QUANTIFICATION OF FACTORS INFLUENCING ROAD NETWORK DAMAGE USING RELATIVE IMPORTANCE INDEX METHOD

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DAMAGE USING RELATIVE IMPORTANCE INDEX METHOD

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ABSTRAK

Kertas kerja ini menerangkan kajian mengenai faktor-faktor yang menyumbang kepada kepada kerosakan jalan raya di sekitar Tanah Merah, Kelantan. Kerosakan kepada struktur jalan mempengaruhi fungsi optimum dan ketahanan jalan raya. Selain daripada itu, kerosakan jalan mendedahkan pengguna dengan kemalangan jalan raya dan menyumbang kepada kerugian negara terutama dalam sektor jalan raya. Kajian ini meningkatkan pengetahuan pemandu awam berkaitan faktor-faktor yang paling menyumbang kepada kerosakan jalan dan cara yang berkesan untuk meningkatkan kualiti jalan raya. Justeru itu, kaji selidik telah disediakan berdasarkan kajian literature, sesi temu bual dengan orang yang profesional yang terlibat dalam bidang pembinaan dan diedarkan kepada 200 responden yang melibatkan pemandu awam berlesen berumur lapan belas (18) tahun ke atas. Kajian ini melibatkan untuk memberikan skala (kedudukan) dari 1 (sangat tidak setuju), 2 (tidak setuju), 3 (tidak tahu), 4 (setuju), dan 5 (sangat setuju) kepada faktor-faktor yang dijangkakan. Daripada analisis data menggunakan kaedah relatif indeks kepentingan (RII), menunjukkan bahawa faktor-faktor kumpulan kenderaan muatan berada pada kedudukan RII pertama dengan 0.883 yang menunjukkan faktor paling mempengaruhinya kepada kegagalan turapan jalan raya. Kumpulan kedua faktor adalah jumlah trafik dengan RII sebanyak 0.870 dan diikuti oleh sistem perparitan jalan raya yang buruk dengan RII 0.857. Kerajaan mesti mengambil tindakan serius terutamanya berkaitan masalah kenderaan berat yang boleh menyebabkan kerosakan jalan raya menjadi lebih teruk, menjadualkan semula kerja-kerja penyelenggaraan dengan bijak dan teratur.

ABSTRACT

This paper describes the survey for significant causes to road damage in Tanah Merah, Kelantan. Damage to road structure influence the optimal function and serviceability of the road line. Other than that, road damage expose the users with traffic accidents and contribute to country losses especially in road sector. This research enhance the public drivers' knowledge about the most contributing factors to road damage and effective ways to keep the quality of the road. Then, a questionnaire was prepared based on literature review study, interview session with professional person that involved in the construction field and directed to 200 respondents involving the public drivers (licensed user) above eighteen (18) years old. The survey was involving to give a scale (rank) from 1 (strongly disagree), 2 (disagree), 3 (do not know), 4 (agree), and 5 (strongly agree) to the expected factors. From the data analysis using relative importance index (RII) method, review that group factors of vehicles overloading ranked the first RII with 0.883 which indicate the most influencing factors to road pavements failure. The second group of factors is traffic volume with 0.870 and followed by bad drainage system with 0.857. The government must take a serious action especially the heavy vehicles problems which can inhibits the road damage becomes worse, reschedule the maintenance work wisely and systematic.

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LIST OF ABBREVIATIONS

RII	Relative Importance Index
MIROS	Research Institute of Malaysia Road Safety
PWD	Public Works Department
HMA	Hot-Mix Asphalt

CHAPTER 1

INTRODUCTION

1.1   Background of Study

Transportation engineering is defines as the planning, functional design, management and operation of facility for some application of technology and principles in order to prepare comfortable, speed, safety and economical aspect that would convenient to surrounding, community and things (ITE, 1987). Transportation engineering covered two major scopes which are highways engineering (hardware) and system engineering (software). For highway engineering studies, it includes for geometric design, pavement design and highway materials.

Road system becomes the main mode of national transportation (Agarwal et al., 2011) - the road network damage needs more understanding for the highways engineering studies related to the transportation and road infrastructure. A road is a communication lane that connecting two paths either being paved or upgraded to allow users travels from their origin to destination on foot or by some mode of transport. Based on Law No. 38 of 2004, road also can be derived as the infrastructure includes road traffic of all the roads, including the fittings and accessories kit for transit except the trains and cable car.

Road is much different with street. A Street is a public thoroughfare in a community area that people freely communicate and move in or moves out in an urban context. It has no centre line while a road commonly connects rural areas has divider at centre path. Road system use a stabilized base that open to public traffic use especially for motor vehicles that depends on its own wheels covers also the man-made structures that provides supporting such as tunnels, strong bridges and other supporting structure.

Road infrastructure systems take main role in the success of nation's economy development (Sami et al., 2013). The road network is interconnected from one place to another destination within the design limits of the use and maintenance period. It's can be classified as streets, highways, interstates, local roads which is primary, secondary and tertiary or either parkways as all of them are available for the public use. There will be two types of road pavement design which are flexible pavements and rigid pavements.

This research involved the federal road and state area in Kelantan which use the flexible pavement design. A strong traffic loading will yield elasticity against a true flexible pavement. Flexible pavement is commonly built on relatively thin hot-mix asphalt (HMA) or with treated bituminous surface. The load distribution over the layers of the pavement differentiates the flexible pavement with semi-rigid and rigid pavement. The basic structural design of flexible pavement usually sorted with highest bearing capacity on the top layer followed by lower bearing capacity in decreasing order of load bearing capacity. The common design of flexible pavement (see figure 1.1) include of:
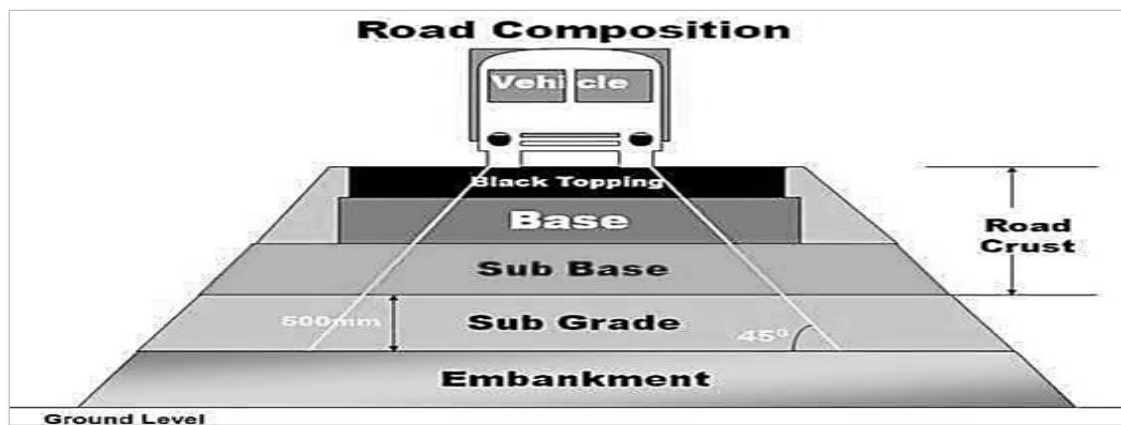
Figure 1.1   The common design of road pavement layer

As we know, when there a lot of number road users at a time it will gives some unfortunate condition to the road system. A continuous and rapid changes to the road development significantly resulted to the unexpected sign of road damage. Some of the built road have achieved the end period of its service life before their design life. It may be a sign of the damaged road which totally affected the road users which sometimes can cause road accidents. Poor road structure such as potholed, narrow and flat roads can lead to road accident problems where undoubtedly pose a danger especially to motorists.

There are possibilities that the road damage causes by the high traffic volume of vehicles (Road Transport Department, 2011) that simultaneously affected the load transferring system. Other factors would be the effects of uncertain weather and also the construction of the design structure pavements below poor management (Ali and Hamzah, 2004; Samsuri, 2009; Abdullah et al., 2010). This research finds that there are three major causes for the design pavement failure: (a) low satisfied and poor structure of pavement, (b) climatic and weather or geography condition (Faturechi et al., 2014) and (c) loading effects of the vehicles (Chen et al., 2014).

The findings later on would be helpful to some party unless we know the most contribution factors in the maintenance preparation stage. The aim of these findings is to identify the factor effects of traffic overload of vehicles, traffic volume system, weather and climatic changes to road accidents, cost expenditure and regularity of maintenance. By that, in order to improve the potential of the economic growth and social improvement, it is essential to make a regular maintenance to the road system as to provide a good road service to users (Frangopol, 2011). There are several way to overcome and control this continuous problem time by time. One of them is by using the geographical information system method in the maintenance and operation part.

1.2   Problem Statement

The streets and roads are the most important transport media in the country and used by almost everyone on a daily basis. Besides the fact that it paved the way for the benefit of road users. It also plays an important role in promoting economic growth and standard of living by the way road, everyone has access to the market, in the workplace, Clinics and hospitals, educational institutions, places sports and recreation and leisure. Nowadays, road availability becomes wider to the road users parallel to the development of our country. Roads are public facilities that are very important as they are used as by everyone all over the world every day.

Whole potential of federal road is much lower rather than highways and expressways as the maintenance of federal road not well organized and provide unsatisfied surface which affects the daily activities of users. With the problem of traffic congestion that never stops, a convenient road conditions would be a determining factor for road users. However, the survey revealed that many roads around the capital and the regions damaged edges, especially with holes and uneven traffic interfere. This road is the main road for the residents in the residential area surrounding the city center.

On the other hand, overloaded vehicles become a danger for traffic, particularly heavy vehicles brake systems and also the brake set. The situation is exacerbated by a strong slopes and closed curves. On steep slopes, where lane of ascent is not available, the slow moving heavy vehicles causing traffic disruption. Traffic accidents caused directly or indirectly by the weight of the vehicle are not normally included when the total cost to the state, caused by the overhead, and are calculated. Heavy vehicles traveling from source to destination through the network of public roads, including the highway as well as the structure of the bridge. If the size and mass of the vehicle is not controlled, it can be a serious weight cause excessive damage to the road infrastructure. Therefore, it has the weight of the right apply.

In addition, the increasing number of vehicles on the study area totally gives high effects to the road structure. Less maintenance process follows the right schedule can cause road damage. Furthermore, the bad technical design, bad detailed specifications and bad changes of weather apparently also lead to broken road (Abas, 2011). One of the places that have problems with worsening road, will increase the maintenance cost as the Federal roads more easy involve with traffic delay, road accidents (Yap, 2010). As now, there will be several ways to improve and maintain the road quality such as by using Geographical Information System (GIS) method, for sure the road damage can be solved affluently.

1.3 Research Aims and Objective

The aim of this research is to identify the factors of road network damage on public view and analyse these factors with relative importance index method.

The objectives of the research are as following:

i. To identify the factor influencing the road damages on view of public licensed user.

ii. To categorize the factors and groups contributing most to road network damage.

iii. To propose and recommends the suitable ways in maintaining the road network system and improves its quality.

1.4 Study Area

This research mainly investigates the problems influencing the smoothness of the road traffic that correlated to the accidents and increasing number of traffic volume. Road network damage analysis covered all the contribution factors and important elements including the scope of study below:

i. This study has been carried out around area Tanah Merah - Kelantan.

ii. The selected road under the study area was State Road and Federal Road that was analysed based on types of road.

iii. The information and data knowledge obtained based on field study, literature review, pilot study, interview session and questionnaire.

iv. Using relative importance index method (RII) method in order to analysis the surveyed data.

v. The target respondents are the licensed public user above 18 years old.

1.5   Significant Study

The research of factors influencing road network damage using relative importance index method would enhance the people knowledge about the common causes of road damage in our country. This is just a small contribution for road maintenance study but effectively would save some waste cost related to broken road. The operation of maintenance should avoid the repeated causes and know well how to deal with the result. The finding's goal also is to differentiate and grouping the most contributing factors to the road damage. This goal can be achieved through the applied method to analysis the survey data. The output of this study becomes helpful for the operation team of damage road to get known with the suggested way and recommendation for controlling the number of damage road.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

One of the most influencing causes fatalities of the motor vehicles cases are the broken or bad condition of road network (Fares et al., 2010). The road network that quite complicated need to be investigated to provide a smooth movement of the people, goods and service. Bad road condition affected by the several factors that contributing most to road failure. The research finds that vehicles user, becomes more severe as the number who face risk of accidents as road damage, such as surface cracking or potholes increase time by time (Kumar and Gupta, 2010).

According to Research Institute of Malaysia Road Safety (MIROS), motorbike and car recorded for each percentage more than 60 reports and 20 percent of fatalities. While the highest rate of fatal accidents involving young people aged between 16 and 25 years and told that Malaysia bear losses about RM9 billion (RM, Malaysian ringgit) in social-economic aspect. People also need to be aware every time using the spotted damage road as they will handle the possibilities being involved with traffic jam, vehicles damage and accident. Ditjen Bina Marga (2006) has grouped the damage away in 3 (three) types, such as: type of holes, the types into heat and the type of deformation.

However, based on British Columbia Ministry of Transportation (2007) indicates that there were 12 (twelve) types of road damages. Then the 12 (twelve) of damage has been grouped into three (3) types of damage, such as: a) cracking, including: longitudinal path wheel longitudinal joint cracking fissuring, edge pavement cracking, transverse cracking, longitudinal cracking meanders, and alligator cracking; b) type of surface deformation such as: Heat, shoving and distortion; c) the type of surface defects such as bleeding, potholes and raveling.

From the findings there are so many effects of the damage road to the country developments, by that we supposed to identify the most influencing factors to road damage. Sukirman (1996) revealed that the damage road commonly affected by: 1) Traffic volume, the increasing load capacity that burden the road structure; 2) Water permeability, related to ground water system on road surface associated with the drainage problems ; 3) Highways material for pavement construction, not standardize with the design materials from expertise person; 4) Soil profile which not meet the stability standard; 5) Climatic effects for equator season which undergo tropical high rainfall and quite air temperature.

It is important for the contractors construct the road pavements follow the right standard and do the road maintenance timely as it will cut the time working and no need for extra working hour. Those factors significantly affect the road network need to be investigated and using the geographical information system (GIS). Geographical information system software is being used nowadays as the transportation infrastructure growth faster in many fields of country development. Actually the overall work and challenges would use and need geography element.

Table 2.1   Number of traffic accidents that cause fatality per road type

TYPES OF ROAD	2008		2009		2010		2011	
	Fatality	%	Fatality	%	Fatality	%	Fatality	%
Expressways	602	9.2	550	8.2	516	7.5	724	10.5
Federal Roads	2297	35.2	2505	37.1	2551	37.1	2449	35.6
State Roads	1480	22.7	1620	24.0	1635	23.8	1616	23.5
Municipal Road	1207	18.5	1130	16.8	1128	16.4	1121	16.3
Others	941	14.4	940	13.9	1042	15.2	967	14.1
Totals	6527	100	6745	100	6872	100	6877	100

Source: Abdul Rahman (2014)

Based on (Table 2.1) above, the higher number of fatality reported (30 % of road accidents yearly) is the reason why the federal road be the main focus area for this research. From the total approximately 157 600 km of Malaysian road network (Ministry of Works, 2014), the three major part were state roads (118 299 km), federal roads (16 613 km) and toll expressways. It indicates also management for federal roads below federal Public Works Department (PWD), while state road under state-level PWDs. However, the administration of Malaysian Highway Authority manages the Toll expressways.

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2.2 Definition

Nowadays, road is one of the main communication that connect all parties in that country as it help in transferring the goods and things. With the facilities provide by road line, the human daily activities becomes smooth. If the road line faces a lot of deterioration, it will make some difficulties especially the accident and fatality cases. There are a lot of causes that influencing the road damage. From that, the responsible parties must take an effectives action to investigate the main factors that contributing to road damage as wish to maintain the road network in better condition.

2.2.1 Road

The road network can derived as interconnected road system that is designed to meet the road vehicle wheels and pedestrian traffic. Road system consists of a network of interconnected paved roads carriageways systems designed for buses, cars and vehicles transporting goods; the general road network forms the most basic level of transport infrastructure within urban areas, and will link to every other field, within and outside the boundaries of the urban area.

2.2.2 Road Damage

Damage to road surfaces usually associated with the structural weaknesses of the road pavement. When it rains almost every day, especially as it is now, the road surface is easily damaged causing the road surface becomes more uneven. Road damage is defined as the destruction, detriment, devastation, harm, hurt, impairment, injury, loss, mischief, mutilation and suffering of the highways infrastructure. There are many studies that have been conducted related to the assessment of road damage, weaknesses and risk assessment of the road structure.

The shallow, flat potholes and uneven, it will not only affect the user experience, but also can lead to accidents and vehicle damage. Based on the instructions and guidelines of the Public Works Department (PWD), the reason of the occurrence of surface defects due to the type of bleeding is the mixture of asphalt unbalanced, the bitumen content is too high, too much during construction, the compression force during the design phase is insufficient and the compression tracking that make the traffic reduces air voids causing bitumen spillage.

2.2.3 Traffic Accident

Accident is an indicator of deficiency. As we know, accident is unplanned, unexpected or undersigned event which occurs suddenly and causes injury or losses. It forces the decrease value of resources or increase in liability. According to statistics, road accidents in the country have doubled in 10 years from 265,175 to 449,040 cases in 2001 to 2011 cases. Traffic accidents caused economic loss of RM9 billion last year after loss of human life and damage. Last year, 6,640 traffic accidents took place or 18.2 deaths per day, which means every 1 hour 20 minutes Malaysia, have been killed on the roads. Furthermore, from the past research finds that in 2008 the number of people lost their lives increase year by year more than 6000 people (Hashim and Rahim, 2009).

2.2.4 Road Maintenance

Pavement performance depends on what, when, and how maintenance is performed. No matter how well the pavement is built, it will deteriorate over time based upon the mentioned factors. So that, it will need the proper planning from maintenance team of the road line. The good maintenance system will lead to increase the road serviceability in long term perspectives.

2.3   Types of Road Network Damage

Significantly, the road infrastructures damage can be separated into two part as structural damage and functional damage. Follow to the Road Maintenance Manual DGH No: 03 / MN / B / 1983, the often types of road damage can be classified into cracking, distortion, potholes, ravelling and polished aggregate. However, there were some others classification for types of road damage from expertise researchers for better explanation. The first one, Gedafa (2006) identify that 3 (three) type of structural damages such as: potholing, rutting and texture depth. Next, Sjahdanulirwan and Nono (2005) revealed the 3 (three) group of road damages such as: a) group of cracks, it is dominated of alligator crack; b) group of disintegration, it is dominated of the holes in the surface; and c) group of deformation.

Another important study from Bennett (2004) and Bennett (2007a,b) stated that there were 8 (eight) types of the road damages that often occurred, such as: a) alligator cracking; b) longitudinal and transverse cracking; c) rut depth; d) shoving; e)potholes; f) scabbing; g) flushing; and h) edge break. In addition, three (types of) damage to roads that often occur: a) the type of ruts, including zest consolidation and instability; Start damaged by cracks; B) potholes, it started as a struggle; and c) the type of depression, starting with deformation (Drakos, 2007). Watanatada et al. (1987) summarize the damage of road in the four (4) types, such as: (a) ruts and cracks; b) contusions; c) distortion and deformation; d) fighting and wrinkles.

Kuswandi et al (2008) also reported that the results of a study in South Ring Road, Yogyakarta, Indonesia that distresses road including alligator cracking, depression, block cracking, longitudinal and transverse crack, polished aggregate, patching, crack slip, shoving and weathering or gravel. The sign of failure for the road can only be found in some parts of the segment. The suggestion is better to make some adjustments treatment for road damage. Some kind of damage to the surface of the flexible pavement is divided into four categories: crack; deformation of the surface; defects and patching surface; and the damage to the potholes (Miller and Bellinger, 2003).

2.3.1 Cracking

This types of road damage commonly occurs due to failure on the pavement surface that can occur in many forms, including small cracks interconnected each other or the whole area connect the entire pavement. Many factors that causes this condition happen such as the effects of the higher loading, soil profile and water level condition and also changes in temperature. There are several types of cracking including hair cracking, alligator cracks, edge joint cracks, lane joints crack, edge cracks, lane joint crack, widening cracks, reflection cracks, shrinkage cracks and slippage cracks. Figure shows the types of cracking problems. Figure 2.1 show one of the road cracking types that most commonly happen.

Figure 2.1   Types of road damage (cracking)

2.3.2 Depression

Depression or deformation affected by the load capacity of the foundation soil which is not in good condition and well compaction layer. The foundation that is not following the right standard will cause further compaction by traffic load. These types of road damage should be well identified to determine the appropriate type of repair and maintenance. Ruts, corrugation, shoving, grade depression and upheaval are some of deformation types of road damage. Based on studies that have been done by Works Institutions Malaysia (IKRAM), there are several levels of indentation that has been outlined by the Public Works Department (PWD) which is low, medium and high. Figure 2.2 shows the grade depression of road damage that always happen in our country.

Figure 2.2   Grade depression damage

2.3.3   Potholes

This damage is a defect mechanical and chemical in the surface layer of road pavement. The forms of damage can be bumpy, fights, explanation. Usually a tree root the asphalt in the basement element causes an increase in the sub-base and the upward pressure on the structure. Potholes damage defines as the shape bucket with small to large size. The existence of potholes can collect rainwater and infiltrations of water gathered on the sidewalk for damage to roads users and improve the appearance of the hole, i.e., the surface layer of the mixture.

This material is not good content (bitumen film is so thin and easy low separately; relationship between asphalt and aggregate is not good because coarse aggregate; the temperature of the mixture does not meet the standards. a thin layer of asphalt surface and link added easily separate the effects of temperature; good drainage does not cause the amount of water that protracted, which then diffuses at the curb. Figure 2.3 shows the potholes damage that occurs in some problematic area.

Figure 2.3   Pothole damage

2.3.4 Ravelling

This damage can be announced by the impact and cause the same type of damage hole. Improved to provide an additional layer on top of the damaged layer after the clean and dry first layer is damaged. The causes can vary because the drainage system is not good, the weather, the material does not meet specification. Ravelling is caused by excessive dust content causes more bitumen coating the dust from the compaction process should be. The surface layer of asphalt is not perfect because aggregate easily slips on the road surface. Figure 2.4 show the ravelling types of pavement failure.

Figure 2.4   Raveling Types Of Road Failure

2.3.5 Polished Aggregate

The existence of polished aggregate is slippery and dangerous roads for vehicles and drivers through corridor. The cause of the damage is not sustained cumulative wear of the vehicle wheel, round units or a smooth cubic. The floor area of the aggregate portion extending over the bituminous binder in the case of hot mix asphalt used , or cement paste, or very little, no coarse particles or corner. The repeated applications of the traffic are generally, as the old pavement rough prominent, angular particles being polished. This can happen quickly if the unit is exposed to abrasion or subjected to excessive wear of studded tires. Figure 2.5 shows the polished aggregate problem in some area of road network.

Figure 2.5   Polished Aggregate Problem

2.4   Factors of Road Network Damage

Many studies and past research has been make an assessment for the factors influencing road network damage. Abhijit (2011) identified the effect of a poor drainage and found that the increasing of moisture content reduces pavement strength. Therefore, the poor drainage will to the premature failure of the paving. In the same line, the pavement tends to break at some point in its life under the combined action of traffic conditions and the environment and climate (Wee et al., 2009).

Wisconsin in Department of Transportation investigates pavement fatigue due to the amount and weight of loads per axle. It also explains how wheel loads, number of truck axles, number of truck tires, sub-base quality, the floor thickness and the seasons that contribute to low fatigue. Weather conditions were observed to have an effect on road deterioration, vehicle operating costs, road safety and the. Transport Canada (2005) has shown that the factors of climate effects are a major cause of pavement deterioration. It is a fact that the temperature, freeze-thaw and moisture are factors that can cause some types of pavement deterioration (Transport Canada, 2005).

Residential community who they faced problems due to road damage because they had to sweep the house more often because of the suspended dust in their homes. From the report, founds that the problems comes from the heavy vehicles that should exceed the load limit that can use the road network. The road should passable only vehicles 20 tons, but the observations we found that there were 26 trucks with tires were the road. This has resulted in vividly damaged and the damage is more serious.

Okikbo (2012) indicates that the definition of "damage road" includes any part of a street, highway, or construction site which does not comply with road safety regulations and also any part of a road, road, or on the construction site which do not comply with regulations for a safe road. From the findings, it concludes that there were several causes for road failure; (a) Effect of Alignment and Geometry; (b) Effect of Traffic Volume; (c) Effect of Pavement Material; (d) Effect of Compaction and Construction; (e) Effect of Climatic effects; (f) Effect of Overloading Vehicles and; (g) Effect of Drainage System.

2.4.1   Effects of Overloading Vehicles

Roman Empire was the original design of road construction. This method still use the same approach which is have several layers and the order of its strength increasingly from bottom of the all the layers. Follow the soil condition, the thickness of the layers were vary from up to bottom (Toll, 1997). The construction and maintenance and operation of the road network needs more understanding about the expected loading of a layers will bear along its life period. Figure 2.6 show the stress distribution for a road pavement.
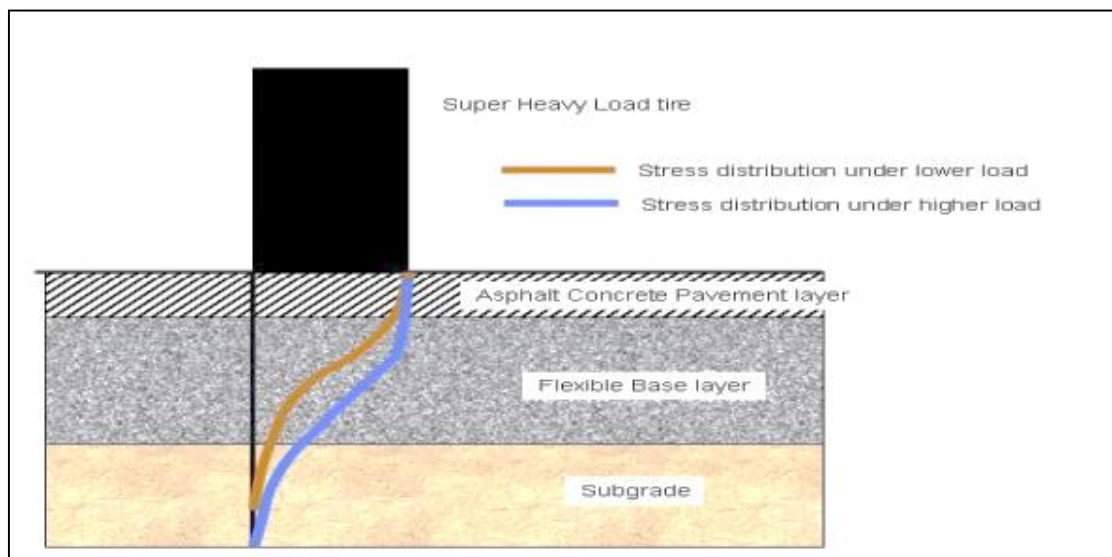

Figure 2.6   The stress distribution for a road pavement.

Overloaded influenced by heavy vehicles or truck most often claimed affects the level of road pavement structure failure. Consequence of stress on surface layer from the higher tyre pressure makes the higher stress on the surface road. The tyre pressure by the heavy mode of transport will identified as the most influencing indicator to the road damage as it's related to contact area of the tyre. The Unconfined Compression (UCS) and Marshall Stability (MS) of surface layers of road pavements materials is the expression for the relationship of stress distribute over pavements and contact area of tyre surface.

Bumps, loose shoulders, and soil deteriorates quickly is the common feature of which is caused by heavy traffic loads. In addition, the potential of the pavements to bear the load transfer through it commonly affected by the strength, stiffness and elasticity of the road pavements. The good quality of the materials have been used, the greater response the loading will be. The design of the road pavements followed the standard specifications and well specified will highly influenced the potential of the pavements.

2.4.2   Effects of Width and Thickness of Road

The design of the road geometry is a branch of engineering concerned with the state of the roads by the physical elements according to the rules and limitations. A key objective of the geometry of the project is to optimize the efficiency and safety and to reduce costs and environmental damage. Geometric design also affects the objectives of the five emerging called habitability, which is defined as the design of ways to promote the objectives of the community, including access to jobs, schools, businesses and homes, to accommodate various ways of transportation, such as walking, cycling , transit, and cars and reduce fuel consumption, emissions and environmental damage.

A wheel alignment geometry can cause or a contributing factor in almost every type of control complaints wheel alignment inspection reveals not only control errors, but also to confirm the suspension components and relationships suspension and steering components of the vehicle structure. These factors affects the road structure as it compromise with the road system most often. Hopefully, there will be some approach to overcome this causes on the road deterioration.

2.4.3   Effects of Traffic Volume

Most roads are designed for a specific traffic volume. But nevertheless, it may be difficult to predict the use of a private road the whole of its design life. Actually, road system bends below the vehicles loading and its several layers bear different loading stage the higher the number of axle contact with the road surface, the less trips that some road structure can bear with. Road damage cases quickly happen when high number axle involved and commonly greater changes rather than the loading increases.

Every country has adopted the maximum axle load and maximum weight limit and the number of vehicles that can be on the road. The higher numbers of car and heavy vehicles repeatedly will sure impact on the sidewalk, make period of life becomes shorter, although the same high standards used during the design and construction. Since it's play important role to the country, road becomes more important to the individual and community. Based on statistic (figure 2.7) from "Jabatan Pengankutan Jalan Malaysia" it shows that there were have an increasing number of accumulated driver each year from 2010 to 2015.
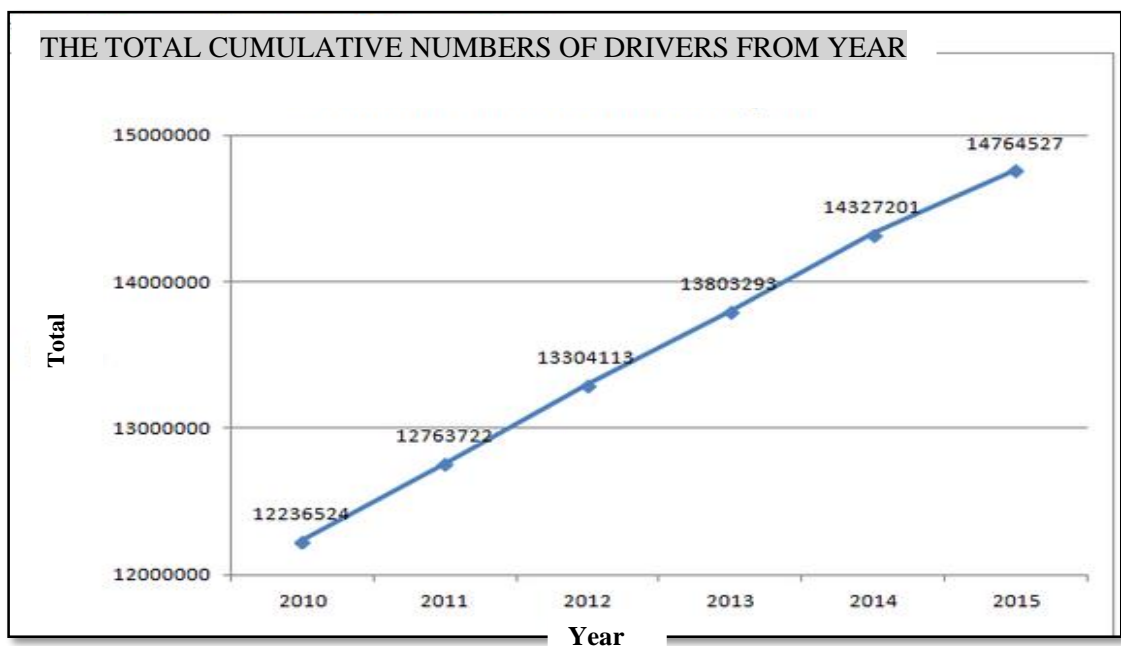
Figure 2.7   Cumulative number of drivers from 2010 - 2015

19

2.4.4   Effects of Climatic Effects

The physical environment can be defined as a set of variables or elements that interact with each other have the energy and materials that can be in and out of the system. The hydrological and ecological systems are examples of major systems in the physical environment. Any changes will have an impact and influence on other systems. Climate change is related to changes in air humidity, sunlight and rain gives impact on the environment and human activities. Indirectly, prolonged rain or uncertainties will affect the structure of the road.

As general , climate derived as regular weather conditions for a location and however the changes in climatic effects makes the current practises may not be suitable for future climate and related to the life of pavements. The construction of road using asphalt pavements design are opened to surface damage due to increased temperature, but more influenced structural damage is caused by increases in water system damage arising from wetter winter and more intensity of rainfall frequency. For this types of road factors damage, it is encourages to provide well manage drainage system and do some development or improving the condition of the pavement.

The climatic changes are most important indicator that need to be well identified in the early stage of designing and planning the infrastructures and cannot make the historic climate as the indicator for future designing as we wish to have a long lifetime for our infrastructure. Others contribute factors such as soil profile, pavement structure and topography features also influencing the climatic impacts on the road failure. The factors are interconnected and link each other. For example, the high temperature and high number of traffic loading would make deformation or distortion effects to pavements. Climate change would cause deterioration failure more frequently ass it was not the new consequences for road damage.

2.4.5 Effects of Pavement Materials

The failure in the road structure gives highly risk to the drivers. Because of that, the construction materials play an important role in giving the best function to the users. The binder must have an optimum degree of adhesion according to the design specifications of the aggregate surface and has sufficient cohesive bond between the aggregate particles. The usage of hydrophilic aggregate as ingredients in construction and optimal degree of compaction is essential for producing a non-transparent surface of the water (Meor Othman Hamzah et al., 1992).

The rutting problems that occurred in the early age of operations is caused by the lack of knowledge among engineers on the performance of the mixed material pavement while on site operation. Based on AASHTO M57- materials classified as A-1, A-2-4, A-2-5 or A-3 can be used for fortifications and should be compacted over 95% of its maximum density. For the design and construction aspects need to be addressed if the material is of a different class. Subgrade is the first layer in road construction which is original or reclaimed land at the bottom of the sub-base.

Design and construction of roads concerned with aspects of the selection of appropriate land. In road construction, one or more layers of material placed on the subgrade. For the base, materials pavement made must have the ability to distribute the load. Typically, this layer is filled with granular material / granular such as crushed rock and has a thickness which is an important asset. Its function is to maintain the site and distribute the load of road vehicles and should also act as a drainage layer.

Bitumen can be classified into two revenue sources, namely natural resources available in the form of hard or soft strata located in geology; the second is bitumen petroleum- widely used in the construction of roads through the process of refining crude oil. Furthermore, the bitumen can be also classified into 4 types; a) penetration bitumen; b) cutting bitumen; c) bitumen emulsified; d) blown bitumen. In road construction, the Marshall method (ASTM D1559) was the most appropriate and best in the mix design of road pavement. This method is a common method proposed by the Asphalt Institute, which is used to determine the optimum bitumen content. It serves to determine the mixing ratio of aggregate and bitumen content to be the best, durable, and economical and have good stability for the construction of pavement materials.

2.4.6   Effects of Bad Road Drainage System

Most roads are designed for a certain volume of traffic. But nevertheless, it can be difficult to plan the use of a particular route for general. Water is a major contributor to failure and damage to roads. Water can be in the form of groundwater, water (rivers and streams) or rain, surface runoff and surroundings. In addition, water can circulate from the side edge of the curb or can be filtered from the water table is high. A good understanding of the dynamics of the flow of water on the road is important for several reasons.

Minor damage can be repaired given as part of routine maintenance of roads and structures. When administered poorly with water flow, the deterioration of the road will be more severe and occur more quickly. This will lead to increased demand for maintenance and, in the worst case cause serious damage that can hinder the flow of traffic. Highway engineers, geotechnical engineers and environmental researcher are three professional groups that natural interested in moisture issues.

The water content of the granular material increases as if the rate of road decline has increased. At least six adverse effects associated with excessive water: reduction of shear strength materials, freezing and thawing and weakness, vast grade basement swelling thin unlimited, movement in the base of flexible coating and base under layers, smooth pumping and resistance to cracking of rigid pavements, flexible asphalt coating detachment.

Generally, it is necessary to maintain or sub-optimal path nearby the water content as possible as can. Effects of different water system on the road added to the some case relating to bad road drainage system. Bad drainage system extremely affects the flow of the water and influence the road network structure before the end life of the infrastructure. Intensive exploitation of water during the rainy season (July to September) also gives a serious problem to the poor drainage system.

2.4.7   Effects of Compaction and Construction

Environmental factors can determine when and where the paving operations may have a float, allowing a limited selection, but the location of the aperture is determined by the location of the road so that there is essentially no "where" choice. Mixing and structural design factors determined before construction and even if they have to take into account the practice and purpose of the construction environment, they often affect the ease of construction and design to achieve compaction. Obviously, this building is the most controllable and adaptable to all the factors affecting compaction. Other factors related to the roller, speed, pattern and number of passes can be manipulated as required to produce the carpet sufficiently compacted.

CHAPTER 3

METHODOLOGY

3.1   Literature Review

The current issue related to the road damage in Malaysia have been identified in order to finds some correlation towards the research outcomes. This thesis actually trying to gives some contribution to the country's road maintenance with some developing tools and skilled method that will eventually useful for parties involved with the road management of operation and maintenance. First objective of this research is to identify the most contributing factors of road damage from the public view. Next, can group and categorize all the causes wisely.

Review the literature and discuss some recommendation in controlling the number of road damage for the study area and displaying collected spatial geography data in some manner. This research will involves with some data knowledge and information that have been survey along the period of data collection involves the public respondents and personal interviewer. Therefore, in this finding, the Relative Importance Index (RII) method would be selected as one of the approach to analysis the collected data.

The received data from the respondents using the survey questionnaire question would be analysed using the Relative Importance Index (RII) method. Regression analysis is a statistical way to investigate the relationship of the study variables. For example, the correlation between the variables is the factor that causes road damage by the public users. The researchers should presents the relative importance index method more regularly while conduct multiple regression analysis.

There were so many types of data collection available in conducting a research such as interview, questionnaire, observation and case study. For this research, the survey questionnaire and interview method was choosing as the method in data collection. All the methods of data collection actually have its own advantages and disadvantages. Like questionnaire approaches that are such easy to accommodate, low costing, lots of information and the uniformity of the questionnaire. For interview method, it is such a good method to gets the information face to face deeply and have flexibility towards the interviewee and interviewed.

The questionnaire is a data collection indirect which contains a number of questions that must be answered selected respondents. Respondents will give the answers or respond in accordance with their own opinion with a simple language that easy to be understands and in short sentences with clear intent. The survey questionnaire way is done by giving the open-ended question and closed ended question. For closed-ended question, the answers can be only answered in one word or short sentences or the respondents simply choose the most suitable answers. Open-ended questions are those classified as the one that require the respondents think and affordable answers more than a simple easy one-word answer. The answers would come in a few sentences, form of list or in unexpected longer phrase in paragraph or essay.

While for interview method, it such different compared to questionnaire method. Interview includes the interview guides that were very common, and to define the issues to be covered without determining the order of questions, that may not be an explicit demand. There would have two main form of interview; unstructured interview as the interview guide outlines just to be asked that needs the creativity of the interviewer. The interviewer comes as the driver of responses. This type of interview is suitable for a special assessment. Other one is structured interview in which guide in detail so as to resemble the check-list. However, interviews commonly use the form of "semi-structured". The responses may include all variables, with detail and depth.

3.2 Methodology of Flow Chart
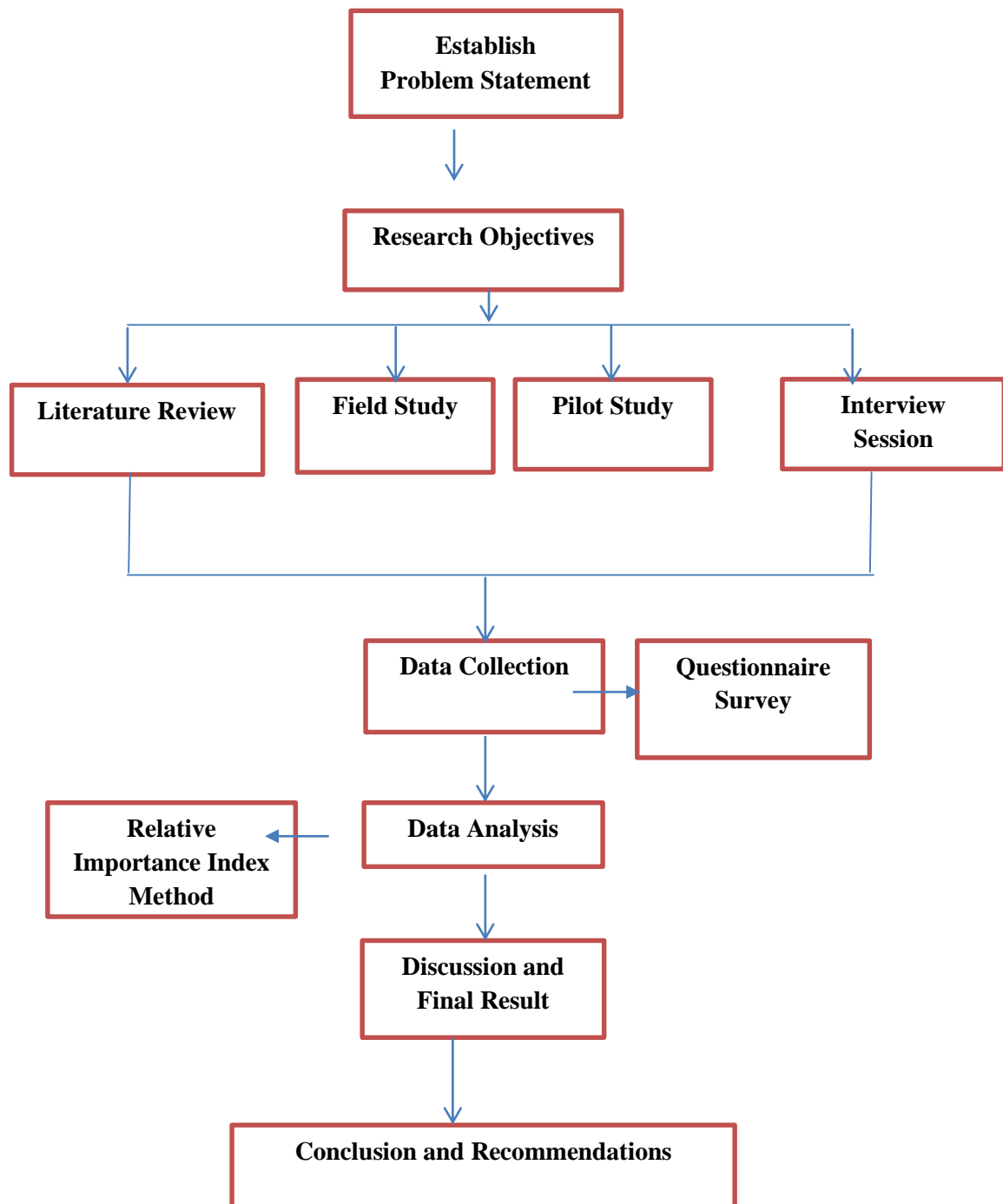
Figure 3.1   Flow chart for Final Year Project

3.3   Study Area

The main focus area of the research topic is around area Tanah Merah - Kelantan. The latitude of the study area location is falling between N5.740 and N5.830 while the longitude is falling between E102.050 and E102.150. The questionnaire is distributes to the public respondent especially who:

     I.   Age 18 (eighteen) years old and above.

    II.   Have licenses card and experience in driving.

  III.   The ones who ever use the route study area once in time.

The selected area study around Tanah Merah, Kelantan is because of the chosen route located in the district that has becomes the second area which is rapidly develop as it population increase from 103,487 in 2000 to 121,319 people in 2010. Coincides with the developments, there is increasing number of traffic volume in one time of period. Other than that, the study area is the main road for daily activities and the movements of the heavy vehicles such as, trucks make the damage road becomes worse. Figure 3.2 show the road network line around district of Tanah Merah, Kelantan.

Figure 3.2   Road network line in Tanah Merah, Kelantan

3.4   Field Study

Field survey conducted to assess the prevailing environment that involves field to compromise the uncertainty in the implementation of the various phases of the construction project. This study is made to have, direct information, important difficulties encountered complaints on the research topic. The goal of conducting field research in this study is to confirm the study of literature review. The field studies involving a series of clear, even if the variables, methods: interview observation, informal, immediate, participation in the life of the group, collective discussion, analysis of personal documents generated in the group, self-analysis, the results of the activities carried out - or online, and the history of life. Although this method is generally characterized by qualitative research, which can (and often does) comprise quantitative dimension.

3.5   Pilot Study

Scale preliminary study conducted to assess feasibility, time, cost, adverse events, and effect size (statistical variability) to predict the appropriate sample size and improve study design prior to project execution. It such mini-version of a full-scale study or a trial done in the preparation stages of the completed findings. A pilot study is done is done by submitting the questionnaire survey to the supervisor. In order to avoid the time and money spent on projects those are designed improperly. A pilot study carried out in public usually related, but those who become part of the final sample. This is because it can influence subsequent behaviour of materials research, if they have been involved in the investigation. Based on the design pilot study with help from the detailed literature review it shows several factors cause road damages in the study area correlated with some other variables.

3.6   Questionnaire Survey

The questionnaires survey is one the selected method to analysis collected data. In accordance to the flow of the research, the questionnaire survey is distributed around the public road users in Kelantan. The 200 samples is conducted to gets the valuable data from the respondents. The questionnaire is given in randomly but follows the scale area. The questionnaires consist three section which is the first section is for the demographic profile of respondents. This section covered the age, sex, and occupations, types of licenses and year of driving experience.

Next, the second section of the survey is for closed-ended question that would include the Likert Scale Question. This part is the most important as it will covers the main topic of this research. Another section is for section three in which the intention of the survey to gets some idea and suitable recommendation on how to manage the road damage problem. Everybody have different idea and different opinion about the thesis topic.

3.6.1   Sample Size

Sample size is chosen using the below following formula.

$$Ss = \frac{\text{Distribution (\%)}}{[M\,(\%)\,/\,Z\,(\%)]}$$

Where;

Ss = the sample size required

Distribution =10 % reflects to the respondents

M (%) =Margin error at 5 %

Z (%) = Confidence level at 95 %

Hence, the sample size = 200. The total questionnaire is returned are 141 sets which are 71 % of return rate based on the total questionnaire prepared.

3.6.2   Likert Scale

Likert scaling derived as psychometric scale that commonly used in research that involved questionnaires method. When involved with Likert scale questions, the respondents identify their level of agree or disagree using a symmetric scale for a phrase of statements. In this research, the data collection based on open-ended questions and closed-ended questions which gives some chances for the researchers. The structure of the question wisely organised and have five point scale that range from 5(five) strongly agree to 1(one) strongly disagree. Respondent's opinion would be such a valuable information in data analysis.

For this research, based on own idea and experience of the selected respondents, they need to choose the factors that they consider most contributing to road damage problems. A Likert element is simply a statement that the respondents were asked to evaluate the quantitative value in any objective or subjective dimension, the level of agreement / disagreement being the most common dimension.

Likert items designed to have both "symmetry" and "balance." Symmetry means that it contains the same number of positive and negative, respectively distance is bilateral symmetry about the "neutral" / zero (this value or is not presented as a candidate). Balance means that the distance between each of the candidates are the same, which allows to make quantitative comparisons, such as min, valid for products containing more than two of the candidates.

3.7   Interview

With such guidelines the interviewer must consider how these questions will be addressed as a solid in the question asked, while adjusting the actual context of the questions during the interview (Poerwandari Patton, 1998). Interviews is a another method to collects data through conversation between two people or more and acts as systematic way to talk and listen to people face to face. The main data of this method is the respondents or called as interviewee.

Interviews are tools for respondents to get involves and stated their opinion. Furthermore, regards to a special condition the interviewee are can contribute their own idea based on their knowledge and specific experienced. Hoyle, Harris and Judd (2002, p. 145) state that, to achieves the aims of study and for better result of the findings the interviewers need to be trained well with the organized survey questions as they will plays as an important characters in the interviews process. The researchers need to keep in minds about the research aims which is to make a collection of data and get data as possible as can but not try change any facts or respondents opinions (Gray, 2004).

In the interview process, the researcher must be aware that the respondents have a clear idea about the questions (why they have been questioned). Make a better understanding covers the aim of the interviews with basic information. Some ideas may long interview and you want to record (explain why). In addition, researchers must know when and where the interview will take place exactly. In an interview session with the treatment, the ethical issues are a major concern.Some list and well-suggested ethical issue solutions:

a. Discuss purpose. Make a discussion on research aims to the respondent.
b. Risk assessment analysis. Considering the conditions method that interview respondents may put.
c. Accessibility of Data. Make evaluation that has the right choices to be involved with secret data and for what purposes.
d. Advices. Be an ethical person when asking for an advice during the progress of the study.
e. Limitation of Data collection. How much efforts will you appoint for data?? How long will you stand in getting the right data?.

3.8   Measurement Error

Measurement error derived as the bias that happen in the actual responses collected in the survey process. It can be categorize to two main sources: the 'questions' and the 'actors' that relatively support the process of getting data (Groves, 1979) – that is, resulted from the respondents themselves, or in the case of face-to-face or telephone interviewing from the interviewer or otherwise either from the design of the questionnaire and the particular questions which being asked.

In addition, data collection methods can affects the quality of measurements and determine how questions are asked or given and also affect the cognition and behavior of respondents and interviewers. For example, if one of the best mode of measurement error documented in relation to the tendency of respondents to modify correct answers to multiple types of survey questions to be presented in a more favorable light (Dillman, 2000) - the impression of which is most common in the aid investigation of the same survey was administered interviewer.

3.9   Relative Importance Index Method

According to Johnson and Lebreton (2004) the RII methods helps in finding the contribution for some variables forecasters with its own criteria and in combination with other predictor variables. Although the importance term often has many connotations, sometimes it refers to statistical significance, while other times it refers to the practical significance. The interpretation of RII is similar to relative risk. The relative risk for the most favored group (at the top of the hierarchy) is summarized with respect to the least favored group (the bottom of the hierarchy).

This interpretation assumes that the variables have been scored so that the highest scores are consistent with an increased risk. In some situations, a variable may explain only a small part of the predictable and yet very significant variance (Martell et al., 1996), while in other situations, a variable may represent a greater proportion of the variance but may provide little practical utility (Cortina and Landis 2009).

The materiality analysis is also applicable to a state school organization that cannot meet the criteria for distribution to meet the assumptions of the least squares ordinary (OLS) regression, as predicted binary criteria as viso volume, promotion of results, training or success. Better to make a judgment will be severe metric relative statistical significance importance. Tonidandel et al. (2009) describes the bootstrap procedure to determine the statistical significance relative weight. This process involves comparing the relative weight produced by forecasters in their data set for the variable named count, random variables. If the relative weight predictor is statistically significantly different relative weight generated by random variables, seers therefore considered important.

This research was selecting the relative importance index method as the method to analysis the collected questionnaire survey data. Below is the formula of Relative Importance Index Method:

$$RII = \frac{\text{Sum of weights } (W1 + W2 + W3 + \ldots + Wn)}{(A \times N)}$$

Where:

RII = Value of relative importance index factor (generally from 0-1)

W = Weights given for each factor by respondents (ranging from 1-5)

Where '1' is strongly disagree, '2' for disagree, '3' for natural, '4' for agree

And '5' is for strongly agree.

A = Highest weight (5 in this case)

N = Total number of the respondents.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter will expose about the finding of data collecting process and all also data analysis in order to achieve the goal of all four objectives. All of the data is collected; the final and essential step is data analysis process. It involves key in process, managing, and analysing of all data and information gathered in previous phases particularly in data collection. The data and information was collected through the questionnaire method that conducted based on the objective of study of these study.

4.2 Responses to the Questionnaire

For the survey, two hundred (200) sets of questionnaire were distributed to the contractors and only 141 were returned completed but only 118 sets of questionnaire will be analysis as it deal will the research objectives and scope of study. The percentages of the overall respondents from the questionnaire process give responses rate about 71 %. The structured questionnaire based on the data obtained from the literature review where the final questionnaire from is presented in Appendix. Table 4.1 below shows the questionnaire distribution and responses rate.

Table 4.1   Number of questionnaire distributed

Number of Questionnaire Distributed	200	
Number of Respondents	*Have Driving License*	*Do Not Have Driving License*
	118	23
Total Respondents	141	
Percentage , %	71	

4.2.1 Types of Organization Sector Involved

Figure 4.1 represented the types of organization involved based on their occupation as indicated by the respondents. The figure shows that 19 % of respondents involved works with private company, followed by self-employed respondents which is 11 %. After that, the involvements of the contractor takes third place which at 11% while the governments company with 25 % which same percentage with the student's respondents. For the respondents that not working take only 9% of the questionnaire survey.
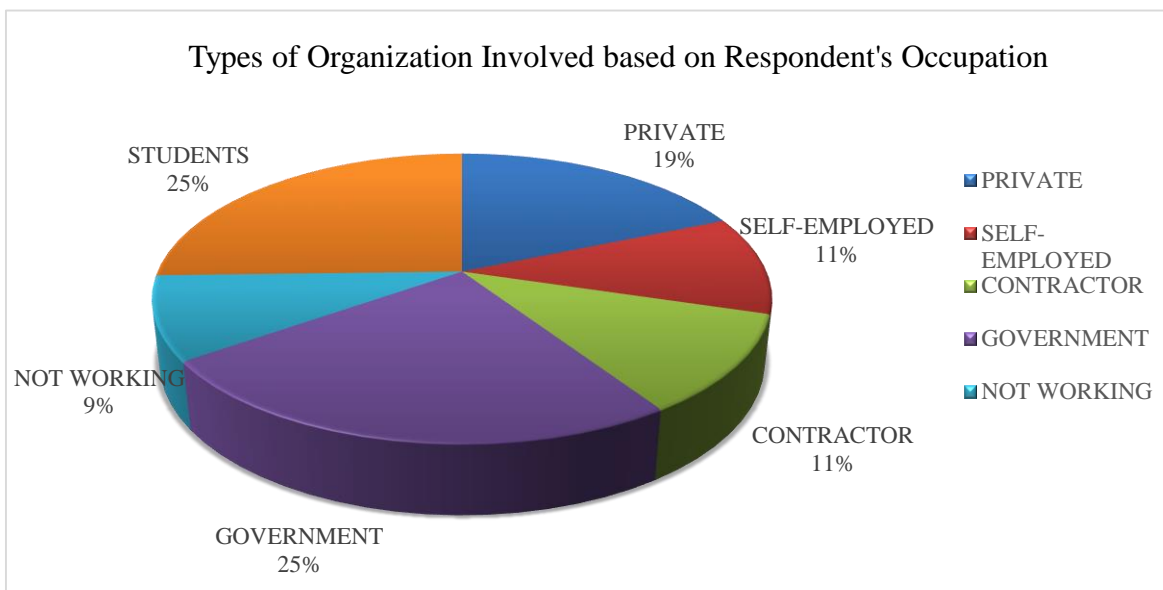
Figure 4.1   Types of Organization Involved

4.2.2 Age of respondents

From Figure 4.2, the age of 18-30 years old was highest number of respondents that take place in questionnaire survey process where 20 respondent is male and 42 is female respondents. The second highest respondents is 31-50 years old where 19 male and 18 female respectively. For the age of 51-70 years old, the total number of respondents involved is 21 number of respondents. Although, the age of < 18 years old involved in this survey, but the data collected for that age is consider as invalid data.
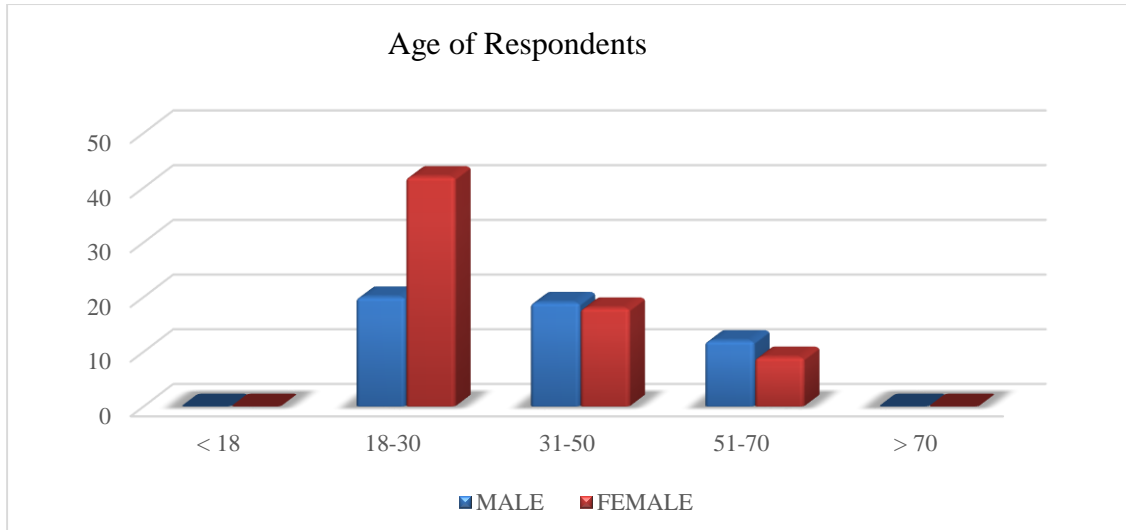
Figure 4.2   Number of respondents involved based on their age

4.2.3   Expenditure of the Respondents

From the Figure 4.3, the average expenditure of the each respondents per month is slightly different based on their occupation. Unfortunately, the highest number of respondents which is 40 respondents was accumulate RM 0 salary per month. The respondents was include the non-working person and students. Next, the highest categories of salary with 38 respondents is the RM 1000 – RM 3000 category where consist the respondents from private, self-employed, government, and contractor. For respondents with expenditure below RM 1000 and is 5 respondents that accumulate for self-employed and private company. The salary in range RM 3000-RM 5000 and above RM 5000 gives 31 and 4 respondents respectively.
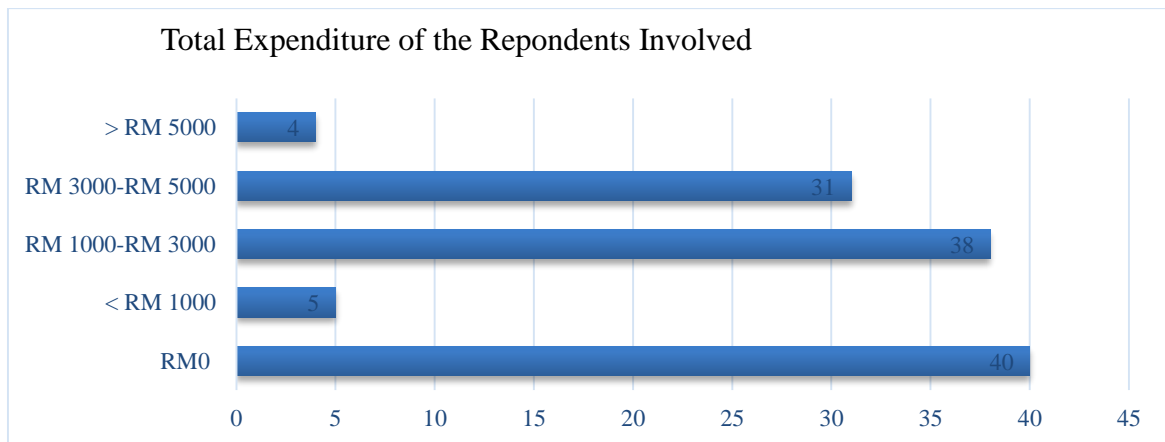
Figure 4.3   Total expenditure of the respondents involved

36

4.2.4   Driving License

The total number of repondents involved in the questionnaire survey is 141 number of respondents but only 118 numbers of respondents have been analysed as these number of respondents have driving license in advance. It followed the scope of these thesis study to do surveying for the public drivers users which above 18 years old and have a driving license. From the table 4.2, the involved public drivers which have the driving license is 51 male and 67 feamale respondents. For the numbers of respondents that do not have driving license ia about 23 respondents.

Table 4.2   The numbers of respondents that have and do not have a driving license.

License	Male	Female
Yes	51	67
No	7	16

For each respondents, they were have a different types of driving license which are class B2 (motocycles not exceeding 250 cc), D (motor car unladen weight not exceeding 3500 kg), DA (motor car without clutch pedal unladen weight not exceeding 3500 kg), class E (heavy motor car unladen weight exceeding 7500 kg), GDL and PSV (vans, lorries and bus in transferring process of goods and things). From figure 4.4, the D and B2 license types indicate the highest classes about 88 and 77 respondents respectively have these types of license.
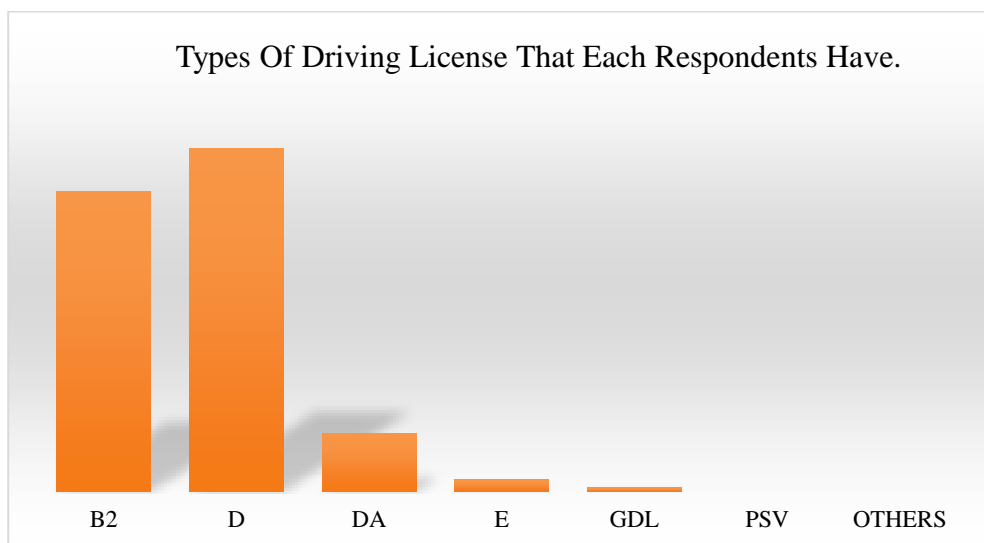
Figure 4.4   The types of driving license

All the drivers respondents have different experience in driving practice. From figure 4.5, it shows that in range 2-5 years of experience the female respondents rank first rather than the male respondents. From the survey, it also indicates that male and female respondents have more experience between 2-5 and above 10 years in driving practice.
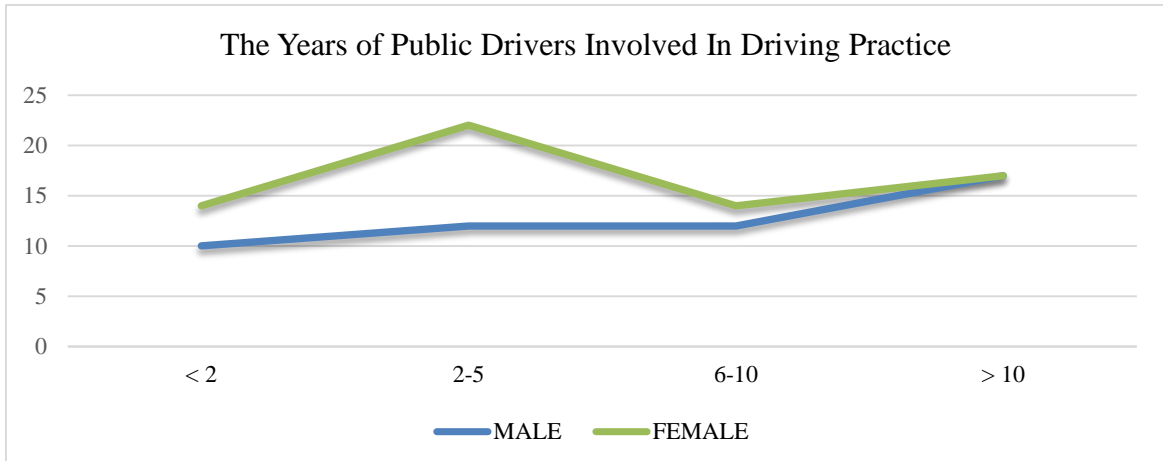
Figure 4.5   The experience of the drivers in driving practice

4.2.5   Frequency the Use of the Road by Respondents

The figure 4.6 below shows the frequency of the drivers involved in these research have been use the road (study area). The respondents give a different answer as it based on their own experience using the road network area. From the survey, almost 40 % of the respondents express that they are more frequently use the road. While 40 % says that they always use the road for their main road line. The rest respondents which 27 % indicates that they were rarely use.
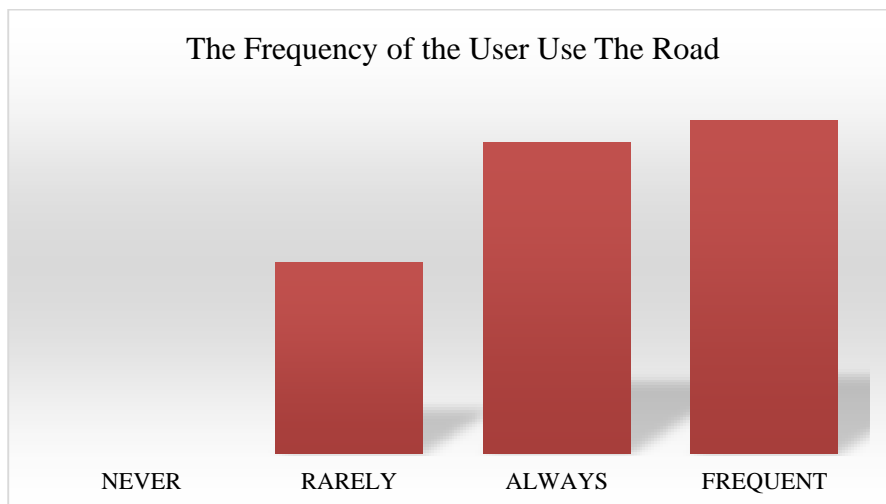
Figure 4.6   The frequency of the user use the research road

4.3   Research Finding and Result

FACTORS INFLUENCING THE ROAD NETWORK DAMAGE	1	2	3	4	5	W	RII	RANK
EFFECTS OF OVERLOADING VEHICLES							**0.883**	**1**
Heavy vehicles are always overloaded	0	2	19	54	43	492	0.834	
Too heavy load of the vehicle is a major factor in road damage problem.	0	0	7	46	65	530	0.898	
Large cargo trucks and heavy lorries are main example of the overloading vehicles	0	1	7	44	66	529	0.897	
Large cargo trucks and heavy lorries often seen in and out on the main roads	0	1	6	42	69	533	0.903	
Road damage due to excessive load factors affect the main function of the road.	0	3	12	33	70	524	0.888	
Heavy vehicles induce road damage	0	1	8	48	61	523	0.886	
Vehicle load greatly influences the strength of the structure of the road.	0	0	13	46	59	518	0.878	
EFFECTS OF WIDTH AND THICKNESS OF ROAD							**0.810**	**5**
The thickness of the road is not enough to support the vehicles load.	0	2	26	54	36	478	0.810	
The thickness of the base tread and the road pavement is not enough during the initial phase of construction.	0	7	30	49	32	460	0.780	
The width of the road is not in accordance with the road for everyday use.	0	2	36	45	35	467	0.792	
The sidewalk of the road pavement is not supported in the best possible and often broken.	2	6	21	50	39	472	0.800	
The occurrence of the falling and the erosion of asphalt (tar road) in the road pavement.	0	2	15	42	59	512	0.868	

FACTORS INFLUENCING THE ROAD NETWORK DAMAGE	1	2	3	4	5	W	RII	RANK
EFFECTS OF TRAFFIC VOLUME							**0.870**	**2**
High traffic volume gives strong pressure to the structure of the road.	0	1	5	51	61	526	0.892	
The amount of traffic will be high when the peak hours.	0	0	8	38	72	536	0.908	
The amount of traffic on Federal Roads and State Roads higher than Tolled Road.	0	2	11	48	57	514	0.871	
Drivers prefer to use Federal Roads and State Roads rather than the Tolled Road.	0	5	15	60	38	485	0.822	
Federal Road and State Road have more facilities than the Tolled Road	0	3	17	42	56	505	0.856	
EFFECTS OF CLIMATIC CHANGE							**0.808**	**6**
The unpredictable changes in weather conditions adversely give impact to the structure of the road.	0	5	18	57	38	482	0.817	
The increasing number of rainfall distribution will cause flooding	0	3	12	60	43	497	0.842	
The severe floods cases will erode and damage the road surface.	0	6	14	51	47	493	0.836	
The flood disaster will result in significant losses in the road sector in Malaysia.	0	6	23	60	29	466	0.790	
Road construction materials are more likely tend to damage if frequently exposed to water and flooding	2	7	5	67	37	484	0.820	
The higher number of rainfall distribution weaken the road structure.	0	8	23	64	23	456	0.773	
The changes in weather conditions will weaken the main function of the road.	0	9	15	73	21	460	0.780	

FACTORS INFLUENCING THE ROAD NETWORK DAMAGE	1	2	3	4	5	W	RII	RANK
EFFECTS OF PAVEMENTS MATERIALS USE							**0.777**	**7**
The construction of roads not in accordance with the standards prescribed material.	0	9	25	53	31	460	0.780	
The selection of building materials not suitable during the first stage of construction.	0	11	28	49	30	452	0.766	
The pavement materials used are not approved by the authorities.	0	12	37	47	22	433	0.734	
The content of the binder mixture of the road is low and inappropriate.	0	6	39	46	27	448	0.759	
The bonding between pavement layers is loose and weak.	0	4	34	50	30	460	0.780	
The use of uncrushed aggregate that naturally quite smooth affects the strength of the surface pavement.	0	3	30	63	22	458	0.776	
The mix design of asphalt (tar road) so poor and not suitable for everyday use design.	0	5	37	55	21	446	0.756	
Deterioration or weakness of the binder or stone diminishing due to higher amount of water content	0	7	28	60	23	453	0.768	
The use of construction materials that does not meet specifications must be removed immediately from the construction site.	0	3	26	59	30	470	0.797	
The selection for appropriate building materials guarantees durability and strength of the road for long periods of time	0	0	17	53	48	503	0.853	

FACTORS INFLUENCING THE ROAD NETWORK DAMAGE	1	2	3	4	5	W	RII	RANK
EFFECTS OF BAD DRAINAGE SYSTEM							**0.857**	**3**
The bad drainage system around the roads gives negative impact to the road structure	0	1	17	44	56	509	0.863	
The higher of groundwater level resulting to the failure of the road function	0	0	22	48	48	498	0.844	
Water seepage through the asphalt (tar road) to break the bond between the top surface and the bottom layer keep increasing.	0	2	12	59	45	501	0.849	
Improper design of road drainage system one of the main causes of these problems.	0	1	11	60	46	505	0.856	
The road drainage system must be arranged properly in order to provide a systematic internal drainage system	0	0	15	46	57	514	0.871	
The designed road drainage system especially the water flow channel must be function well	0	3	10	54	51	507	0.859	
EFFECTS OF COMPACTION AND CONSTRUCTION							**0.820**	**4**
The strength of the base or road surface is inadequate (stability).	0	4	28	58	30	474	0.803	
The clean-up work is not enough before the rolling process of the pavement.	0	7	25	45	41	474	0.803	
The compaction process less good if the weather is too wet and cold.	0	3	27	48	40	479	0.812	
Inadequate compaction process before opening the traffic to road users	0	2	23	51	42	487	0.825	
Parties involved in the construction work needs to examine each of the approved standards and requirements as well as possible.	0	0	19	57	42	495	0.839	
Defects problem may often occur due to poor construction process.	0	0	21	51	45	492	0.834	

4.4   Analysis Relative Importance Index Method at Kelantan

From the analysis, the overloading vehicles-related group factors was the most important group to cause road damage. This related group contribution was mainly due to the factors of the lorries and heavy vehicles that are seen often in and out on the main road (RII=0.903), too heavy load of the vehicle is a major factor in road damage problem (RII=0.898) and also the trucks and large vehicles are main example of the overloading vehicles (RII=0.897). The second most important group influencing road damage was traffic volume–related group, which amount of traffic volume will be high when the peak hours (RII=0.908) and high traffic volume gives strong pressure to the structure of the road (RII=0.892). Then, the bad drainage system-related group of factors influencing at ranking third place. The significant causes by the road drainage system that must be arranged properly in order to provide a systematic internal drainage system (RII=0.871) and the bad drainage system around the roads gives negative impact to the road structure (RII=0.863).

4.5   Mean Score for Relative Importance Index (RII) and Ranking Groups of Delays Factors at Tanah Merah, Kelantan

For further analysis, the mean for each factors are calculated. Table 4.4 shows that the first ranked of mean score are overloading vehicles with RII=0.883, while the traffic volume take second place with RII=0.870, the third ranked is bad drainage system RII=0.857, the fourth ranked is compaction and construction with RII=0.820, the width and thickness of road with RII=0.810, the sixth ranked is for climatic change RII=0.808 and last ranked is the pavement materials use with 0.777.

Table 4.4   Mean RII and Ranking of Groups of Delay Factor

Groups of Factors	RII	Rank
Overloading Vehicles	0.883	1
Traffic Volume	0.870	2
Bad Drainage System	0.857	3
Compaction and Construction	0.820	4
Width and Thickness of Road	0.810	5
Climatic Change	0.808	6
Pavement Materials Use	0.777	7

CHAPTER 5

CONCLUSION

5.1   Introduction

To sum up, this chapter will recover back the research objectives that have been analyses and discussed in Chapter 4 previously. These paper has established that the road damage causes by the overloading vehicles, traffic volume and bad drainage system. So, in this chapter, it will explain about the summary of the findings and proposed some recommendation that already given by the respondent on related research.

5.2   Conclusion

The three objectives of this research study have been successfully achieved. The findings have been summarized as follows:

5.2.1   Objective No 1: To identify the factor of road network damages on view of public licensed user.

From the survey, we found that the factors influencing the road network damage is as below:

    i.   Overloading Vehicles

    ii.   Traffic Volume

    iii. Bad Road Drainage System

    iv. Compaction and Construction

    v.   Width and Thickness of Road

    vi. Climatic Change

    vii. Pavement Materials Use

5.2.2   Objective No 2: Categorize the factors and groups contributing most to road network damage.

From the study, it prove that the most influencing factors that causes to road deterioration and defects as bellow:

- Overloading Vehicles (RII=0.883)
- Traffic Volume Issue (RII=0.870)
- Bad Drainage System (RII=0.857)

5.2.3   Objective No 3: To propose and recommends the suitable ways in maintaining the road network system and improves its quality.

From the survey, the respondents give some recommendation that might be used to maintain and keep the road in suitable condition is as follow:

i.   Optimize the number of the heavy vehicles and lorries on main road and make a further action to them.

ii.   Improved the drainage system in that road area especially in flooding area.

iii. Make a systematic maintenance schedule for road maintenance.

5.3   Discussion

Overall, the objectives of the study were has been achieved in the time assigned. The objectives of this study were achieved by questionnaires conducted. The fixed and systematic schedule for maintenance process for road line will ensure the life of the road. The good maintenance work is totally need to keep the quality of the road service in better condition that can provide a satisfied facilities. The causes that have been analysed need to well investigate and proposed with the suitable recommendation for that situation.

5.4 Recommendation for Future Studies

There are several recommendation in order to provide a satisfied result in future. Since the study only covered a limited scope in Tanah Merah, Kelantan it is proposed that the further study can be conducted in other state in Malaysia so that it can contribute more significantly to the organization in Malaysia. This study also was only based on the opinion of public road users. In the future, it is recommended that the research can be expanding the domain of study for all grades of contractor to develop efficiency of the factors. Other than that, it is recommended also every particular factors influencing road damage used in research scope needs to be well studied and well specified based on the literature review and interview session.

5.5 Summary

This study had successful provided an overview on the factors that most influencing to road structure. Accordingly, it is hope that this study can truly support and motivate future studies on the subject matter according to the recommendation suggested.

REFERENCES

[1] ASTM Annual Book. 1996. Standard Classification of Peat Samples by Laboratory Testing (D4421-92). ASTM Standard.

[2] Agarwal S, Yadav SP and Singh SP (2011) DEA based estimation of the technical efficiency of state transport undertakings in India. Opsearch 47(3):216-230. Retrieved from http://dx.doi.org/10.1007/S12597-011-0035-4

[3] Ankit Gupta (2004) Report on Case Studies on Failure of Bituminous Pavements Report Submitted to PWD, Aligarh. 2004. pp-1-14.

[4] Bennett C. R. (2004) Sectioning of Road Data for Pavement Management, Proceeding of the International Conference on Managing Pavements, Brisbane. Retrieved from http://lpcb.org/lpcb-downloads/papers/2004_pms.pdf.

[5] Bennet C. R. (2007a) Business Processes and Data Collection for Road Management Systems, The World Bank, Washington, D.C.

[6] B. C. Ministry of Transportation (2007) Pavement Surface Condition Rating Manual, 2 nd Edition, Geoplan Consultant Inc., Victoria, B.C

[7] Chen Y, Corr DJ and Durango-Cohen PL (2014) Analysis of common-cause and special-cause variation in the deterioration of transportation infrastructure: a field application of statistical process control for structural health monitoring. Transportation Research Part B: Methodological 59: 96–116.

[8] Drakos, C., (2007) Flexible Pavement Distress, University of Florida.

[9] Ditjen Bina Marga (2006a) Kajian Pengembangan Metode Kuantifikasi Impact for Road Management, Public Work Department, Jakarta.

[10] Frangopol DM (2011) Life-cycle performance, management, and optimisation of structural systems under uncertainty: accomplishments and challenges. Structure and Infrastructure Engineering 7(6): 389–413

[11] Gedafa, D.S. (2006) Present Pavement Maintenance Practice. A Case Study For Indian Conditions Using HDM-4, Fall Student Conference Midwest Transportation Consortium, Ames, Iowa.

[12] Faturechi R, Levenberg E and Miller-Hooks E (2014) Evaluating and
     Optimizing Resilience of Airport Pavement Networks. Computers &
     Operations   Research 43: 335–348. Retrieved From
     http://dx.doi.org /10. 1 016/j. cor. 2013.10.009

[13] Jabatan Pengangkutan Jalan Malaysia (JPJ), (2016).Jumlah Pendaftaran
     Kenderaan Mengikut Tahun. [Online] Retrieved from
     http://www.jpj.gov.my/statistics.

[14] Miller and Bellinger (2003) Distress Identification Manual for the Long-Term
     Pavement Performance Program. Manual June 2003.

[15] Pavement Design Guide, (2011). Types of Flexible Pavement. [Online]
     Retrieved from
     http://onlinemanuals.txdot.gov/txdotmanuals/pdm/types_ of_flexible_
     pavements.

[16] Okikbo, K. (2012). Causes of Highway Failures in Nigeria. International Journal
     of Engineering Science and Technology (IJEST), Vol. 4 No. 11 November
     2012

[17] Sjahdanulirwan and Nono (2005b) Modus dan Mekanisme Kerusakan
     Perkerasan Lentur. Jurnal Litbang Jalan. Volume 22, No. 1.

[18] Patil Abhijit, D.Y.Patil Prathisthan's Y.B.Patil Polytechnic, Akurdi (2011)
     Effects of Bad Drainage on Roads. Civil and Environmental Research,
     Vol 1, No.1, 2011.

[19] Sjahdanulirwan and Nono (2005b) Modus dan Mekanisme Kerusakan
     Perkerasan Lentur. Jurnal Litbang Jalan. Volume 22, No. 1.

[20] Sukirman, S. (1995) Perkerasan Lentur Jalan Raya, Nova, Bandung

[21] Watanatada (1987) The Highway Design and Maintenance Standards Model,
     The Highway Design and Maintenance Standards Series, Vol. 1:
     Description of the HDM-III Model, The Johns Hopkins University Press,
     Baltimore and London.

[22] Wee, Chan and Teo (2009) Potential Modeling of Pavement Deterioration Rate
     Due to Cracking. Unimas E-Journal of Civil Engineering.

SURVEY FORM

Hai and Good Day, I am a final year student of the Faculty of Civil Engineering & Earth Resources, University of Malaysia Pahang. This is part of a study to analyze the factors that affect the damage to roads around the main streets in Tanah Merah, Kelantan. The information you provide will be used solely for academic purposes and will be kept as well as possible. Your cooperation is greatly helped me in completing this survey and first with thanks.

Section 1: Demographic Profile

Please read the following statements carefully and check your answers in the space provided.

1. Gender
Male
Female

2. Age
< 18
18 - 30
31 - 50
51 - 70
> 70

3. Marital Status
Single
Married
Others

4. Driving License
Yes
No

5. Types of Driving License
B2
D
DA
E
GDL
PSV
Lain-lain

6. Driving Experience (Year)
< 2
2 - 5
6 - 10
> 10

7. Occupation
Government
Private
Contractor
Self-Employed
 (*Exclude Contractor*)
 Not-Working
Students

8. Expenditure per Month
(If a students, Neglect it)
< RM 1000
 RM 1000 - RM 3000
 RM 3000 - RM 5000
> RM 5000

9. Frequency use the research road
(Tanah Merah, Kelantan)
Never
Rarely
Always
Frequently

Section 2:

Below are some of the research factors that influencing the road damage around Tanah Merah, Kelantan. Give the score for the statement below based on your own experience and your opinion.

SCALE	1	2	3	4	5
MATTER	STRONGLY DISAGREE	DISAGREE	NATURAL	AGREE	STRONGLY AGREE

		S	C	A	L	E
NO	FACTORS					
1	**EFFECTS OF OVERLOADING VEHICLES** Heavy vehicles are always overloaded					
	Too heavy load of the vehicle is a major factor in road damage problem.					
	Cargo trucks and large vehicles are main example of overloading vehicles					
	Large cargo trucks and lorries often seen in and out on the main roads					
	Road damage due to excessive load factors affect the main function of the road.					
	Heavy vehicles induce road damage					
	Vehicle load greatly influences the strength of the structure of the road.					
2	**EFFECTS OF WIDTH AND THICKNESS OF ROAD** The thickness of the road is not enough to support the vehicles load.					
	The thickness of the base tread and the road pavement is not enough during the initial phase of construction.					
	The width of the road is not in accordance with the road for everyday use.					
	The sidewalk of the road pavement is not supported in the best possible and often broken.					
	The occurrence of the falling and the erosion of asphalt (tar road) in the road pavement.					
3	**EFFECTS OF TRAFFIC VOLUME** High traffic volume gives strong pressure to the structure of the road.					
	The amount of traffic will be high when the peak hours.					
	The amount of traffic on Federal Roads and State Roads higher than Tolled Road.					
	Drivers prefer to use Federal Roads and State Roads rather than the Tolled Road.					
	Federal Road and State Road have more facilities than the Tolled Road					
4	**EFFECTS OF CLIMATIC CHANGE** The unpredictable changes in weather conditions adversely give impact to the structure of the road.					
	The increasing number of rainfall distribution will cause flooding					
	The severe floods cases will erode and damage the road surface.					
	Flood disaster will result in significant losses in the road sector in Malaysia.					
	Road construction materials are more likely tend to damage if frequently exposed to water and flooding					
	The higher number of rainfall distribution weaken the road structure.					
	The changes in weather conditions will weaken the main function of the road.					

NO	FACTORS	S	C	A	L	E
		1	2	3	4	5
5	**EFFECTS OF PAVEMENTS MATERIALS USE** The construction of roads not in accordance with the standards prescribed material.					
	The selection of building materials not suitable during the first stage of construction.					
	The pavement materials used are not approved by the authorities.					
	The content of the binder mixture of the road is low and inappropriate					
	The bonding between pavement layers is loose and weak.					
	The use of uncrushed aggregate that naturally quite smooth affects the strength of the surface pavement.					
	The mix design of asphalt (tar road) so poor and not suitable for everyday use design.					
	Deterioration or weakness of the binder or stone diminishing due to higher amount of water content					
	The use of construction materials that does not meet specifications must be removed immediately from the construction site.					
	The selection for appropriate building materials guarantees durability and strength of the road for long periods of time					
6	**EFFECTS OF BAD DRAINAGE SYSTEM** Bad drainage system around the roads gives negative impact to the road structure					
	The higher of groundwater level resulting to the failure of the road function					
	Water seepage through the asphalt (tar road) to break the bond between the top surface and the bottom layer keep increasing.					
	Improper design of road drainage system one of the main causes of these problems.					
	The road drainage system must be arranged properly in order to provide a systematic internal drainage system.					
	The designed road drainage system especially the water flow channel must be function well					
7	**EFFECTS OF COMPACTION AND CONSTRUCTION** The strength of the base or road surface is inadequate (stability).					
	The clean-up work is not enough before the rolling process of the pavement					
	The compaction process less good if the weather is too wet and cold.					
	Inadequate compaction process before opening the traffic to road users					
	Parties involved in the construction work needs to examine each of the approved standards and requirements as well as possible.					
	Defects problem may often occur due to poor construction process.					

Section 3: Opinion / Suggestion from Road User

(Any idea or suggestion to control the road damage problem as to provide a useful and suitable way to keep the road quality that perhaps will give the best function to the road users around Tanah Merah, Kelantan)

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Thank You.