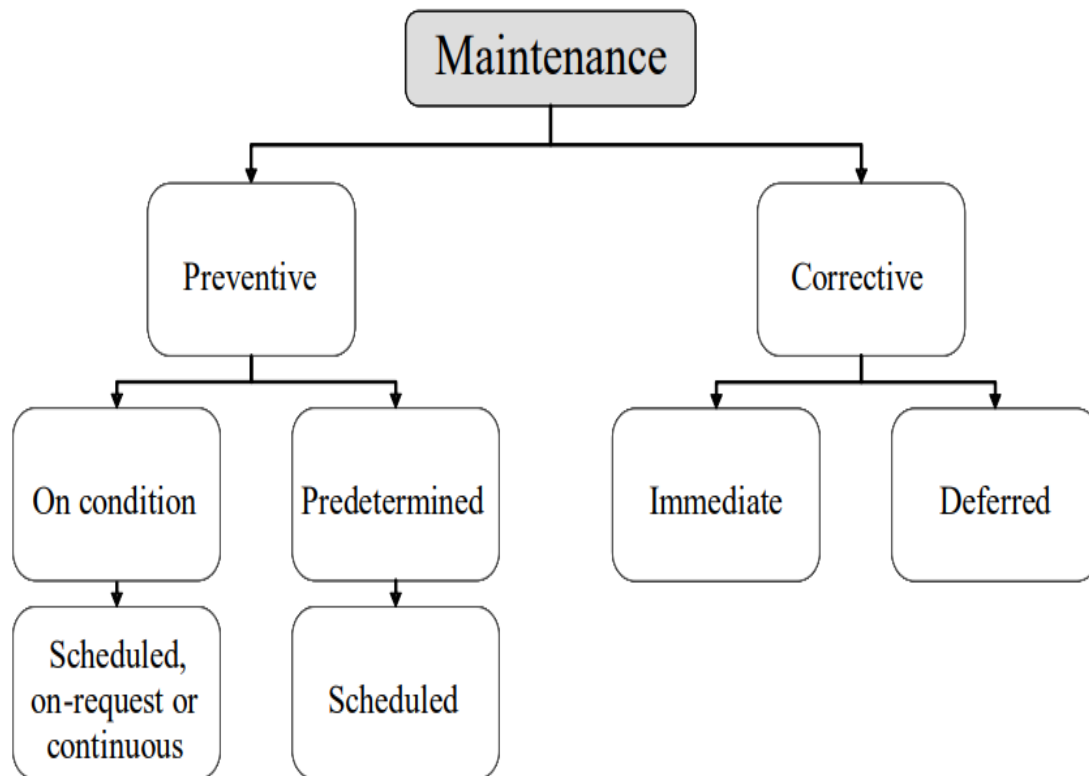


Figure 2-1 Types of Road Maintenance

(Yilma et al., 2019), Summarized the typical activities of each type of maintenance work.

Table 2-2 Types of Road Maintenance

Type	Activity
Routine including Preventive	Clearing of pavement
	Mowing and maintenance of plants
	Clearing of ditches and culverts
	Repair of traffic signs and road markings
	Shoulder grading
	Pothole patching and crack sealing
	Repair of sealants and expansion joints of bridges
	Repair of cut and fill slopes
Periodic	Regraveling
	Resealing/surface dressing
	Overlay
	Maintenance of traffic signs and road markings
Emergency	Removal of debris or obstacles from natural causes
	Repair of damage caused by traffic accidents

2.5 Road maintenance management

Road maintenance management can be defined as managing road maintenance activities to ensure the availability of road components and facilities, which helps to keep the downtime to a minimum. Road maintenance management is a management philosophy, and it should be considered a business function that provides opportunities to retain the quality, life, and value of the road (Ayalew et al., 2022).

Road maintenance management is all management activities that determine maintenance objectives, strategies, and responsibilities. Maintenance management is concerned with good control of the maintenance function and its related areas best to assist the objectives and goals of the entire organization. Road maintenance is under two subdivisions:- physical maintenance and traffic services. Physical maintenance is the preservation and upkeep of a highway in its constructed Condition. Traffic services are defined as the operation of a highway facility, and services help to provide safe, convenient, and economical highway transportation (Sultana et al., 2013). A pavement Maintenance management program is necessary in order to implement a preventive maintenance program successfully (Thomas et al., 2019)

According to (Arshad et al., 2022), road maintenance management can be defined as managing the road maintenance activities to ensure the availability of the road components and facilities helps to keep downtime to a minimum.

Road maintenance management is a management philosophy, and it should be considered a business function that provides opportunities to retain the quality, life, and value of the road.

Critical elements of a successful pavement preservation program are (Johnson, 2010):

- selecting the roadway
- determining the cause of the problem
- identifying and applying the correct treatment(s)
- determining the correct time to do the needed work
- observing performance

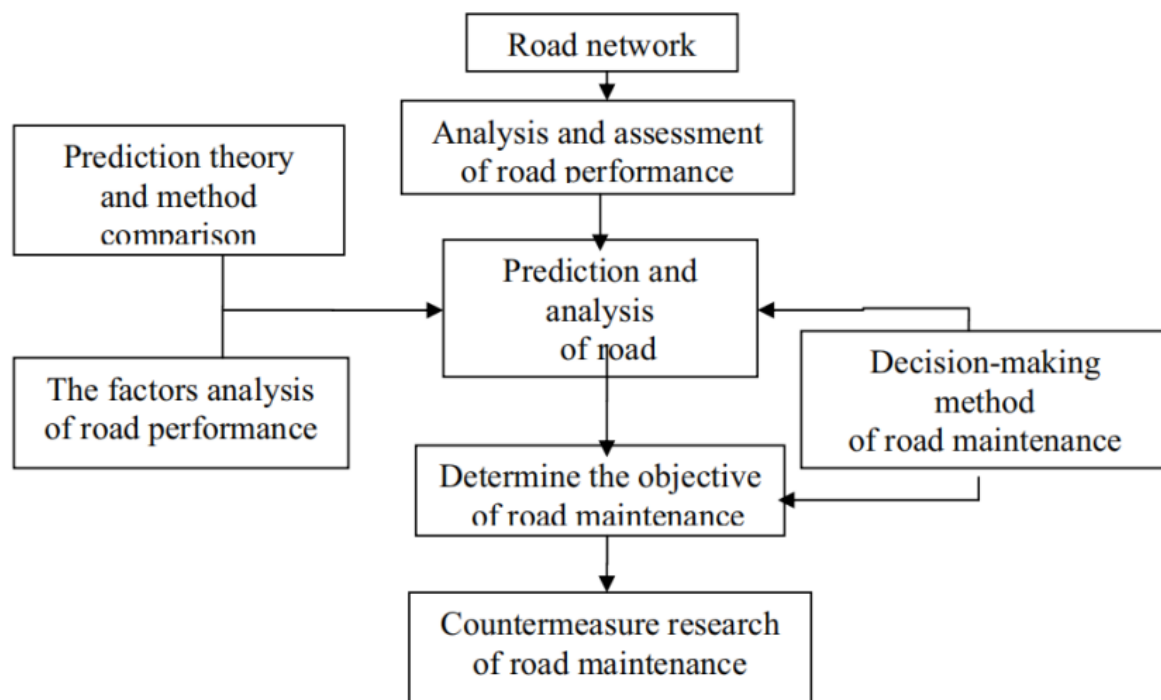


Figure 2-2 Typical flow chart of road maintenance management and planning (Sahoo, 2022)

A Pavement Management System is one component of a broader asset management system. While a PMS cannot make final decisions, it can provide the basis for an informed understanding of the possible consequences of alternative decisions. "A Pavement Management System is characterized as the techniques for gathering, dissecting, keeping up, and revealing asphalt information, to help the chiefs in discovering ideal procedures for keeping up asphalts in useful condition over a given timeframe for the least expense." The advantage of a PMS is that it allows the users to output the information in a clear and understandable format, which helps them make better decisions on how to manage their roads (Priyanka, 2019).

2.6 Factors that affect asphalt road maintenance management

Pavement deterioration causes are important factors that can affect on-road deterioration, such as environment, material characteristics, traffic volume, type of design standards, pavement age, and pavement construction quality (Hafizyar, 2020).

- Traffic loads are harming the roads, which is the result of vehicle loads and their volumes.
- A significant decrease in the strength of the subgrade and gravel materials is happening from the penetration of Moisture, humidity, or dampness. It simply enters the cracks through holes on the surface into the subgrade and from the capillary section with water on that part of the structure. Swelling and shrinkage are from environmental factors. It is clarified in reflective cracking
- that ageing in the pavement is a matter of fact, and the road will show distress on the surface after more than 30 to 40 years. When the traffic grows larger and time passes, the road begins to accumulate; for instance, solidifying increases the hardness of asphalt gradually with its ageing, though it improves the sensitivity of thermal cracking.

The major factors that control the performance of many pavement preservation treatments are pretreatment pavement condition, materials selection and quality, construction and workforce, mix and structural design, traffic level, and climate during and immediately after construction (Beth, 2015).

There are so many factors that affect asphalt road maintenance management. A number of physical factors affect the frequency and nature of road maintenance works. The key factors are:

- Road Surface Type
- Traffic Flows and Composition
- Road Surface Condition
- Climate
- Terrain

Combinations of the above factors can have a significant impact on road maintenance expenditure, e.g. earth roads in wet climate zones or any road surface type with a high heavy. The factors influencing the maintenance of rural road networks are the influence of cost, politics, technology, and time on maintenance (Hafizyar, 2020).

2.7 The methods to maintain the asphalt road

Pavement maintenance techniques are the methods used to accomplish a strategy or to correct some deficiency in a pavement segment. Techniques include the use of overlays, seal coats, pothole repair, crack sealing, and so on. Maintenance techniques are classified according to their purpose or function as either corrective or preventive (Burningham et al., 2015).

Tool or method that assists in optimizing strategies for providing and maintaining pavements in a serviceable condition over a given period are:-

As stated by (Rajgor, et al., 2019) Asphalt Pavement Rehabilitation Techniques

- Asphalt patching
- Cold milling
- Hot in-place recycling
- Cold-in place recycling
- Asphalt overlay
- Concrete overlay

As stated by (Ayalew et al., 2022), the different options or techniques available when it comes to asphalt repairs and asphalt maintenance are:-

2.7.1 Pothole Repair

Potholes are the most obvious sign that your asphalt paving needs repair. Potholes can and will wreak havoc on vehicles if not repaired properly. They can create even larger issues in your pavement if addressed slowly. As one of the leading local asphalt paving companies, we have dealt with potholes all over the Greater Vancouver Area. We are well versed in how to address each unique situation best, no matter how disastrous it may seem.

2.7.2 Crack Sealing

Crack sealing is affordable maintenance that can be performed on virtually all asphalt surfaces – be they residential paving, municipal paving, industrial paving, or commercial paving. By placing adhesive into the cracks, the professionals at Burnaby Blacktop can prevent Moisture from bleeding into your asphalt, extending its life for up to five years. If performed early and regularly enough, crack sealing is one of the more affordable means of maintaining the surface, in some cases doubling its lifespan, and can be completed rather quickly.

2.7.3 Seal Coating

Seal coating is a routine maintenance need for asphalt, especially in the Pacific Northwest, where nature can take its toll. By applying a protective coat to the asphalt every few years, the experts at Burnaby Blacktop can help prolong its lifespan by shielding it from the water, oil, and UV rays that will damage the surface and wear it down.

2.7.4 Asphalt Milling and Asphalt Grinding

Asphalt milling, or asphalt grinding, is the process of removing the upper layer of the asphalt to improve drainage and help keep it level. While it does not need to do it often, asphalt milling is a great way to strengthen the asphalt. This will help maintain its water resistance and increase its overall longevity. It can also be a potential solution when cracking occurs.

For many business owners and property managers, asphalt milling is the top choice when it comes to surface repair. This method is the most efficient and cost-effective way to maintain a safe and attractive asphalt surface. This method is perfect when the damage is widespread. Keeping the sub-base intact and adding a smooth top layer is a good way to avoid having to start from scratch.

2.7.5 Asphalt Patching

Depending on the scale of the pothole or asphalt repair, asphalt patching may be the best option. Patches treat local weaknesses. They can either extend to the pavement substrate or partially penetrate the asphalt. It all depends on the extent of the damage. These quick repairs are a good way to prevent further damage while saving money on a more costly repair.

Table 2-3 Asphalt Maintenance Techniques (Arshad et al., 2022)

Asphalt Maintenance Techniques		
1. Crack Treatment	2. Surface treatments	3. Pothole and Patching Repair
➤ Crack repair with sealing ➤ Clean and seal ➤ Saw and seal ➤ Rout and seal ➤ Crack filling ➤ Full-depth crack repair	➤ Crack repair with sealing. ➤ Clean and seal ➤ Saw and seal ➤ Rout and seal ➤ Crack filling ➤ Full-depth crack repair	➤ Cold mix asphalt ➤ Spray injection Patching ➤ Hot-Mix Asphalt

Also, as stated by (Thomas et al., 2019), the methods of asphalt Road maintenance are discussed as follows:-

2.7.6 Skin Patching

As the name implies, a skin patch is a thin asphalt lift, generally less than 40 mm, that is placed directly on pavement without any milling (milling is the partial removal of the surface of a paved area). Skin patching is used to resolve drainage issues temporarily, to minimize poor ride quality on uneven areas of the roadway, and for water infiltration.

Skin patching is also used to build up low areas and improve the profile of the roadway before applying surface treatments, such as an asphalt overlay or micro surfacing.

2.7.7 Crack Sealing

Crack sealing is a low-cost maintenance treatment that involves sealing slight to moderate severity cracks – between three to 20 mm wide – with a modified asphalt-based sealant. This generally results in a slower rate of growth for the sealed Crack and reduces the potential for further deterioration of the pavement structure from water seepage or penetration.

Crack sealing is a preventative maintenance technique and can extend the pavement service life. Some studies have shown that the service life of the pavement is extended by two to five years if the crack sealing is applied within the first three to five years following the previous upgrade.

2.7.8 Street Planer Patching

Street planer patching is typically used as a maintenance treatment to repair areas of pavement exhibiting localized accelerated distress. Alligator cracking patching of these distressed areas can extend the pavement service life when localized areas of distress are treated.

Street planer patching is a low-cost maintenance treatment that involves the removal of the existing asphalt, in partial or full depth, in a relatively small area and replacement with new asphalt. It is primarily used in areas where there is localized accelerated distress or where the pavement is in need of rehabilitation (i.e. used as a holding strategy). However, proper materials and procedures are required in order for the patching to be effective.

2.7.9 Chip Sealing

A chip seal is constructed by embedding a small aggregate chip – typically eight mm – into the surface of the asphalt emulsion.

A double chip seal is when two layers of emulsion and aggregate chips are placed. Chip seals are typically used as a surfacing material on lower-volume asphalt or gravel roads.

Chip seals may also be used on asphalt pavements to seal the surface, improve skid resistance, and extend the service life of the pavement for a few years when surficial distress becomes severe. If a chip seal is placed over an asphalt pavement, then it can be classified as a rehabilitation treatment.

Micro-Surfacing

Micro-surfacing is a thin surface treatment that is typically used on pavements that are structurally adequate but have minor surface deficiencies. These deficiencies may include the following:

- Raveling
- Low surface friction
- Minor cracking

Micro-surfacing is not an appropriate treatment for pavement in poor Condition, and it will not address structural deficiencies.

Asphalt Overlay

An asphalt overlay produces a new road surface with improved ride quality and skid resistance. An asphalt overlay may be an appropriate treatment to address the following pavement surface distresses:

- Raveling
- Low surface friction
- Minor cracking
- Minor rutting

Mill and Overlay

Mill and overlay consists of the partial removal of existing asphalt concrete and overlaying it with hot mix asphalt. A mill and overlay rehabilitation will extend the service life of the pavement by removing some deteriorated or distressed asphalt from the pavement surface and providing a new surface.

Mill and overlay may also be an appropriate treatment for the following:

- Minor to moderate cracking
- Minor to moderate rutting and distortion
- Minor to moderate rippling and shoving
- Roads with existing curbs and gutters
- Roads where grade raises cannot be accommodated

Partial Depth Cold in Place (CIP) Recycling

Partial depth cold in-place (CIP) recycling is the process of removing the existing asphalt partial depth, typically by milling and screening the milled materials on site to limit oversized particles. The screened material is then stabilized with either an emulsion or expanded asphalt, placed back on the road using a paver, and then compacted.

2.7.10 Full-Depth Recycling

Full-depth recycling (FDR) with expanded asphalt (EA) – FDR w/ EA – is similar to regular FDR (pulverization) but adds the step of stabilizing the blended mix of pulverized asphalt concrete and granular material with expanded asphalt, followed by a one-lift overlay. This provides a higher strength and quality mix than regular FDR.

2.7.11 Partial Depth Reconstruction

Partial depth reconstruction is the removal of existing asphalt concrete, followed by the placement of a gravel leveling course and resurfacing with two or more lifts of asphalt concrete. A partial depth reconstruction is an appropriate treatment for most distresses.

2.7.12 Full Reconstruction

Full reconstruction is the removal of asphalt concrete and granular material to a specified depth and the replacement with new material. The reconstruction will follow a specified design based on the roadway classification, traffic volume and structural composition.

CHAPTER THREE

3. RESEARCH METHODOLOGY

3.1. Research Area

This research was conducted in the Southwestern part of Ethiopia at Oromia Regional State Jimma Zone in Jimma Town at a distance of 356 Km from Addis Ababa, the capital of Ethiopia. Based on the (<https://all-populations.com/en/et/population-of-jimma.html>) Population of Jimma in 2023 statistics, Jimma has a total population of 207,573 with an area of 50.52 square kilometers with an annual growth rate of 3.8%. Its astronomical location is 7°40'N North Latitude and 36°50' East Longitude, and elevation varies from 1,780 m-2000 m above sea level. Groundwater level in the area is variable and ranges from 3-7 m.

The study covers 10 kilometers, which starts from Shenene Gibe Hospital through Yeteberut to Jimma University BECO College through Kochi to Mercato.

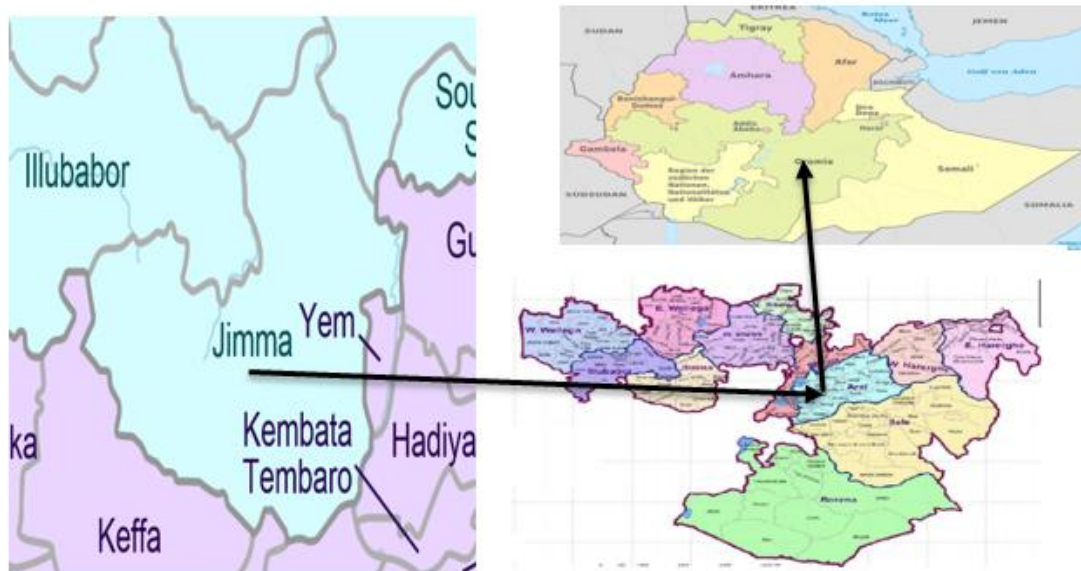


Figure 3-1 Study Area

3.2. Research Design

The research used both mixed approaches of Qualitative and quantitative descriptive types of research. Quantitative data was collected by using a questionnaire (close-ended and open-ended), whereas qualitative data was collected through field observation.

3.3. Study Variables

3.3.1. Dependent Variable

Asphalt Road Maintenance Management

3.3.2. Independent Variables

- Road Surface Type
- Traffic Flows and Composition
- Road Surface Condition
- Climate
- Cultures of Road Maintenance

3.4. Population and Sampling Method

Since the population of the research was being determined, the research used a non-probability, Purposive sampling technique.

3.5. Sources of Data and Collection Procedure

The sources of data were primary and secondary: The primary data were interviews, questionnaires, and field observation. The secondary source of Data were documents Review (books, published journals and magazines)

3.6. Data Presentation and Analysis

The Data was collected from a questionnaire survey, interview, observations and then processing and sorting. To analyze the data and rank the factors, the Relative Importance Index (RII) has five-point scale factors. The relative importance index technique is used to determine the relative importance of the various factors and is calculated using the following formula (Rajgor et al., 2019).

$$RII = \Sigma W / (A * N) \dots\dots\dots (Equ. 1)$$

Where:

W: Weighting given to each factor by the respondent.

A: the highest weight in the research.

N: Total number of respondents.

$$Severity\ Index\ (S.I.)\ (\%) = \Sigma a\ (n/N) * 100 \dots\dots\dots (Equ.2)$$

Where:

a: is the constant expressing weighting given to each response (ranges from 1 for little up to 5 for severe)

n: is the frequency of the responses, and

N: is the total number of responses.

Then, the data will be presented and analyzed by using descriptive statistics like graphs, charts and tables in a Microsoft Excel sheet.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1 Basic Information about the Respondents

According to the plan, sixty questionnaires were distributed. Out of these, the questionnaires were collected as stated in Table 4.1 below.

Table 4-1 Respondents' Information

Types of Respondents Organization	Questionnaires Distributed	Questionnaires Returned	Response Rate in (%)
Client's Representatives and Users	18	17	94%
Public Transport provider	5	3	60%
Regulatory Body	12	10	83%
Consultants	10	9	90%
Contractors	10	8	80%
Sub-Contractor	5	3	60%
Total	60	50	83%

4.2 Respondent's Position, Education Level and Level of Experience

The following tables and Figures are Respondent's Position, Education level and Level of Experience

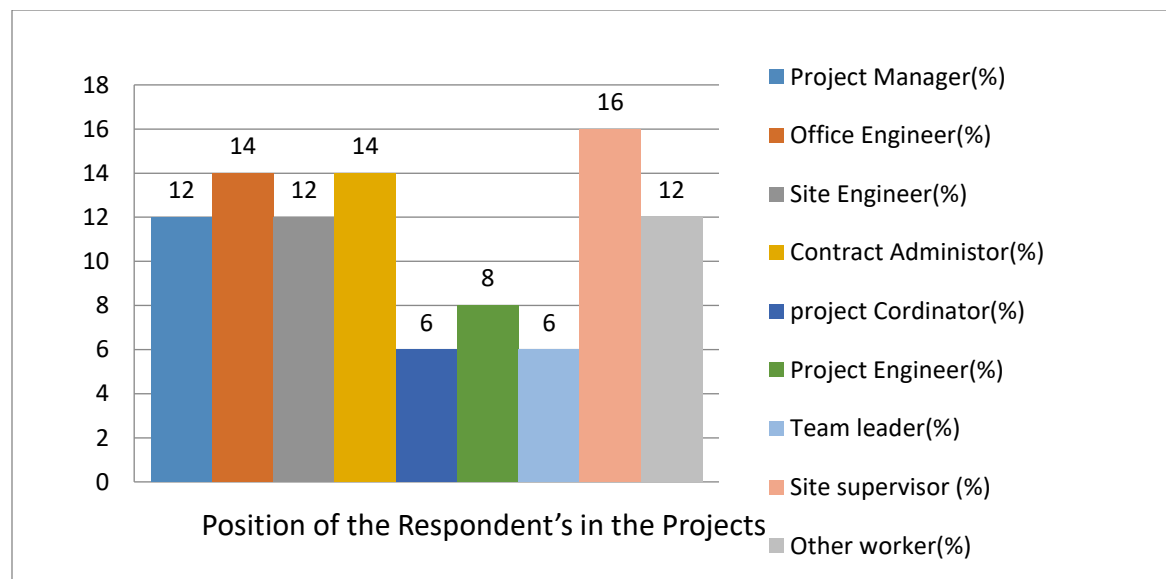


Figure 4-1 Position of the Respondents in the Projects

The following tables indicate the Educational and Experience levels of the Respondents

Table 4-2 Respondents' Information

Education level	Rate in (%)
Diploma	2
Bachelor's Degree	36
Master's Degree	12
Doctorate's Degree	0
TOTAL	50

Level of Experience	Rate in (%)
0 to 5 years (%)	31
5 to 10 years (%)	41
10 to 15 years (%)	22
15 to 20 (%)	4
>20 %	2
TOTAL (%)	100

4.3 Asphalt Road Maintenance Practice

4.3.1 Asphalt road construction and quality of materials

Asphalt road is made from a mixture of aggregates, binder, and filler. Aggregates are processed mineral materials such as crushed rock, sand, gravel, slags, or various recycled materials.

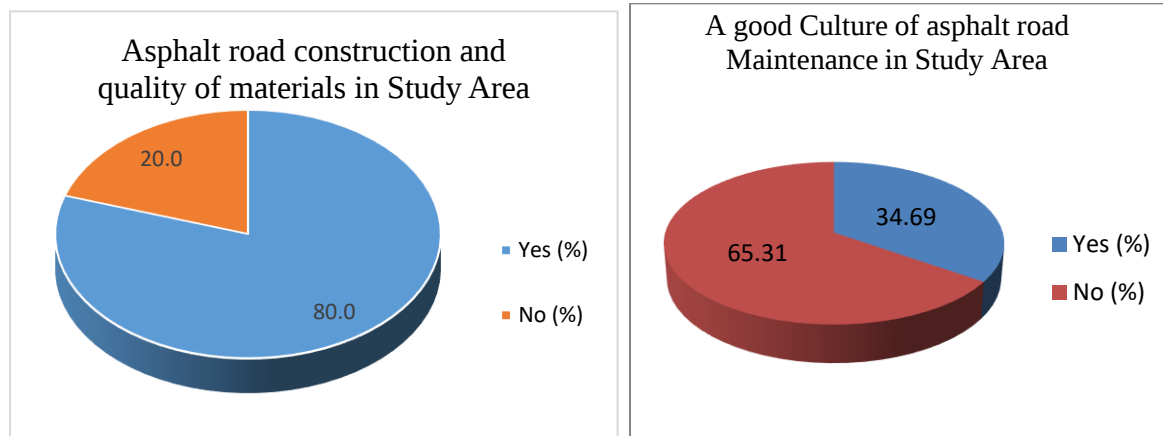


Figure 4-2 Asphalt Road Construction and Cultures of Asphalt Road Maintenance in Study Area

According the respondents most respondents responded during asphalt road construction in the study area using quality materials, but as indicated in Figure 5, there needs to be a better Culture of asphalt road Maintenance. This shows that in the study area, a sustainable road maintenance culture should be adopted and applied.

4.3.2 Effects of qualified and skilled Labour on Asphalt road maintenance

Unskilled labourers are one of the key challenges faced by the construction industry, as skilled labourers during Asphalt road maintenance play an essential role in the enhancement of project performance.

However, unskilled laborers are one of the most unproductive labour types in the construction industry that influence project performance. As shown in the figure below, respondents responded that there is qualified and skilled labour on asphalt road maintenance in the study area, but as stated, there needs to be a series of management of qualified and skilled labour on asphalt road maintenance projects.

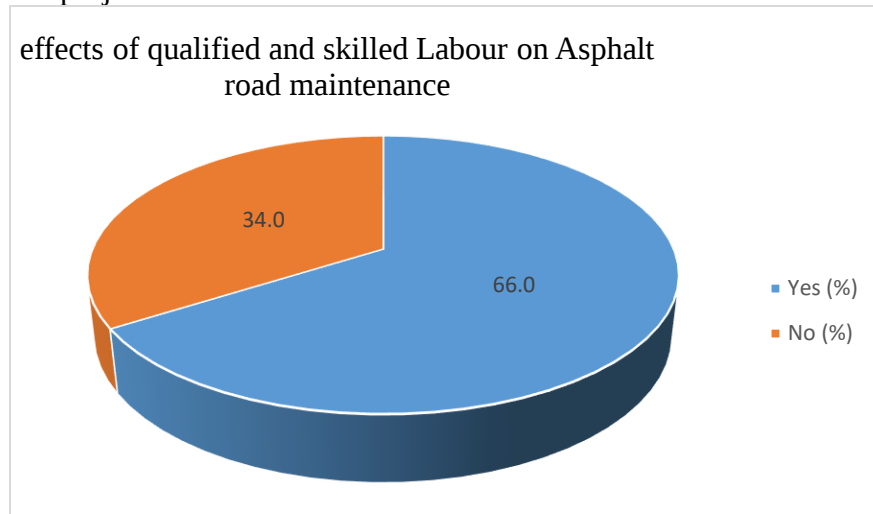


Figure 4-3 Effects of qualified and skilled Labour on Asphalt road maintenance

4.3.3 Negative Impacts of poor ARM Management on daily activities of Users

Poor asphalt road maintenance management impacts the daily activities of both road users and vehicles. As Investigated by the respondents, as shown in the figure below, poor asphalt road maintenance management has negative impacts on local societies.

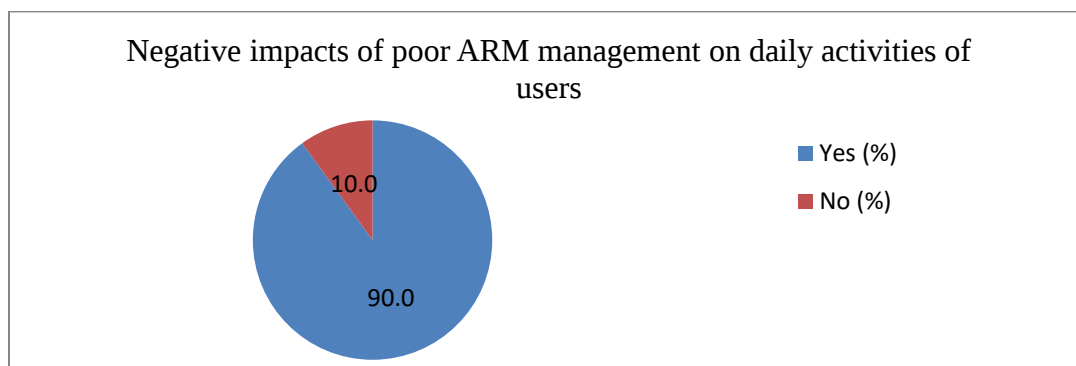


Figure 4-4 Negative impacts of poor ARM management on the daily activities of users

Poor asphalt road maintenance management has negative impacts on users' daily activities. As mentioned by the respondents, it causes too many vehicle accidents, affects the environment, causes traffic jams, Make the life span of the road short.

Also, it causes high vehicle maintenance costs, increases travel time and Decreases transport accessibility, service delivery quality and road safety.

4.3.4 Effects of Roadway facilities on Road maintenance management

Roadway Facility means existing and proposed streets and all related facilities, including drainage facilities, sidewalks, signals, markings, signage, streetlights, median openings, turn lanes, and acceleration or deceleration lanes.

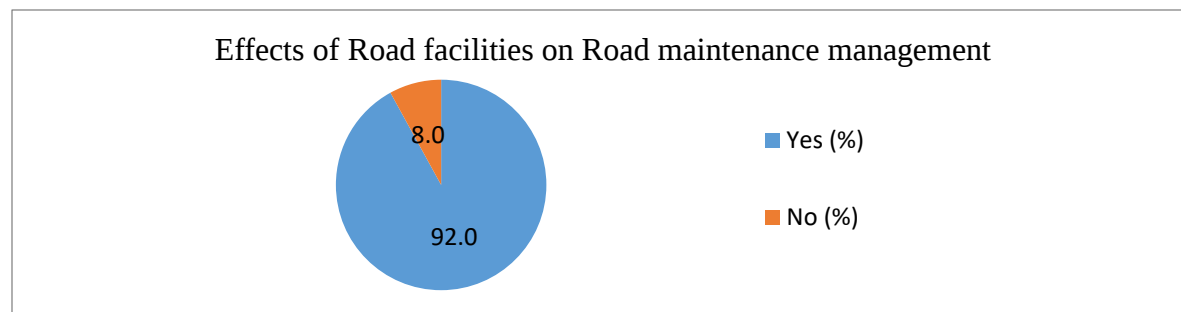


Figure 4-5 Effects of Road facilities on Road maintenance management

As stated in the above figure, the absence of road facilities has negative impacts on the users and vehicles; it also has effects on the transportation system as this brings about frequent vehicle breaks and increased maintenance costs.

4.4 The most common causes of Road failure

According to the assessment, the most common causes of Road failure are stated below:- Insufficient Strength Properties of Bituminous, Mixes Poor Maintenance Culture, Movement Of Over Loading Vehicles, Bad Drainage Condition, Natural Disaster, Expansion and contraction from seasonal temperature changes, Sun Exposure, Poor Engineering Design, Poor Construction Methods/Technique, Poor road-use culture, Poor Use (Abuse) of Road Facilities, Poor Quality of Materials and Timing of Maintenance.

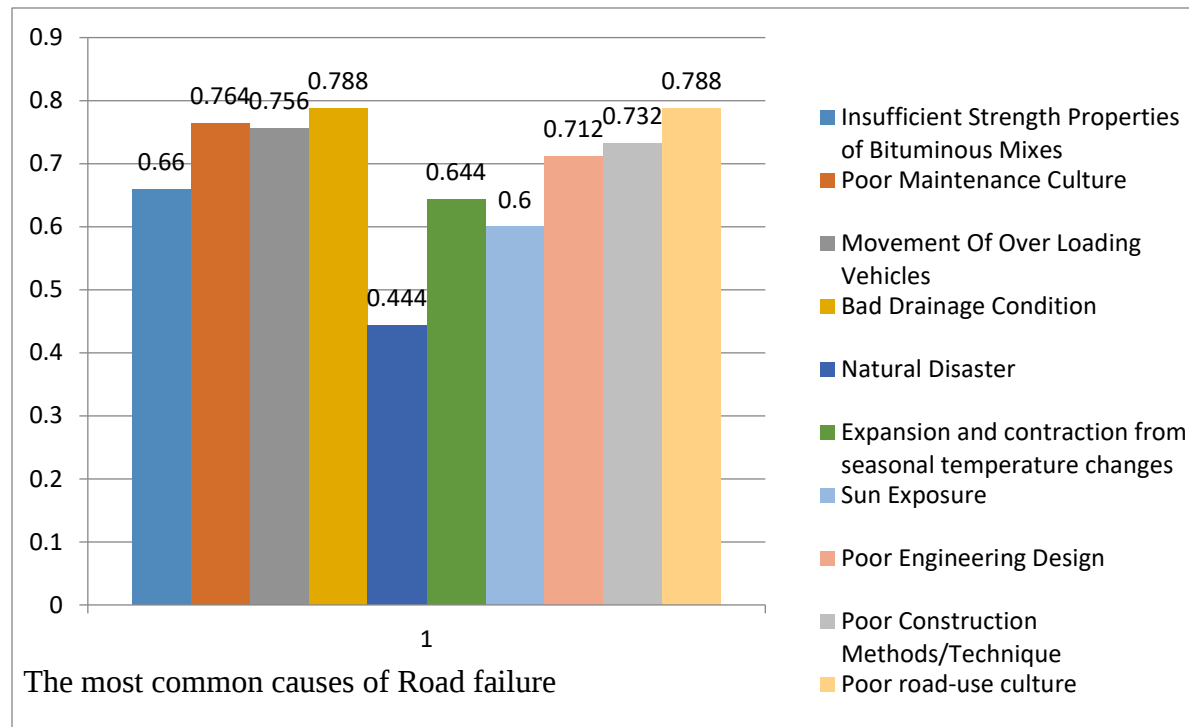


Figure 4-6 The most common causes of Road failure

From the stated causes based on the respondents:- Timing of Maintenance, Poor Maintenance Culture, Movement Of Loading Vehicles, Bad Drainage Condition, Poor Construction Methods/Technique, Poor road-use culture, Poor Use (Abuse) of Road Facilities and Poor Quality of Materials are the most common causes of Asphalt road failures in the case study area. These indicate that Periodic maintenance is based on detailed inspection performed at certain time intervals, such as seasonally or yearly, depending on the type and kind of facilities. It includes checking and testing the conditions of various structures and facilities. Defects and damage will be reported for repairs or remedies.

4.5 failures or Defect present on asphalt Road

Pavement failure occurs when an asphalt surface no longer holds its original shape and develops material stress, which causes issues. Based on the study, the following defects are identified:- Water Bleeding, Shear failure cracking, Depressions, Edge Subsidence, Consolidation of pavement layers (Rutting), Edge Damage, Local Aggregate Loss, Potholes And Shovel, Longitudinal cracking, Raveling (very porous asphalt)

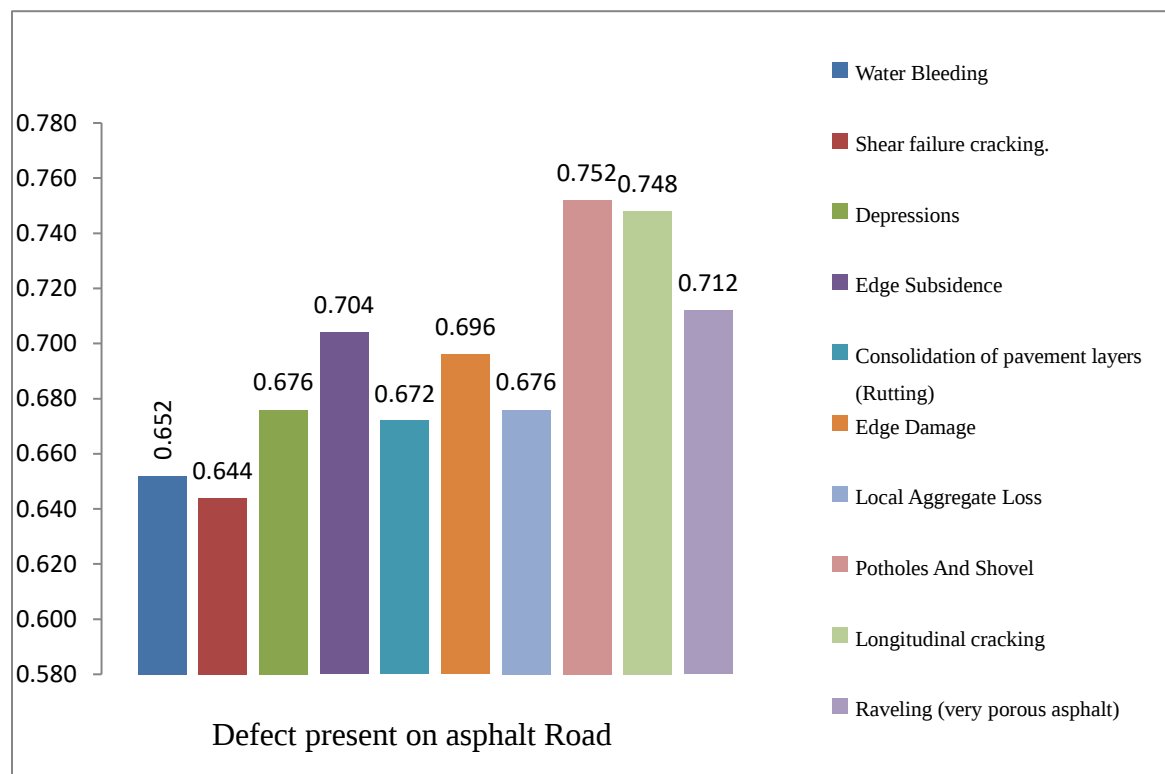


Figure 4-7 Failures or Defect present on asphalt Road

According to the result: - Potholes and Shovels, Longitudinal cracking, Edge Subsidence, Depressions and Raveling (very porous asphalt) are the most common defects present in the case study area. Potholes are holes in the roadway that vary in size and shape, caused by the expansion and contraction of ground water after the water has entered into the ground under the pavement. Longitudinal cracks occur parallel to the centerline of the pavement. It can be caused by a poorly constructed joint, shrinkage of the asphalt layer, cracks reflecting up from an underlying layer and longitudinal segregation due to improper paver operation.

4.7 The main factors that affect asphalt road maintenance

This study identified the main factors that affect road maintenance: traffic Flows and Composition, Road Surface Condition, Climate, Terrain, Pavement Construction Details, Maintenance Age, Availability of Drainage System, Environmental Factors and Road Surface Type.

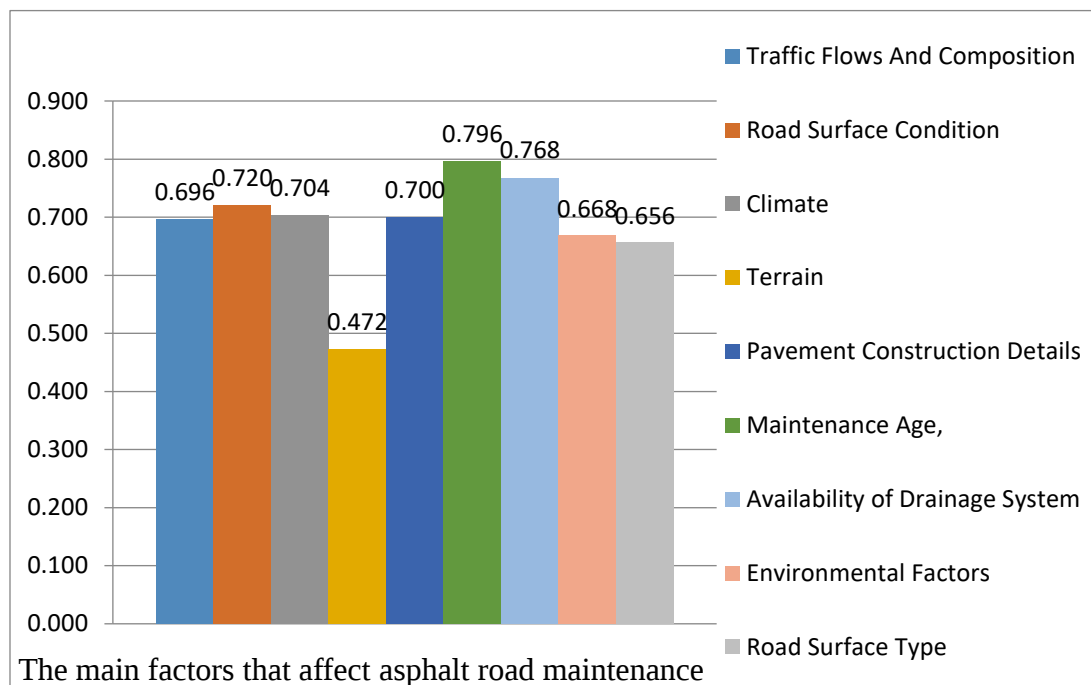


Figure 4-8 shows the main factors that affect asphalt road maintenance

As indicated from the above chart, most factors are verified accordingly: Maintenance Age, Road Surface Condition, Terrain, Pavement Construction Details and Availability of Drainage System. These are the factors that affect asphalt road maintenance the most in the case study area. This indicates that, typically, pavement deteriorates at an ever-increasing rate: at first, very few distresses are present, and pavement stays in relatively good Condition, but as it ages, more distresses develop, with each distress making it easier for subsequent distresses to develop. Also, the quality of the road surface is critical to ensure the safety of drivers and other road users. Poor road conditions can lead to accidents, delays, and additional costs for road maintenance

4.8 Methods of Road Maintenance

There are so many methods of road maintenance, among these: Clean and seal, Rout and seal, Crack filling, Full-depth crack repair, Fog seal, Slurry seal, Pothole patching and Crack repair are surveyed in the case study area.

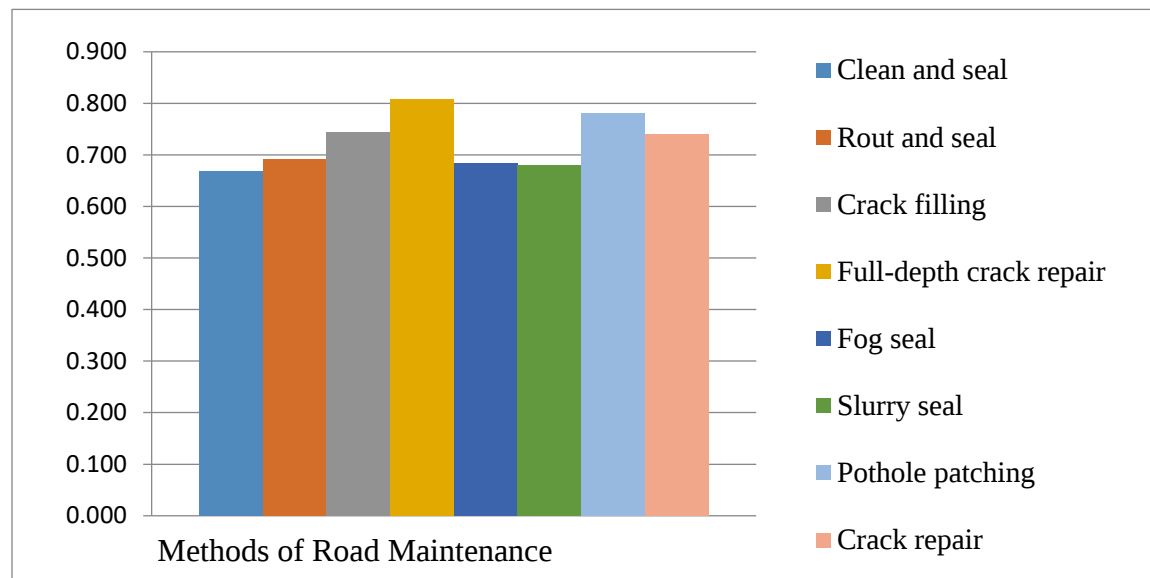


Figure 4-9 shows the main factors that affect asphalt road maintenance

As indicated from the above figure, most Road maintenance types matched with the study area are assessed by using Relative importance index like this, Clean and seal (RII 0.668, Rank 8), Rout and seal RII (0.692, Rank 5), Crack filling (0.744, Rank 3), Full-depth crack repair (0.808, Rank 1), Fog seal (0.684, Rank 6), Slurry seal (0.680, Rank 7), Pothole patching (0.780, Rank 2), Crack repair (0.740, Rank 4). The most commonly performed applicable types in the study area are full-depth crack repair, pothole patching, crack filling, and crack repair, according to survey respondents.

Full-depth repair is removing and replacing at least a portion of a slab to the bottom of the concrete in order to restore areas of deterioration. Also, Full-depth patches improve pavement rideability and structural integrity and extend pavement service life. Crack filling is the placement of asphalt emulsion into non-working cracks to reduce water infiltration and reinforce the adjacent pavement, and Crack Repair is a liquid substance that can be poured into any cracks or voids that appear in asphalt roads or footways; this is a preventive maintenance procedure that will prevent water ingress and give the surface a longer lifespan.

4.9 Recommended Road Maintenance Management Strategies

The concept of road maintenance management refers to the process of organizing and supervising road maintenance activities in order to minimize downtime by ensuring the availability of road components and facilities. The following are the different types of road maintenance strategies used for the study area.

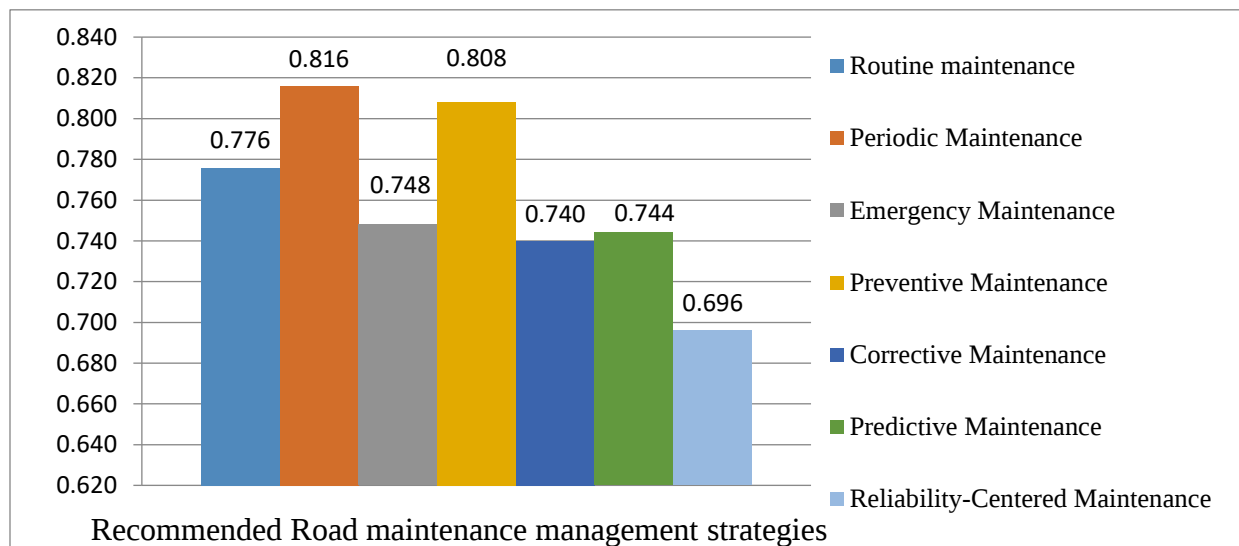


Figure 4-10 Recommended Road maintenance management strategies

Based on the survey, Routine maintenance (RII 0.776, Rank 3), Periodic Maintenance (RII 0.816, Rank 1), Emergency Maintenance (RII 0.748, Rank 4), Preventive Maintenance (RII 0.808, Rank 2), Corrective Maintenance (RII 0.740, Rank 6), Predictive Maintenance (RII 0.744, Rank 5), Reliability-Centered Maintenance (RII 0.696, Rank 7). Accordingly: - Periodic Maintenance, Preventive Maintenance, Routine maintenance and Emergency Maintenance are the most recommended road maintenance strategies for the study area. Maintenance types such as Time-Based Maintenance, Failure Finding Maintenance, Risk-Based Maintenance, Condition Based Maintenance, and Predictive Maintenance are all part of Preventive Maintenance, which is carried out prior to a failure occurring. Emergency maintenance is for issues that might cause immediate harm to occupants or others. Routine maintenance is for issues that can be addressed after some time.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATION

5.1 Conclusions

Based on the study, there is qualified and skilled Labour on Asphalt road maintenance in the study area, but as assessed, there needs to be a series of management of qualified and skilled Labour on Asphalt road maintenance projects.

Poor asphalt road maintenance management has negative impacts on users' daily activities. As mentioned by the respondents, it causes too many vehicle accidents, affects the environment, causes traffic jams, Make the life span of the road short. Also, it causes high vehicle maintenance costs, increases travel time and Decreases transport accessibility, service delivery quality and road safety. At the same time, the Roadway Facility includes drainage facilities, sidewalks, signals, markings, signage, streetlights, median openings, turn lanes, and acceleration or deceleration lanes. The absence of road facilities has negative impacts on the users and vehicles and also has effects on the transportation system as this brings about frequent breakdowns of vehicles and increased maintenance costs. According to the assessment, the most common causes of road failure are identified:-insufficient strength properties of bituminous, poor maintenance culture, movement of overloading vehicles, bad drainage conditions, natural disasters, expansion and contraction from seasonal temperature changes, sun exposure, poor engineering design, poor construction methods/technique, poor road-use culture, poor use (abuse) of road facilities, poor quality of materials and timing of maintenance. From the assessed causes of road failure:- the timing of maintenance, poor maintenance culture, movement of overloading vehicles, bad drainage condition, poor construction methods/technique, poor road-use culture, poor use (abuse) of road facilities and using poor quality of materials are the most common causes of asphalt road failures in the case study area. According to the result: - Potholes and Shovels, Longitudinal cracking, Edge Subsidence, Depressions and Raveling (very porous asphalt) are the most common defects present in the case study area. Potholes are holes in the roadway that vary in size and shape, caused by the expansion and contraction of ground water after the water has entered into the ground under the pavement.

Longitudinal cracks occur parallel to the centerline of the pavement. It can be caused by a poorly constructed joint, shrinkage of the asphalt layer, cracks reflecting up from an underlying layer and longitudinal segregation due to improper paver operation.

In this study, the most factors that affect road maintenance are verified, accordingly: - Maintenance Age, Road Surface Condition, Terrain, Pavement Construction Details and Availability of Drainage System;- are the most factors that affect asphalt road maintenance in the case study area. This indicates that, typically, pavement deteriorates at an ever-increasing rate: at first, very few distresses are present, and pavement stays in relatively good Condition, but as it ages, more distresses develop, with each distress making it easier for subsequent distresses to develop. Also, the quality of the road surface is critical to ensure the safety of drivers and other road users. Poor road conditions can lead to accidents, delays, and additional costs for road maintenance.

There are so many methods of road maintenance. Clean and seal, Rout and seal, Crack filling, Full-depth crack repair, Fog seal, Slurry seal, Pothole patching and Crack repair are assessed in the case study area. From these, as assessed: - full-depth crack repair, pothole patching, crack filling, and crack repair are the most applicable methods in the study area.

Full-depth repair is removing and replacing at least a portion of a slab to the bottom of the concrete in order to restore areas of deterioration. Also, Full-depth patches improve pavement ride ability and structural integrity and extend pavement service life. Crack filling is the placement of asphalt emulsion into non-working cracks to reduce water infiltration and reinforce the adjacent pavement, and Crack Repair is a liquid substance that can be poured into any cracks or voids that appear in asphalt roads or footways; this is a preventive maintenance procedure that will prevent water ingress and give the surface a longer lifespan.

The different types of road maintenance strategies are assessed for the study area. Accordingly: - Periodic Maintenance, Preventive Maintenance, Routine maintenance and Emergency Maintenance are the most recommended road maintenance strategies for the study area. Maintenance types such as Time-Based Maintenance, Failure Finding Maintenance, and Risk-Based Maintenance, Condition Based Maintenance, and Predictive Maintenance are all part of Preventive Maintenance, which is carried out prior to a failure occurring. Emergency maintenance is for issues that might cause immediate harm to occupants or others. Routine maintenance is for issues that can be addressed after some time.

5.2 Recommendation

To improve the culture of road maintenance in the case study area, the stakeholders should bring significant change and take responsibility.

- A. For the Communities: - Communities play a major part in the implementation of information-gathering and road maintenance programs. Communities should get involved right away in it.
- B. For the Municipality of the study area. According to the survey in the study area, there needs to be a better Culture of asphalt road Maintenance. So, the Municipality must adopt alternative maintenance strategies and a good Culture of asphalt road Maintenance to extend the lifespan and service duration of the asphalt roads. Provincial and local governments are responsible for roads within their areas. They undertake the planning, construction and maintenance of roads and bridges.
- C. For Road Maintenance Contractor: -During the construction and maintenance of the roads, the contractor should consider the quality and skill of materials and labour, respectively.
- D. For Regulatory bodies: - Based on the survey, the most recommended type of Road maintenance is Preventive Maintenance, which includes:- Time-Based Maintenance, Failure Maintenance, Risk-Based Maintenance, Condition Maintenance, and Predictive Maintenance. So, the regulatory bodies should recommend it to the concerned bodies.
- E. For another Researcher

Further detailed research is needed to improve the implementation of road maintenance, specifically on the Computer Road Maintenance Management Information System.

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JIMMA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
JIMMA INSTITUTE OF TECHNOLOGY
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
CONSTRUCTION ENGINEERING AND MANAGEMENT STREAM

Research title “Assessment of Asphalt Road Maintenance Management Practice: In Case of Jimma Town”

QUESTIONNAIRE FOR CONSTRUCTION COMPANIES.

Objective of the questionnaire survey

Dear respondent,

A road pavement must fulfil two basic functions, which are structural and functional requirements. In terms of functional performance, the pavement must have a good riding quality to ensure comfortable travel for the road user, and the surface must have adequate drainage, skid resistance, reflectivity and line markings to ensure safe travel.

Taking care of pavement deterioration at the proper time and in the proper manner can significantly increase the life of the pavement. In Jimma Town, there still needs to be a gap in integrated and Timely maintenance. Due to this increased and continued traffic crossing, pavements are more easily damaged and distressed. Therefore, for these problems, a series of investigations on maintenance management practice of asphalt road maintenance identify factors affecting asphalt roads and techniques to maintain the asphalt roads in Jimma Town.

Asrat Eshetu Teshome

Jimma University, Jimma Institute of Technology School of Graduate Studies Faculty of Civil and Environmental Engineering Construction Engineering and Management Stream.

Phone no.: +251 911 48 45 48 Email: asrat1234@gmail.com

Appendix A

I. Respondents Profile

Mark your answer by ticking on the provided area.

1. Responsible:- Client ☐ Consultant ☐ Contractor ☐ Sub-Contractor ☐
Local Authorities ☐ Regulatory Body ☐ Residents ☐ Public
transport providers and users ☐
2. Position: - Project Manager ☐ Office Engineer ☐ Site Engineer ☐
Contract Administrator ☐ Site Supervisor ☐ Project Coordinator ☐ Other, please
specify.....
3. Level of education:-Diploma ☐ Bachelor's Degree ☐ Master's Degree ☐ PhD ☐
other, please Specify.....
4. Level of experience in years:- 0-5 ☐ 5-10 ☐ 10-15 ☐ 15-20 ☐ > 20 ☐

II. Data Survey on Jimma Town Asphalt Road Maintenance Practice

1. According to your perception, during asphalt road construction in Jimma Town, does it use
quality materials? Yes ☐ No ☐
2. As per your observation, is there a good Culture of asphalt road Maintenance in Jimma
Town?
Yes ☐ No ☐
3. Does involving qualified and skilled professionals and Labour in Asphalt road
maintenance? Yes ☐ No ☐
4. Have you realized any negative impacts on the daily activities of users because of poor
asphalt road maintenance management? Yes ☐ No ☐
5. If your answer is "Yes", please specify it.....
6. Are Road facilities having effects on Road maintenance management? Yes ☐ No ☐

7. If your answer is "Yes", please specify it.....

III. The most common causes of Road failure

The scale of the Agreement level

1 = Strongly Disagree

4 = Ag

2 = Disagree

5 = Strongly Agree

3 = Moderately Agree

The most common causes of Road failure		Scale of Agreement level				
		1	2	3	4	5
1	Insufficient Strength Properties of Bituminous Mixes					
2	Poor Maintenance Culture					
3	Movement Of Over Loading Vehicles					
4	Bad Drainage Condition					
5	Natural Disaster					
6	Expansion and contraction from seasonal temperature changes					
7	Sun Exposure					
8	Poor Engineering Design					
9	Poor Construction Methods/Technique					
10	Poor road-use culture					
11	Poor Use (Abuse) of Road Facilities					
12	Poor Quality of Materials.					
13	Timing of Maintenance.					

IV. The most failures or Defect present on asphalt Road

No .	The most failures or Defect present on asphalt Road	Scale of Agreement level				
		1	2	3	4	5
1	Water Bleeding					
2	Shear failure cracking.					
3	Depressions					
4	Edge Subsidence					
5	Consolidation of pavement layers (Rutting)					
6	Edge Damage					
7	Local Aggregate Loss					
8	Potholes And Shovel					

9	Longitudinal cracking					
10	Raveling (very porous asphalt)					

V. The main factors that affect asphalt road maintenance

No.	The main factors that affect asphalt road maintenance	Scale of Agreement level				
		1	2	3	4	5
1	Road Surface Type					
2	Traffic Flows And Composition					
3	Road Surface Condition					
4	Climate					
5	Terrain					
6	Pavement Construction Details					
7	Maintenance Age,					
8	Availability of Drainage System					
9	Environmental Factors					
10	Road Surface Type					

IV. Types of Maintenance Treatments

No.	Recommended Treatment methods for Surface Defects/distress	Scale of Agreement level				
		1	2	3	4	5
1	Clean and seal					
2	Rout and seal					
3	Crack filling					
4	Full-depth crack repair					
5	Fog seal					
6	Slurry seal					
7	Pothole patching					
8	Crack repair					

V. Recommended Road maintenance management strategies

No.	Road maintenance management strategies	Scale of Agreement level				
		1	2	3	4	5
1	Routine maintenance					
2	Periodic Maintenance					
3	Emergency Maintenance					
4	Preventive Maintenance					
5	Corrective Maintenance					
6	Predictive Maintenance					
7	Reliability-Centered Maintenance					

Thank you so much.

Asrat Eshetu Teshome

Jimma University, Jimma Institute of Technology School of Graduate Studies Faculty of Civil and Environmental Engineering Construction Engineering and Management Stream.

Phone no.: +251 911 48 45 48 Email: asrat1234@gmail.com

APPENDIX B

- Sample pictures and evidence from the Case study area

