EXPLORATION ON DRIVERS' PERCEPTION TOWARDS TRAFFIC INVENTORY PERFORMANCE

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EXPLORATION ON DRIVERS' PERCEPTION TOWARDS TRAFFIC INVENTORY PERFORMANCE

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Thesis submitted in partial fulfillment of the requirements
for the award of the degree of
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SUPERVISOR'S DECLARATION

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This hard work is dedicated to my beloved family and my precious friends who love me and support me during my whole journey of education.

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ABSTRACT

Managing traffic performance is the practice of councils and highway authorities in controlling the use of road network in order to provide safety and achieve efficiency of traffic flow. Often the reliability of traffic performance is neglected when the development of new road evolves over time. However, the significance of road performance cannot be ignored as it involves the safety of road users that cannot be compromised. Therefore, this study is intended to explore drivers' perception towards traffic inventory performance as well as to suggest basic approach for improving the road. To achieve this, Jalan Kuantan – Gambang was chosen as study location. This study was conducted by using a qualitative study by means of questionnaires distribution. Then the average index method was performed to indicate the driver's perception towards traffic performance. This study may provide a handy reference to the road authorities and can be used in value engineering appraisal if required by interested party.

ABSTRAK

Hal ehwal prestasi trafik adalah urusan majlis – majlis dan pihak berkuasa lebuh raya merangkumi pengawalan penggunaan rangkaian jalan raya demi menjaga keselamatan dan mencapai kecekapan aliran trafik. Kebiasaannya, kebolehpercayaan prestasi trafik tidak lagi diendahkan apabila pembangunan jalan baru berkembang dari masa ke masa. Walau bagaimanapun, kepentingan prestasi jalan raya tidak boleh diabaikan kerana ia melibatkan keselamatan pengguna jalan raya yang tidak boleh dikompromi. Oleh itu, kajian ini bertujuan untuk meninjau persepsi pemandu terhadap prestasi inventori trafik serta mencadangkan pendekatan asas bagi memperbaiki jalan raya. Untuk mencapai matlamat ini, Jalan Kuantan - Gambang telah dipilih sebagai lokasi kajian. Kajian ini dijalankan dengan menggunakan kajian kualitatif melalui pengedaran borang soal selidik. Kemudian, kaedah indeks purata telah dilakukan untuk mengenalpasti persepsi pemandu terhadap prestasi lalu lintas. Kajian ini mungkin dapat dijadikan sebagai bahan rujukan yang berguna kepada pihak berkuasa lebuh raya dan boleh digunakan dalam menilai penilaian kejuruteraan jika dikehendaki oleh mana – mana pihak yang berkepentingan.

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CHAPTER I

INTRODUCTION

1.1 BACKGROUND OF STUDY

Road has become among one of the most important infrastructure equipment worldwide. History of the road construction was already commenced from China and Roman civilization since the birth of figures like Robert Philips, John Metacalf, Thomas Telford and John Macadam (Mimi Das Saikia et al., 2010). Ever since the era, the development of the highway system in Malaysia continues to evolve over time as the roads is one of the important aspects of human relationships primarily involves commercial activities. The need for efficient road networks and safety is very important and for that reasons, today's efforts in improving the ease and safety of road users is growing rapidly.

In Malaysia, roads network and highways are important as it plays the role to connect a destination to another destination. As rapidity of development in Malaysia has contributes to the economic growth, it has indirectly increases vehicle occupancy over the last ten years. Based on Malaysia's transportation statistic, the number of vehicles on the roads increased by about 5 percent per year. Reported in year 2012, a total of 905 931 vehicles registered in the state of Pahang. The number increased from a total of 856 279 in 2011 and 807 808 in 2010 (Ministry of Transport, 2012).

Over the years, industrialization and urbanization with high growth rate has causes several traffic conflicts all over the world. Nowadays, traffic inventory performance is among the important problems worldwide. Like most of the developing country, Malaysia is facing an increase of vehicle occupancy and of accompanying problems with the loading of this traffic volume. Unceasingly, road facilities experience failures more rapidly than expected due to the increases of traffic volume and insufficient degree of maintenance. Therefore, it will be desirable to minimize the conflicts and increases the competence of traffic management in handling road facilities.

In transportation engineering, a traffic conflict is an event involving two or more moving vehicles approaching each other in a traffic flow in such a way that a traffic collision would ensue unless at least one of the vehicles performs an emergency maneuver. According to Dinesh Mohan (2002), road traffic accidents is the leading cause of death by injury and the tenth-leading cause of all deaths globally which now make up a surprisingly significant portion of the worldwide burden of ill-health. Exposure to potential road traffic injury has increased largely because of rapid motorization, coupled with poor road conditions, rapid population growth, lack of safety features in cars, crowded roads, poor road maintenance, and lack of police enforcement (Population Reference Bureau, 2006).

In order to reduce traffic conflicts, effective traffic inventory management should be applied to ensure the traffic flow smoothly, efficiently and functioning accordingly at all acceptable safety level. Traffic inventory is an important transportation consideration because it relates to geometry design, road furniture, network location and environment (Paterson and Scullion, 1990). It is often suggested that old roads are designed without adequate investigation of driver risk perception. Therefore, association of driver’s risk perception towards traffic inventory should be taken into account when conducting a relevant study. Although the attitude of road users is hard to be emphasized, however according to many researchers, it is imperative that human factor can be considered during the design of the road infrastructure. The main goal is to have a better traffic flow in any intervention through the assessment of traffic inventory management analysis through risk perception.

Therefore, a relevant study must be conducted for a better understanding in the exploration of traffic inventory performance. The need to investigate the driver's perception towards traffic inventory management system has become necessary in order to for seen traffic needs as to propose traffic management strategy.

1.2 PROBLEM STATEMENT

Accidents are relatively unpredictable. The widely known contributing factor deduce to road accidents involved human factor, vehicle factor, road and environment factor (Road Safety Department Malaysia, 2010). It can happen by a combination of tired drivers and poor road geometry or poor vehicle condition. Accidents due to human occur in many ways including human perception and driving behavior varies with age, emotion, belief and attitude. In addition, the fact that accident can happen due to poor road environment management should not be neglected. Unidentified road environment factors that can activate an accident together with the manageable roadside areas are a hidden factor that seldom been discussed among road safety research. Road environment covers many aspects such as road conditions, roadside conditions, traffic volumes, operational speed and the conditions driving ambience itself. Prior to this issue, this study was conducted to explore on driver's perception towards traffic inventory performance that maybe a potential factor affecting road safety.

1.3 OBJECTIVES

This study is of interest to explore traffic inventory management through the assessment of risk perception before planning effective countermeasures. To achieve the aim of this study, the following objectives have been set:

i. To explore drivers perception towards traffic inventory performance.
ii. To suggest basic approach for improving road performance.

1.4 SCOPE OF STUDY

The scopes of study have been determined in order to ensure that literature study is focusing on certain fields only. The limitations of this study are listed below.

i. The study area is focused on Jalan Kuantan-Gambang because it is the main trunk road connecting Kuala Lumpur and Johor to east coast.
ii. The starting point of study area is from intersection of Jalan Tun Razak until Jalan Tanah Putih in front of Giant Hypermarket excluding central business district.
iii. A questionnaire method is done for the data collection to obtain drivers' perception.
iv. The targeted group is people who are familiar with the road so that the data will not be bias and more focus.
v. The samples are stratified based on age where younger in between 18 to 34, middle age in between 35 to 64 and older is 65or above.
vi. The questionnaire is focused on 4 elements of traffic management; geometry design, road furniture, network location and environment (Paterson and Scullion, 1990).

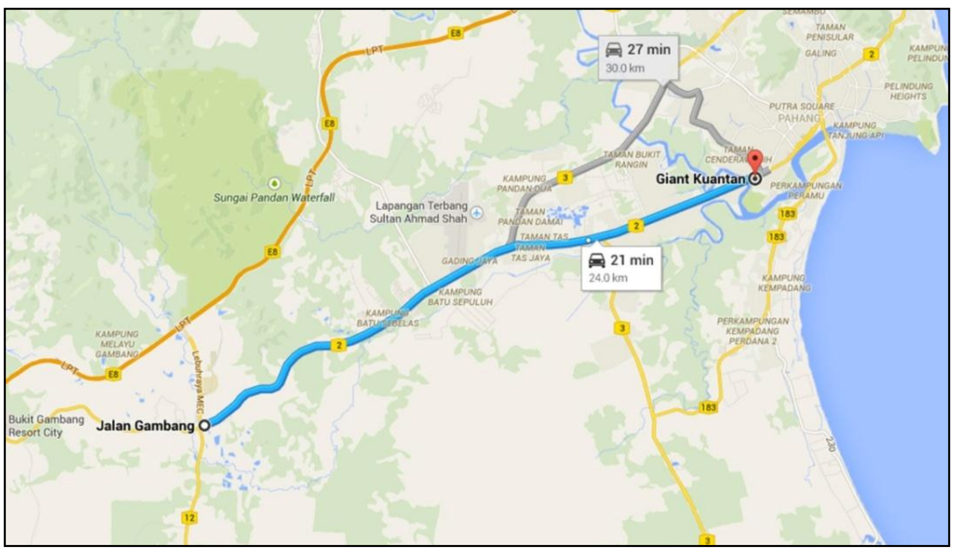


Figure 1.1: Study area of Jalan Kuantan - Gambang

1.5 SIGNIFICANT OF STUDY

Since traffic management involves large amount of data collection and analysis, it is thus intended in this study to gather data for traffic inventory management system which will raise the awareness of local authority regarding the existing road performance and anticipated traffic needs along Jalan Kuantan-Gambang. This survey can be made as a feeder for Road Safety Audit to fill in the gap of justification as they provide a vital role in road checking if it has been designed and built with safety. (Martin Belcher et al., 2008). From this study, we can also propose basic approach for improving traffic inventory performance.

Furthermore, the data gathered in management system studies upon the performance of a traffic stream along the network can be useful for further investigation on traffic management. The most important thing is that it is absolutely practical to be aware of the weakness in traffic inventory management system so that improvement can be made.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

The fundamental objective of any intervention or countermeasure in traffic is to provide safety and achieve efficiency of traffic flow. Whenever the management system deficiencies are encountered, it is expected of the PWD's responsibilities to plan implementation strategies if it requires any physical construction. Countermeasures can be implemented soon after a problem is analyzed and a solution is developed. As to meet the demand of road users, the evaluation of the existing road performance is vital to plan methods of improving the transportation system of the region. For this reason, the need to investigate the relationship between driver's perceptions with traffic management has become necessary in order to foreseen traffic needs as to propose traffic management strategy.

2.2 TRAFFIC MANAGEMENT

A highway information system is a system for identifying, collecting, storing, retrieving and managing all data relating to highways which are relevant to the planning, management and operation of a road network (William D. O. Paterson and Thomas Scullion, 1990). It is commonly believed that road management systems are computer programs. This is wrong. Computer software systems are data management and decision support tools used for road management. They are but one part of the overall management process and, thus, the road management system (HTC Infrastructure Management World Bank, 2000). The management process includes all of the people involved and includes much data collection, analysis, design, and other activities outside the computer software. There may be several software systems which are used in the management process, some of which interact and some of which operate independently. Everything ties together to constitute a road management system.

Management systems therefore serve several functions: they ensure rational and efficient allocations of resources; they maximize the benefits from investments; and, they help ensure that investment objectives and spending priorities are met. These functions can only be achieved by considering the needs of the entire network in the analysis process. This is because the appropriate solution for any one section depends not only on the condition of the section, but also on the needs for the entire network. In addition, it is necessary to consider a wide range of solutions for each section since when operating under budget constraints, which prevail throughout the world, we will usually need to select suboptimal solutions after considering the network needs.

According to Finnish Transport Agency (2010), traffic management measures are aimed at improving the safety and flow of traffic, reducing traffic emissions and utilizing traffic artery capacity more effectively. Traffic management is used to curb demand for transport and affect the selection of the mode of transport, route, or the time of travel or transport. In particular, it is utilized during the first stages of the four-step principle applied in the development of traffic conditions.

Having adequate data is a pre-requisite for effective road management. Although having good data will not guarantee that the correct decisions are made, bad data make sound management difficult (Finnish Transport Agency, 2010). As the figure above shows, a central database is at the heart of the software used for road management. Road management data can be placed into three broad groups:

i. Inventory - These are the physical elements of the road network which do not change markedly over time.
ii. Condition - The elements of the network which change over time and/or under traffic.
iii. Traffic - Data on traffic volumes, composition, load, costs, etc.

Although these groups of data differ quite markedly, there are common principles that need to be considered when establishing a data collection programme. (Christopher R. Bennett et al., 2007)

On the other hand, the familiar tools (which are considered traditional) those are applied as traffic and demand management tools in order to increase the efficiency of the transport system include and not limited to:

i. Prioritization of road users (i.e. introduction of truck lanes, bicycle and pedestrian routes, peak lanes, etc.)
ii. Road hierachisation (i.e. classification of road function)
iii. Road markings and signs, enforcement devices (i.e. camera, police patrol, etc.)
iv. Regulation of parking space, congestion charges, fuel prices, traffic restraints (i.e. limiting entry to city centre, pedestrization of city centre, etc.)
v. Improvement of public transportation, etc.

These tools are relatively cost-effective and technologically affordable and are applicable both in developing and developed countries. However, much as they may seem affordable, yet they are not effectively implemented in most developing countries (Masatu L.M. Chiguma, 2007).

2.3 ROAD INVENTORY

When considering the road infrastructure and its associated data, there are different types of data used for road management. **Table 2.1** shows one data grouping from Paterson and Scullion (1990). This report only focuses on the first element.

Table 2.1: Road Management Data (Paterson and Scullion, 1990).

Element	**Aspects**
Road Inventory	Geometry Furniture/Appurtenances Network/Location Environs
Pavement	Pavement Structures Pavement Condition
Structures	Structures Inventory Bridge Condition
Traffic	Volume Loadings Accidents
Finance	Unit Costs Budget Revenue
Activity	Projects Interventions Commitments
Resources	Institutional Materials Equipment

Public road inventory is a compilation of information about the status and condition of the road system. Necessary to classify and monitor the highways, roads and streets within a state, the transportation data section collects and maintains road information. From the data gathered, reports such as Federal Highway Performance Maintenance System are written and submittal (Oregon TPR, 1991).

In other words, inventory system is a data base, compiled by the Federal Highway Administration, with information on all road structures. The data is often used to analyze road and judge their performance. The traffic inventory is develop with the purpose of having a unified database for road, including identification information, road types and specification, operational conditions, geometric data and functional description, inspection data. Etc.

According to Christopher R. Bennett et al. (2007) inventory data are the physical elements of the road system. These do not change markedly over time. Road inventory data are typically collected in a once-off exercise and require updating when changes are made to the road, such as new roads or realignment. It is common to verify or update the data every five years or so.

It is known that road inventory should be viewed as an important national asset and must be regularly maintained to keep them serviceable like any other assets (Nurul Wahida Mohamed, 2010). Effective asset performance from the view of traffic management means that council and road authority is capable in controlling the use of road network as to face real costs for the construction of the assets, to make decision making process about repair, rejuvenation or reconstruction of the assets based on economic criteria (Ján Mikolaj, Mária Trojanová, Ubomír Pepucha, 2012). Public Work Department has been procured to capture and update the inventory and condition of traffic facilities asset on federal road networks throughout the state which includes but not limited to the following traffic asset (Technical Direction, 2003):

i. Signs, eg. Regulatory, Warning and Guide Signs
ii. Longitudinal Line marking, eg. Lane lines, Edge lines and Centerlines
iii. Transverse Lines, eg. Stop/Give Way lines. Pedestrian crosswalk lines, etc
iv. Other Markings, eg. Speed Numerals, Arrows, Chevrons, etc
v. Pavement Markers, eg. RPMs and RRPMs
vi. Safety Barriers, eg. Guard Rail, Wire Rope, Mesh Fencing, etc
vii. Guide Posts
viii. Traffic Signals (locations and associated signs & markings only)
ix. Other Assets, eg. Roadside Rest Areas, Street lights, etc

From the view of road users, road asset must be well maintained by the authority as to provide safety and comfort. According to Ahmad (2002) maintenance is always a must for any structure in order to maintain its serviceability and to prevent deterioration that may shorten the service life. In reality, maintenance works are not given the attention it should have as the inventory management system can be seen as poorly managed. Therefore, it is a fact that effective management is the most important since the allocation of maintenance need to be carried out to prolong or at least maintain serviceability of structure until the end of its service life without prior consideration of budget. It is fundamental to be aware of the objective of any intervention or countermeasure in traffic is to provide safety and reduce fatalities.

2.4 ROAD SAFETY

Traffic accidents rank fifth among the leading cause of deaths in Malaysia (Department of Statistic, 2008). Accidents are relatively rare and unpredictable, sometimes it is direct observation and often impossible. However, the number of traffic accidents in Malaysia continues to raise despite implementation of various intervention measures over the years. It is quite difficult to control accidents since there are too many factors that influence the accidents to happen. Such factors are weather conditions, road conditions, right-of way constraints, and the drivers' behavior themselves. This could also be due to growth in urbanization and in the number of vehicles which exceeds the designed volume that they are able to carry.

Research by the Malaysian Institute of Road Safety (Miros) showed that averages of 18 people were killed on Malaysian roads daily. Therefore, roadside safety must be improved and an appropriate action must be taken very seriously. Since the country's independence, a number of bodies concerned with road safety have been formed within government departments, private sector agencies and voluntary organizations. Road traffic safety has been considered as one of the social responsibilities to be taken care of by the Malaysian Government. The concern for road safety was to reduce or minimize the effects from vehicle accidents such as death, injuries, and property damage.

Till 80s more focus was in developing road length by constructing new roads and very low consideration was given for maintenance and road safety. Road construction followed standard geometrics with least concern for road safety. Most of the roads and bridges did not have walkways and other required road safety features. The road intersections, blind curves, and bridge approaches were the most vulnerable spots for the motorists, as well as the pedestrian.

Considering the importance of road asset preservation and to reduce the road users cost, rehabilitation and maintenance program were implemented in the strategic roads. Improved road condition induced sudden increase in vehicle fleet and speed, resulting increase in road accidents and casualties.

It is difficult to be accurate about the number of road accident as many accidents, including ones where people are injured, are not reported to the Police. Only those accidents with high injury or property damage or with disputes are reported and recorded in the police office.

2.5 ROAD SAFETY AUDIT

Road safety is now recognized as a major socioeconomic concern facing the gulf region (Municipality of Abu Dhabi City, 2010). Increasing traffic volumes, the rapid growth in traffic and the higher speeds made possible by construction improvement and rehabilitation of roads can all add to the safety problem. Problems can sometimes arise when insufficient attention is given to road safety impacts. For example, higher speeds that become possible on improved roads can lead to an increase in road safety risk for communities along such route and for vulnerable road users. This, in turn, can lead to an increase in the number of deaths and casualties on such roads.

The concept of Road Safety Auditing is becoming more widespread and the number of countries adopting Road Safety Audit Procedures and practices is increasing worldwide. Experiences around the world have demonstrated that it is possible to substantially reduce potential safety problems by implementing systematic safety checks which enable potential hazards to be identified and eliminated. The road safety auditing alone cannot solve all the safety concerns but can play an important part in preventing the circumstances that can lead to road accidents.

Road Safety Audit is a systematic process for checking the safety of new schemes on road. It should be based on sound safety principles and should ensure that all highways schemes operate as safely as is practicable by minimizing future accident numbers and severity (Martin Belcher at el, 2008). Road Safety Audit is not an opportunity to redesign a scheme or to make changes to design with no apparent link to safety issue. It is not intended to be a technical check on the design elements nor a design standard check. These should be carried out independently of the Road Safety Audit. Although Road Safety Audit does look at scheme design from the road user’s point of view, it is not in fact a ‘road user audit’.

A Road Safety Audit (RSA) is a very effective tool to reduce injuries and fatalities on the roads. It is a formal safety performance examination of an existing or future road or intersection by an independent and multi-disciplinary team. It estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users (Municipality of Abu Dhabi City, 2010).

The primary purposes of carrying out safety audit is to ensure that any changes carried out on the highway do not include features, or combination of features, that may have a contributory influence on future injury collision. Road Safety Audits are generally carried out at up to five stages of a new road project: feasibility study, draft design, detailed design, pre-opening and a few months after opening. They should be done by experienced teams that are independent from the project teams (Allsop R., 1997). A key part of a compressive road safety plan must be the safe design of our road infrastructure. Road Safety Audit provides a vital role in checking that road have indeed been designed and built to the highest safety standard (Martin Belcher at el, 2008).

Most countries do not carry out such audits, but those that do, such as Malaysia, can provide guidelines. Together with area-wide safety impact assessments before proposals for projects are improved, safety audits can help to optimize the safety of the whole road network. Even where area-wide impact assessment and road safety audits are carried out, experience may show that certain sites, sections or areas are hazardous and need improvement. Possibilities include: adding skid-resistant surfaces, improving lighting, providing central refuges or islands for pedestrians, adding signs or markings, improving junctions with signals or roundabouts and adding pedestrian bridges. Safety defects may also arise through poor maintenance: for example, road surfaces and signs are deteriorated and roadside lights do not function. Nevertheless, the improvements needed to make an entire road network or a hazardous site safer often cost little but can result in huge benefits in terms of reduced incidence of road crash and injury (Margie Peden et al, 2004).

For many years Road Safety Audit has made a significant contribution to improving highway safety. The formal audit process involves looking at schemes throughout the various stages of design, planning and construction, and trying to identify road safety problems. The auditor then goes on to recommend solutions to the problems that have been described. One of the benefits of RSA is that the auditor can suggest measures that mitigate against the constrains imposed upon the design.

Road Safety Audit (RSA) provides road safety engineers with an opportunity to feed their experience into the highway design process. RSA should improve the awareness of safe design practices by all concerned in the design, construction and maintenance. This makes it more like that the road will operate safely in the environment in which it has to operate.

2.6 GEOMETRY DESIGN

The highway engineer must design for a wide range of vehicle operating characteristics and allow for great differences in driver and pedestrian characteristics. Most highway facilities must be designed to accommodate the smallest automobile as well as the largest tractor-trailer truck. A well-designed highway facility provides consistent information to the road user, assures a safe facility for the most vulnerable user of the system, and conforms to context-sensitive placement issues.

The design of highways necessitates the determination of specific design elements, which include the number of lanes, lane width, median type and width, length of acceleration and deceleration lanes for on- and off-ramps, need for truck climbing lanes for steep grades, curve radii required for vehicle turning, and the alignment required to provide adequate stopping and passing sight distances. When one considers the diversity of vehicles’ performances and physical dimensions, and the interaction of these characteristics with the many elements constituting highway design, it is clear that proper design is a complex procedure that requires numerous compromises (Fred L. Mannering et al, 2005).

Geometric design practices of the state highway and other designing agencies are not entirely uniform on a national basis. A considerable variation exists in the laws of the various states, which serve to limit the size and weight of motor vehicles. Differences in local condition among regional factors such as terrain, weather condition and available construction materials affect standards and design practices on a state-by-state basis (Paul H. Wright and Karen Dixon, 2004).

For a given class of highway, the choice of design speed is governed primarily by the surrounding topography, regional importance within the larger highway network, magnitude of related construction impacts and capital costs associated with construction of the highway project. Once a design speed is chosen, many of the elements of design (e.g., horizontal and vertical alignment, shoulder width and side slope) may be established on the basis of fundamental human sensory capabilities, vehicle performance and other related operating characteristics (Paul H. Wright and Karen Dixon, 2004).

In a situation where the volume of traffic is light or in a free flowing condition, driver's selection of speed is usually constrained by such factors as the road geometry features, lighting, and weather conditions.

Yagar and Vanar (1983) list the factors affecting capacity and speed-flow relationships for two-lane highways under three headings, as follows;

i. Geometric factors: grades, bendiness, lane width, lateral clearance
ii. Traffic factors: vehicle mix, abutting land use (not really a traffic factor), turning movements
iii. Weather-surface factors: darkness, pavement roughness and the winter season alone (without adverse weather) all decreased speed.

The dimensions of the motor vehicles that will utilize the proposed facility also influence the design of a roadway project (Paul H. Wright and Karen Dixon, 2004). The width of the vehicle naturally affects influence the width of the traffic lane; the vehicle length has a bearing on roadway capacity and affects the turning radius and the vehicle height affect the clearance of the various structures. Vehicle weight affects the structural design of the roadway.

Closely related to lane width is the width of the shoulder. For roads without curbs, it is necessary to provide shoulders for the safe operation and to allow the development of full traffic capacity. Well-maintained, smooth, firm shoulder increase the effective width of the traffic lane, as most vehicle operators drive closer to the edge of the pavement in the presence of adequate shoulders. To accomplish their purpose, shoulder should be wide enough to permit and encourage vehicle to leave the travel lane when stopping. The greater the traffic volume, the greater is the likelihood of the shoulders being put to emergency use.

2.7 ROAD FURNITURE

Road furniture is a collective term used for objects and pieces of equipment installed on streets and roads for various purposes. It includes but not limited to the following; traffic barriers, traffic signs, traffic lights, streetlamps, bollards, benches and public lavatories. An important consideration in the design of road furniture is how it affects road safety (Cambridge Dictionary, 2012).

Roadside barriers are used to shield motorists from hazard located along each side of a roadway. Roadside barriers are commonly referred to as guardrail. A guardrail should be provided in location where there is sudden change in alignment and where a greater reduction in speed is necessary. In location with deep roadside ditches, steep banks or other right-of-way limitation, it is often necessary to steepen the side slope and to require the use if guardrail. Where a guardrail is used, the width of the shoulder is increased to allow space for placing the posts (Paul H. Wright and Karen Dixon, 2004).

There are three functional classes of traffic signs; regulatory, warning and guide sign. Markings consist of paint placed on the pavement, curb or object to convey traffic regulations and warnings to drivers. The most common type of markings includes longitudinal and transverse lines, words and symbol. In many situations, however, the final decision as to whether to use a certain sign and markings are left to the judgment of the engineer, guided by an engineering study that might, for example, indicate that a certain sign would be unnecessary. There is considerable local evidence to suggest that warning signs and road markings can have a significant influence on safety. However, there is now pressure to remove signs and lines to reduce street clutter and there are suggestions that removing signs and marking will make roads safer (Martin Belcher at el, 2008). To be more visible at night, signs are fabricated with retro reflective sheeting that reflects back to the driver a large percentage of the light from vehicle headlights.

Roadway intersection are a sources of great concern to traffic engineers due to conflicting traffic movements which can be a major sources of crashes and vehicle delays. An intersection is defined as an at-grade crossing of two or more roadways. For analysis, the roadways entering the intersection are segmented into approaches, which are defined by lane groups. These lane groups are usually based on allowed movements; left, right and through within each lane and the sequencing of allowed movements by the traffic signal.

From a driver's perspective, a traffic signal is just a collection of light-emitting device and lenses that are housed in casings of various configurations, referred to as signal heads whose purpose is to display red, yellow and green full circle or arrows. The illumination of one or more signal lenses (green, yellow, red) indicating an allowed or prohibited traffic movement. A poorly timed signal or one that is not justified can have a negative impact on the operation of the intersection by increasing vehicle delay, increasing the rate of vehicle crashes, causing a disruption to traffic progression and encouraging the use of routes not intended for through traffic.

Allocating effective green times to competing approaches in an optimal fashion has been a goal of traffic engineers since traffic signals were first used. Unfortunately, the problem of optimal timing is complicated by a number of factors (Fred l. Mannering et al., 2005). On what basis should traffic signal timing be optimized? Under favorable progression most of the vehicle travel without stops and delays between successive intersection ‘green wave’. On the other hand, “bad” offset cause high delays and may result in spillovers especially for short signal spacing.

Under low flow condition, this is the time when a vehicle should be able to travel at or close to the free-flow speed. The free flow time is the time a vehicle needs to travel the length of the link without interference from the presence of the signal. The delay at the traffic signal is calculated as the sum of the delay of a single vehicle approaching the traffic signal, the delay because of the queues formed at the intersection, and the oversaturation delay, the additional delay caused when the arrival rate is greater than the service rate at signal. (Alexander Skabardonis and Nikolaos Geroliminis, 2005). Activities likely to disrupt traffic flow include the following;

I. Blockage of the traveled way (i.e. reduction of effective width) which include:
    i. Public transport vehicles which may stop anywhere to pick up and set down passengers
    ii. Pedestrians crossing or moving along the traveled way
    iii. Non-Motorized vehicles and slow moving motor-vehicles
II. Shoulder activities
    i. Parking and un-parking activities
    ii. Pedestrians and non-motorized vehicles moving along shoulders
III. Roadside activities
    i. Roadside accessibility including vehicles entering and leaving roadside premises via gates and driveways
    ii. Trading activities (i.e. food stalls, vendors), and movement of vehicles and pedestrians depending on land use type.

In consequence, traffic flow is considerably interrupted, and thereupon diminishing the performance of traffic operations and undermine capacity and functional integrity of the road. (Masatu L. M. Chiguma, 2007). According to Fred L. Mannering (2005), a poorly timed signal or one that is not justified can have a negative impact on the operation of the intersection by increasing vehicle delay, increasing the rate of vehicle crashes particularly rear-end crashes, causing a disruption to traffic progression adversely impacting the through movement of traffic, and encouraging the use of routes not intended for through traffic such as routes through residential neighborhoods.

While street lighting does provide safety benefit in some situation, from a lighting point of view there is sometimes a problem with the optimum location for a column. For example, the best way to light a bend is to put columns on the outside, providing 'silhouette' lighting tails across the carriageway towards an oncoming driver. However, column on the outside of bends are vulnerable to being hit and can cause injury in loss-of-control accidents (Martin Belcher at el, 2008).

As the emphasis in the specification and design of road lighting is on ensuring visibility, with all that implies for the detection and recognition of the presence and movement of objects ahead, it is important to appreciate that there are other benefits associated with road lighting. They are an increase in the amount of time the driver has before a response is essential, a reduction in the amount of discomfort and disability glare produced by opposing vehicles' headlamps and guidance on the direction of the road far ahead (Peter R. Boyce, 2009).

2.8 NETWORK LOCATION

It is well recognized that land use and transportation systems interact strongly with each other, and the consideration of only one of these systems will not fully reveal a system's responses to major infrastructure developments and policy changes (H. W. Ho and S. C. Wong, 2005).

Table 2.2: Various land use factors, transport impacts and planning objectives (Todd Litman, 2015).

Land Use Factors	**Transport Impacts**	**Planning Objectives**
Regional accessibility	Vehicle ownership	Congestion reduction
Density	Vehicle trips and travel (mileage)	Road and parking cost savings
Land use mix	Walking	Consumer savings and affordability
Centeredness	Cycling	Improved mobility for non-drivers
Road and path connectivity	Public transit travel	Traffic safety
Roadway design	Ridesharing	Energy conservation
Active transport (walking and cycling conditions)	Telecommuting	Pollution emission reduction
Public transit service quality	Shorter trips	Improved public fitness and health
Parking supply and management		Habitat protection
Site design		Improved community livability
Mobility management		
Integrated smart growth programs		

Table 2.2 shows how various land use factors affect transport impacts and therefore the ability of smart growth (also called new urbanism or compact development) policies to achieve various planning objectives. Although most land use factors have modest individual impacts, typically affecting just a few percent of total travel, they are cumulative and synergistic (Todd Litman, 2015). Care is needed when evaluating the impacts of specific land use factors. Impacts vary depending on definitions, geographic and time scale

of analysis, perspectives and specific conditions, such as area demographics. Most factors only apply to subset of total travel, such as local errands or commute travel. This report only focuses on land use mix, connectivity and mobility factors.

Table 2.3: Land use impacts summary (Todd Litman, 2015)

Factor	**Definition**	**Travel Impacts**	**Mechanism**
Mix	Proximity between different land uses (housing, commercial, institutional)	Tends to reduce vehicle travel and increase use of alternative modes, particularly walking. Mixed-use areas typically have 5-15% less vehicle travel.	Reduces travel distances between local destinations (homes, services and jobs). Increases the portion of destinations within walking and cycling distances.
Network Connectivity	Degree that walkways and roads are connected and allow direct travel between destinations.	Increased roadway connectivity can reduce vehicle travel and improved walkway connectivity increases non-motorized travel	Reduces travel distances. Reduces congestion delays. Increases the portion of destinations within walking and cycling distances.
Mobility management	Strategies that encourage more efficient travel activity	Tends to reduce vehicle ownership and use, and increase use of alternative modes. Impacts vary depending on specific factors.	Improves and encourages use of alternative modes.

Table 2.3 summarizes the effects of land use factors on travel behavior. Actual impacts will vary depending on specific conditions and the combination of factors applied. Land use patterns affect accessibility, people's ability to reach desired services and activities, which affects mobility, the amount and type of travel activity (Litman 2003). Different land use patterns have different accessibility features. Urban areas have more accessible land use and more diverse transport systems, but slower and more costly automobile travel. Suburban and rural areas have less accessible land use and fewer travel options but driving is faster and cheaper per mile.

Based on Professor Ron Bridle and John Porter (2002), the professional staffs of General Planning Highways Division (GPH) were responsible for developing the national strategic road network plan which encompassed the motorways and the all-purpose trunk roads, planned as a single, integrated network of nationally important roads. The road programme that brought this into existence was composed of the entire motorway network together with a large number of major trunk road improvement schemes, primarily dualling existing single carriageway trunk roads and dual carriageway bypasses or new alignment which together formed an integrated strategic road network. Implementation of this plan over the years resulted in a massive redistribution of traffic and significantly changed land use. Both effects removed and shifted pressure points around, both removing and sometimes creating new traffic problems.

Trunk roads are an integral element of important routes within the national strategic road network even though they are distinct from the motorway network, many major trunk road improvement schemes began as sequences of town and village bypasses, followed in later years by scheme that linked these bypasses, creating major routes that were near to motorway standard. The only difference for many of these was the absence of a full width hard shoulder and the junction design often being without grade separation: the provision of overpasses and underpasses.

A community's pattern of land use affects the number and lengths of trips people make and their choice of route and travel mode (Hummel T, 2001). Smart-growth policies, for example, favors compact, higher density development with mixed uses so that the places where people live, work, go to school, shop and find opportunities for recreation and entertainment are close together. They may choose to walk, cycle or use public transport rather than use private cars (Litman T, 2003). However, most pedestrians and cyclists are likely to take shorter and easier paths, even if this is less safe (Peden et al., 2004). Studies in Brazil, Mexico and Uganda found that pedestrians would rather cross a dangerous road than go out of their way to take pedestrian bridges (Forjuoh, 2003; Mutto, Kobusingye, and Lett, 2002).

A road traffic system should ensure that the shorter routes are also the safer ones for vulnerable road users. Motor vehicle traffic should be channeled as much as possible along other routes in areas where pedestrians and cyclists are common (Hummel T, 2001). For example, through-traffic that neither originates in nor is destined for residential neighborhoods should be routed away from these neighborhoods (Khayesi M, 1998). In addition, local traffic should be calmed to speeds that are less risky for vulnerable road users.

The interaction between transport and land use is very significant. Changed land use generated new traffic and causes existing traffic to redistribute itself over the network as does investment in new highways, which in turn has an effect on the location of new land use (Ron Bridle and John Porter, 2002).

2.9 ENVIRONMENT

Pavements are among the costliest items associated with highway construction and maintenance (Fred L. Mannering et al, 2005). Pavement provides two basic functions. First, it helps guide the driver and delineate the roadway by giving a visual perspective of the horizontal and vertical alignment of the travelled path. Consequently, pavement gives the driver information about the driving task and the steering control of the vehicle. The second function of pavement is to support vehicle loads. Prior to the AASHO Road Test, there was no real consensus as to the definition of pavement failure. In the eyes of an engineer, pavement failure occurred whenever cracking, rutting or other surfaces distresses became visible. In contrast, the motoring public usually associated pavement failure with poor ride quality.

At a minimum, roads that handle buses should be designed with such a vehicle in mind. Thus, lane widths, turning radii and pavement thickness should reflect the type of transit vehicle that will use the street. There are also other design issues associated with local transit service that relate to the locations where riders get on and off the transit vehicle. Not only should these locations be design from the perspective of rider convenience and safety, but they should also reflect the impacts of stopped transit vehicle o the capacity and safety of the road (Paul H. Wright and Karen Dixon, 2004). Bus stop that are properly located, adequately designed and effectively enforced can improve bus service and expedite traffic flow (TCRP, 1996).

Removal of rubbish and debris is one of the vexing and expensive problems of roadside maintenance. Debris such as fallen branches, rocks, landslides and articles that have fallen from trucks should be removed immediately in order to protect the travelling public. The remains of animal killed by motor vehicles should also be removed promptly and buried at a convenient location. Garbage and trash dumped within the highway right-of-way must be removed because its unsightliness and for reason of health. Generally speaking, roadside should be thoroughly cleared of litter in the spring and periodically as needed thereafter (AASHTO, 1999).

2.10 HUMAN FACTOR

Human factor is a body of knowledge about the human abilities and human limitation that are relevant to the design of tools and machines, task and environment, in addition to system (Chapanis, 1996).

It is widely accepted that human factors are main contribution to accidents (Sabey and Taylor, 1980). Authors have stressed that research of human factors in highway and traffic engineering may be seen as mainly including the study of driver risk perception and driver behavior (Kanellaidis, 1996). Further, according to Kanellaidis (1996), driver perception of risk is an important parameter in theories developed in road-safety research, including risk compensation and the interaction between objective and subjective risk (Kanellaidis et al., 1997; Watts and Quimby, 1980; Wright and Boyle, 1987; Zerva et al., 1998).

It is often suggested that older drivers are more often involved in accidents at intersections and are more frequently cited as being at fault (Stamatiadis, 1994). Furthermore, some researchers conclude that older driver behavior can be characterized as ambiguous (Schlag, 1991). According to these authors, older drivers maintain greater distances from the cars ahead than young drivers, but on the other hand, are less careful when reducing their speed in the proximity of an intersection or when changing traffic lanes. Another important finding is that older person tends to overestimate their driving abilities and reject, to some extent, the notion that aging characteristics affect their driving performance. On the other hand, older drivers seems to have great difficulty driving on high-speed road such as motorways and also exhibit high perception-reaction times during some driving maneuvers such as overtaking (Schlag, 1991).

According to Cerreli (1989), Benekohal, Michaels, Shim, and Resende (1994), and Ranney and Pulling (1990), older driver accident rates are higher than those of younger drivers. Further, older driver seem to be more injury prone when involved in accidents because they present higher injury and fatality rates. The question that arises is why older drivers present higher rates although they are more experienced. The answer, according to researchers, is the decrease in physiological abilities, that is, in ages over 65 all the physiological and psychological operations decline.

All these findings reinforce the case for a more elaborate investigation of older driver risk perception and behavior. They also indicate the significance of a more "driver oriented" approach in the road design procedure by taking into account older driver attitudes and special needs (Kanellaidis, 1996). On top of this is also interesting, from an engineer's point of view, to investigate the potential role of road design on risk perception formation (Kanellaidis et al., 1997; Watt & Quimby, 1980; Zervas et al., 1998). In an American study, an attempt was made to investigate the influence of geometric design on driver expectancy. At a next stage, Kanellaidis et al. (1997) and Zervas et al. (1998) used a qualitative approach to evaluate risk perception and the influential role of geometric design.

It is well establish that driving patterns change as people age. These changes result from changes in lifestyle and economic status, and from drivers regulating their driving to compensate for declining abilities (Hakamies-Blomqvist, 2004). Collectively, these changes have been labeled behavioral adaptations (Hakamies-Blomqvist, 2004; Smiley, 2004). A large body of literature has known that when compared to younger drivers, older adult drivers are more likely to avoid difficult driving situations such as nighttime, inclement weather, high traffic times, urban areas and highways (Ball et al., 1998; Chipman et al., 1993; Gallo et al., 1999; Hakamies-Blomqvist and Wahlstrom, 1998; Kostyniuk, Shope & Molna, 2000; Stamatiadis et al., 1991). Some older drivers also make adaptations to driving behaviors such as driving slower , driving more often with a passenger, avoiding unprotected left turn across traffic, needing larger traffic gaps for merging and more frequent use of safety belt (Ball, Owsley, 1998; Eby et al., 2000; Hakamies-Blomqvist & Wahlstrom, 1998; Keskin et al., 1989; Van Wolffelaar et al., 1991). However, recent works shows there is considerable variation across studies, making it difficult to determine the extent of self-regulation by older drives. For example, rates of self-reported avoidance of night driving varies from 8 percent (Baldock et al., 2006), to 25 percent (Charlton et al., 2001), to 60 percent (Ruechel & Mann, 2005), and to 80 percent (Ball, Owsley et al., 1998). There are also mixed results with regard to the association between self-regulation by older drivers and the functional declines they may be experiencing (Baldock et al., 2006; Ball, Owsley, 1998; Charlton et al., 2001, 2006; Stalvey & Owsley, 2000).

CHAPTER III

METHODOLOGY

3.1 INTRODUCTION

The aim of this chapter is to verify the method of conducting this research, in order to explore drivers' perception towards traffic inventory performance and suggesting basic approach for improving road performance. The aspects that will be focused in this chapter are:

i. Research planning
ii. Study Location
iii. Data Collection
iv. Data analysis

3.2 RESEARCH PLANNING

To achieve the objective of this study, certain methods and procedures are used to get the information needed for the focused question. Research planning is necessary in order to make sure the progress is kept on track. The flows comprises of several stages starting from problem statement, objectives, data collection, data analysis, result and discussion. Finally a conclusion is derived and recommendation is made. **Figure 3.1** showed the flow chart of research planning used to achieve the objectives that have been set.

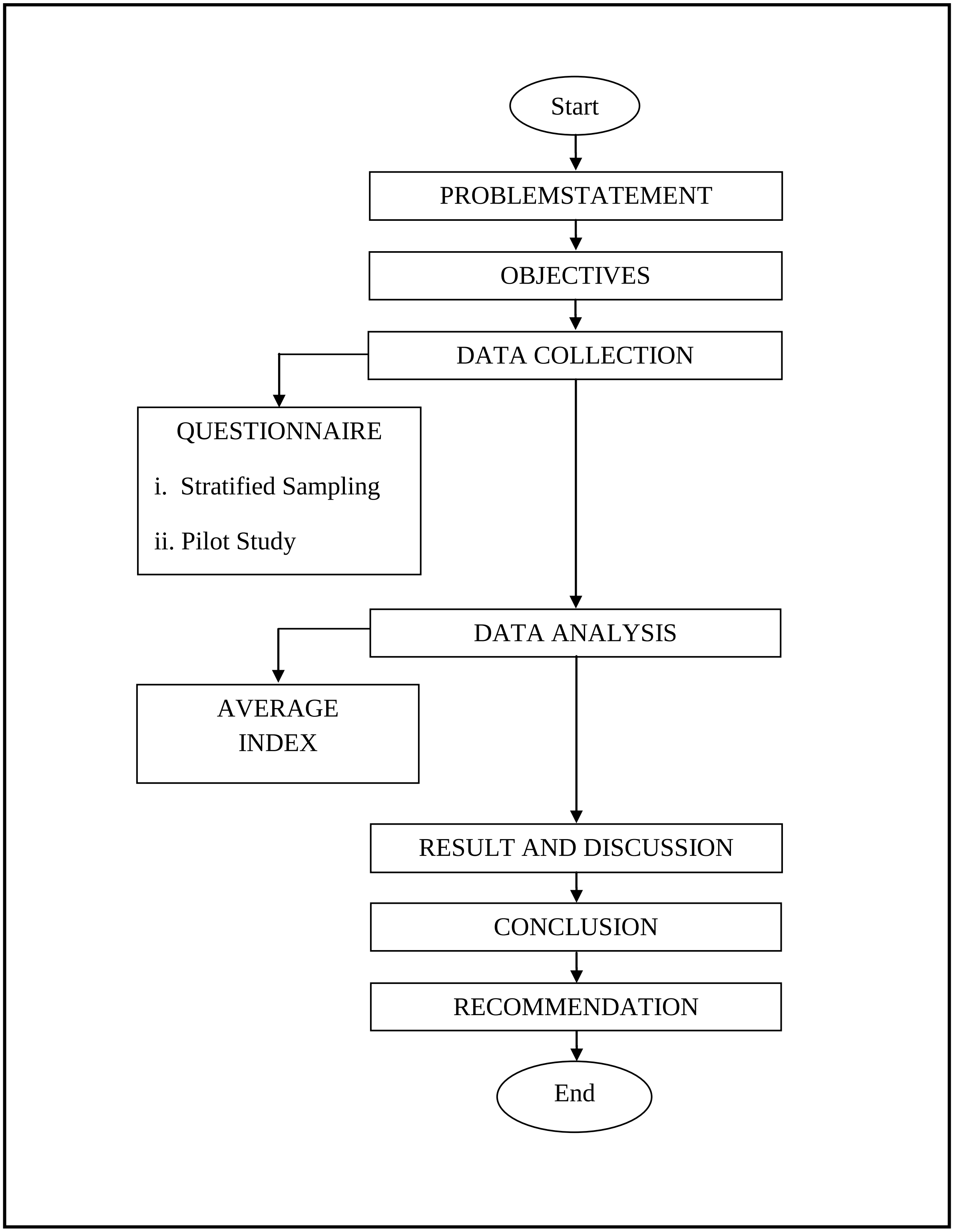


Figure 3.1: Research Planning

Based on the **Figure 3.1**, problem statement has been set and developed as the most important component before initiating the research. This is important because the problem need to be rectified before forming any objectives. After that, the objectives was constructed. The steps were furthered by verifying sampling and population for the data collection. Next, informations gathering were started to fulfill the research literature review and as a basis for questionnaire development.

Pilot test was executed using a sample set of questionnaire. This test was done to test for the validity and reliability of the questionnaire. After the validity and reliability value is obtained, the actual questionnaires were formed and distributed for conducting field study. Data was collected after adequate time has been given to the respondent to answer the question. When all the possible data has been collected, data analyzing is done so that objectives can be achieved. Conclusion and recommendation were given adequately to complete the research.

3.3 STUDY LOCATION

The study area was focused on Jalan Kuantan-Gambang because it is the main trunk road connecting Kuala Lumpur and Johor to east coast. This Federal Highway route 2 is a two lane dual carriageway where the starting point of study area is from intersection of Jalan Tun Razak until Jalan Tanah Putih in front of Giant Hypermarket excluding central business district. It was chosen as study area since Pahang state government are urged to overhaul this main access road to Kuantan from East Coast Highway. This was due to the main road involved should be upgraded or repaired, but until now still pose a problem to the public (Pahang Daily Online, 2012).

3.4 DATA COLLECTION

Questionnaire

The main target of the data collection was to identify drivers' perception towards traffic inventory performance. The main source of information obtain for data analysis was by the use of questionnaire. Questionnaire was chosen to be the main research instrument as it is one of the efficient mechanisms in data assortments and because of its high reliability level as Tuckman (1998) claimed. Furthermore, questionnaires were useful instrument of collecting the primary data since the respondents could read and give responses to each item (Orodha, 2004). According to Mohd Najib Abd Ghafar (1999), questionnaire was used to collect data of perception, attitude and opinion from the respondents towards an event on research. Moreover, it does not require a long time to answer the closed-ended questions. Close-ended questions in the questionnaire are very useful when using a large number of respondents. It is because lists of answers make it much easier to analyze the data collected as acclaimed by McIntyre (2005).

In this research, the questionnaires were distributed by hand from door to door at residential along the study area. The questionnaires were distributed during clear weather to get the practical data which show the level of performance of Jalan Kuantan-Gambang. Each item in the questionnaire was developed to address the objectives of the study.

3.4.1 Population and Sampling

Population is a complete set of groups that fulfill the specification (Kenneth D. Bailey, 1992). Only people who are familiar with the road were taken into account as respondents to make sure the data is not biased. McKenna (1991) stresses that familiarity is a critical factor because the drivers who know a road are better prepared to estimate risk.

McGwin, Owsley and Ball (1998) present an overview of the characteristics of traffic crashes among young, middle aged and older drivers. The results suggest that the youngest and oldest drivers were more likely to be considered at fault. Some researchers stressed that the role of age is very significant because younger drivers, due to lack of experience are more vulnerable (McKenna, 1991). According to Kanellaidis et al. (1995), older drivers are more conservative in their perception of their driving behavior and more vulnerable in terms of their physiological characteristics. Furthermore, older driver accidents rates are higher than those of younger drivers due to decrease in physiological abilities, that is, in ages over 65 all the physiological and psychological operations decline (Cerreli, 1989; Benekohal et al., 1994; Ranney and Pulling, 1990).

Therefore, prior to this study, the respondents were grouped into three different ages. The respondents were stratified into younger age, middle age and older age. Younger age comprises of people aged from 18 to 34 while middle aged ranges from 35 to 64 and older people account for 65 years old and above.

Sample is a portion of population without taking consideration whether it can represent the population or not (Salkind, 1997). Random sampling was used to acquire 30 sets of questionnaire from each group of targeted respondent who answer the questionnaire.

3.4.2 Development of Questionnaire

The content of questionnaire was based on the findings in literature review. Geometry design, road furniture, network location and environment formed the main four elements in the close ended questionnaire based on data grouping by Paterson and Scullion (1990). The questionnaire item consists of introduction, instruction and request for answer. The questionnaire was formulated in such a way that it is easy to understand, direct and clear where jargons and terminologies are be kept at a minimum level and simple English is used. The concept of Keep it Short and Simple (KISS) were used in developing the questionnaire. Designing the questionnaire includes:

i. Choice of topic
ii. Choice of the most important variables
iii. Choice of operationalization
iv. Test the quality of the questionnaire
v. Formulation of the final questionnaire

The questionnaires were structured to have two main parts. The first part focuses on general information of the respondents. This part consists of 4 questions which is single-choice for question 1, 2 and 4 where question 3 is a multiple-choice. Part two was made up of likert scale questions ranging from 1 (most disagree) to 5 (most agree). There are 27 questions based on four elements which related to risk perception towards traffic inventory management. When responded to a likert questionnaire item, respondents specified their level of agreement to a statement. Typical questions were being asked and respondents needed to express their agreement or disagreement in a five point scale. This scale is as shown in **Table 3.1**.

Table 3.1: Likert Scale (McIntyre, 2005)

Likert Scale	**Scale**
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

A five point scale was selected because the literatures suggest that scales with more than 5 points can create understanding difficulties for the respondents (Grigg, 1978).

3.4.3 Pilot Study

Pre testing was done to see the applicability of the tools and seeing how the questionnaires were acceptable to the respondents. Pilot was conducted before the actual study prior to assess on reliability of questionnaire. Reliability test is one of the characteristics that could determine the quality of research instrument. According to Homes et, al. (2005) reliability means that the measurement will give the same result all the time.

In order to for seen how people understand the question, it is wise to carry out pilot study. It is one way to identify the difficulty level of the items. 30 samples were required for pilot study where 10 from each targeted respondent answered the questionnaire. Furthermore, it helps in supporting the data analysis for the actual study as well as the following:

i. To ensure the suitability of questionnaire used in this research
ii. To ensure the respondent understanding towards the questionnaire
iii. To ensure the respondent understanding towards every instruction given in the questionnaire

After the pre test, alterations were made to tools. When considering data collection methodologies, pilot studies are very useful. In the pilot implementation, all proposed data should be collected so as to determine the collection costs, as well as the appropriateness of the data collected.

3.5 DATA ANALYSIS

Frequency analysis was used to analyze the percentage of the respondents with the relation to the variables in part A of the questionnaires. The areas of interest were age group, gender, mode of transportations and frequent user of the road. The result of the analysis is further interpreted into pie chart and bar graph to give a clearer view of the frequency.

For the statistical processing of the survey in part B, frequency tabulation was used to sort the frequencies of request for answers from the respondents. Five point scales was used to indicate the degree of agreement with the statement in the questionnaire. In order to analyze the data gathered, average index analysis was used to gather the level of importance of the data (Muhd Zaimi Abd. Majid dan McCaffer, 1997).

$$\text{Average Index, } X = \frac{1X_1+2X_2+3X_3+4X_4+5X_5}{N}$$

Where, x_1 = No of respondents for strongly disagree

x_2 = No of respondents for partially disagree

x^3 = No of respondents for neutral

x_4 = No of respondents for partially agree

x_5 = No of respondents for strongly agree

n = no of population

Table 3.2: The index attributes (Abd. Majid and McCaffer, 1997).

Level of Importance or Evaluation	**Average Index**
Most Agree	4.5 < Average index < 5.0
Agree	3.5 < Average index < 4.5
Average	2.5 < Average index < 3.5
Disagree	1.5 < Average index < 2.5
Most Disagree	1.0 < Average index <1.5

The index shows the levels of contentment with the road performance and refer to an entire range of satisfaction agree from “strongly agree” to “strongly disagree” rather than just state of being “agree”.

CHAPTER IV

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter discuss on data analysis obtained from the survey carried out upon the existing highway, Jalan Kuantan – Gambang. All information required was collected from the residential area nearby the road. The purpose of the analysis was to obtain the information from the respondents on the highway performance in traffic inventory and the basic approach for improving the road performance.

The survey was conducted at residential nearby to account the factor of familiarity because drivers who knows the road are better prepared to estimate risk as stressed by McKenna (1991). According to Zervas (1998), familiar drivers are frequent users of the road and therefore are aware of some dangerous "black spot" either from their driving experience or because they are aware of the accident records of these spots. This observation is important to show that they know the road well enough to answer the questionnaire.

The aim of the questionnaire was to attain the first objective of the study which is to explore drivers' perception towards traffic inventory performance. The method of study conducted was discussed in the previous chapter, Chapter 3. The following paragraph will discuss the result of the data obtained from the questionnaires.

The questionnaires were divided into two sections, which include the respondent background and level of agreement on road condition. Four elements were tested in the questionnaire which are; geometry design, road furniture, network location and environment. There are 90 sets of questionnaire that were distributed to the respondents. From the questionnaire, the analysis was done using an average index which was discussed in Chapter 3.

4.2 RESPONDENTS BACKGROUND

The graph shows the number of vehicle according to their mode of transportation and number of respondents according to their gender. The analysis is carried out by using frequency distribution from the random sampling. Both demographics indicate the background of respondents.

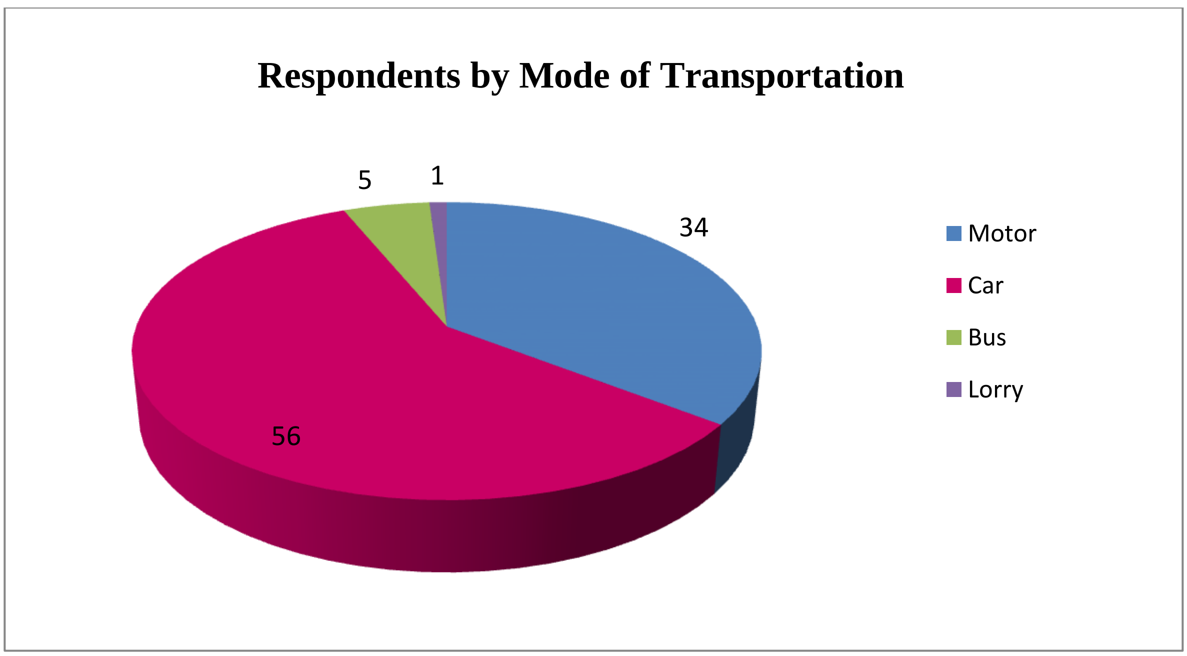


Figure 4.1: Respondents by Mode of Transportation

Based on **Figure 4.1**, the majority for mode of transportation is by car which is 56 followed by motorcycle at 34. Only 5 people chose bus and the least is lorry chosen by 1.

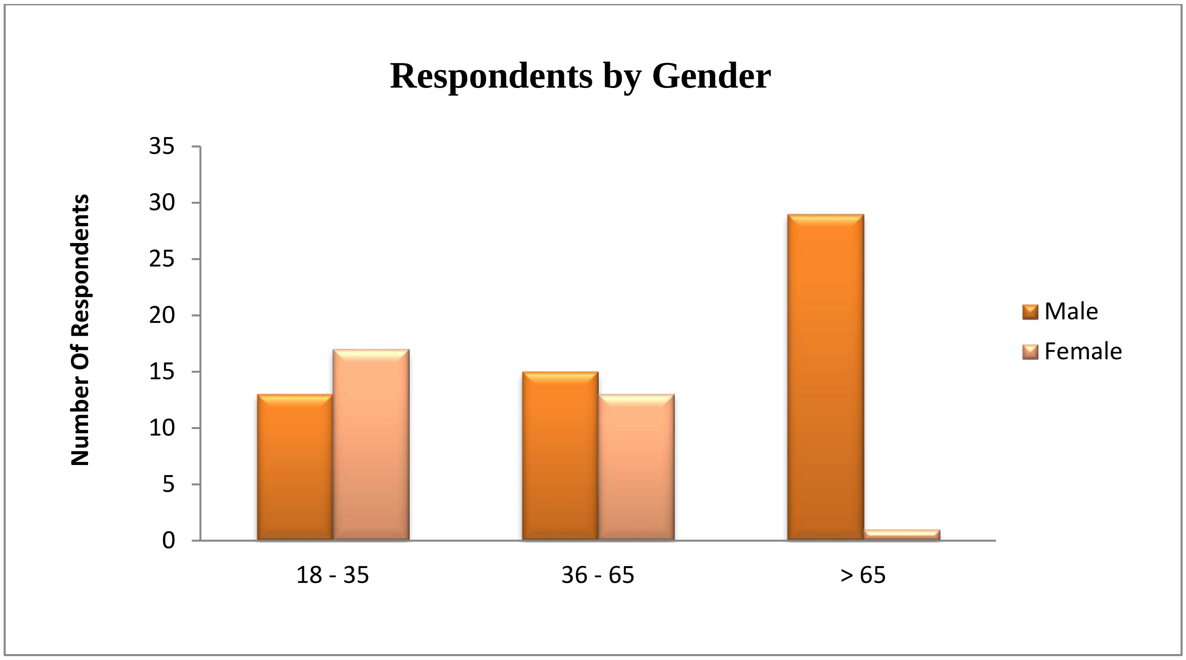


Figure 4.2: Respondents by Gender

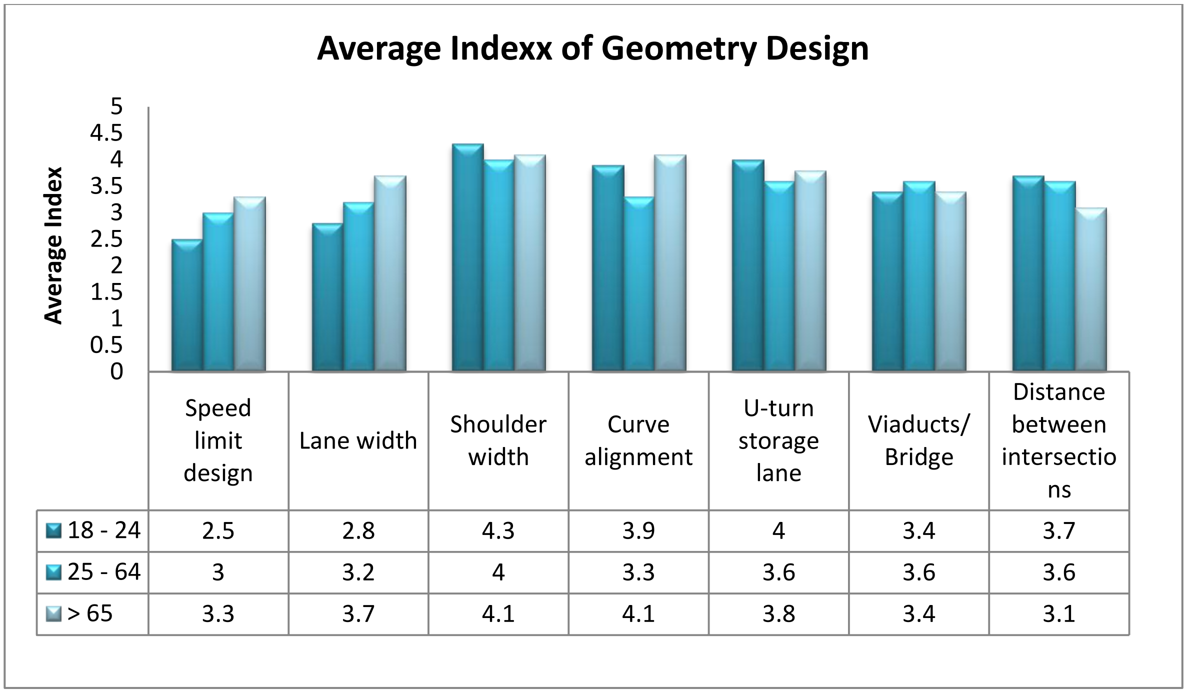
In this study, 13 males from younger group took the survey while the remaining 17 were females. Meanwhile, there are 15 males and 13 females in middle aged group. For older group, 29 were males and only 1 female who answered the questionnaire based on figure 3.

4.3 ATTRIBUTES CONSIDERED IMPORTANT IN TRAFFIC INVENTORY PERFORMANCE

A very interesting result arose from the comparison of 3 groups of drivers, separated by age consideration. The elements which are important to be considered in the traffic inventory performance are breakdown into few attributes. Figures showed that differences between younger, middle and older respondents are not consistent throughout.

4.3.1 ROAD GEOMETRY

In the first part of the analysis showcase how perception perceived by drivers associated with geometry design. The three groups were compared as to their ratings for each attributes of the element.



	Speed limit design	Lane width	Shoulder width	Curve alignment	U-turn storage lane	Viaducts/ Bridge	Distance between intersectio ns
18 - 24	2.5	2.8	4.3	3.9	4	3.4	3.7
25 - 64	3	3.2	4	3.3	3.6	3.6	3.6
> 65	3.3	3.7	4.1	4.1	3.8	3.4	3.1

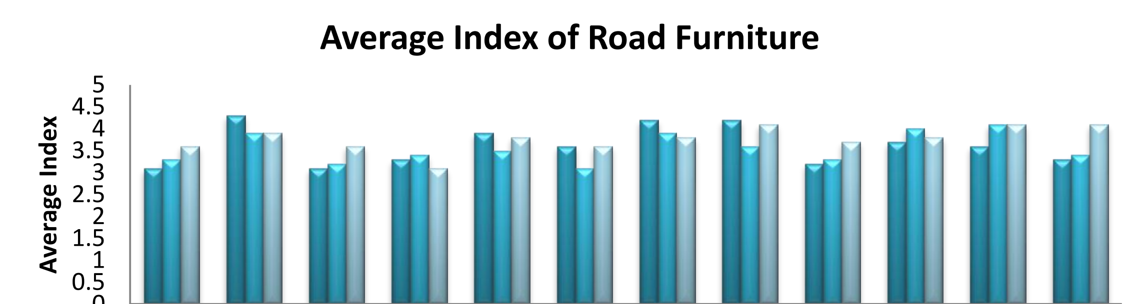
Figure 4.3: Average Index of Geometry Design

Figure 4.3 shows although older drivers' rate speed limit in "Average" category, but it is ranked highest among the three groups corresponding to research done by Kanellaidis (1995) where he states that older driver demand lower speed limit and abide by, at a very high percentage, the existing speed limits. Other than that, older driver ranked "Agree" saying the lane width is too small. It proves that older driver need more space to feel safe and drive in a safer manner (Kanellaidis, 1995). It is stressed that older drivers are used to driving at low speeds in order to balance their decreasing driving abilities.

For other attributes, shoulder width being significant to all groups of drivers as they "Agree" in statement for the width to be too small. According to Paul H. Wright (2004), most vehicle operators drive closer to the edge of the pavement in the presence of adequate shoulders therefore, it is necessary to provide shoulders for the safe operation and to allow the development of full traffic capacity. Similar to speed limit design and lane width, older drivers ranked "Agree" for curve alignment. As for the length of U-turn storage lane, all drivers "Agree" that the storage lane being too short. Only middle age drivers "Agree" that the existing bridge have small spaces and the distance from the first traffic light intersection to the next traffic light intersection are short.

4.2.2 ROAD FURNITURE

This study was furthered to see if different groups of drivers present differences in perception of road furniture. It is of interest to observe how each attribute associated with road furniture element may be perceived by drivers.



	Guard rails	Marginal strips and edge line	Pedestrian crossing bridge	Street name and road number	Service information sign	Guide sign	Road median	Night reflectors/ Cat's eye	Distance between lamp posts	U-turn's street lights	Distance between U-turn	Red light duration
18 - 24	3.1	4.3	3.1	3.3	3.9	3.6	4.2	4.2	3.2	3.7	3.6	3.3
25 - 64	3.3	3.9	3.2	3.4	3.5	3.1	3.9	3.6	3.3	4	4.1	3.4
> 65	3.6	3.9	3.6	3.1	3.8	3.6	3.8	4.1	3.7	3.8	4.1	4.1

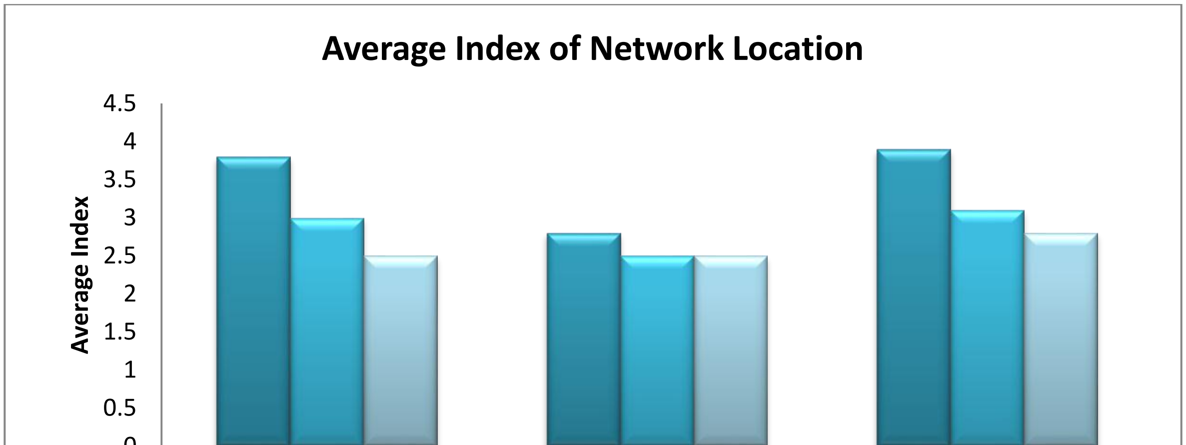
Figure 4.4: Average Index of Road Furniture

Based on **Figure 4.4**, only older drivers ranked “Agree” for guardrail while other groups ranked “Average’. Moreover, other attributes are in “Agree” by all drivers includes marginal strip and edge line, service information sign, road median, night reflectors or cat’s eye, street lights at U-turn and distance between U-turn. This shows that road markings and edge lines were invisible, no help signs for road or vehicles services, no median that could prevent vehicle crashes from the opposing lane and night reflector or cat’s eye studs were missing. Moreover, street lights are absent at U-turn interchange and the distance between two U-turns were too far.

Similar to guardrail, other attributes in “Agree” only to older drivers are pedestrian crossing bridge and distance between two lamp posts. They see eye to eye that there is no pedestrian crossing bridge at convergence areas and the distance between two lamp posts is inappropriate. While street lighting does provide safety benefit in some situation, from a lighting point of view there is sometimes a problem with the optimum location for a column (Martin Belcher at el, 2008). It is more frustrating if lamp posts are available but street lights are out of order. Besides that, road signage was “Average” in the level of agreement by middle age group. All groups ranked “Average” for availability of street name and road number.

4.2.3 NETWORK LOCATION

Next, the study identified whether the different groups of drivers present differences in perception of network location.



	Mobility	Accessibility	Coverging area interferences
18 - 24	3.8	2.8	3.9
25 - 64	3	2.5	3.1
> 65	2.5	2.5	2.8

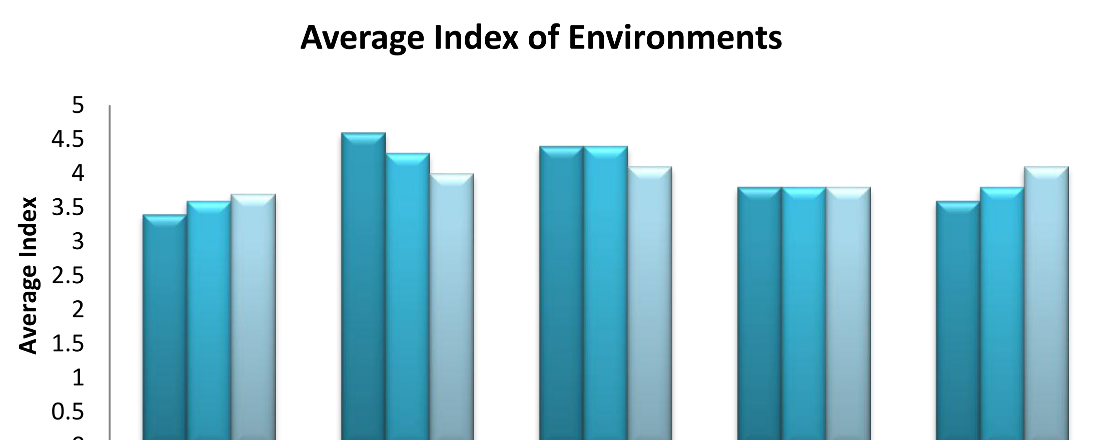
Figure 4.5: Average Index of Network Location

From the **Table 4.5**, it shows that mobility and interferences in converging area were in “Agree” category ranked by younger drivers. It shows that younger drivers think that the road is interfered by converging area such as residential, business and industrial area and by using the road, time travel increases. This is due to younger driver tends to drive fast thus upon facing convergence area they feel delayed while travelling. Although suburban and rural areas have fewer travel options but driving is faster and cheaper per mile (Litman, 2003).

Other groups viewed these two attributes as "Average". However, all groups are in agreement by rating "Average" for accessibility. Therefore, ability to reach desired destinations such as housing, commerce and industrial were neither difficult nor easy. According to Litman (2003) different land use patterns have different accessibility features, which affect mobility.

4.2.4 ENVIRONMENT

Lastly, to achieve the first objective of the study, analyzing is further to see whether the different groups of drivers present differences in perception of environments.



	Fixed object	Potholes	Ruts and Irregularities	Cleanliness	Busstop
18 - 24	3.4	4.6	4.4	3.8	3.6
25 - 64	3.6	4.3	4.4	3.8	3.8
> 65	3.7	4	4.1	3.8	4.1

Figure 4.6: Average Index of Environments

On the subject of road environment shown in **Figure 4.6**, only younger drivers viewed fixed objects as "Average" while other attributes were in "Agree" category by all groups. Younger drivers oversee fixed objects along the road being neither too far nor too close to the carriageway. From the result obtained for the other attributes, it shows that the road is poorly damaged with potholes, ruts and irregularities as well as do not have strategic bus stop locations or clean surroundings.

Generally speaking, the motoring public usually associated pavement failure with poor ride quality. (Fred L. Mannering et al, 2005). Furthermore, roadside should be thoroughly cleared of litter since removal of rubbish and debris is one of the vexing and expensive problems of roadside maintenance (AASHTO, 1999). Not only should bus stop locations be design from the perspective of rider convenience and safety, but they should also reflect the impacts of stopped transit vehicle on the capacity and safety of the road (Paul H. Wright and Karen Dixon, 2004).

4.2.4 SUMMARY

Finally, the most important attribute can be summarized from each element. From the analysis, rating frequencies for the highest ranked and the least ranked attributes for which described the performance of Jalan Kuantan – Gambang are derived from the respond of respondents.

Based on the **Table 4.1,** attribute that should have the most attention in the element of geometry design is shoulder width. It can be said that marginal strip and edge line is the most important attribute in road furniture element while for network location element is interference of converging areas. Moreover, the most significant attributes in environments are pothole, ruts and irregularities.

Overall, the most important attributes in traffic inventory performance is potholes, ruts and irregularities whilst the least is mobility at 4.30 and 3.10 mean rating. The respondents seem to be very sensitive to environment element. Nevertheless, these results suggest the need for improvement to avoid potential factor affecting road safety.

Table 4.1: Attributes' Average Index and Mean Rating

No	Attribute	Average Index			Mean Rating
		Younger (18-24)	Middle (25-64)	Old (>65)	
Geometry Design					
1	Speed limit design	2.5	3.0	3.3	2.93
2	Lane width	2.8	3.2	3.7	3.23
3	Emergency lane width	4.3	4.0	4.1	4.13
4	Curve alignment	3.9	3.3	4.1	3.77
5	U-turn storage lane	4.0	3.6	3.8	3.80
6	Viaducts/Bridge	3.4	3.6	3.4	3.47
7	Distance between intersections	3.7	3.6	3.1	3.47
Road Furniture					
8	Guardrails	3.1	3.3	3.6	3.33
9	Marginal strip and edge line	4.3	3.9	3.9	4.03
10	Pedestrian crossing bridge	3.1	3.2	3.6	3.30
11	Street name and road number	3.3	3.4	3.1	3.27
12	Help signs	3.9	3.5	3.8	3.73
13	Road signage	3.6	3.1	3.6	3.43
14	Road median	4.2	3.9	3.8	3.97
15	Night reflectors/ Cat's eye	4.2	3.6	4.1	3.97
16	Distance between lamp posts	3.2	3.3	3.7	3.40
17	U-turn's street lights	3.7	4.0	3.8	3.83
18	Distance between U-turn	3.6	4.1	4.1	3.93
19	Red light duration	3.3	3.4	4.1	3.60
Network Location					
20	Mobility	3.8	3.0	2.5	3.10
21	Accessibility	2.8	2.5	2.5	2.60
22	Converging area interferences	3.9	3.1	2.8	3.27
Environment					
23	Fixed objects	3.4	3.6	3.7	3.57
24	Potholes	4.6	4.3	4.0	4.30
25	Ruts and irregularities	4.4	4.4	4.1	4.30
26	Cleanliness	3.8	3.8	3.8	3.80
27	Bus stop	3.6	3.8	4.1	3.83

4.3 BASIC APPROACH FOR IMPROVING ROAD

Each management must have their strength and weakness. From the study, drivers' perception was defined and it has been found that several attributes need resolution upon their weakness. The basic approach for improving the current traffic inventory performance is shown in **Figure 4.7**. This analysis was conducted on the data gathered through questionnaire.

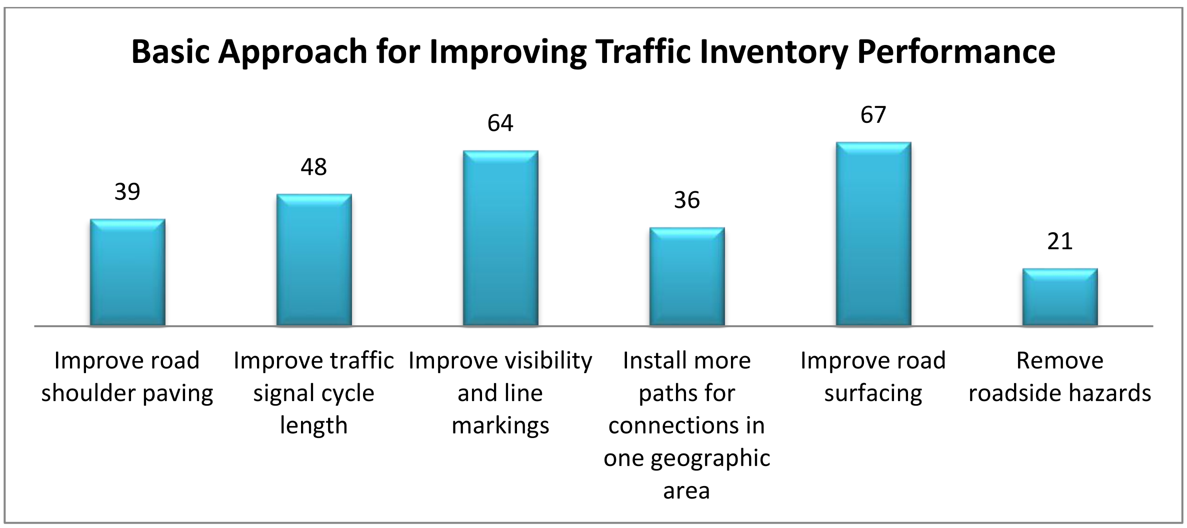


Figure 4.7: Basic Approach for Improving Traffic Inventory Performance

From the survey that has been conducted, it was found that there are two basic approach for improving the traffic inventory performance as listed below:

i. Improve visibility and line markings
ii. Improve road surfacing

From the data gathered using questionnaires, frequencies of highest and lowest ranked for basic approach for improving the traffic inventory performance are derived from the respondents' feedback. The highest ranked for basic approach is improve road surfacing whilst the lowest ranked is removed roadside hazards at frequency of 67 and 21.

CHAPTER V

CONCLUSION AND RECOMENDATION

5.1 CONCLUSION

From the analysis, it can be concluded that from the four elements, the respondents seemed to be very sensitive to environments. Potholes, ruts and irregularities seems to be the critical attributes that affect overall risk perception. Basically this study is important as the problem occurred can cause poor quality ride for the public. Another interesting finding of the analysis was the comparison between different groups of drivers regarding each attribute which gave a more detailed description of the nature of this influence. Some researchers stress that the role of age is very significant because younger drivers, due to lack of experience are more vulnerable (McKenna, 199). On the other hand, older drivers are more vulnerable in terms of their physiological characteristic. As the issue was raised, urgent professional judgment is needed on how to improve road surfacing generally to reduce time and cost for repairs. This concern should raise the need for authorities to review the effectiveness of pavement design guideline. Clearly the data analyzed in this article give insight to road user perception towards the following road elements; geometry design, road furniture, network location and environments.

5.2 PROBLEMS ENCOUNTERED

During this study, there are several problems encountered that could possibly affect the result obtain. The problems are:

i. Study location has different character for every few kilometers. Therefore, it is best to make sections for a single highway.
ii. Population of older age is small thus it is difficult to account for high number of sample.

5.3 RECOMMENDATIONS

For future research, there are more extensive studies could be carried out in order to understand more clearly types of data used for road management when considering the road infrastructure and its associated data. There are some suggestions for future study such as:

i. Other elements can also be used for data collection such as pavement structures and pavement conditions.
ii. Next, targets on the unfamiliar road users to perceived risk could be done using appropriate measures.
iii. Moreover, research on self-assessment should be done to perceive drivers behavior.

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APPENDIX A

SAMPLE OF QUESTIONNAIRE

PENEROKAAN SISTEM PENGURUSAN INVENTORI TRAFIK (SOAL SELIDIK)

Soal selidik ini digunakan untuk membuat kajian terhadap presepsi pengguna **Jalan Kuantan – Gambang** terhadap sistem pengurusan inventori yang akan membantu dalam menjangka keperluan jalan raya di sepanjang lalu lintas. Segala maklumat yang diberikan dalam soal selidik ini adalah sulit dan hanya digunakan untuk tujuan kajian semata-mata. Kerjasama anda didahului denga ucapan terima kasih.

BAHAGIAN A

Jantina : ☐ Lelaki ☐ Perempuan

Umur : ☐ 18 - 35 ☐ 36 - 65 ☐ > 65

*Jenis pengangkutan : ☐ Motosikal ☐ Kereta ☐ Bas ☐ Lori

Pengguna kerap Jalan Kuantan – Gambang: ☐ Yes ☐ No

**Anda boleh menanda lebih daripada satu.*

BAHAGIAN B

Berikut adalah beberapa kenyataan mengenai sistem pengurusan inventori trafik kami.
Sila tandakan (/) mengikut tahap persetujuan anda.
1 – Sangat tidak bersetuju, 2 – Sederhana tidak bersetuju, 3 – Neutral, 4 – Sederhana bersetuju, 5 – Sangat bersetuju

Elemen	No.	Item	1	2	3	4	5
Reka Bentuk Geometri	1	Reka bentuk had laju adalah terlalu tinggi					
	2	Kelebaran jalan adalah terlalu kecil					
	3	Kelebaran lorong kecemasan adalah terlalu kecil					
	4	Selekoh jalan terlalu tajam					
	5	Panjang susur U-turn terlalu pendek					
	6	Jejambat / Ruang jambatan jalan adalah terlalu sempit.					
	7	Jarak antara lampu isyarat pertama ke lampu isyarat seterusnya adalah terlalu pendek					
	8	Jangka masa isyarat merah terlalu lama					
	9	Tidak ada penghadang jalan di selekoh					
	10	Garis pembahagi jalan dan garis tepi jalan tidak kelihatan					
	11	Tidak ada jejantas untuk pejalan kaki di kawasan tertumpu.					
	12	Tidak ada tanda nama dan nombor jalan					

	13	Tidak ada tanda maklumat bantuan untuk perkhidmatan jalan atau kenderaan					
	14	Papan tanda jalan mengelirukan pengguna jalan raya					
	15	Tiada reflektor malam/cat's eye stud.					
	16	Tidak ada pembahagi jalan yang mencegah silau dari arah berlawanan					
	17	Jarak antara dua tiang lampu tidak bersesuaian					
	18	Tidak ada lampu jalan di persimpangan U-turn					
	19	Jarak antara dua U-turn terlalu jauh					
Lokasi Rangkaian	20	Peningkatan masa berlaku apabila menggunakan jalan tersebut.					
	21	Akses ke destinasi seperti perumahan, perniagaan dan perindustrian adalah sukar.					
	22	Jalan terganggu dengan pergerakkan dari kawasan tertumpu seperti kediaman, perniagaan dan kawasan perindustrian.					
Persekitaran	23	Objek tetap terlalu dekat dengan jalan raya di sepanjang jalan					
	24	Terdapat banyak lubang di sepanjang jalan					
	25	Permukaan jalan beraluran.					
	26	Jalan tidak mempunyai persekitaran yang bersih					
	27	Lokasi perhentian bas tidak strategik					

BAHAGIAN C

Sila tandakan (/) mengikut pendapat anda. Anda boleh menanda lebih daripada satu.

1. Apakah elemen yang perlu dipertingkatkan?
   - ☐ Reka bentuk geometri
   - ☐ Perabot jalan
   - ☐ Lokasi rangkaian
   - ☐ Persekitaran

2. Apa yang akan anda cadangkan untuk penambahbaikan jalan?
   - ☐ Menurap bahu jalan
   - ☐ Menambahbaik panjang kitaran isyarat lalu lintas
   - ☐ Menambahbaik penglihatan dan garisan jalan
   - ☐ Membina lebih banyak jalan sambungan dalam satu kawasan
   - ☐ Memperbaiki permukaan jalan
   - ☐ Menyingkirkan bahaya di tepian jalan

EXPLORATION ON TRAFFIC INVENTORY MANAGEMENT SYSTEM (QUESTIONNAIRE)

This questionnaire is used to carry out a case study of your perception towards the traffic inventory management system in Jalan Kuantan – Gambang which will help us to anticipate traffic needs along the road. All information provided in this questionnaire is confidential and used only for research purposes. Thank you in advance for your cooperation.

PART A

Gender : ☐ Male ☐ Female

Age : ☐ 18 - 35 ☐ 36 - 65 ☐ > 65

*Transport Mode : ☐ Motor ☐ Car ☐ Bus ☐ Lorry

Frequent user of Jalan Kuantan – Gambang: ☐ Yes ☐ No

**You may tick more than one.*

PART B

Here are some statements about our traffic inventory management system.
Please tick (/) according to your level of agreement.
1 – Disagree strongly, 2 – Disagree partially, 3 – Neutral, 4 – Agree partially, 5 – Agree strongly

Element	No.	Items	1	2	3	4	5
Geometry Design	1	The speed limit design for the road is too high.					
	2	The lane width is too small.					
	3	The emergency lane width is too small.					
	4	The alignment of road curve is too narrow.					
	5	The length of U-turn lane is too short.					
	6	Viaducts/Bridge spaces along the road are too small.					
	7	The distance from the first traffic light intersection to the next traffic light intersection is too short.					
	8	Duration of red light is too long					
Road Furniture	9	There are no guardrails at road curves.					
	10	Road markings of marginal strip and edge line are invisible					
	11	There is no pedestrian crossing bridge at convergence areas.					
	12	There are no sign of street names and indicator of road number.					

	13	There are no help signs for road or vehicle services.					
	14	Road signage to get to places is confusing.					
	15	There is no median preventing glares from the opposing lane.					
	16	Night reflectors/ Cat's eye studs are absent.					
	17	The distance between two lamp posts is inappropriate.					
	18	Street lights are absent at U turn interchange.					
	19	The distance between two U turn is too far.					
Network	20	Time travel increase when using the road.					
	21	Access to destinations such as housing, commerce and industry is difficult.					
	22	The road is interfered by converging area such as residential, business and industrial area.					
Environment	23	Fixed objects along the road are too close to the carriageway.					
	24	There are too many potholes.					
	25	There are too many ruts and irregularities.					
	26	The road does not have clean surroundings.					
	27	Bus stop locations are not strategic.					

PART C

Please tick (/) according to your opinion. You may tick more than one.

1. What element do you think is necessary to be improved?
   - ☐ Geometry design
   - ☐ Road furniture
   - ☐ Network location
   - ☐ Environments

2. Which would you suggest for road improvement?
   - ☐ Improve road shoulder paving
   - ☐ Improve traffic signal cycle length
   - ☐ Improve visibility and line markings
   - ☐ Install more paths for connections in one geographic area
   - ☐ Improve road surfacing
   - ☐ Remove roadside hazards