

AN OVERVIEW OF PAVEMENT
MAINTENANCE PRACTICE BY LOCAL
AUTHORITY AND GOVERNMENT AGENCY

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B. ENG(HONS.) CIVIL ENGINEERING

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AN OVERVIEW OF PAVEMENT MAINTENANCE PRACTICE BY LOCAL
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ABSTRAK

Jalan adalah salah satu infrastruktur yang paling penting dalam komuniti. Penyelenggaraan yang sewajarnya oleh pihak berkuasa jalan ke arah rangkaian jalan dapat memudahkan perniagaan dan aktiviti harian masyarakat. Kesedaran di kalangan pihak berkuasa yang mengendalikan penyelenggaraan jalan raya sangat rendah. Penyelenggaraan yang betul dan tepat pada masa oleh pihak berkuasa jalan adalah penting untuk keselamatan dan keselesaan pengguna. Penggunaan sistem pengurusan penyelenggaraan jalan memberikan manfaat penting seperti mengenal pasti masalah biasa dalam penyelenggaraan jalan, ramalan tepat tentang kerosakan jalan dan memperbaiki amalan penyelenggaraan jalan oleh pihak berkuasa jalan dari semasa ke semasa. Objektif kajian adalah untuk meneroka amalan semasa sistem pengurusan penyelenggaraan jalan dalam industri pembinaan dan untuk mengenal pasti masalah biasa dalam sistem pengurusan penyelenggaraan jalan. Dengan mengedarkan soal selidik yang secara langsung dijalankan dengan pihak berkuasa jalan raya dari agensi kerajaan dan pihak berkuasa tempatan dari jabatan jalan raya penyelenggaraan dan pemulihan. Data yang dikumpul dianalisis dengan menggunakan kaedah purata indeks dan statistik deskriptif untuk mendapatkan keputusan. Dari hasilnya, amalan sistem pengurusan penyelenggaraan jalan yang paling strategi penyelenggaraan yang dipilih oleh pihak berkuasa tempatan ialah 70% daripada kriteria peringkat dan paling kurang 5% dari HDM-4. Dari sini, ia menunjukkan bahawa kakitangan lebih suka melakukan strategi penyelenggaraan secara manual dengan menggunakan kriteria peringkat. ia menunjukkan terdapat kurang kakitangan pengalaman di pihak berkuasa tempatan. Ini kerana, HDM-4 memerlukan kakitangan pakar dan pengalaman untuk mengendalikan perisian tersebut. Bagi masalah biasa dalam sistem pengurusan penyelenggaraan jalan, indeks purata bagi agensi kerajaan dalam peringkat reka bentuk masalah adalah 3.5

yang bersifat neutral manakala untuk pihak berkuasa tempatan ialah 3.45 yang juga neutral. Oleh kerana kekurangan kawalan dan pemantauan oleh pihak berkuasa untuk agensi kerajaan ialah 3.23 yang neutral manakala untuk pihak berkuasa tempatan adalah 2.93 yang juga neutral. Seterusnya, dana untuk penyelenggaraan jalan untuk agensi kerajaan adalah 3.83 yang sepatutnya sementara untuk pihak berkuasa tempatan adalah 4 yang sangat setuju. Bagi komunikasi dan kemahiran kakitangan ialah 3.15 yang neutral manakala untuk pihak berkuasa tempatan adalah 3.25 yang juga neutral. Seterusnya bagi latihan dan pemahaman kakitangan untuk agensi kerajaan adalah 3.88 yang sepatutnya manakala pihak berkuasa tempatan adalah 3.78 yang juga bersetuju. Dari hasilnya, kita dapat lihat bahawa masalah yang paling biasa dalam sistem pengurusan penyelenggaraan untuk agensi kerajaan adalah latihan dan pemahaman staf. Bagi pihak berkuasa tempatan adalah dana untuk penyelenggaraan jalan.

ABSTRACT

Roads are one of the most important infrastructures in a community. A proper maintenance by road authority towards the road network can ease the business and daily activity of a community. The awareness among the authorities that handle the road pavement maintenance is very low. Proper and timely maintenance by road authorities is important for safety and comfort of users. The use of pavement maintenance management system provides significant benefits such as identification of the common problem in pavement maintenance, accurate prediction of road deterioration and improves the practices of pavement maintenance by road authorities from time to time. The research objective was to explore current practise of pavement maintenance management system in construction industry and to identify the common problems in pavement maintenance management system. By distributing the questionnaire that was directly being conducted with the road authorities from the government agency and local authorities from the maintenance and rehabilitation road department. The data collected were analyzed using an average index method and descriptive statistics to obtain the result. From the result, the current practice of pavement maintenance management system the most type of maintenance strategy chooses by local authority was 70% from ranking criteria and the least was 5% from HDM-4. From here, it shows that the staff preferred to do the maintenance strategy manually by using ranking criteria. it shows there were lacking of experience staff in local authority. This is because, HDM-4 needs an expert and experience staff to handle the software. As for the common problem in pavement maintenance management system, the average index for government agency in problem design

stage was 3.5 which is neutral while for local authority was 3.45 which is neutral as well. For lack of controlling and monitoring by authority for government agency was 3.23 which is neutral while for local authority were 2.93 which is neutral as well. Next, funds for pavement maintenance for government agency were 3.83 which is agree while for local authority was 4 which is strongly agree. For communication and skill of the staff was 3.15 which is neutral while for local authority was 3.25 which is neutral as well. Next for training and understanding of staff for government agency was 3.88 which is agree while for local authority was 3.78 which is agree as well. From the result, we can see that the most common problem in pavement maintenance management system for government agency is training and understanding of staff. While the local authority is funds for pavement maintenance.

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LIST OF SYMBOLS

DBKL	Dewan Bandaraya Kuala Lumpur
PWD	Public Work Department

LIST OF ABBREVIATIONS

DBKL	Dewan Bandaraya Kuala Lumpur
PWD	Public Work Department
AVI	Average Index Method

CHAPTER 1

INTRODUCTION

1.1 Research Background

Road network is one of the most important economic activities. In other words, road network is an investment of public funds. A proper pavement maintenance management system to the roadway network must be made in order to sustain and maintain the roadway condition. Maintenance is always a must for any structure in order to maintain its serviceability and to prevent deterioration that may shorten the service life (Ahmad, 2002).

A pavement management system ensures efficient management of road assets. It also provides cost effective decisions on the allocation of funds for better road maintenance (Haas et al, 1994) (Robinson et al, 1998). Road deteriorate translate into more money requirements. This, in turn, increases maintenance and rehabilitation costs (sue mcneil, 1992). Many countries have been implement a pavement maintenance management system (PMMS) including Malaysia, which this system help the decision makers such as pavement engineers to apply the best technique and solution for pavement rehabilitation within a short period.

Authorities in Malaysia have responsibilities to ensure road condition is in good condition. However, lack of proper maintenance management on managing pavement

deterioration and lack of awareness among the authorities' staff in Malaysia. Due to that, lack of maintenance culture facilities in Malaysia is also brings poor maintenance activities carried out (Abdullah, 2006). Maintenance, repair, rehabilitation and reconstruction of road pavement are important to not only the economic but also the road user.

An appropriate maintenance management tool should be used and any suitable tools available can be used to assist decision makers to ensure the facilities are well managed (McNeil et al, 1992). So pavement maintenance management system(PMMS) considered as an essential strategy to minimize the road deterioration rates, protect road user's safety, elongate pavement life and increase efficiently in addition to utilize resources in best ways (Shafik and Mehar, 2005).

Therefore, it is very important to study pavement maintenance management system (PMMS) in order to provide significant benefits such as identification of the most effective pavement treatment for a certain road in Kuala Lumpur.

1.2 Problem Statement

Malaysian federal roads are not well maintained and so exhibit much surface damage, which causes difficulties for road users (Mohd hizam,2009) and means that their overall performance is below that of highway and expressway (mansor,2010). The rapid urbanization in Kuala Lumpur has caused many road problems such as potholes, cracking and others that appeared on the road.

Due to that, the efficiency of the traffic, comfortness of the road and safety of the road to the public in Kuala Lumpur are lacking. The awareness among the authorities that handle the road pavement maintenance is very low. Too often only emergency maintenance and repair is undertaken (New Straits Times, 2001). This has shown that

the priority and proper maintenance was not carried out. Poor awareness and management have caused low maintenance activities by the road authorities. That is why proper and timely maintenance and rehabilitation is important to ensure safety of road user and smoothness of road traffic.

1.3 Research objective

- i. To explore current practise of pavement maintenance management system in government agency and local authority
- ii. To identify the common problems in pavement maintenance management system

1.4 Scope of work

The scope of study for achieving the objective is to focus on maintenance work done for federal road by road authorities and the practise of the pavement maintenance management sytem done by road authorities on federal road . Unit kejuruteraan awam dan pengangkutan bandar in government agency (JKR) and local authority staff involve in this area of study. This study will only focus on current practice of pavement maintenance system practice by road authorities on managing and handling reports and problem occurs. Other than that, the common problem in pavement maintenance management system also involved in this study.

1.5 Research Methodology

Chapter 1: Background of the study

This chapter is including of an introduction of the study, problem statement, objectives or destinations of the study, degree and confinement of the study, significant of the study, methodology, and arrangement of chapters.

Chapter 2: Literature Review

This chapter will outline the background of the study and the literature review from the secondary sources that related to the study issue. The information will comprise from the past research by other researcher and it will support the aim and destination of this study.

Chapter 3: Research Methodology

This chapter will briefly expose and explain the methodology and case work, which it will generate the information and data required to support the study in order to achieve the study objectives.

Chapter 4: Analysis and Finding

This chapter is about the data analysis and presenting the findings obtain from the study by setting out the result.

Chapter 5: Conclusion and Recommendation

This chapter will provide the conclusion of the study which the decision is made on the data analysis. From the study result, the suitable recommendation can be made to resolve the problem study and for future research.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, we will discuss on pavement maintenance management system. The economic life of a building or infrastructure can be prolonged through improved initial design and a regular maintenance program (Christian and Pandeya, 1997). Dealing and handling effectively with information from observation is an important part for good maintenance practice. The facilities on the infrastructure maintenance are not in good working condition when assets like machinery, utilities, roads, sewage systems, buildings and vehicles are in good working order, there will be substantially less wastage of time and resources on repair and rework, as well as fewer delays due to breakdowns of assets (Hassan, 2007).

2.2 Background Of Roads In Malaysia

The roads network in Malaysia has undergone several stages; the first stage was before 1950s when roads were built for trade purposes, and the second stage was the construction of the Rural roads to accelerate road development during the period 1960s-1970s, after that the stage of alleviation of transport problems by built Inter-urban 5 linkages during the period 1980s-1990s, and the last stage is Connecting the developed

areas with the less developed areas since 2000 onward, and nowadays the total length of the Malaysian road network is 73,403km (Dato’ Ir. Hj. Mohamad Razali bin Othman 2006).

Table 1: Road Categories and Length

Road Categories Length (km)	Road Categories Length (km)
Toll Expressways	1700
Federal	17500
State	61100

2.3 Road types in Malaysia

Roads in Malaysia are classified into four types, in order to organize the road network Hierarchy.

2.3.1 Federal roads

Federal roads are all roads declared under the Federal Roads Ordinance (1959) and the major interurban roads joining the state capitals and roads leading to points of entry to and exit from the country. Also includes highways and roads under the administration of the public work department Malaysia, and the regional development scheme roads, such as those within the federal land development authority (FELDA) schemes, federal land consolidation authority (FELCRA). Federal roads construction

and maintenance is done by the Public Works Department Malaysia (Malaysian roads general information, 2003).

Table 2: Administrative Agencies For Federal Road Maintenance

Road category	General description	Responsible authority
Toll Expressways	Inter-urban toll expressways	Malaysian Highway Authority (MHA)
National highways	Inter –urban linking Federal capitals	PWD Malaysia
Regional road schemes	Roads forming network in RDA	PWD Malaysia regional units
Minor roads (access to government buildings)	Roads lead to within federal government institution	State PWD

2.3.2 State roads

State roads generally comprises of the primary roads providing intra-state travel between the district administrative centers. Other roads included in this category are the urban collector roads under the municipalities and other minor roads within the villages and the rural inhabited areas under the Districts Offices.

Table 3: Administrative Agencies For State Road Maintenance

Road category	General description	Responsible authority
Roads within Federal Territories	Roads other than the designated Federal Roads.	City hall of Kuala Lumpur and municipal council of Labuan
Primary Roads	Major roads forming the basic network within a state, linking state capitals and major towns	State PWDs
Secondary roads	Roads forming the network within a district	State PWDs
Minor roads	Minor road within a village or rural inhabited area.	District officers
Urban collector roads	Road serving as collectors and distributors of traffic within a local authority area	Respective local authorities (with assistance from state PWDs in most cases)
Local streets	Basic road network within an urban neighbourhood, serving primarily to offer direct access to abutting land	Respective local authorities

*PWD ; Public Work Department of Malaysia , which is one of the department under Malaysian Highway Authority

2.3.3 Local authority roads

Local authority roads are the roads within the limit of the local authority, and are normally maintained by the responsible local authority, (JKR, DBKL)

2.3.4 Kampong (district office) roads

Kampong (district office) roads are all roads under the district office; they are usually earth roads with no right of way. The maintenance of these roads is the responsibility of the district office, (JKR guide on geometric design).

2.4 Road pavement

The road pavement is the actual surface on which the vehicles will travel. Its purpose is two fold, to provide friction for the vehicles and to transfer normal stresses to the underlying soil. There are several type of pavement layer in flexible pavement as shown in the figure below :-

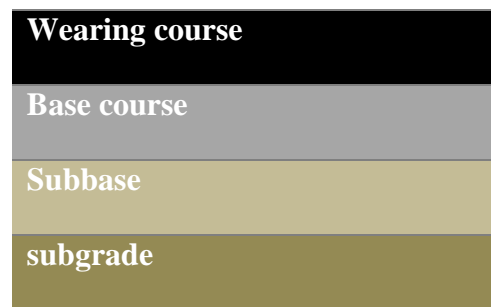


Figure 1: Type of Pavement Layer in Flexible Pavement.

2.5 Pavement management system

PMS provides consistent, objective and systematic procedure for determine priorities, schedule, allocating resources and budgeting for pavement maintenance and rehabilitation (FAA 2006). Pavement management system can be split into two major parts that is network and project level.

2.5.1 Network level

The network level focuses on creating the most effective use of budgetary resources for the entire network.

2.5.2 Project level

Project level is specific to a given area that has been identified for potential rehabilitation

2.6 Maintenance management system

Maintenance management can be defined as a combination of all technical, administrative and managerial actions during the life cycle of an item, intended to retain it or restore it to a state in which it can perform the required function (Wireman, 1990). Maintenance management plays an important role to determine the successful of maintenance work that have been carried out.

Maintenance management defined as the organization of maintenance within an agreed policy that determine the maintenance objectives and responsibilities and how to implement them by means such as maintenance planning, maintenance control and supervision, and several improving methods including economic aspect in an organization (Armstrong, 1987).

A maintenance system can be seen as simple input-output system (Duffuaa et al, 2000). Maintenance management is not a static process, but it is dynamic in the sense that the strategy and policies are continually reviewed to ensure that it is in line with the overall objective (Coetzee, 1999). Thus road authorities should give concern na put an effort for improvement to achieve its objective.

2.7 Road maintenance

Maintenance reduces the rate of pavement deterioration, it lowers the cost of operating vehicles on the road by improving the running surface, and it keeps the road open on a continuous basis (World Bank, 1988). It also includes the process of enhancing the environment of the road itself, including the immediate surroundings. Maintenance should also be carried out to improve safety and satisfactory of the road users.

2.8 Decision tree analysis

A decision tree is a decision support tool that uses a tree-like graph or model of decisions and their possible consequences including chance event outcomes, resource costs, and utility. It is one way to display an algorithm. In this decision tree analysis, the most common used for road database for pavement maintenance and management are ID3 Decision Tree and C5.0 Decision Tree. Furthermore, decision analysis provides insight into how the defined alternatives differ from one another and then generates suggestions for new and improved alternatives (Arsham H, 2004).

2.9 HDM-4

HDM-4 calculates the present values (PVs) of the lifecycle total transport cost (TTC) associated with given initial pavement designs and maintenance options for a given road section (specified by geometric characteristics and environmental conditions), for a specified period of analysis. The initial step was to use data from the existing Database for roads, bridges and tunnels for which the field survey was carried out as part of the “Road rehabilitation” project financed by the World Bank (Spornol, 2005)

2.10 Falling weight deflectometer

The falling weight deflectometer are commonly used for nondestructive testing of pavements. Figure 2 show the falling weight deflectometer



Figure 2 : falling weight deflectometer

2.11 International Roughness Index

The International Roughness Index (IRI) is the roughness index most commonly obtained from measured longitudinal road profiles. It is calculated using a quarter-car vehicle math model, whose response is accumulated to yield a roughness index with units of slope (Sayers, M.W, Karamihas, S.M, 1998). The simulation of the roughness response of a car traveling at 80 km/hr. It is the Reference Average Rectified Slope, which expresses a ratio of the accumulated suspension motion of a vehicle, divided by the distance traveled during the test (Khaled Ksaibati, 2002) from figure 3, it show the IRI roughness scale.

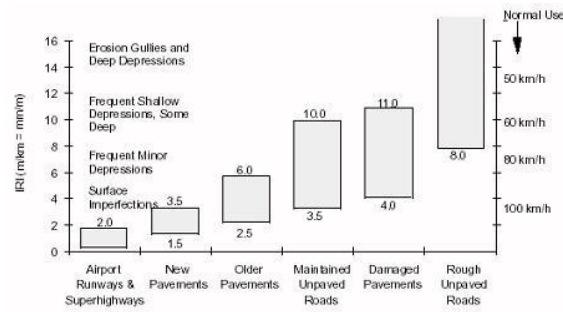


Figure 3: IRI roughness scale replotted (Sayers et al., 1986)

2.12 Periodic Maintenance

These operations covers section of road at regular and relatively long scale. Due to the large scale it requires specialized equipment and skilled personnel. They cost more than routine maintenance works and require specific identification and planning for implementation and often even design. Activities can be classified as preventive, resurfacing, overlay, and pavement reconstruction. Resealing and overlay works are generally undertaken in response to measured deterioration in road conditions. For a paved road repaving is needed about every eight years; for a gravel road re-graveling is needed about every three years (WB Maintenance website).

2.13 Routine Maintenance

Routine maintenance comprises small-scale works conducted regularly, aims “to ensure the daily passability and safety of existing roads in the short-run and to prevent premature deterioration of the roads” (PIARC, 1994). Frequency of activities are different but is generally once or more a week or month. Typical activities include roadside verge clearing and grass cutting, cleaning of silted ditches and culverts,

patching, and pothole repair. For gravel roads it may include regrading every six months.

2.14 Ranking Criteria

Ranking criteria helps the decision makers in selective the best alternative. Ranking criteria determine the priority weight of pavement maintenance factor such as road type, pavement condition, traffic volume, maintenance cost and others.

2.15 Percent Of Cracking/Km

Cracking occurs predominantly to the pavement. It can occur anywhere within the lane. Low Cracks with a mean width of < 0.25 in. (6 mm). Sealed cracks with sealant in good condition and a width that cannot be determined. Medium Cracks with a mean width > 0.25 in. (6 mm) and ≤ 0.75 in. (19 mm). Also, any crack with a mean width < 0.75 in. (19 mm) and adjacent random low severity cracking. High Cracks with a mean width > 0.75 in. (19 mm). Also, any crack with a mean width < 0.75 in. (19 mm) and adjacent random medium to high severity cracking.

2.16 Percent Of Potholes

Percent of potholes is the number of potholes per kilometre in term of the number of standard sized potholes of area 0.1m^2 . a potholes being defined as an open cavity in road surface with at least 150mm diameter and at least 25mm depth.

2.17 Percent Of Rutting

The minimum depth under 2m straight edge placed transversely across a wheelpath. Low Ruts with a measured depth $\geq 0.20''$ and $\leq 0.49''$ Medium Ruts with a measured depth $\geq 0.50''$ and $\leq 0.99''$ High Ruts with a measured depth $\geq 1.00''$ Ruts $<$

0.20” are not included in the distress calculations. From figure 4, it shows the measuring rutting is being evaluated.

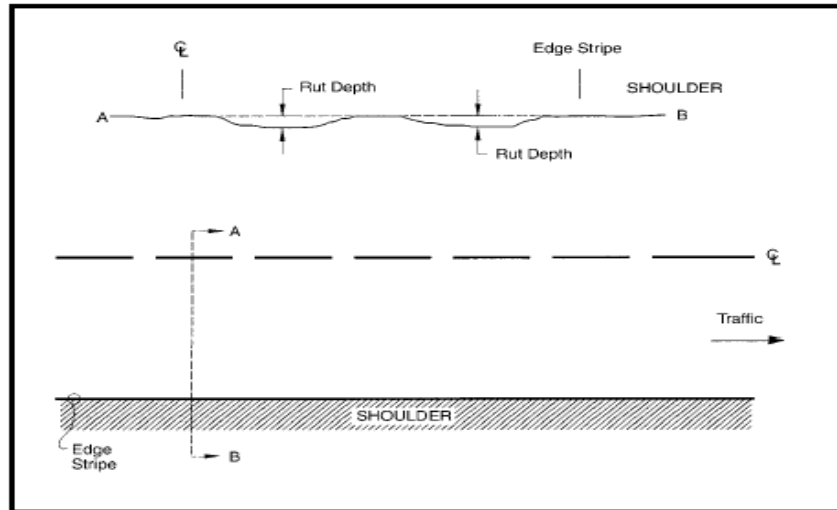


Figure 4: Measuring Rutting

2.18 Skid Resistance Data

Resistance to skidding expressed by the sideways force coefficient. Skid resistance depends on a pavement surface's microtexture and macrotexture (Corley Lay, 1998). Road Surface Analyzer can be used for measuring texture, aggregate segregation, grooves, tining, joints, and faulting (FHWA, 2001).

2.19 Cracking

Identification of the road cracks at an early stage is essential as preventive road maintenance and effective remedial measures can be applied before the problem becomes too severe and the pavement fails. Table 4 show the type or road cracking that commonly occurs on road.

Table 4 : type of cracking

Type of cracking
Fatigue Cracking Square
Block Cracking Square
Edge Cracking
Wheel Path Longitudinal Cracking
Non-Wheel Path Longitudinal Cracking
Reflection Cracking at Joints - Transverse Reflection Cracking - Longitudinal Reflection Cracking
Transverse Cracking

2.20 Potholes And Patching

Patching is an area of pavement surface that has been removed and replaced with patching material or an area of pavement surface that has had additional patching material applied. Patching may encompass partial lane or full lane width. On full lane width patching, the total, contiguous length of patch may not exceed 0.30 mi. (4.84 km). (Any full-lane patch exceeding 0.30 mi. in length is considered a pavement change). Patching must have a quantifiable area. Potholes are bowl-shaped holes of various sizes occurring in the pavement surface.



Figure 5 : potholes and patching

2.21 Edge Break

Edge break is defined as fretting or breaking of the edge of a bituminous surface, such that seal loss encroaches into the carriageway by more than 100mm from the nominal seal edge or onto the white edge line.



Figure 6: edge break

2.22 Pavement Unevenness

Pavement unevenness affects the vehicle operating cost, speed, riding comfort, safety, fuel consumption, wear of tires, and pavement service life (Zhang et al., 2017).

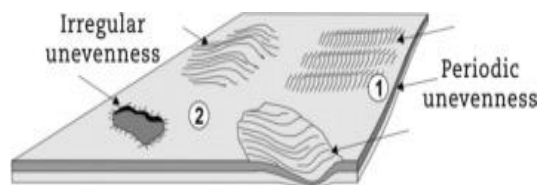


Figure 7: Periodic and irregular unevenness in the longitudinal direction (Krause and Maerschalk, 2010).

2.23 Automatic Crack Detection

Crack detection also done by automatic inspection where trending technology image processing is used. (Kammar et al, 2014) have proposed a gadget for street crack detection and characterization to limit the human involvement. Furthermore, the statistical technique proved to be green and accurate for information analysis and filtering of snapshots (Kammar et al, 2014). Consistent with the technique, a sequence of photos is processed through the crack detection set of rules for you to come across the cracks. Along with the detected crack the set of rules gets photos as inputs and outputs a brand new image with crimson debris. Even no pavement picture databases are public to be had for crack detection and characterization assessment functions (Henrique, 2014).

2.24 Axle Load

The axle load survey team normally consists of about 15 people working on a three shift basis with 4 - 5 people on each shift. The success of an axle load survey and the ease with which it can be carried out will depend largely on the choice of site. In general the site must be selected to make it possible to weigh the vehicles easily and safely.

2.25 Minor Maintenance

Minor road maintenance is when the road is fair to good condition for example patching and filling. Small medium to large crack. Minor Maintenance means routine preventive or corrective maintenance works such as minor repair, reconditioning, or replacement of spare parts to ensure serviceability of existing and new infrastructure assets procured and installed by the Contractor.

2.26 Use In House Resources

In-house refers to conducting an activity or operation within a company, instead of relying on outsourcing. This occurs when a firm uses its own employees and time to keep a division or business activity. Additionally, it may allow the business to exert higher levels of control over the actions of the divisions by keeping the services and personnel under direct control. It may also pose fewer security risks depending on the kinds of data that would have to be supplied to an outside party should the activity be outsourced (Adam Hayes, 2019)

2.27 Performance based contract

Contractor is paid monthly based on performance outputs measured against standards stated in the contract rather than inputs. Penalties are imposed if the outcomes for a specific activity fail to comply with the contract standards, and payment may be reduced or suspended until the necessary repairs are done. Less effort is spent on contract administration, and corruption tends to decline. The contractor's share of responsibility increases over time. The contractor decides whether to use innovative and more efficient methods to cut costs and meet the required performance standards. As the road agency and contractors gain more experience, the routine maintenance contract can be extended from one year to three or more. If the contract is extended to cover periodic maintenance once the contractor has the necessary skills, the contract should be issued for three years or more since periodic maintenance occurs less frequently. This type of contract can be used for roads in poor condition, but initial rehabilitation should be specified using agreed rates and measured quantities.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter discussed about pavement maintenance management system, the definition and detail about pavement maintenance management system. Instead, this chapter will explain more about the way to collect the data and information to support the facts and as evidence for the previous chapter. According to Jamil (2013), based on the research objective, methodologies have been identified at an early stage of to help the as guidelines for research.

The classification of the roadway network (urban or rural) is the first step in the implementation of the system. It is followed by Zonings, if it is an urban area; the roadway network is divided into municipality zones, while if it is rural area, then road sections and segments of the section are considered. Means that, each and every section of road will be different in term of their ways in maintenance and how the road authorities handle the system in their road jurisdiction.

Maintenance alternative may include more than one repair technique, which may be necessary to repair single, or multiple distress in the same project. The final choice of maintenance alternative and the technique to be considered as feasible maintenance for specific pavement will be based on project evaluation results, service life extension

expected, and duration of maintenance, traffic control problems, and cost analysis. Availability of multiple choice of method for maintenance work makes the decision makers to decide which method was the best way to implement at the road. Thus by doing this, the strategy and problem that occur when the decision maker maintaining the pavement in their road jurisdiction were obtained.

3.2 Research planning

In this research planning, the first step involved is to provide a flow chart to help implementing of the study. Designing a research was to identify the flow of research method. The next process it to prepare sample of questionnaire needed to be distribute in this study. Results data was gathered and analysed. After analysis of the study,the conclusion and recommendations were proposed. After the entire previous step was done, the writing process started and the project was complete.

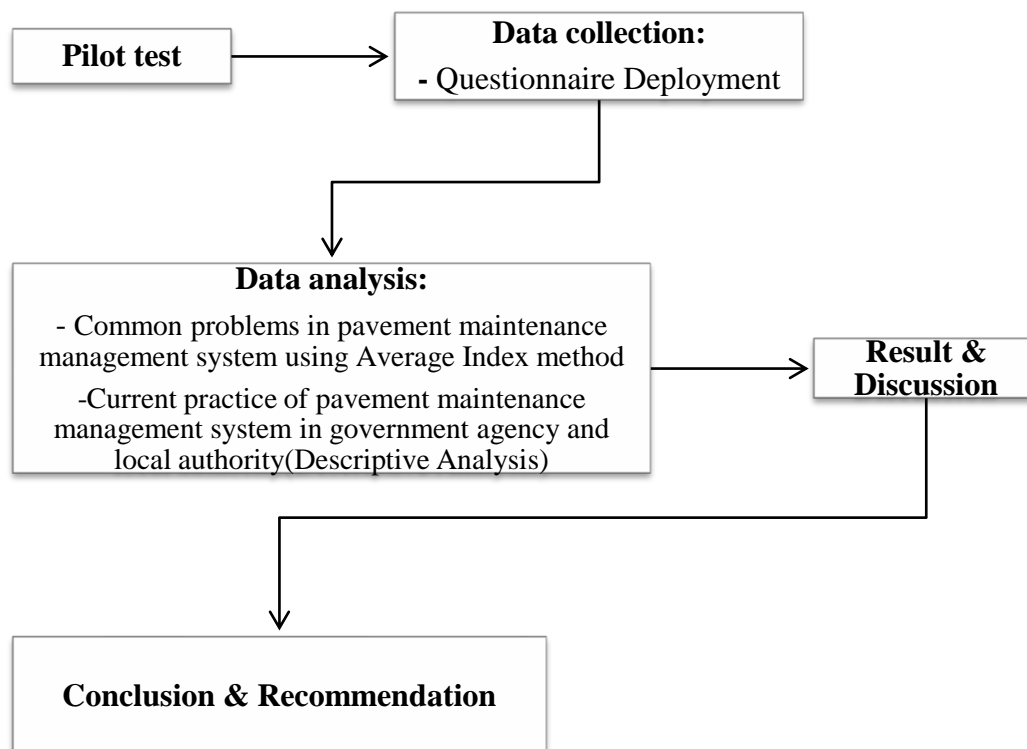


Figure 8 : Flowchart of work progress

3.3 Research strategy

Data collection that was used for this research is by using quantitative data. Quantitative research is explaining phenomena by collecting numerical data that are analyzed using mathematical based methods (in particular statistics) (Aliaga and Gundersan, 2000). Not only that, it can be used to analyze from the generating data by using a statistical approach.

Quantitative data collection methods include various form of survey which is online surveys, paper surveys, mobile survey, telephone interview, website interceptors and others. In this research, paper surveys is selected for this scope of study. Nevertheless, it also have disadvantages which is no objectively verifiable result, skillful requirement for interviews and time consuming during interviewing process and intensive category process (Looi.T.C,2014).

3.4 Research approach

The main objective of this research was to identify the current practice of pavement maintenance management system by local authority and government agency and common problem in pavement maintenance management system. Road authorities that involved in this study are JKR and DBKL whom involved in pavement maintenance. This research was only focus on maintenance management practices. Therefore, in order to get the accurate data that were needed researcher decided to use questionnaire survey form.

3.4.1 Questionnaire

Quantitative method that was use is questionnaire. This is another method to collect primary data. This method gives advantage in gathering descriptive data and also can cover a wide range of topics. But it also weak in terms of provide adequate information on context. It may provide a general picture about the issue but lack depth and may cause biased in reporting. The questionnaire are from a set of question for obtaining information from the respondent.

The questionnaire were divided into three parts. The first part is part A, which the question was cover on the respondent backgrounds. For part B, which was covered for practice in pavement maintenance. The last part which is part C was covered for problems in pavement maintenance.

For most of part B and part C the question was used likert scale questions to indicate staff of road authorities on maintenance management system with the statement in the questionnaire ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire was made in such a way that it is easy to understand, direct and clear which is in simple English.

3.4.2 Pilot test

Basically, pilot testing means finding out if your survey, key informant interview guide or observation form will work in the “real world” by trying it out first on a few people. The purpose is to make sure that everyone in the sample not only understands the questions, but understands them in the same way. The pilot test is tested on people that represent the various subgroups within the intended sample.

3.4.3 Random sampling

Random sampling is the most straightforward probability sampling strategy. It is also the most popular method for choosing a sample among population for a wide range of purposes. In simple random sampling each member of population is equally likely to be chosen as part of the sample.

The logic behind a random sampling is that remove any for of bias from the selection. The use of random numbers, an alternative method also involves numbering of population members from 1 to N . Then, the sample size of N has to be determined by selecting numbers randomly. The use of random number table similar to one below can help greatly with the application of this sampling technique. Based on figure 8 , the random number table is the most suitable example to represent th N number in a population that going to be choose randomly.

For this research, a random sampling in government agency and local authority was made. From a large number of group in the maintenance facility, the questionnaire were distributed randomly to the staff in the maintenance facility. Based on the random sampling that was made, the total number of N was 100 for government agency and local authority.

Random Number Table

20	17	42	01	72	33	94	55	89	65	58	60
74	49	04	27	56	49	11	63	77	79	90	31
94	70	49	49	05	74	64	00	26	07	23	00
22	15	78	49	74	37	50	94	13	90	08	14
93	29	12	20	26	22	66	98	37	53	82	62
45	04	77	48	87	77	66	91	42	98	17	26
44	91	99	08	72	87	33	58	12	08	91	12
16	23	91	95	97	98	52	49	40	37	21	46
04	50	65	37	99	57	74	98	93	99	78	30
32	70	17	05	79	58	50	26	54	30	01	88
03	64	59	55	85	63	49	46	61	89	33	79
62	49	00	67	28	96	19	65	13	44	78	39
61	00	95	85	86	94	64	17	47	67	87	59
89	03	90	40	10	60	18	43	97	37	68	97

Figure 9: Random number table

3.5 Data analysis

Analysis of this research was to evaluate whether the research study has met its goal or vice versa. The data collected from the quantitative method of research. Analysis has been done by develop the tables, charts, and graphs that transfer the information precisely. A part from that, a summary of the analysis result has to be in report. Then conclusion of an analysis has to be in a presentation. In this research quantitative approach is used to achieve the study's aim. Data collection was carried out among government agency (JKR) and local authority(DBKL).

3.5.1 Average index method

The data gather from the questionnaire was analyse using average index method to gather the level of current practice of pavement maintenance management system and common problem in pavement maintenance management at the study area. Average index method has been proposed by Abd Majid and McCaffer (1997) based on agreement attributes and frequent index as shown on table 5

Table 5: The Index Attributes

5 points Likert Scale	Attributes of Indexes	Average Index
5	Strongly Agree	$4.5 < \text{Average index} < 5.0$
4	Agree	$3.5 < \text{Average index} < 4.5$
3	Neutral	$2.5 < \text{Average index} < 3.5$
2	Disagree	$1.5 < \text{Average index} < 2.5$
1	Strongly Disagree	$1.0 < \text{Average index} < 1.5$

Source: Abd majid and McCaffer

Average index analysis was also used to analyse the data gathered. The purposes of using average index were to accumulate the level of significance of data to get the ranking of the variables. Below, figure 10 shows the formula how to calculate average index:

$$\text{Average Index Method: } \frac{1(X1)+2(X2)+3(X3)+4(X4)+5(X5)}{X1+X2+X3+X4+X5}$$

Figure 10 : Average index method formula

Whereas: X1 = Number of Respondents for Strongly Disagree

X2 = Number of Respondents for Disagree

X3 = Number of Respondents for Neutral

X4 = Number of Respondents for Agree

X5 = Number of Respondents for Strongly Agree

3.5.3 Frequency analysis

Frequency analysis is one of descriptive analysis. A frequency analysis can be conducted to find out mean, median, mode and standard deviation of a population. Frequency analysis usually deals with three types of measures that is central tendency, measure of dispersion and percentile values. These tools of frequency analysis are important for analysis and interpretation of any data.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter will analyse and discuss the result obtained from the study. After going through the literature review in Chapter 2 and the methodology of study in Chapter 3, the study was carried out at road authorities' personnel. A total respondent for this research is 100 persons who work at local authority and government agency under the department of road maintenance facilities. The results were then interpreted and analysed based on the objectives.

4.2 Data of respondent

In this section, the results from the distribution of questionnaire were obtained. The first section will be the background of respondent. This part will cover their Year of service in respective organization, Types of road that commonly involved in, Types of road maintenance that involved, types of road that are commonly involved, types of road maintenance that involved and types of road surface that are commonly involved. This research was conducted by distributing sets of questionnaire randomly to the respondents consisted of local authority and government agency

Besides that, all the information and knowledge that was obtained is very important in process of preparing the questionnaire and to decide the suitable type of

respondent for this research. It is important so that the original purpose of this research will not run away.

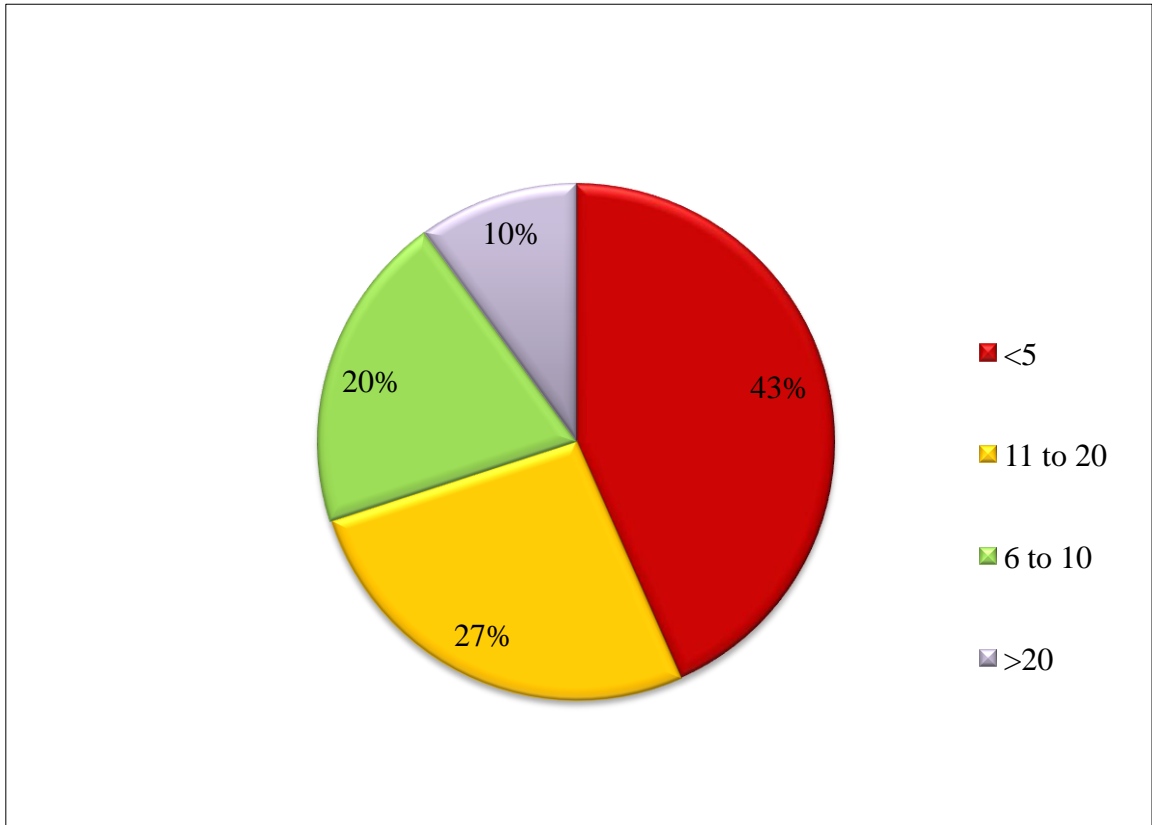


Figure 11 (a): Year of service in government agency

Figure 11 (a) showed year of service in government agency. Based on this figure above, the highest respondent from government agency which is 43% was obtain from less than 5 year of service. Followed by, 27% from 11 to 20 year of service, 20% 6 to 10 year of service and the least 10% was obtain from 20 and above year of service in government agency. From this data, it shows that there are lack of experience from the staff due to the least staff was in between 20 years and above.

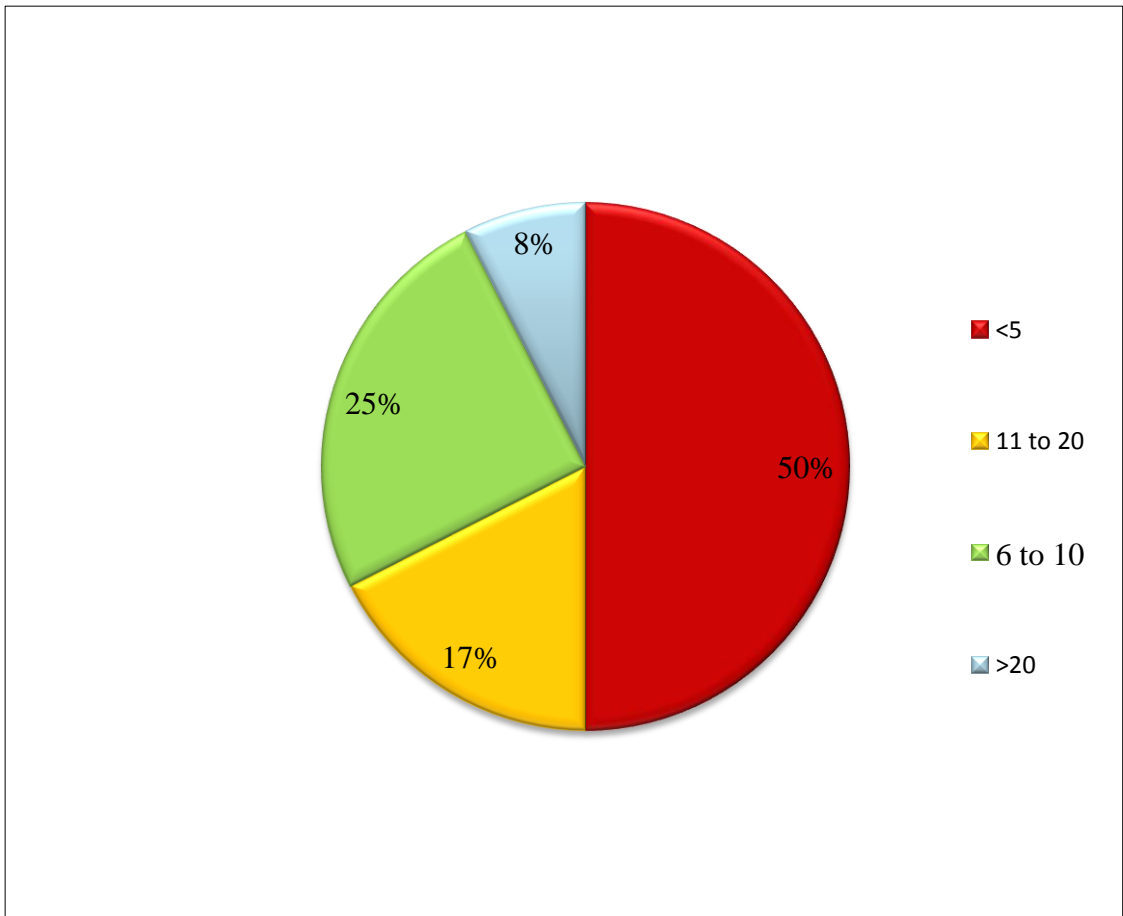


Figure 11 (b): Year of Service in local authority

Figure 11 (b) showed year of Service in local authority. Based on this figure, the highest respondent obtain from local authority was less than 5 year of service which was 50%. Followed by, 25% from 6 to 10 year of service, 17% was obtain from 6 to 10 year of service and the least was 8% from 20 years and above of service. From the data obtain, local authority are lack of experience from the staff due to the least staff was in between 20 years and above. From here we can see that both local authorities and government agency does not have enough experience and skill workers.

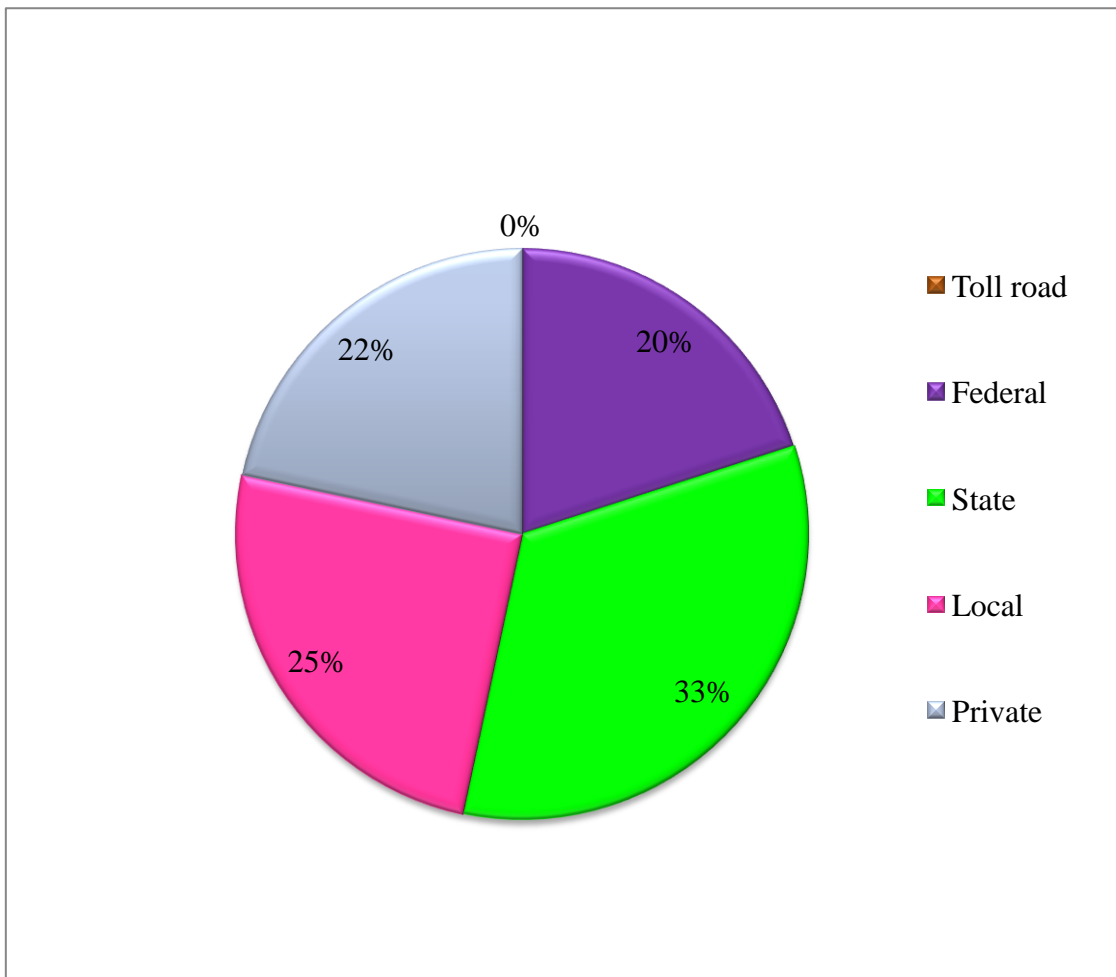


Figure 12 (a): Types of road that commonly involved in government agency

Based on figure 12 (a), the highest percentage of type of road that commonly involved in government agency was 33% from state road. Followed by, 25% from local road. Next, 22% from private road and the least was 20% from federal road. The toll road did not covered by the government agency due to other agency that is in charge of toll road. Based on the data obtain, the total road involved by government agency covers larger area and type of road in their jurisdiction

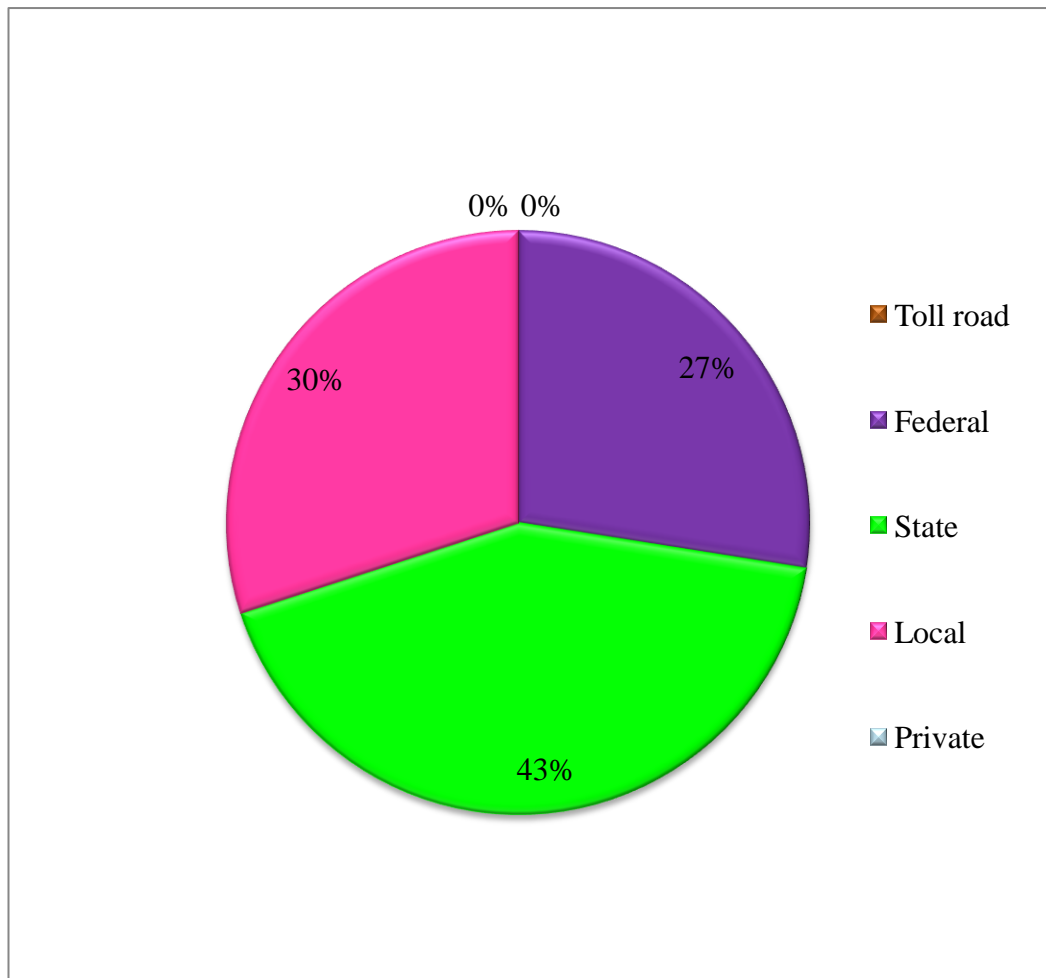


Figure 12 (b): Types of road that commonly involved in local authority

Based on figure 12 (b), the most type of road that commonly involved in local authority was 43% from state road. Followed by 30% from local road and the least was 27% from federal road. From the data obtain, it shows that the types of road involved from local authority was smaller area compared to government agency that covers private road as well. But both government agency and local authority does not cover toll road.

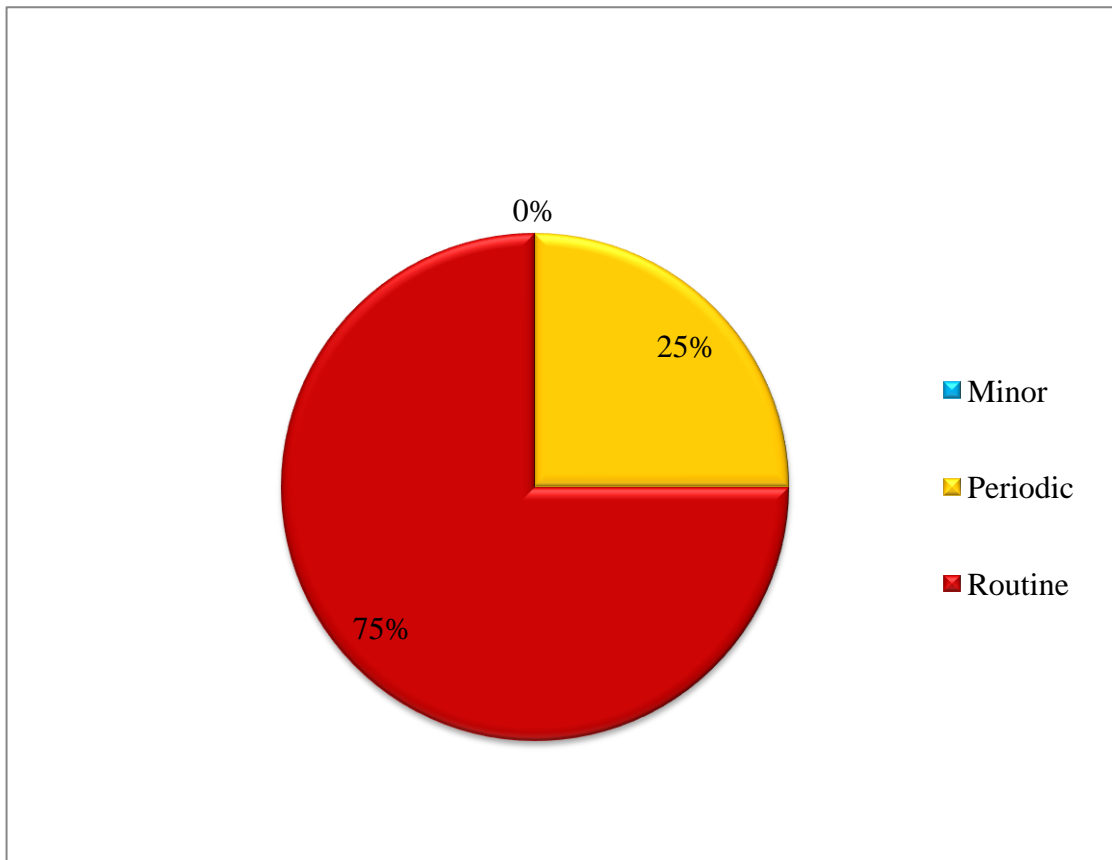


Figure 13 (a): Types of road maintenance that involved in government agency

Based on figure 13 (a) the most types of road maintenance that involved in government agency was 75% from routine maintenance and 25% from periodic maintenance. The reason for routine maintenance, it was less cost compare to periodic maintenance. To ensure the daily passability and safety of existing roads in the short-run and to prevent premature deterioration of the roads (PIARC 1994). Eventhough the routine maintenance will need an investmest and time, but it will ensure the road does not defect easily.

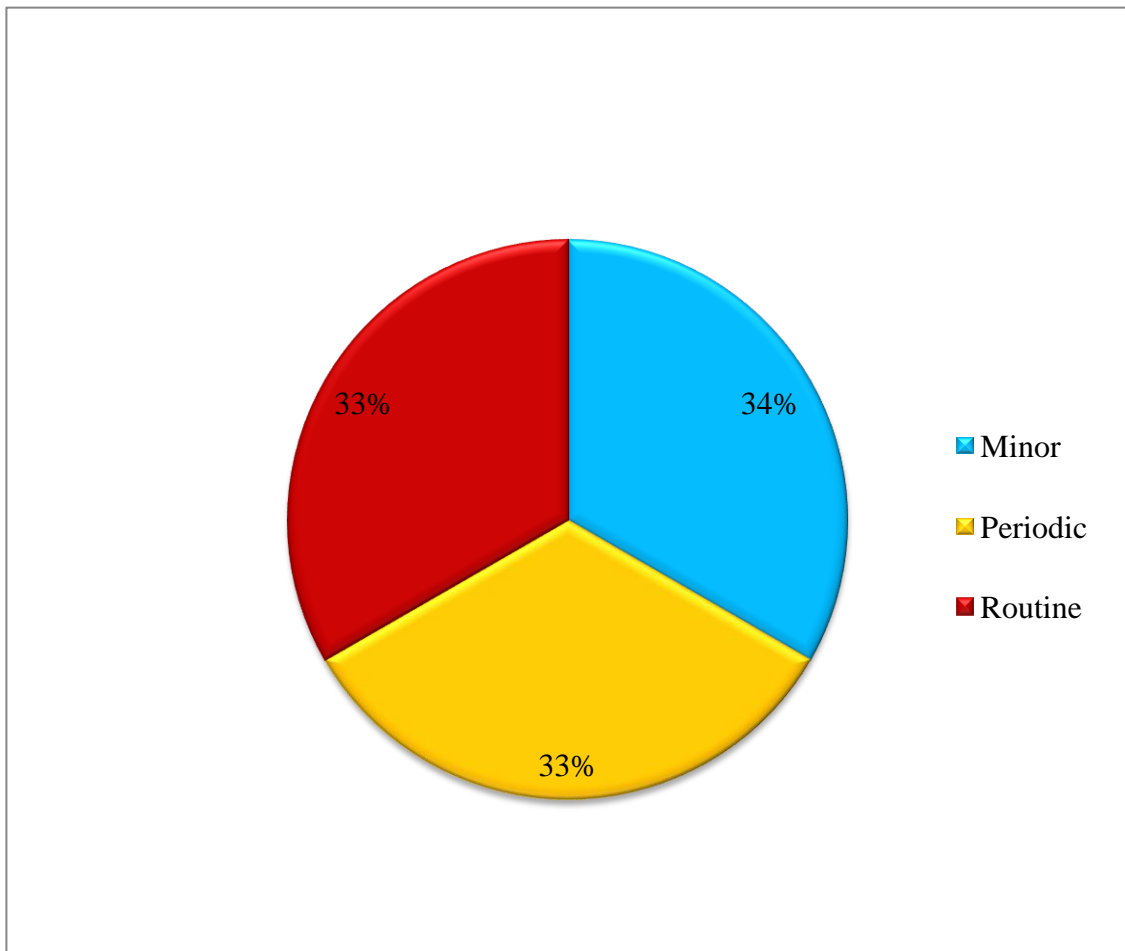


Figure 13 (b): Types of road maintenance that involved in local authority

From figure 13 (b), the highest percentage choose by the local authority for the type of road maintenance that involved in government agency was 34% from minor routine. Followed by, 33% from both routine and periodic maintenance. From here, it shows that local authority chooses the less cost for maintenance compared to government agency. Although minor maintenance only involved minor works but for these benefits to be sustained, road improvements must be followed by a well-planned program of maintenance. Without regular maintenance, roads can rapidly fall into disrepair, preventing realization of the longer term impacts of road improvements on development, such as increased agricultural production and access to services.

4.3 Current practice of Pavement Maintenance System Analysis Using Descriptive Statistics

In this section, the objective is to explore the current practice of pavement maintenance management system by government agency and local authority. Types of maintenance strategy, Type of equipment used to monitor road condition, Type of road condition data, frequency of organization conduct condition monitoring data of road, level of successful in the current maintenance strategy which using ranking or decision tree analysis and current condition of road maintenance work were obtained and analyse by using descriptive statistics.

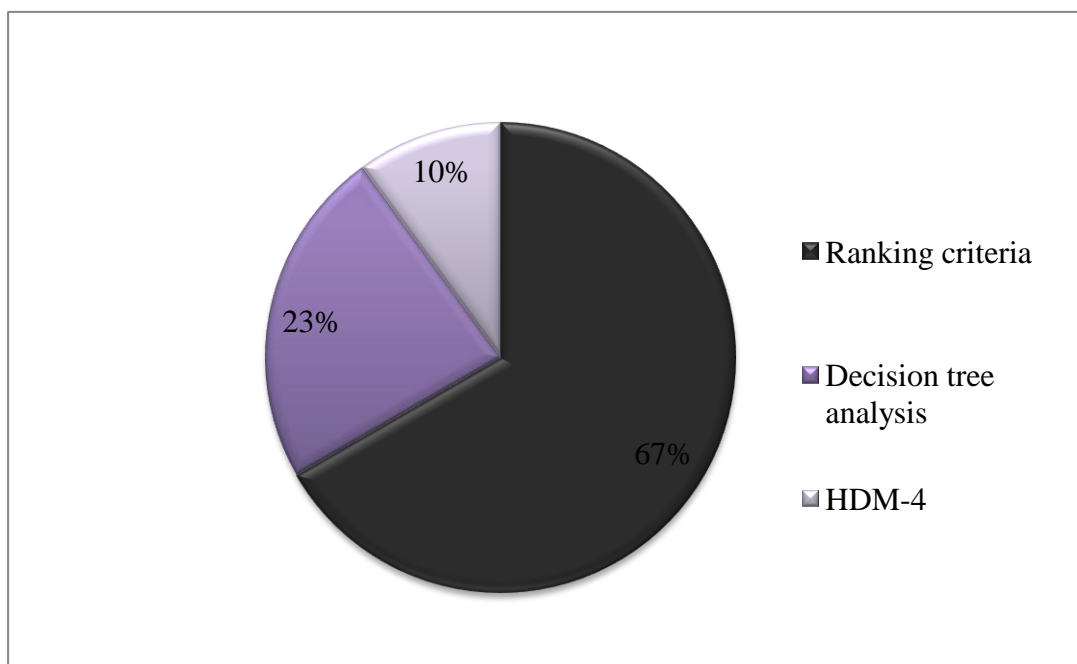


Figure 14 (a): Types of maintenance strategy by government agency

Based on figure 14 (a), the most type of maintenance strategy by government agency was 67% from ranking criteria. Followed by 23% from decision tree analysis and the least was 10% from HDM-4. Based on the data obtain, it shows that the staff does not prefer to do the maintenance strategy using software. From figure 10 (a), it

shows that there was lack of experience staff. This may be the reason for the staff to choose doing it manually over software.

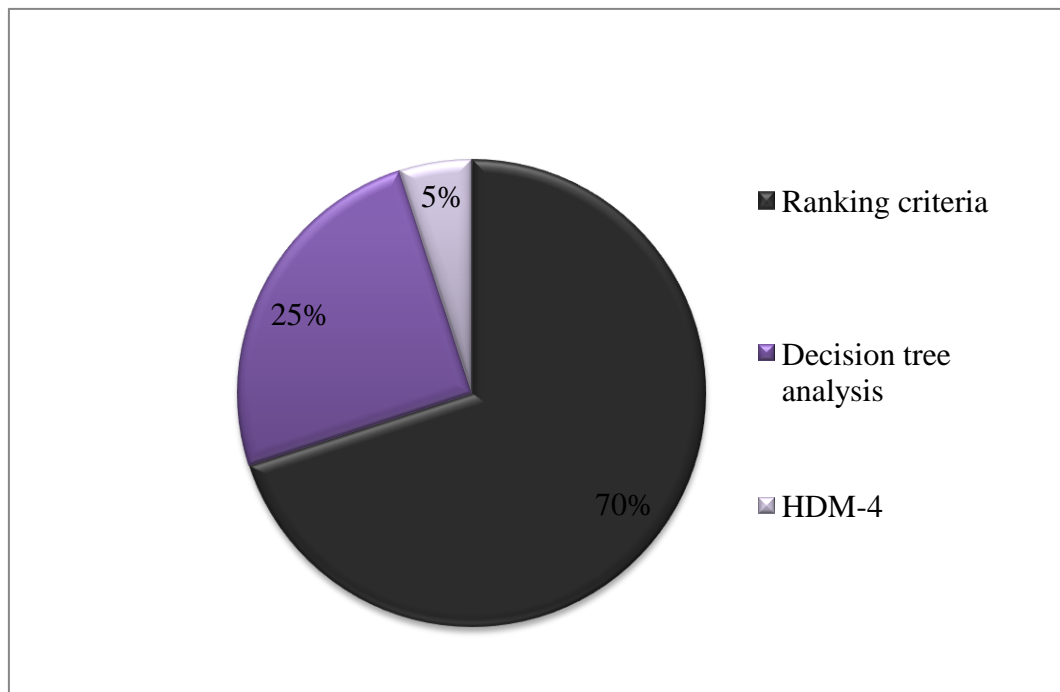


Figure 14 (b): Types of maintenance strategy by local authority

From figure 14 (b), the most type of maintenance strategy choose by local authority was 70% from ranking criteria. Followed by, 25% from decision tree analysis and the least was 5% from HDM-4. From here, it shows that the staff preferred to do the maintenance strategy manually by using ranking criteria. Based on figure 10 (b), it shows there were lacking of experience staff in local authority. This is because, HDM-4 needs an expert and experience staff to handle the software. The road agency needs strong technical capacity to operate such models and to modify them appropriately in calculating costs for subnational-level roads (Sally Burningham and Natalya Stankevich, 2005).

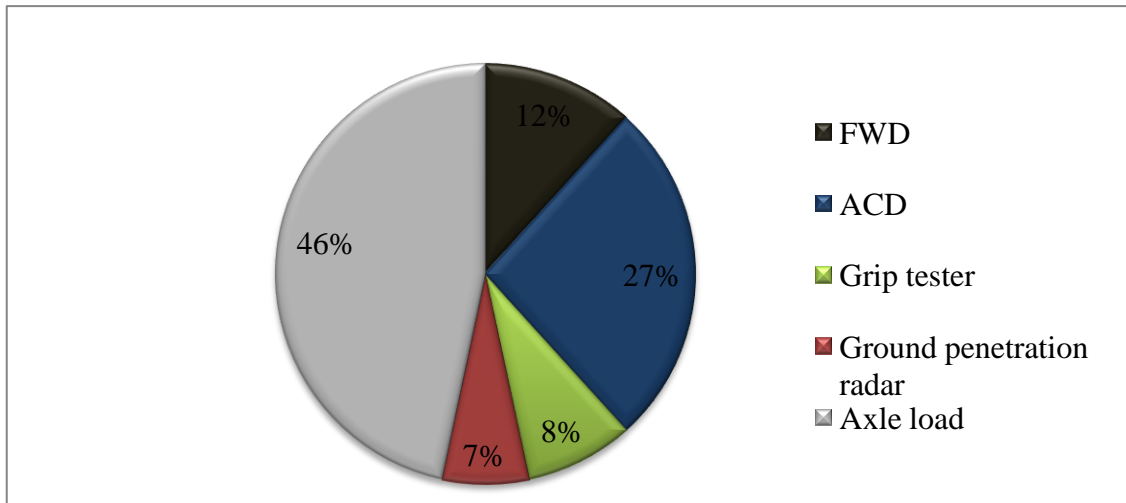


Figure 15 (a): Type of equipment used to monitor road condition by government agency

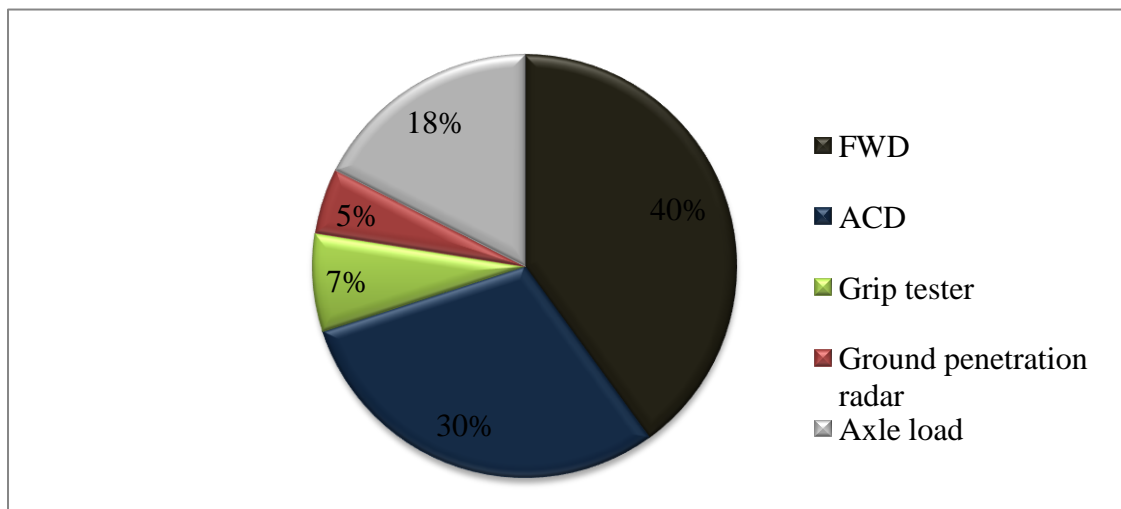


Figure 15 (b): Type of equipment used to monitor road condition by local authority

Based on figure 15 (a) and (b) the most type of equipment used to monitor road condition by government agency was axle load that was 46%. Followed by ACD from 27%, FWD from 12%, grip tester from 8% and ground penetration radar from 7%. As for local authority, the highest respondent choose was FWD from 40%. Followed by ACD from 30%, axle load from 18%, grip tester from 7% and the least was ground

penetration radar from 5%. This were because the length of road and type of road covers by the government agency was larger compared to local authority. Besides, the percentage of experience workers from government agency and local authority was different. Government agency had higher experience workers compared to local authority. This was the reason government agency preferred axle load as their type of equipment used to monitor road condition. For local authorities, the road covers was smaller compared to government agency and the lack of experience workes compared to government agency was the reason for them to use FWD as their most preffered type of equipment used to monitor road condition.

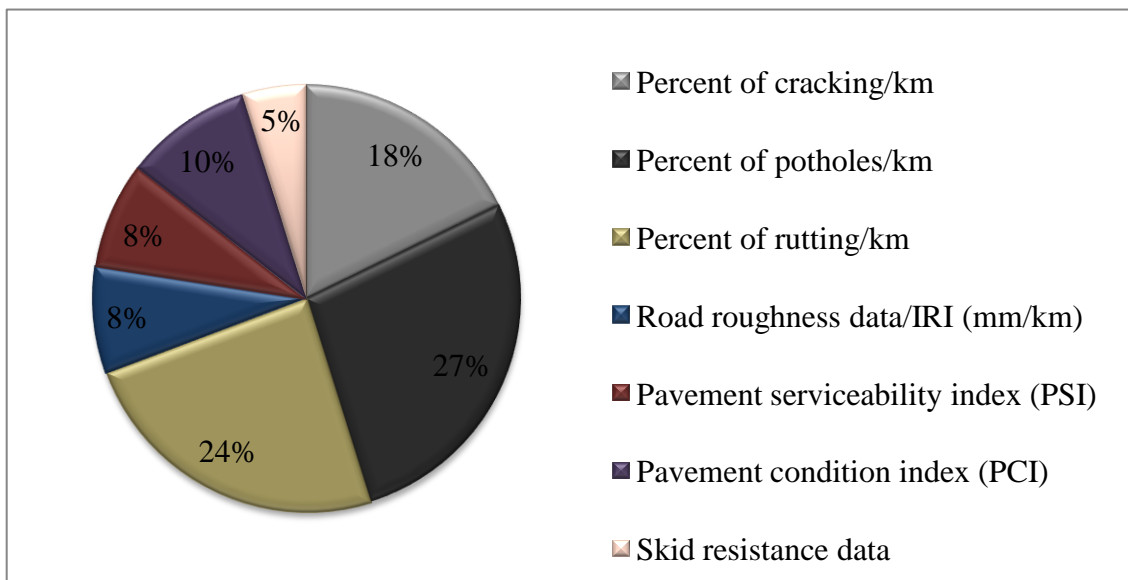


Figure 16 (a): Type of road condition data choose by government agency

Based on figure 16 (a), the highest percentage of the type of road condition data choose by government agency was 27% from percent of potholes/km. followed by, 24% from percent of rutting/km, 18% from percent of cracking/km, 10% from pavement condition index (PCI), 8% from road roughness data/IRI and pavement serviceability index (PSI) and the least is skid resistance data from 5%. Based on the data obtain, it

shows that the most common road damage occurs at road under government agency jurisdiction was potholes. It showed that the routine maintenance that was done by the government agency was insufficient. Other than that, the percent of rutting data also shows high percentage. This showed that the road damage that occurs under government jurisdiction is mainly potholes and rutting.

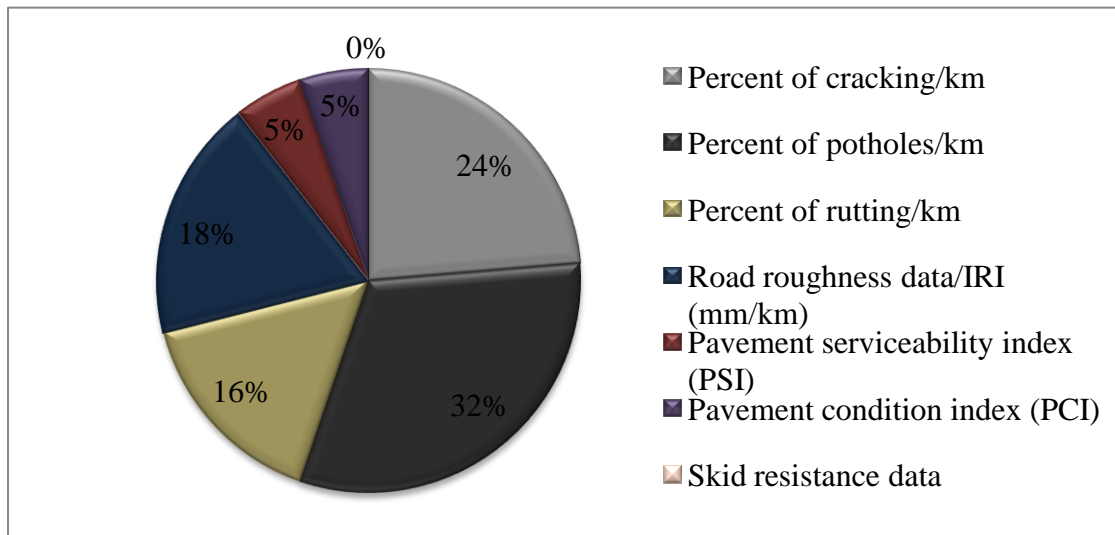


Figure 16 (b): Type of road condition data choose by local authority

From figure 16 (b), the most type of road condition data choose by local authority was percent of potholes/km that is 32%. Followed by, percent of cracking from 24%, road roughness data/IRI from 18%, percent of rutting from 16% and the least is pavement serviceability index (PSI) and pavement condition index (PCI) both from 5%. From the data, it show that the most road damage occur in the local authority road jurisdiction is potholes and cracking. This showed that , the minor maintenance done by the local authority is not satisfy and insufficient due to the high percent of potholes data and percent of cracking data at the road under their jurisdiction.

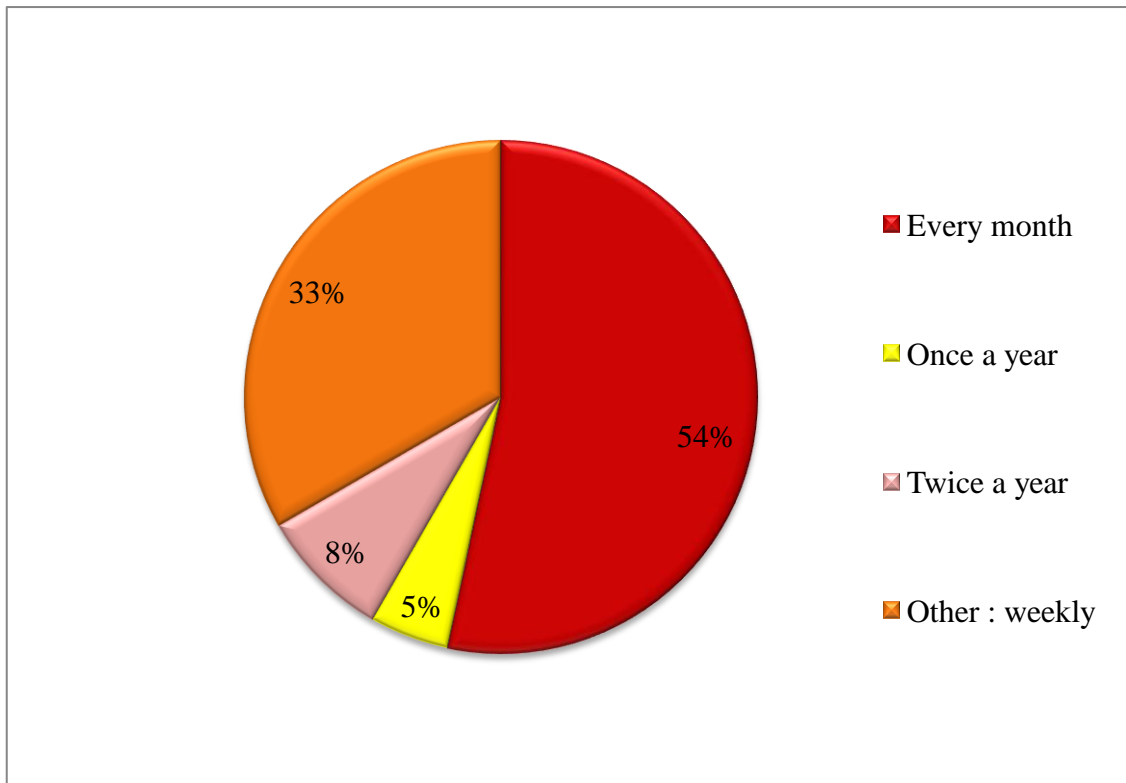


Figure 17 (a): Frequency of government agency condition monitoring data of road

Figure 17 (a) showed the frequency of government agency condition monitoring data of road. Based on this figure, the highest frequency of organization conduct condition monitoring data of road for government agency was 54% from every month. Followed by, 33% from weekly. Next, 8% from twice a year and the least was 5% from once a year. From here, it shows that government agency does their monitoring maintenance every month. Based on figure 13 (a), the road maintenance done by government agency every month is routine maintenance, while the other was periodic maintenance.

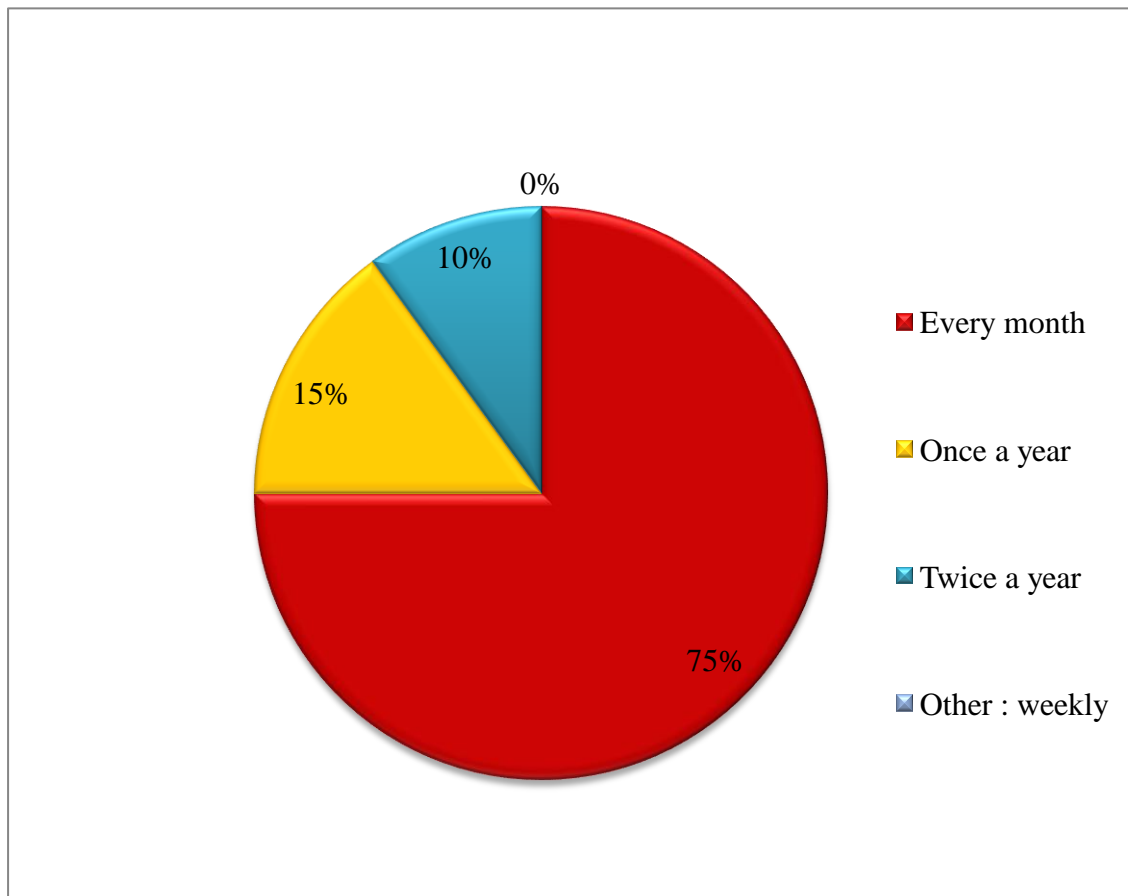


Figure 17 (b): Frequency of local authority condition monitoring data of road

Figure 17 (b) showed the frequency of local authority condition monitoring data of road. Based on this figure above, the highest frequency of local authority conduct condition monitoring data was 75% from every month. Followed by, 15% once a year. Lastly, 10% from twice a year. From the data obtain, local authority did the monitoring every month. From the figure 13 (b), minor maintenance was conducted every month while the other once a year and twice a year was periodic and routine maintenance.

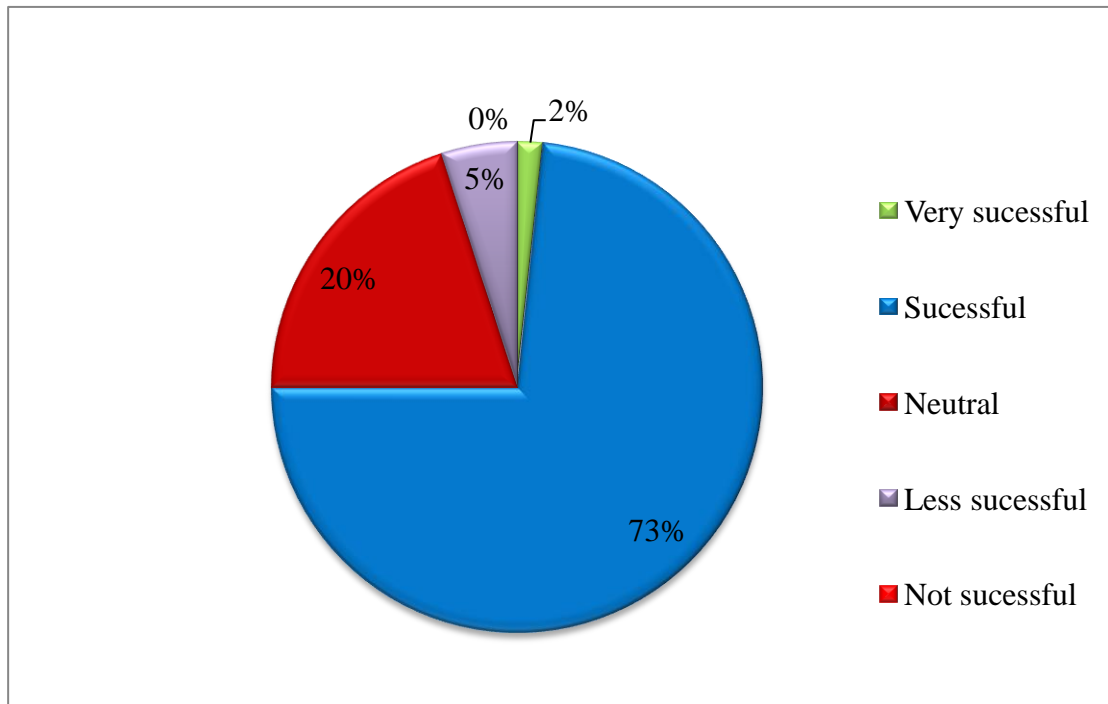


Figure 18 (a): Preferred level of successful in government agency

Based on figure 18 (a), the most preferred level of successful in the current maintenance strategy which using ranking or decision tree analysis from government agency is 73% from successful. Followed by, 20% from neutral, 5% from less successful and the least is 2% from very successful. From the data obtain, it shows that the staff in the government agency prefer and used to the practice of using ranking criteria and decision tree analysis as their types of maintenance strategy. Not being exposed to the software because of the lack of experience staff in the government agency as stated on figure 11 (a). An appropriate maintenance management tool should be used and any suitable tools available can be used to assist decision makers to ensure the facilities are well managed (McNeil et al., 1992).

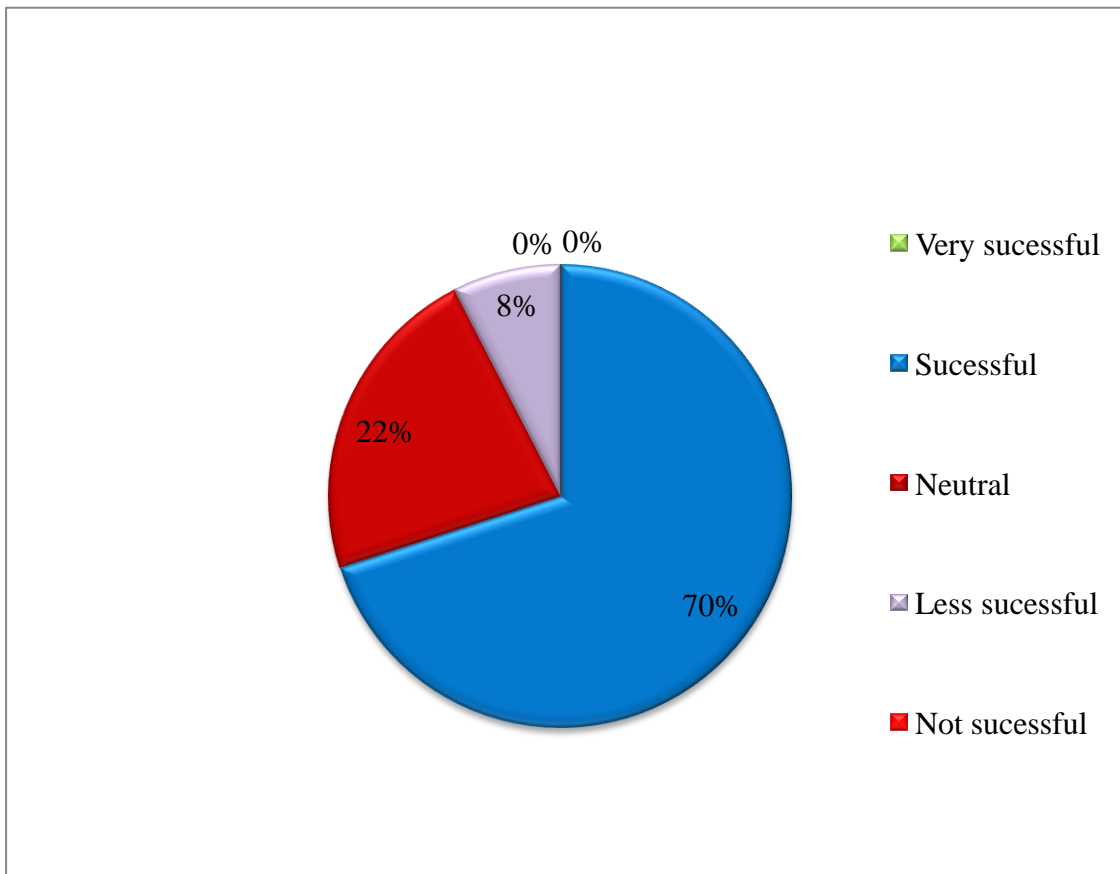


Figure 18 (b) Preferred level of successful in local authority

Figure 18 (b) showed the preferred level of successful in local authority. Based on this figure above, the preferred level of success by local authority was 70% from successful. Followed by, 22% from neutral, 8% from less successful. From the data, this shows that the types of maintenance used by local authority were also prefers to use the manual type compared to software. The factors to be considered in any priority ranking model include agency cost, pavement serviceability and condition index, functional classification, and traffic level (Fwa, 2006).

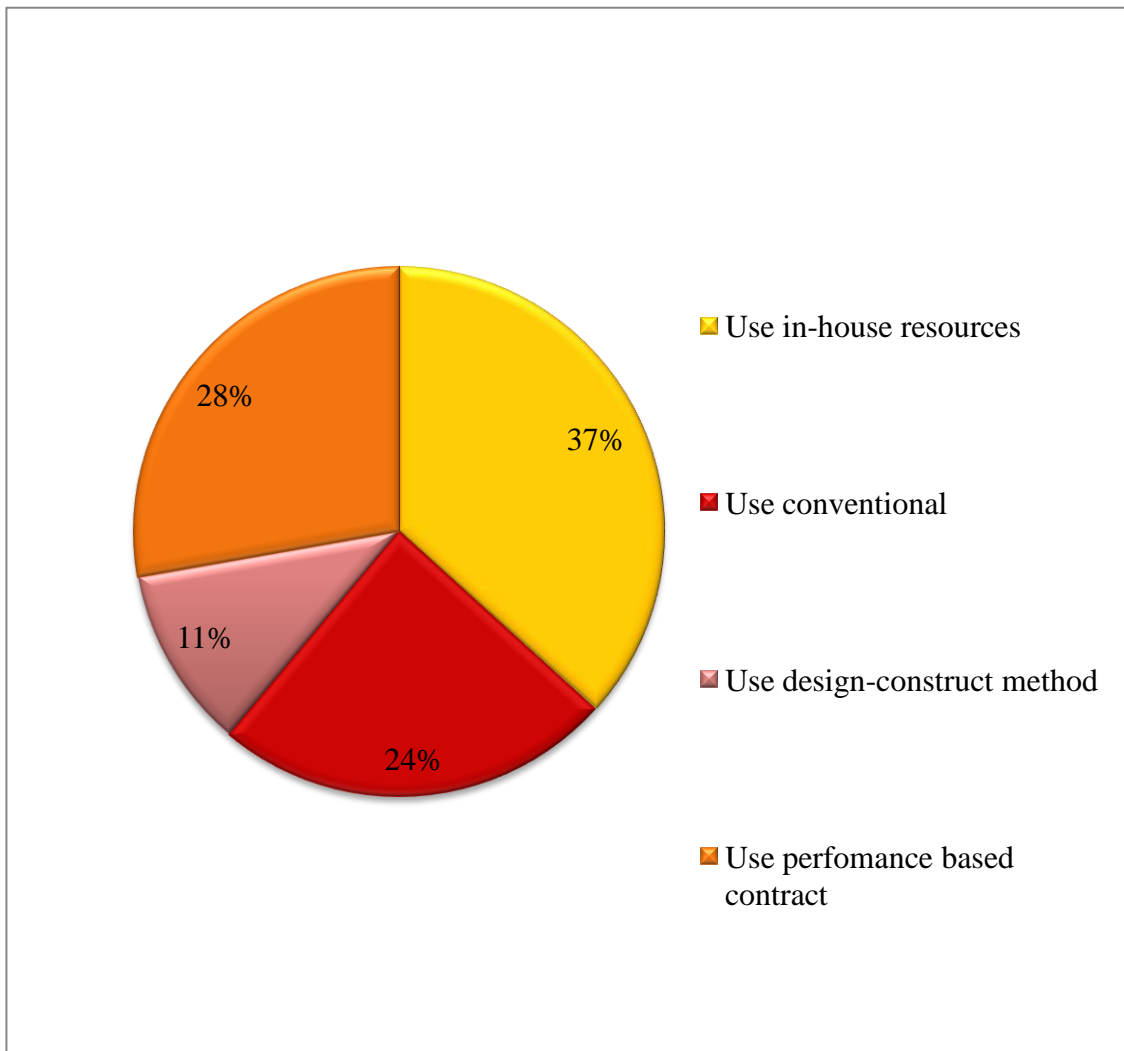


Figure 19 (a): Current condition of road maintenance work by government agency

Based on figure 19 (a) the most current condition of road maintenance work by government agency was 37% from use in house resources. Followed by, 28% use performance based contract. Next, 24% from use conventional method and the least was 11% use design-construct method. This was because the use in house resources was reliable and trusted. It is also convenience and does not cost much to the agency. That was the reason the most preferred condition of road maintenance work is use in house resources.

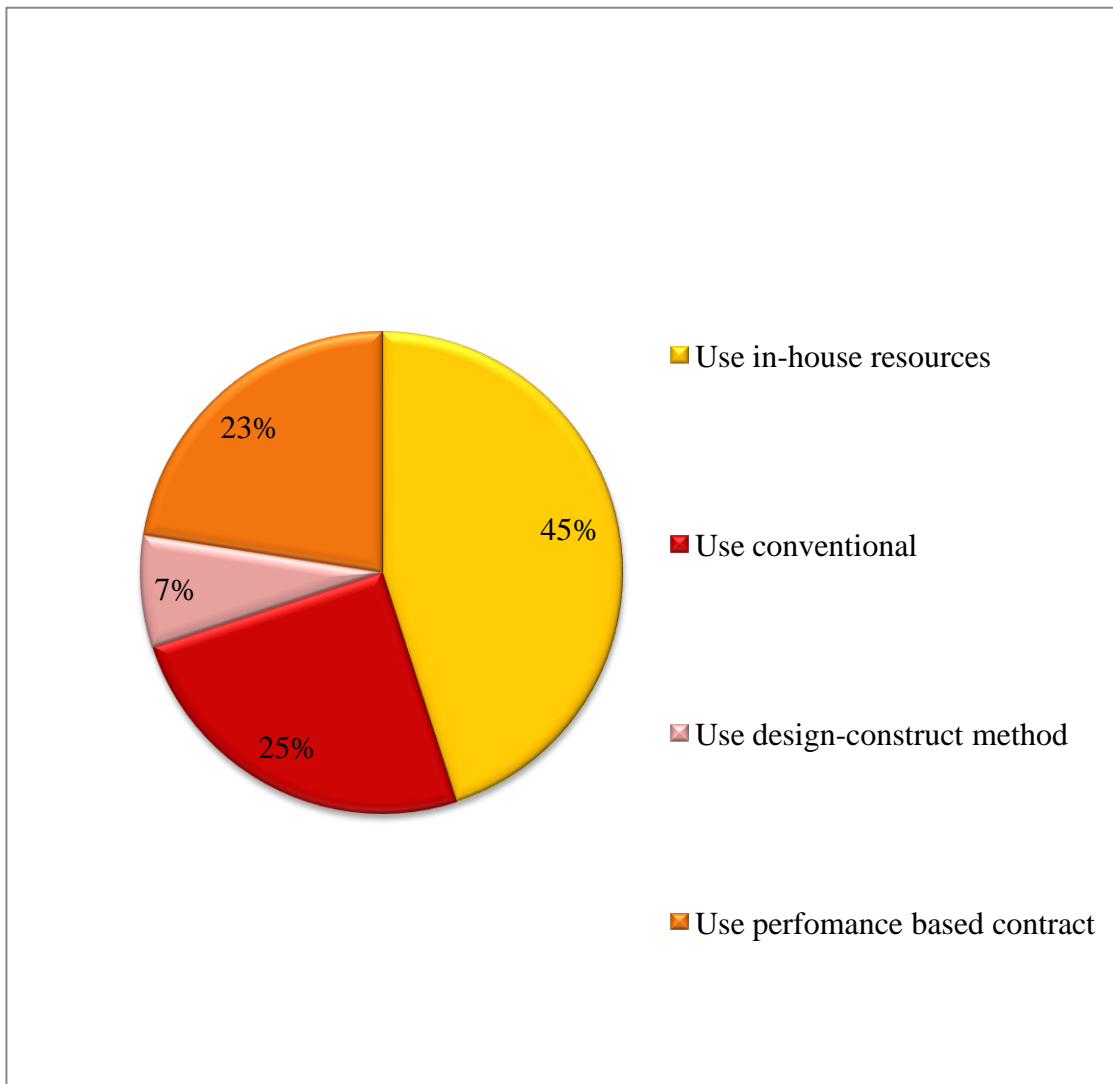


Figure 19 (b): Current condition of road maintenance work by local authority

Based on figure 19 (b), the most current condition of road maintenance work by local authority was 45% from use in house resources. Followed by, 25% from conventional, 23% from performance based contract and the least was 7% from design construct method. From the data obtain, the most easy and reliable sources that can obtain by local authority was use in house resources. Same goes to government agency.

4.4 Current practice of pavement maintenance system analysis using average index method.

In this section, the objective is to explore current practice of pavement maintenance system by government agency and local authority by using average index method. Issue that influence other decision to conduct maintenance intervention, road surface condition which require greater attention and preference of pavement maintenance management system were analyzing by using average index method. Here, which part that the respondent strongly agrees to least agrees was obtained.

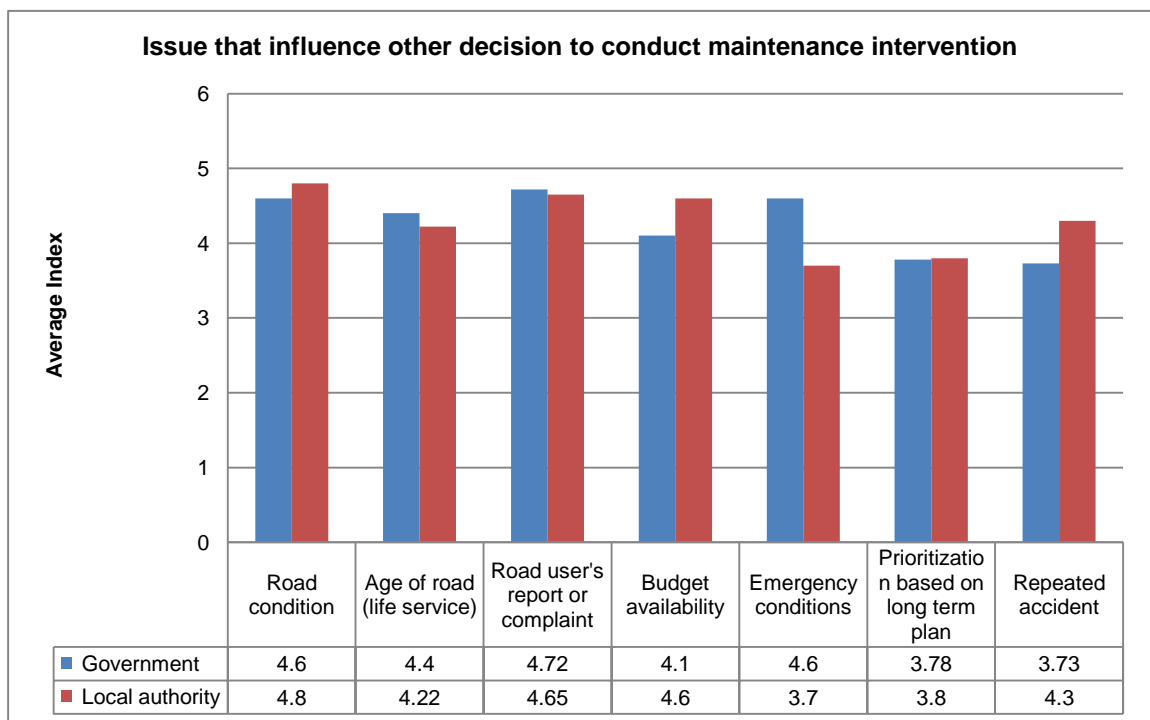


Figure 20: Issue that influence other decision to conduct maintenance intervention

Based on figure 20, for government agency average index for road condition was 4.6 which is strongly agree while for local authority, the average index was 4.8 which means the respondent strongly agree. For the age of road (life service), government

agency average index was 4.4 which is agree while local authority average index for age of road (life service) was 4.22 which falls into the agree category. Next, for road user's report or complaint, the average index for government agency was 4.72 which is strongly agree while for local authority average index was 4.65 strongly agree as well. For budget availability, the average index for government agency was 4.1 which is agree while local authority average index for budget availability was 4.6 which is strongly agree. As for the emergency condition, the average index for government agency was 4.6 which are strongly agreed while the local authority average index was 3.7 which are agreed. Next, prioritization based on long term plan for government agency was 3.78 which is agree while for the local authority was 3.8 same with government agency which is agree. Lastly, for repeated accident in government agency average index was 3.73 while for local authority was 4.3 which is both of them agree that repeated accident contribute to one of the issue that influence other decision to conduct maintenance intervention.

From here, the most issue that influences other decision to conduct maintenance intervention for government agency was from road user's report or complaint and the least was from repeated accident. As for local authority, the most issue that was chosen was the road condition. From here we can see that government agency does the maintenance when there are complaint and report from the road users. This was because the road covers by government agency were too large to be focus on monitoring maintenance that was done every month compared to local authority. While local authority also chooses that budget availability was one of the reasons for issue that influence to conduct maintenance. Clearly showed here with the result from figure 13 (a) (b) the most type or road maintenance involved by local authority was minor. This was because minor maintenance does not costly compare to periodic and routine.

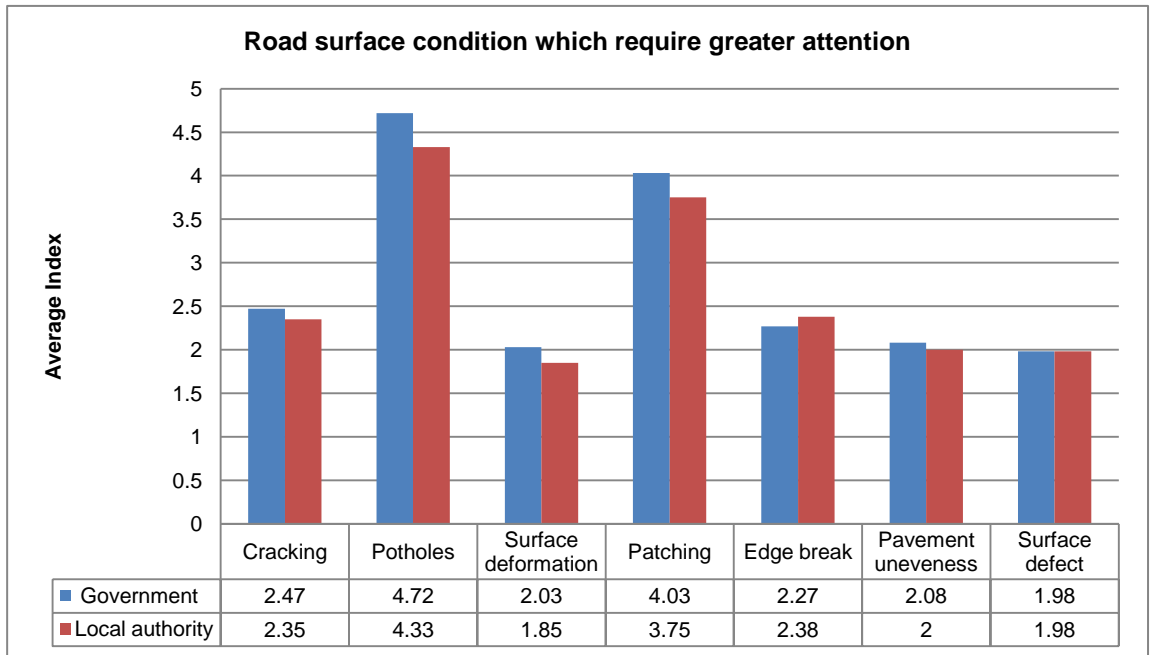


Figure 21: Road surface condition which require greater attention

Based on figure 21, the average index for cracking in government agency was 2.47 which is disagree while for local authority average index was 2.36 which is disagree as well. For potholes, the average index for government agency was 4.72 which are strongly agreed while the average index for local authority was 4.33 which are agreed. Next, surface deformation average index for government agency was 2.03 which is disagree while local authority average index was 1.85 which is disagree as well. For patching, the average index for government agency was 4.03 which is agree while local authority was 3.75 which is agree as well as government agency. For edge break condition, the average index for government agency was 2.27 which is disagree while local authority was 2.38 which is disagree as well. Next, pavement unevenness for government agency average index was 2.08 which is disagree while local authority was 2 which is disagree as well. Lastly, the surface defect for government agency average

index was 1.98 which is disagree while local authority was 1.98 which is disagree as well. From here, the type of road that requires greater attention for government agency and local authority is potholes. The least that require attention for government agency is surface defect. For local authority the least is surface deformation. From here, potholes are the major road defect in both local and government agency road jurisdiction. Besides, from the type of road condition data both road authorities from figure 16 use percent of potholes/km as their most type of road condition data. So, from the data, it can support that potholes is the most road surface that require greater attention.

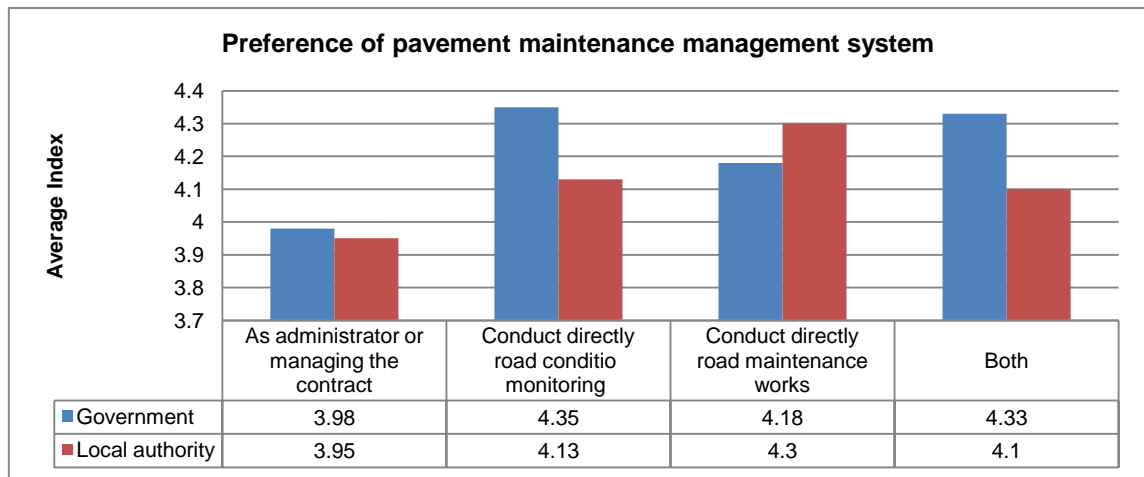


Figure 22: Preference of pavement maintenance management system

Based on figure 22, the average index for administrator or managing the contract for government agency was 3.98 which is strongly agree while for local authority was 3.95 which is strongly agree as well. For conduct directly road condition monitoring for government agency was 4.35 which is agree while local authority was 4.13 which is agree as well. Next, for conduct directly road maintenance works for government agency was 4.18 which are agreed while local authority was 4.3 which are agree as well. Lastly, for both conduct directly road condition monitoring and maintenance work

for government agency was 4.33 which is agree while local authority was 4.1 which is same as well agree. From this data, government agency preferred to do conduct directly road condition monitoring. As for local authority the highest preferred is by conducting directly road maintenance works. The least preferred by government agency is as administration or managing the contract same goes to local authority. From this data, refer to figure 20, the reason why government agency prefers to do the road monitoring while local authority does the road maintenance works.

4.5 Common problem in pavement maintenance management system.

In this section, the objective is to identify the common problems in pavement maintenance management system by distributing the questionnaire and analyse using average index method.

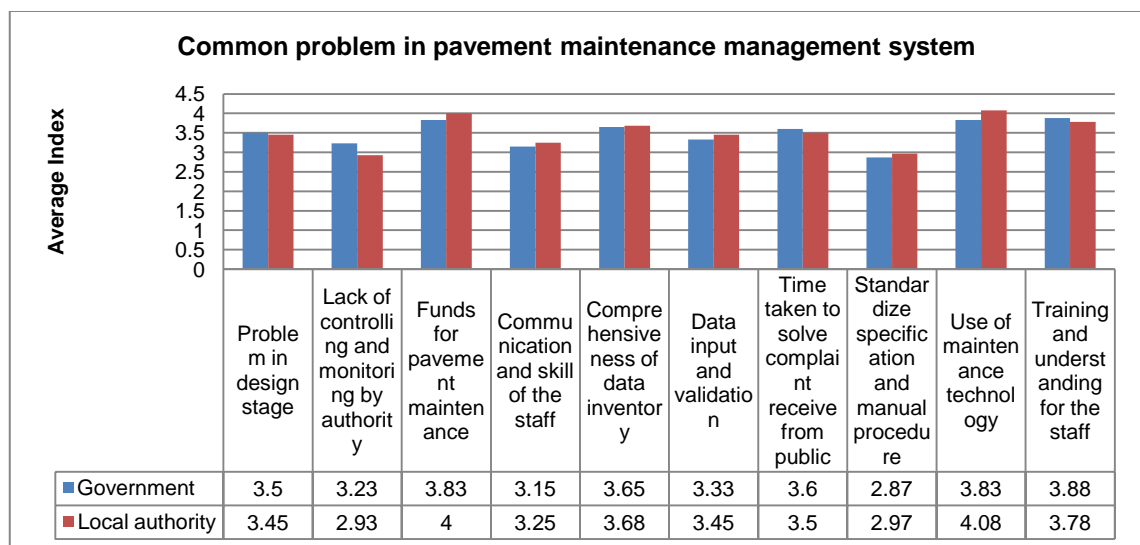


Figure 23: Common problem in pavement maintenance management system

From figure 23, the average index for government agency in problem design stage was 3.5 which is neutral while for local authority was 3.45 which is neutral as well. For lack of controlling and monitoring by authority for government agency was 3.23 which is neutral while for local authority was 2.93 which is neutral as well. Next, funds for

pavement maintenance for government agency was 3.83 which is agree while for local authority was 4 which is strongly agree. For communication and skill of the staff was 3.15 which is neutral while for local authority was 3.25 which is neutral as well. Next for training and understanding of staff for government agency was 3.88 which is agree while for local authority was 3.78 which is agree as well. From the result, the most common problem in pavement maintenance management system for government agency is training and understanding of staff. While the local authority is funds for pavement maintenance. Based on this problem, we can see from the previous section on the practice of pavement maintenance from government agency and local authority which is match with their current practice and the problem occur in the pavement maintenance management system. From here, the reason for local authority to choose minor maintenance as their most type of road maintenance involved in their jurisdiction because minor maintenance less cost among the other maintenance.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter will summarize the studies that have been conducted and concluded based on the analysis and the results already obtained. Through the collected data from the group of respondents in government agency and local authority. The conclusion and summary of findings for this study were also described briefly in previous chapter 4. In this chapter will state the overall conclusion and the best recommendation to this research .

5.2 Conclusion

As stated in chapter 1, the purpose of this research is to explore the current practice of pavement maintenance management system and to identify the common problem in pavement maintenance management system in government agency and local authority. It can be conclude that this study was achieved all of the objectives.

From this study, conclusion related to the objective of the research is made. For objective 1:

Phase 1: Beginning

Road authorities obtained information about the type of pavement damage and the condition of pavement damage by using the maintenance equipment provided by the road authorities. Other than that, a feedback from the road users were considered as well for the maintenance to be executes.

Phase 2: planning

By using ranking criteria as the most preference to plan and determine the priority weight of pavement maintenance factor such as the road type, pavement condition, traffic volume, maintenance cost and other issue that could affect the road maintenance. This method can help the authorities to select the most appropriate maintenance technique, through determining the present and expected pavement situation.

Phase 3: execution

After the planning was done, the road authorities should use the work programmed according to decision maker. Generally this execution is to realize the actual situation or performance of the pavement.

Phase 4: evaluation

After the maintenance was executed, the pavements were monitored based on performance. Lastly, the pavement is the were maintain monthly or weekly by using minor, routine and periodic maintenance.

For the next objective is to identify the common problem in pavement maintenance management system was achieved. It can be concluded that the most common problem occur in government agency is training and understanding of staff whereas the local authority is facing a funding issue. It can be concluded that the budget is the vital element in the whole planning of the road maintenance system. The procedure of pavement maintenance is considered as an approach of a cost effective rehabilitation and treatment to a specific pavement system of roads (FAA, 2006). Without the budget, the maintenance system cannot be implemented and after a few years the road will be demolished and required the highest cost.

5.3 Recommendation

During the analysis, there were some problems that been faced in obtaining the data. Although the form was created with good survey questions and properly, but still there are various problems that arise. The major problems arise when carrying out the process of collecting data from the respondent, they do not give the full commitment. Most survey forms was distributed are not filled by the respondent intended, but be filled by others. The distributed survey forms also are not filled in by the respondent and not return it to the researcher above reasons are too busy so they do not have time to fill out the questionnaire.

It is very difficult because the researcher need to find many more respondent to meet the required number of target respondents for this study. This also makes it difficult for the researcher to analyze the collected data. This problem cannot be avoided as it is due to human error. Humans often make mistakes and it is possible to occur when filling out this questionnaire. In addition, there are a few respondents who answered incorrectly. This may be because they does not understood English. They may also do not have time to read the questions one by one and they just answered randomly without reading it.

Thus, to ensure that the problem does not occur in future research, the questionnaire need to be in multi language and short. So that the respondent can go through the questionnaire easily and without taking their time for so long.

Other than that, to ensure the questionnaire will achieve the target, make an extra questionnaire and distribute it to more respondent so that it can backup the target. Not only that, to ensure the respondent answer the questionnaire correctly, further

explanation and confirmation of their understanding is needed before we leave the questionnaire to them.

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APPENDICES

APPENDIX A

Part A: Respondents Background

1. What type of organization/company do you represent? (Please tick that apply)/(Apakah jenis sector organisasi yang anda wakili?)

1. Government Agency (JKR)	1 <input type="checkbox"/>
2. Malaysian Highway Authority (LLM)/Toll road company	2 <input type="checkbox"/>
3. Municipal Government/Council/Local Authority	3 <input type="checkbox"/>
4. District Government	4 <input type="checkbox"/>
5. Contractor	5 <input type="checkbox"/>
6. CONSULTANT	6 <input checked="" type="checkbox"/>

2. How long have u been in the organization? (Berapa lama anda telah berkhidmat dalam organisasi sekarang? (tahun))

<5 6 – 10
 11 – 20 > 20

3. What type of road(s) that you commonly involved in? (Jenis jalan di bawah seliaan agensi anda?)

1. Toll Road (Jalan bertol)	1 <input type="checkbox"/>
2. Federal Highway road (Jalan Perskutuan)	2 <input checked="" type="checkbox"/>
3. State road (Jalan Negeri)	3 <input type="checkbox"/>
4. Local road (Jalan Tempatan)	4 <input type="checkbox"/>
5. Private road (Jalan Pesendirian)	5 <input type="checkbox"/>
6. Other – Please specify..... (Lainlain jalan-sila nyatakan)	6 <input type="checkbox"/>

4. What types of road maintenance that you are involved in? (Apakah jenis penyelenggaraan jalan yang anda pernah terlibat)

<input checked="" type="checkbox"/> Minor Rehabilitation (full depth maintenance) (Pemulihan kecil – Penyelenggaraan Kedalaman Pemah)	<input type="checkbox"/> Periodic /Preventive Maintenance (e.g. Overlay) (Penyelenggaraan Pencegahan- e.g. Tindihan Lapisan)	<input type="checkbox"/> Routine Maintenance (e.g. Crack sealing, patching, shoulder and drainage repair) (Penyelenggaraan Rutin- e.g. Tampalan Bekahan, Penampalan, pembaikan Bahu jalan dan saliran)
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5. What types of road surface that your agency commonly involved in?? (Apakah jenis permukaan jalan yang biasa ada di bawah penyelenggaraan agensi anda?)

Flexible Pavement Rigid Pavement Both flexible and Rigid

Part B: Pavement Maintenance Practice

1. Type of maintenance strategy that your organization uses? (*Apakah jenis strategi pemeliharaan yang di aplikasikan oleh organisasi anda?*)

1. Ranking criteria based on the condition monitoring or surface inspection. (Penyusunan criteria berdasarkan pemantauan keadaan atau pemeriksaan permukaan)	1 <input type="checkbox"/>
2. Decision tree analysis.	2 <input type="checkbox"/>
3. HDM-4.	3 <input type="checkbox"/>
4. None of the above (Tiada yang berkenaan di atas)	4 <input checked="" type="checkbox"/>
5. Other – Please specify..... (Lain-lain jalan-sila nyatakan)	5 <input type="checkbox"/>

2. What type of equipment/machine used to monitor road condition in your organization?

1. IRI	1 <input type="checkbox"/>
2. ACD	2 <input type="checkbox"/>
3. Grip Tester	3 <input type="checkbox"/>
4. Ground Penetrations Radar	4 <input type="checkbox"/>
5. Axle Load	5 <input type="checkbox"/>
6. Others – Please Specify <i>N/A</i>	6 <input checked="" type="checkbox"/>

3. What type of roads condition data that you currently have in your organization? (*Apakah jenis data kondisi jalan yang ada di organisasi anda?*)

1. Percent of cracking per kilometre	1 <input type="checkbox"/>
2. Percent of potholes/km	2 <input type="checkbox"/>
3. Percent of rutting/km	3 <input type="checkbox"/>
4. Road roughness data/IRI (mm/km)	4 <input type="checkbox"/>
5. Pavement serviceability index (PSI)	5 <input type="checkbox"/>
6. Pavement condition index (PCI)	6 <input type="checkbox"/>
7. Skid resistance data	7 <input type="checkbox"/>
8. None	8 <input checked="" type="checkbox"/>

4. How often your organization conduct condition monitoring data of road sections under jurisdiction? (Berapa kekerapan organisasi anda menjalankan pemantauan kondisi jalan di bawah seliaan?)

1. Every month	1 <input type="checkbox"/>
2. Once a year	2 <input type="checkbox"/>
3. Twice a year	3 <input type="checkbox"/>
2. Once every two years	4 <input type="checkbox"/>
3. Once every 4 years	5 <input type="checkbox"/>
4. Once every 5 years	6 <input type="checkbox"/>
5. Never	7 <input type="checkbox"/>
6. Other - Please specify... <i>DAILY</i>	<input checked="" type="checkbox"/>

5. How would your organization rate the importance of the following issues that influence the decision to conduct maintenance intervention? (Bagaimana organisasi anda mengklasakan kepentingan isu di bawah dalam membuat keputusan untuk menjalankan penyelenggaraan.)

		SCALE				
		1	2	3	4	5
		Least Important	Less Important	Average	Important	Very Important
1	Road conditions					5
2	The age of road (life service)				3	
3	Road users' reports or complaints					4
4	Budget availability					4
5	Emergency conditions (e.g. flooding, slope failure)					5
6	Repeated accidents					5
7	Prioritization based on long term plan				3	
8	Other - Please specify.....					

6. How would your organization rank the importance level of these road surface conditions which require greater attention? (Bagaimana organisasi anda mengelaskan keadaan permukaan jalan yang memerlukan pemerhatian segera?)

Road Surface condition (Keadaan Permukaan Jalan)	Important level (Please rank 1-5)* *1 is the most important
Cracking (Retakan)	5
Potholes (Lopak)	1
Patching	1
Surface Deformation (Rutting, shoving, depression, etc)	3
Edge break (Pecahan bahu jalan)	3
Surface Defect (Polishing, Bleeding etc)	2
Pavement unevenness due to base failure	5
Other, please specify.....	<input type="checkbox"/>

7. As the government or owner, which of these reflect your preference? (Sebagai pemilik jalan, sila tandakan yang mana berkenaan)

SCALE					
	1	2	3	4	5
	Least Agree	Less Agree	Average	Agree	Extremely Agree
1 As administrator or managing the contract				1	2 3 4 5
2 Conduct directly road condition monitoring				1 2 3	4 5
3 Conduct directly road maintenance works				1 2 3	4 5
4 Conduct directly both road condition monitoring and maintenance work.				1 2 3 4	5
5 Other - Please specify.....				1 2 3 4	5

8. In your opinion, how successful is the current maintenance strategy which using ranking/decision tree? (Please ignore if you are using software)(Pada pendapat anda, bagaimanakah kejayaan strategy penyenggaraan sekarang yang menggunakan ranking/decision tree?) - N/A -

Not Successful	Less Successful	Neutral	Successful	Very Successful
1	2	3	4	5
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

9. In your opinion, how successful is the current maintenance strategy which using software? (Please ignore if you are NOT using software) (Pada pendapat anda, bagaimanakah kejayaan strategy penyenggaraan sekarang yang menggunakan ranking/decision tree?) - **N/A** -

Not Successful	Less Successful	Neutral	Successful	Very Successful
←-----→				
1	2	3	4	5
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

10. How your organizations conduct road maintenance work currently? (Bagaimanakah anda menjalankan kerja penyenggaraan jalan sekarang?)

Maintenance work (kerja penyenggaraan)	Please tick (sila tandakan)
1. Use in-house resources (own staffs conduct direct work) (Menggunakan sumber tenaga manusia sedia ada staff menjalankan kerja secara langsung)	<input type="checkbox"/>
2. Use conventional method (Kaedah konvensional) i.e. engage a consultant to design and evaluate maintenance needs then appoint a contractor to do the work (via tender or other method) (melantik konsultan untuk merencanakan dan menilai kerja penyenggaraan yang diperlukan seterusnya melantik kontraktor untuk melaksanakan kerja)	<input type="checkbox"/>
3. Use design-construct method (Kaedah mereka bentuk dan melaksana) (e.g. a contractor does both assessment and maintenance work)(kontraktor menilai dan menyenggara kerja)	<input checked="" type="checkbox"/>
4. Use performance-based contract (Kaedah berdasarkan kemajuan kontrak) (i.e. payment based on performance and service availability of road not based on volume/bill of quantity)(pembayaran berdasarkan kemajuan dan servis keupayaan jalan bukan berdasarkan volume/bill of quantity)	<input type="checkbox"/>
5. Other, please specify..... (Lain-lain jalan -sila nyatakan)	<input type="checkbox"/>

Part C: Factors influence the effectiveness of Pavement Maintenance Management System

1. Types of road defects occur on road under your jurisdiction.

		SCALE				
		1	2	3	4	5
		Least Frequent	Less Frequent	Average	Frequent	Very Frequent
1	Potholes				1	2 3 4 ✓
2	Longitudinal Crack				1 ✓	3 4 5
3	Transverse Crack				1 ✓	3 4 5
4	Edge Crack				✓ 2	3 4 5
5	Block Crack				✓ 2	3 4 5
6	Crocodile Crack				1 ✓	3 4 5
7	Crescent Shape Crack				1 ✓	3 4 5
8	Rutting				1 ✓	3 4 5
9	Depression				1 2	✓ 4 5
10	Shoving				1 ✓	3 4 5
11	Corrugation				✓ 2	3 4 5
12	Polishing				✓ 2	3 4 5
13	Bleeding				✓ 2	3 4 5
14	Raveling				✓ 2	3 4 5
15	Patching				1 ✓	3 4 5

2. Factors that influencing road defects on roads under jurisdiction.

		SCALE				
		1	2	3	4	5
		Least Frequent	Less Frequent	Average	Frequent	Very Frequent
1	Overload heavy vehicles				1 2 3 4	✓ 5
2	Higher traffic volume				1 2 3 4	✓ 5
3	Heavy rainfall weakens road structure				1 2 3 4	✓ 5
4	Road materials exposed continually to water and flooding				1 2 3 4	✓ 5

5	Alternating weather conditions	1	2	✓	4	5
6	Due to accident	✓	2	3	4	5
7	Low quality in materials used in construction	✓	2	3	4	5
8	Imperfection in construction	✓	2	3	4	5
9	Improper maintenance	✓	2	3	4	5

3. Factors that influencing the optimization of Pavement Maintenance Management System.

		SCALE				
		1	2	3	4	5
		Least Frequent	Less Frequent	Average	Frequent	Very Frequent
1	Problems in design stage				✓	2 3 4 5
2	Lack of controlling and monitoring by authority				✓	2 3 4 5
3	Funds for pavement maintenance				✓	2 3 4 5
4	Communication and skill of the staff				✓	2 3 4 5
5	Comprehensiveness of Data Inventory				1	✓ 3 4 5
6	Data input and validation				✓	2 3 4 5
7	Time taken to solve complaint receive from public				✓	2 3 4 5
8	Standardize specification and manual procedure				1	✓ 3 4 5
9	Use of maintenance technology				1	✓ 3 4 5
10	Training and understanding for the staff				1	✓ 3 4 5

What are the current problems that you think as the main challenge in road maintenance?
(Sila nyatakan apakah masalah utama/cabaran dalam penyenggaraan jalan raya)

No issue

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If you are using software to manage the roads, what are the weaknesses of this method? Please state the name of the software.

(Apakah kelemahan-kelemahan yang didapati apabila menggunakan software bagi tujuan pengurusan jalan? Sila nyatakan nama software yang di gunakan?)

- N/A -

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End of survey

Thank you very much for your co-operation